

The CBRT's Monetary Policy Transmission Mechanism: Evidence from Real Interest Rate Dynamics in Türkiye

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Abstract

This study examines the effectiveness of the monetary transmission mechanism in Türkiye by analyzing the short and long-run relationships between real interest rates and selected macroeconomic variables. Using quarterly data covering 1998Q1–2024Q4, the study estimates an ARDL error-correction model incorporating inflation, real effective exchange rate growth, industrial production growth, BIST100 performance, GDP growth, and M1 money supply growth. The Supremum Wald test identifies a structural break in 2009Q2, which is controlled for through a structural-break dummy. The bounds test provides strong evidence of a long-run cointegrating relationship among the variables. The negative and statistically significant adjustment coefficient (-0.1576) indicates that approximately 15.76% of the previous quarter's disequilibrium is corrected in each subsequent quarter. The long-run results show that inflation and industrial production growth have positive and statistically significant coefficients, whereas real effective exchange rate growth, GDP growth, and

M1 money supply growth have negative and statistically significant coefficients. The BIST100 coefficient is statistically insignificant. In the short run, inflation and industrial production growth have negative coefficients, while M1 money supply growth has a positive coefficient. Diagnostic tests provide no statistically significant evidence of heteroskedasticity or first-order serial correlation. After controlling for the 2009Q2 structural break, the CUSUM and CUSUMSQ results indicate parameter stability. The findings emphasize the importance of price stability, effective liquidity management, productive capacity, and predictable monetary policy communication in strengthening monetary transmission in Türkiye.

Keywords: Central Bank, Monetary Policy, Monetary Transmission Mechanism, Monetary Policy Efficiency, Türkiye, ARDL

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1. Introduction

The effectiveness of monetary policies in Türkiye is critical for ensuring economic stability and sustainable growth. Monetary policies are implemented to achieve price stability, control inflation, and stabilize

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financial markets (Mishkin, 1996). Especially in developing countries, the effects of central banks' policy decisions on the real economy are transmitted through the monetary transmission mechanism. This mechanism operates through channels such as interest rates, credit volume, asset prices, and exchange rates to transmit monetary policies to economic agents (Taylor, 1995). At the same time, the depth of financial markets and the communication strategies of the central bank are among the key elements that can strengthen the operation of this mechanism. Despite the growing literature on monetary policy in Türkiye, there remain significant gaps. Most studies focus on individual channels of the transmission mechanism or short-term effects, while few comprehensively analyze the interaction of multiple channels and structural changes over time. Furthermore, the post-global financial crisis period has introduced new dynamics that are not fully captured in existing empirical research. Addressing these gaps, this study contributes to the literature by providing a comprehensive empirical assessment of the monetary transmission mechanism in Türkiye, examining the dynamic effects of key macroeconomic variables on real interest rates and identifying structural breaks that reflect regime shifts in policy effectiveness.

Understanding the monetary transmission mechanism is particularly important in the context of Türkiye, a country whose macroeconomic environment differs markedly from many advanced and emerging economies. Türkiye exhibits a unique combination of features such as a high degree of exchange-rate pass-through, persistent inflationary pressures, a relatively shallow financial system, and frequent shifts in monetary policy orientation that shape how central bank actions are transmitted to the real economy.

Moreover, the Central Bank of the Republic of Türkiye (CBRT) operates under structural and institutional constraints that influence the effectiveness and predictability of its policy interventions. These characteristics make Türkiye an ideal case study for examining how monetary transmission channels function in economies marked by volatility, financial dollarization, and evolving policy frameworks. Focusing exclusively on Türkiye therefore allows this study to offer deeper analytical insights into the distinctive transmission dynamics of a highly open, vulnerable, and structurally diverse economy insights that may not emerge from broader cross-country analyses.

In this context, evaluating the effectiveness of the monetary transmission mechanism in Türkiye is essential to enhance monetary policy success and ensure economic stability. In particular, the efficiency of the interest rate channel, the effects on the real sector through the credit channel, and the role of the exchange rate channel on macroeconomic stability are decisive for the success of monetary policies. By integrating multiple channels and accounting for structural breaks, this study provides both theoretical and practical insights for policymakers, highlighting the advantages and limitations of the current system and offering evidence-based recommendations for improving monetary policy effectiveness in emerging economies like Türkiye.

This study makes several contributions to the existing literature on monetary transmission in Türkiye. First, it provides a comprehensive theoretical and empirical assessment of the effectiveness of the monetary transmission mechanism using recent data that capture the country's rapidly changing macroeconomic conditions. Second, unlike many previous studies that focus on isolated channels, this

research simultaneously evaluates multiple transmission channels interest rate, credit, exchange rate, and asset price channels allowing for a more integrated understanding of policy effects. Third, the study employs advanced econometric methods that account for structural breaks, regime shifts, and non-linear dynamics, which are particularly relevant for economies experiencing policy inconsistency and macro-financial volatility such as Türkiye. Finally, by linking empirical findings to policy implications, the study contributes to the broader debate on the credibility, effectiveness, and communication strategies of the Central Bank of the Republic of Türkiye (CBRT). Overall, this paper offers a more holistic and updated perspective on how monetary policy decisions permeate through the Turkish economy.

The remainder of this study is organized as follows. Section 2 presents the conceptual and theoretical framework, including the definition and importance of the monetary transmission mechanism, its main channels, and the factors influencing its efficiency in Türkiye. Section 3 reviews the relevant literature and identifies the existing research gaps. Section 4 outlines the methodology employed in the study, followed by Section 5, which details the econometric model and presents the empirical analysis. Finally, Section 6 concludes the study by summarizing the main findings, discussing their policy implications, and providing recommendations for enhancing the effectiveness of monetary policies in Türkiye.

2. Conceptual and theoretical framework

The monetary transmission mechanism is a critical tool for central banks to effectively implement their policy decisions on the real

economy. In Türkiye, the effectiveness of this mechanism is shaped through channels such as interest rates, credit supply, exchange rates and asset prices. However, structural difficulties, uncertainties in financial markets and external economic factors sometimes prevent the mechanism from operating at full capacity. Therefore, in order to improve the effectiveness of monetary policy in Türkiye, banking sector reforms, financial market deepening and increased predictability of monetary policies are required. In this section, the conceptual and theoretical background of the monetary transmission mechanism, which is highly influential on the impact of the Central Bank's monetary policy decisions on the real economy, will be discussed from a broad perspective.

The analysis of the monetary transmission mechanism in the context of the effectiveness of monetary policies has a large place in the economics literature. The monetary transmission mechanism is one of the main processes that explain the effects of monetary policies implemented by central banks on the real economy. This mechanism works through various channels such as interest rates, exchange rates, asset prices and the credit channel (Mishkin, 1996). In the case of Türkiye, practices such as the inflation targeting regime and independent central banking have been decisive factors in the functioning of the monetary transmission mechanism (Başçı & Kara, 2011). In this context, analyzing the components of the monetary transmission mechanism in a conceptual and theoretical framework is of great importance for understanding the effectiveness of economic policies.

2.1. Definition and importance of the monetary transmission mechanism

The monetary transmission mechanism refers to the processes through which the central bank directs economic activity by controlling the money supply and interest rates. (Bernanke & Blinder, 1992). This mechanism affects the economy through various transmission channels such as interest rates, credit channel, exchange rate and asset prices. Researchers such as Bernanke and Gertler (1995: 27) use a black box analogy to understand the monetary transmission mechanism. According to them, it is difficult to understand exactly how this process works

The effectiveness of monetary policy and the monetary transmission mechanism are very important issues. Central banks' efforts to ensure economic stability by using monetary policy instruments are usually

realized through the monetary transmission mechanism. The monetary transmission mechanism explains how the effects of the central bank's monetary policy decisions are propagated and transmitted to the real economy.

Figure 1 below illustrates how the monetary transmission mechanism works, depicting how central banks use instruments such as policy interest rates to influence the money supply and thus economic activity.

The simplified monetary transmission mechanism in Figure 1 above shows how monetary policy instruments (i.e. the policy rate) affect aggregate demand and inflation through channels such as interest rates in financial markets, asset prices, the exchange rate and expectations. In this process, changes in the central bank's interest rate affect banks' lending rates, the exchange

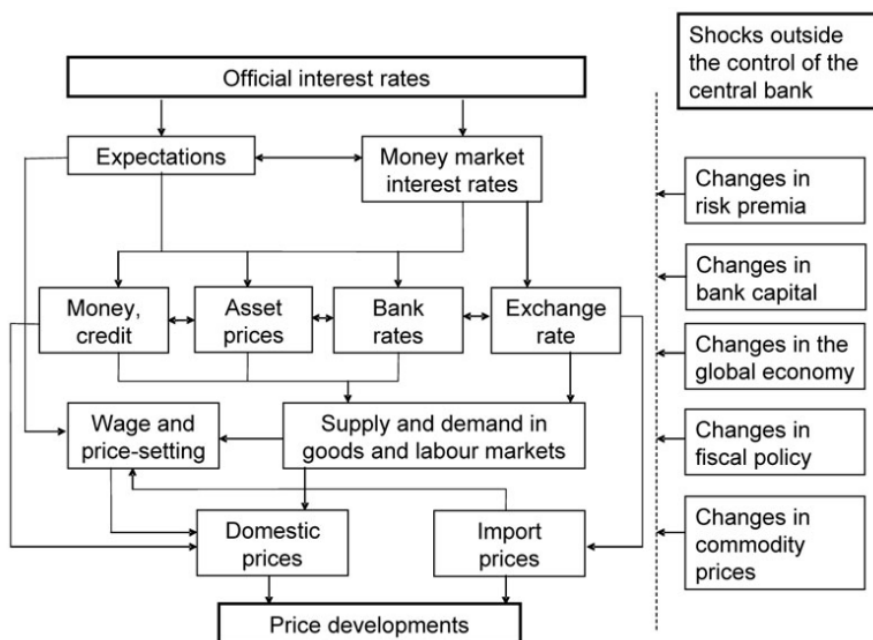


Figure 1. Simplified Monetary Transmission Mechanism

Source: European Central Bank 2025.

rate and asset prices, which in turn guide consumption and investment decisions and thus affect economic activity. For example, when the central bank lowers interest rates, banks' lending rates also fall, which encourages consumers and businesses to take out loans. Increased demand for credit boosts aggregate demand and supports economic growth. At the same time, a fall in interest rates can affect the exchange rate, increasing the competitiveness of exports and positively affecting external demand. This mechanism is critical for understanding the effectiveness of monetary policy and its impact on the economy. Understanding how central banks' monetary policy decisions are transmitted to the real economy through changes in financial markets and economic expectations and how they affect inflation and economic activity is essential to assess the success of monetary policy actions.

Economists have put forward different ideas on the monetary transmission mechanism from past to present. Classical economists argue that money supply has no effect on real economic variables in the long run. This view is supported by the "monetary neutrality" hypothesis (Lucas, 1972). In the classical model, the short-term effects of monetary policies are limited due to price and wage flexibility and markets quickly reach equilibrium (Barro, 1976). Monetarists, on the other hand, see the money supply as the most important component of the monetary transmission mechanism. Friedman and Schwartz (1963) emphasized that changes in the money supply can have substantial effects on real economic activity, particularly in the short run. Friedman (1968) argued that an unexpected monetary expansion may temporarily increase output and employment by initially lowering interest rates and stimulating aggregate

spending. In the long run, however, sustained monetary expansion cannot permanently keep real economic activity above its natural level; once expectations adjust, its effects are reflected mainly in higher inflation rather than in permanently higher real output. Keynesian theory emphasizes the impact of monetary policies on aggregate demand and focuses particularly on the relationship between interest rates and consumption and investment decisions (Keynes, 1936). The concept of liquidity trap suggests that monetary policies may become ineffective if interest rates fall to very low levels (Krugman et al, 1998). The New Keynesian approach explains the functioning of the monetary transmission mechanism by developing models based on price and wage rigidities and information asymmetry (Woodford, 2003). Due to nominal price and wage rigidities, it is emphasized that monetary policies can have an impact on real variables in the short and medium term (Gali, 2008). New Keynesian models analyze the effects of monetary transmission on the economy, especially within the framework of dynamic stochastic general equilibrium (DSGE) (Smets & Wouters, 2007).

2.2. Main channels of the monetary transmission mechanism

Credit channel theory argues that the banking system plays a critical role in the effects of monetary policy on the economy (Bernanke & Gertler, 1995). Due to banks' control over the supply of credit, a change in interest rates by the central bank can affect firms' and individuals' access to credit, which in turn can drive investment and spending (Kashyap & Stein, 2000).

The effectiveness of the monetary transmission mechanism largely depends on the channels through which it operates. These channels can be listed as follows:

- I. **Interest Rate Channel:** Changes in the policy rate by the central bank affect loan and deposit interest rates and thus direct consumption and investment expenditures (Taylor, 1995). In the post-2010 period in Türkiye, empirical evidence suggests that the effectiveness of the interest rate channel of monetary transmission has been limited, largely due to structural factors and weak pass-through to real economic activity (Baştav, 2020).
- II. **Credit Channel:** Loans provided to businesses and households through financial intermediaries shape the impact of monetary policies on economic activity. In Türkiye, the structural dynamics of the banking sector and changes in credit supply play an important role in the functioning of this channel (Kara, 2012).
- III. **Exchange Rate Channel:** The asset price channel analyzes the impact of the prices of financial assets such as stocks, bonds and real estate on consumer spending and investment decisions (Mishkin, 2001). The effects of monetary policy on financial markets can influence economic activity by shaping asset prices, investors' wealth and confidence. Evidence from Türkiye shows that contractionary monetary policy tends to reduce stock market returns and appreciate the domestic currency, thereby affecting wealth and risk sentiment among investors; in turn, these financial market responses can feed back into broader economic activity through the exchange rate and asset price channels (Kartal et al., 2024).
- IV. **Asset Price Channel:** The effectiveness of the monetary transmission mechanism largely depends on the channels through which it operates. Among these, the asset price channel conveys monetary policy effects to economic activity by influencing

stock market and other asset prices, thereby affecting consumer and investor wealth and confidence. Empirical studies on Türkiye indicate that the stock price channel's effectiveness has been limited in certain periods, partly due to relatively shallow capital markets and structural factors that weaken the pass-through from policy impulses to asset prices and real economic outcomes (Keskin & Akkaya, 2023; Alev, 2025).

2.3. Factors on the efficiency of the monetary transmission mechanism in Türkiye

The effectiveness of the monetary transmission mechanism in Türkiye is influenced by the structure of financial markets, exchange rate dynamics, financial dollarization, external financing constraints, and currency and maturity mismatches in bank and corporate balance sheets. Evidence from the post-2001 period indicates that the interest rate and credit channels have become increasingly visible in affecting economic activity, whereas the relative importance of the exchange rate channel has declined following the adoption of prudent fiscal policies, a floating exchange rate regime, and inflation targeting. Improvements in central bank communication and credibility have also strengthened the expectations channel (Başçı et al., 2008).

Finally, changes in Türkiye's financial structure and monetary policy framework have altered the operation of the monetary transmission mechanism. Before the reforms that followed the 2001 crisis, limited financial deepening, weaknesses in the banking and financial sectors, dollarization, and currency and maturity mismatches constrained conventional transmission and increased the importance of exchange-rate movements. During the subsequent transformation

which included banking- and public-sector restructuring, the transition to inflation targeting, and the introduction of a new central bank law traditional transmission channels became more operative, with the interest-rate and credit channels becoming increasingly visible in economic activity (Başçı et al., 2008). After the CBRT gained independence in 2001, it acted as a strong inflation targeter during the early part of the period. After 2009, however, its weaker response to inflation coincided with a loss of the nominal anchor visible in estimated policy rules and asset prices, although strong policy responses were still capable of stabilizing expectations and asset prices (Gürkaynak et al., 2015).

The functioning of the monetary transmission mechanism in Türkiye varies depending on various structural and cyclical factors. Some of these factors are as follows:

➤ **Depth of Financial Markets and Banking**

Structure: The banking sector plays an important role in the transmission of financial conditions to economic activity in Türkiye. Credit developments, banks' asset quality, funding conditions and the pricing of deposits and loans can influence the availability and cost of financing. In 2020, pandemic-related uncertainty affected the credit risk outlook, while changes in interest rates were rapidly reflected in average deposit pricing, creating pressures on bank profitability amid slowing loan growth (Central Bank of the Republic of Türkiye, 2020).

➤ **Monetary Policy Regime:** The credibility and communication framework of the monetary policy regime influence the expectations channel in Türkiye. Based on survey data for 2003–2007, Başkaya et al. (2008) find that economic agents considered the CBRT's inflation targets and official forecasts when forming their expectations. Expectations

were firmly anchored by the announced targets during 2002–2005; however, following the financial turbulence of 2006, they became more sensitive to past inflation, exchange rate movements and sovereign risk premiums. Kara and Ögünç (2008) find that the pass-through from imported inflation to domestic prices weakened and slowed following the transition to inflation targeting. They identify enhanced credibility and changing expectation formation as possible explanations, while acknowledging that the effects of simultaneous changes cannot be separated conclusively. Güler (2021) further shows that monetary policy credibility strengthens the anchoring role of inflation targets and identifies Türkiye as one of the relatively weaker credibility performers in the examined country group.

➤ **Macroeconomic Shocks and External**

Factors: In Türkiye, monetary policy transmission operates alongside exchange-rate movements and external macroeconomic conditions. Using VAR and SVAR models for the explicit inflation-targeting period, Can et al. (2020) find that policy interest rates affect domestic output, whereas the nominal exchange rate plays an important role in determining prices. Their results also show that external factors, represented by the federal funds rate and world commodity prices, have explanatory power for fluctuations in output but not for inflation. Complementing these findings, Yıldırım (2020) shows that adverse external financial shocks, together with exchange-rate, country-risk-premium, and political-risk shocks, can produce recessionary effects and higher inflation in Türkiye. These findings suggest that the effects of domestic monetary policy should be

evaluated together with exchange-rate dynamics and the economy's exposure to external financial conditions.

3. Literature review

Theoretical and empirical studies on the monetary transmission mechanism in Türkiye have analyzed the effects of monetary policies on the real economy and the channels through which this effect is realized. This literature review summarizes important studies that evaluate the efficiency and functioning of the monetary transmission mechanism in Türkiye. In this section, the theoretical and empirical studies analyzing the monetary transmission mechanism are presented in chronological order. Kadioğlu (2005) analyzed the functioning of the monetary transmission mechanism in the disinflation process by constructing a model based on rational expectations for the Turkish economy. The study shows that monetary policy affects prices through exchange rate and expectations. Çiçek (2005) analyzed the monetary transmission mechanism in Türkiye with a VAR model covering the period 1995-2003. Örnek (2009) analyzed the channels and efficiency of the monetary transmission mechanism in Türkiye using the VAR model. Özcan (2016) analyzed the monetary transmission mechanism channels in Türkiye using a VAR model covering the period 1990-2008. The study shows that the traditional interest rate channel is effective, but the exchange rate channel is not effective on real activity, affecting only the general level of prices. Bayramoğlu and Allen (2017) analyze the efficiency of interest rate, exchange rate and credit channels for Türkiye using data for the period 2003:Q2-2015:Q3. They analyzed short-run relationships with the VAR model and long-run relationships with ARDL Bounds Test. The results show that inflation is affected by

exchange rate, interest rate and GDP growth in the short run and by exchange rate, interest rate and credit expansion in the long run. The exchange rate has the biggest impact on inflation. Serel and Güvenoğlu (yazar sırası değişti) (2020) analyzed the monetary transmission mechanism in Türkiye within a theoretical framework and evaluated the effectiveness of different channels. The study draws attention to the importance of the exchange rate and expectations channel in the Turkish economy. In this study by Berber and Bayraktar Daştan (2020), the functioning and efficiency of the monetary transmission mechanism are analyzed with the Central Bank of the Republic of Türkiye (CBRT) and the European Central Bank (ECB). The study emphasizes that understanding the complex structure of the monetary transmission mechanism is important for central banks to implement an effective monetary policy and determine the appropriate set of instruments. Cevik and Erduman (2020) assessed monetary policy uncertainty (MPU) using both news-based and survey-based measures, demonstrating through VAR analyses that MPU shocks have adverse effects on economic activity. Similarly, Samour, Isiksal, and Resatoğlu (2020) investigated the transmission effects of external sovereign debt and U.S. interest rates on Türkiye's equity market using an ARDL model, showing that these channels significantly influence equity returns. These studies are important as they highlight the international spillover effects of monetary policy and the role of uncertainty. Nevertheless, the existing literature rarely provides comprehensive empirical analyses that consider multiple monetary policy channels such as interest rates, exchange rates, production, and other macroeconomic variables simultaneously while accounting for structural breaks. In this context, the present study

aims to fill this gap by examining the dynamic effects of key macroeconomic variables on real interest rates using an ARDL model, while employing the Supremum Wald test to identify potential structural breaks. In doing so, it offers a more holistic and up-to-date understanding of monetary policy effectiveness in Türkiye. Günbegi and Karahan (2021) analyze the effectiveness of the monetary transmission mechanism on the bank lending channel in Türkiye using the VAR model. As a result of the analysis with quarterly data for 2005-2019, it is found that bank loans are sensitive to money supply, while investments respond to bank loans. Accordingly, it is concluded that the bank credit channel has been functioning efficiently in Türkiye during this period. Keskin and Akkaya (2023) analyze the functioning and efficiency of the interest rate, credit, exchange rate and asset price channels for the period 2007:10- 2022:06 using the Diebold-Yılmaz (2012) Spillover Analysis method. The results show that the credit channel has a larger effect on output, while the exchange rate channel has a larger effect on inflation. Keskin and Akkaya (2023) analyzed the efficiency of interest rate, credit, exchange rate and asset price channels in Türkiye for the period 2007:10-2022:06 using Diebold-Yılmaz (2012) Spillover Analysis. Their findings reveal that the credit channel is more effective on output, while the exchange rate channel is more effective on inflation. In another study by Alkaç Özdemir (2023), a scientific mapping of the credit channel, one of the channels of the monetary transmission mechanism, was conducted. In this study, the most influential authors, institutions, annual number of publications and number of citations related to the credit channel are presented with visual maps using the bibliometric analysis method. This analysis constitutes an important source for future research on the effectiveness

of the credit channel. Özdemir (2024) analyzes the efficiency of the bank credit channel in the Turkish economy for the period 2011-2023. In this study, vector autoregressive (VAR) models and Hatemi J (2012) asymmetric causality analysis methods are used. The results show that the bank credit channel plays an important role in the transmission of monetary policy shocks to real variables.

3.1. Literature gap

Although a substantial number of theoretical and empirical studies have examined the monetary transmission mechanism in Türkiye, several research gaps remain. Earlier studies predominantly focused on individual channels, such as the interest rate, credit, or exchange rate channels (Kadioğlu, 2005; Çiçek, 2005; Örnek, 2009). Subsequent research employed VAR and ARDL models to evaluate the short- and long-term effectiveness of various channels, highlighting the importance of interest rates, exchange rates, and credit in influencing inflation, output, and other macroeconomic indicators (Özcan, 2016; Bayramoğlu & Allen, 2017; Kaçar, 2019; Serel & Güvenoğlu, 2020; Berber & Bayraktar Daştan, 2020). More recent studies also emphasize the impact of monetary policy uncertainty and international spillovers, such as external sovereign debt and U.S. interest rates, on domestic markets (Cevik & Erduman, 2020; Samour, Isiksal, & Resatoğlu, 2020). Additionally, bibliometric and spillover analyses have further explored the credit channel and other transmission mechanisms, identifying key contributors and measuring cross-channel interactions (Günbegi & Karahan, 2021; Keskin & Akkaya, 2023; Alkaç Özdemir, 2023; Özdemir, 2024). Despite this extensive literature, there is a scarcity of studies that simultaneously analyze multiple monetary transmission channels while

accounting for structural breaks and regime shifts, particularly over long time periods encompassing pre- and post-crisis dynamics. Most existing studies either focus on a single channel, a limited set of macroeconomic variables, or short-term effects, leaving an important gap in understanding the comprehensive and dynamic functioning of the monetary transmission mechanism in Türkiye. In response to these gaps, the present study aims to provide a holistic assessment by examining the dynamic effects of key macroeconomic variables such as inflation, exchange rate volatility, industrial production, and economic growth on real interest rates using the ARDL model, while also employing the Supremum Wald test to detect potential structural breaks. By doing so, this study contributes to the literature by offering a more integrated and up-to-date understanding of monetary policy effectiveness in Türkiye, particularly in the context of evolving macroeconomic conditions and structural changes.

4. Methodology

In this study, the ARDL (Autoregressive Distributed Lag) model is used to analyze the effectiveness of monetary policy in the Turkish economy in quarterly periods between 1998 and 2024. Various statistical tests are applied to ensure the validity of the model. In this section, the applied tests and econometric methods are explained in detail, respectively.

4.1. Unit root tests

Unit root tests are one of the basic methods used to determine whether a time series is stationary. The Augmented Dickey-Fuller (ADF) test, developed by Dickey and Fuller (1981), is performed by adding extended lagged differences. The test hypotheses are as follows:

H₀: The series has a unit root (non-stationary).

H₁: There is no unit root in the series (stationary).

In the ADF test, the following regression model is shown in equation 1.1 below:

$$\Delta Y_t = \alpha + \beta_t + \gamma Y_{t-1} + \sum \delta_i \Delta Y_{t-1} + \varepsilon_t \quad (1.1)$$

Here, whether the coefficient is significant or not provides information about stationarity. If it is statistically significant, it is concluded that the series is stationary (Dickey & Fuller, 1981).

4.2. HEGY (Hylleberg-Engle-Granger-Yoo) Seasonal unit root test

The HEGY test is used to analyze stationarity in time series with seasonal components. This test, developed by Hylleberg, Engle, Granger and Yoo (1990), determines whether there is a seasonal unit root in four-quarter data. Test hypotheses:

H₀: There is a seasonal unit root.

H₁: There is no seasonal unit root.

The advantage of this test is that it can separately examine seasonal unit roots at specific frequencies (Hylleberg et al., 1990).

4.3. Structural break test: supremum wald test

Considering that structural breaks can have significant effects on the time series, the Supremum Wald test is applied. This test was proposed by Bai and Perron (1998) and tests for the presence of structural changes at certain points in the series. The model is shown in equation 1.2 below:

$$\Delta Y_t = X_t + \beta_j + \varepsilon_t, t = T_{j-1} + 1, \dots, T_j \quad (1.2)$$

4.4. ARDL model

The ARDL model developed by Pesaran, Shin and Smith (2001) is used to analyze the

long-run relationship between the series. The model is shown in equation 1.3 below:

$$Y_t = a + i = 1p\phi_i Y_{t-1} + j = 0p\phi_j X_{t-J} + \varepsilon_t \quad (1.3)$$

4.5. Bound test and cointegration analysis

The linking test is a method used to examine the cointegration relationship of the ARDL model.

The hypotheses of this test proposed by Pesaran et al. (2001) are as follows:

H₀: There is no long-run relationship.

H₁: There is a long-run relationship.

The result of the test using the F statistic is compared with the critical values to assess whether there is cointegration (Pesaran et al., 2001).

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Considering that structural breaks can have significant effects on the time series, the Supremum Wald test is applied. This test was proposed by Bai and Perron (1998) and tests for the presence of structural changes at certain points in the series. The model is shown in equation 1.2 below:

$$\Delta Y_t = X_t + \beta_j + \varepsilon_t, t = T_{j-1} + 1, \dots, T_j \quad (1.2)$$

4.7. ARDL model

The ARDL model developed by Pesaran, Shin and Smith (2001) is used to analyze the long-run relationship between the series. The model is shown in equation 1.3 below:

$$Y_t = a + i = 1p\phi_i Y_{t-1} + j = 0p\phi_j X_{t-J} + \varepsilon_t \quad (1.3)$$

4.8. Bound test and cointegration analysis

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The hypotheses of this test proposed by Pesaran et al. (2001) are as follows:

H₀: There is no long-run relationship.

H₁: There is a long-run relationship.

The result of the test using the F statistic is compared with the critical values to assess whether there is cointegration (Pesaran et al., 2001).

4.9. Heteroskedasticity test

Breusch-Pagan and White tests are applied to determine whether there is a problem of changing variance in time series. The test developed by Breusch and Pagan (1979) is based on the following hypotheses:

H₀: There is constant variance (homoskedasticity).

H₁: There is variance (heteroskedasticity).

By examining the relationship between the squares of the regression error terms and the explanatory **variables**, it is determined whether there is heteroskedasticity.

4.10. Autocorrelation test

Breusch-Godfrey Autocorrelation test is used to determine whether there is an autocorrelation problem in time series. The test hypotheses are as follows:

H₀: No autocorrelation.

H₁: There is autocorrelation.

The advantage of this test is that it can also detect higher order autocorrelation (Breusch, 1978; Godfrey, 1978).

4.11. Structural Break and Model Stability Test: CUSUM Test

The CUSUM test was applied to assess the stability of the model. This test, developed by Brown, Durbin and Evans (1975), tests whether the regression coefficients change over time. If the coefficients change over time, it is concluded that the model is unstable.

5. Econometric model and analysis

This study aims to analyze the dynamic relationships of selected macroeconomic variables of the Turkish economy in quarterly periods from the beginning of 1998 until the end of 2024. As an econometric model, the ARDL (Autoregressive Distributed Lag) model is used since the dependent variable is of I(1) order of integration. In order for the ARDL model to provide reliable results, all series in the model must be stationary. Accordingly, ADF (Augmented Dickey-Fuller) unit root tests are applied to prove that the statistical properties of the series do not change over time nor the results.

5.1. Data set and model

The data set used in the study includes macroeconomic variables of the Turkish economy obtained quarterly for the period 1998-2024. These variables reflect the economic dynamics of the country in a multidimensional way.

Table 1 includes the name, measurement method and comprehensive explanations of the variables.

Table 1 presents the dependent and independent variables in the model and their explanations.

Table 1. Variables and Explanations Used in the Study

Variables Name	Variable	Measurement Method / Conversion	Sources of Variables	Description
Lnfa	Dependent Variable	Natural logarithm (logarithmic transformation)	Central Bank of the Republic of Türkiye, Electronic Data Delivery System (CBRT-EVDS).	Logarithm of the seasonally adjusted real interest rate. This transformation was applied to stabilize the variance in the data and facilitate the interpretation of the relationship between the variables.
En	Independent Variable	Inflation	OECD Data Portal	Calculating the inflation rate as the growth rate reveals the effects of price stability on economic growth.
Dov	Independent Variable	Exchange Rate	Central Bank of the Republic of Türkiye, Electronic Data Delivery System (CBRT-EVDS).	Growth rate of real effective exchange rates. It is used to analyze the effects of exchange rate fluctuations on exports, imports and external financing.
Sa	Independent Variable	Industry Index	TÜİK	Growth rate of the industrial product index. It measures the impact of changes in industrial production on the production capacity and performance of the national economy.
Bi	Independent Variable	Bist100 Index	Borsa İstanbul	Growth rate of the BIST100 index. It is an important indicator reflecting investor confidence and overall market performance in financial markets.
GDP	Independent Variable	Growth Rate	TÜİK	The growth rate of Gross Domestic Product (GDP) in current dollars. It reveals the overall growth dynamics and macroeconomic performance of the country's economy.
M1	Independent Variable	Money Supply	EDVS	M1 money supply, which is the sum of money in circulation and demand deposits held by persons other than domestic banks.

Source: Compiled by the author

According to this

Lnfa (Logarithmic real interest rate):

Interest rates are one of the most important determinants of the economy. Taking the natural logarithm of the seasonally adjusted real interest rate stabilizes the variance in the data and allows for a more accurate interpretation of the relationship between variables.

En (Inflation):

The growth rate of the inflation rate is calculated in order to reveal the effects of price increases on economic growth. In this way, the effects of inflation on the economy can be analyzed in a more dynamic and comparable way.

Dov (Real effective exchange rate):

In open economies like Türkiye, the effects of exchange rate fluctuations on economic balance are of critical importance. The real effective exchange rate growth rate serves to analyze the effects of changes in exchange rates on exports, imports and other foreign trade transactions.

Sa (Industrial product index):

The industrial sector is one of the main dynamics of economic production and growth. The growth rate of the industrial product index measures the reflection of sector performance and changes in production capacity on economic growth.

Bi (BIST100 Index):

The general condition of financial markets can be monitored through the growth rate of the BIST100 index. This indicator is an important reference point for assessing investor confidence and market dynamics.

GDP growth rate:

GDP, which is used to measure the overall economic performance of the economy, is considered in the model with the growth rate calculated in current dollar terms. This variable plays a key role in assessing the sustainability of economic growth and the overall level of welfare.

M1 (Money supply growth rate):

M1 money supply, which is the sum of cash and short-term deposits in the economy, is a critical indicator in liquidity and monetary policy analysis. Changes in money supply also reflect the effects of central bank policies.

The econometric model of the study is shown in equation 1.4:

$$\begin{aligned} \text{Lnfa}_t = & a + \beta_1 \text{Lnfa}_{t-1} + \beta_2 \text{Lnfa}_{t-2} + \gamma_0 \text{En}_t + \gamma_1 \\ & \text{En}_{t-1} + \delta_0 \text{Dov}_t + \delta_1 \text{Sa}_t + \delta_2 \text{Sa}_{t-1} + \delta_3 \text{Sa}_{t-2} \\ & + \lambda_0 \text{Bi}_t + \phi_0 \text{GDP}_t + \psi_0 \text{M1}_t + \psi_1 \text{M1}_{t-1} \\ & + \kappa \text{Break}_{2009\text{Q2},t} + \epsilon_t \end{aligned} \quad (1.4)$$

In the model:

a: Constant term,

β_1, β_2 : Coefficients of lagged values of Lnfa,

γ_0, γ_1 : Lagged coefficients of En variable,

δ_0 : Coefficient of the Dov variable (no lag),

$\theta_0, \theta_1, \theta_2$: Coefficients of the variable sa,

λ_0 : Coefficient of variable Bi (no lag)

ϕ_0 : Coefficient of GDP variable (no lag)

ψ_0, ψ_1 : Lagged coefficients of M1 variable,

$\kappa \text{Break}_{2009\text{Q2},t}$: Structural-break dummy representing the regime change identified in 2009Q2.

ϵ_t : Represents the error term.

The econometric model includes different lag lengths of the dependent and independent variables in accordance with the ARDL (2,1,0,2,0,0,1) specification.

5.2. ADF unit root test application

In econometric analysis, it is a fundamental requirement to determine whether the series are stationary or not. Stationarity implies that the basic statistical properties of the series such as mean, variance and covariance remain constant over time. Since analyses with non-stationary series may lead to spurious regression results, it is necessary to test whether all variables are stationary.

For this purpose, the ADF (Augmented Dickey-Fuller) unit root test is applied by checking the presence of constant and trend terms and taking them into account in the analysis. The main hypothesis of the test, H_0 (random walk hypothesis), suggests that there is a unit root in the series, while H_1 states that the series is stationary. The results indicate that the variables are stationary either at level or after first differencing. The hypotheses of the test are as follows:

H_0 : The series are non-stationary.

H_1 : The series are stationary.

The summary results of the ADF unit root tests applied in the model are presented in Table 2:

As reported in Table 2, the ADF statistic for the first difference of the logarithmic real interest rate, $D.Infa$, is -6.424 , which is more negative than the corresponding 1% and 5% critical values. Its p-value is below 0.001; therefore, the null hypothesis of a unit root is rejected for $D.Infa$. This finding indicates that the first difference of $Infa$ is stationary. Provided that $Infa$ is non-stationary at level, it can consequently be classified as an $I(1)$ variable.

The ADF statistics for inflation (en), BIST100 growth (bi), GDP growth, industrial production growth (sa), real effective exchange rate growth (dov), and M1 money supply growth are also more negative than

their respective critical values. The null hypothesis of a unit root is therefore rejected for each of these variables. Accordingly, en , bi , GDP, sa , dov , and M1 are stationary at level and can be classified as $I(0)$. Overall, the results indicate that the variables are integrated of either order zero or order one, with no evidence of any $I(2)$ variable, thereby satisfying the integration-order requirement of the ARDL bounds-testing approach.

These results reveal that the stationarity assumption required for the application of the ARDL model is met and increase the reliability of the modeling results. Thus, a solid methodological basis has been established for the analysis and the examination of long-run relationships.

HEGY test is used in the model to analyze seasonal effects. The joint statistics of the HEGY test allows the effects of all seasonal frequencies in the series to be evaluated together. The hypotheses of the HEGY seasonal unit root test are as follows:

H_0 : The series contains a seasonal unit root.

H_1 : The series does not contain a seasonal unit root.

Table 3 presents the results of the HEGY Seasonal Unit Root Test.

As reported in Table 3, the joint seasonal-frequency statistics for all variables exceed the corresponding critical values at the 1%, 5%, and 10% significance levels. Therefore, the null hypothesis of a seasonal unit root is rejected for $Infa$, en , GDP, sa , dov , bi , and $m1$. The results provide evidence that the series do not contain stochastic unit roots at the tested seasonal frequencies.

However, the rejection of seasonal unit roots does not imply that all variables are stationary at the zero frequency or that they are completely free from deterministic

Table 2. ADF Unit Root Test Results

Variable	Lag	Test Statistic	1% Critical Value	5% Critical Value	p-value
D.Infa	0	-6.424	-4.038	-3.449	0.0000
En	0	-4.551	-4.038	-3.449	0.0012
Bi	0	-10.411	-4.038	-3.449	0.0000
GDP	0	-5.775	-3.508	-2.890	0.0000
Sa	0	-13.515	-3.508	-2.890	0.0000
Dov	0	-13.245	-3.508	-2.890	0.0000
M1	0	-11.177	-3.508	-2.890	0.0000

Source: Author's own calculations.

Table 3. Results of the HEGY Seasonal Unit Root Test

Variables	Joint Seasonal-Frequency Statistic	1% Critical Value	5% Critical Value	10% Critical Value	Decision
Lnfa	43.768	4.730	3.000	2.360	Reject H_0
En	33.056	4.730	3.000	2.360	Reject H_0
GDP	28.023	4.730	3.000	2.360	Reject H_0
Sa	32.649	4.730	3.000	2.360	Reject H_0
Dov	32.758	4.730	3.000	2.360	Reject H_0
Bi	28.345	4.730	3.000	2.360	Reject H_0
M1	27.213	4.730	3.000	2.360	Reject H_0

Note: H_0 states that the series contains a unit root at the jointly tested seasonal frequencies.

Source: Author's own calculations.

seasonal variation. In particular, Infa may still contain a non-seasonal unit root, as evaluated by the ADF test. Accordingly, seasonal dummy variables are retained in the ARDL model to control for possible deterministic quarterly effects. Thus, the HEGY findings support the absence of stochastic seasonal non-stationarity, while the quarterly dummy variables account for any remaining deterministic seasonal patterns.

5.3. Structural break analysis

When analyzing economic time series, it is essential to account for potential structural breaks. Economic crises, policy regime changes, and other major shocks may alter

model parameters and lead to biased or misleading estimates if such changes are ignored. Therefore, the Supremum Wald test is employed to examine the stability of the model parameters and identify a potential structural break over the sample period. Table 4 presents the results of the test. The hypotheses of the Supremum Wald test are specified as follows:

H_0 : The model parameters are stable; there is no structural break.

H_1 : The model parameters are not stable; there is at least one structural break.

As reported in Table 4, the Supremum Wald statistic is 192.3985, with a p-value below 0.001. Therefore, the null hypothesis

Table 4. Supremum Wald Structural Break Test Results

Test	Test Statistic	p-value
Supremum Wald	192.3985	0.0000

Source: Author's own calculations.

Table 5. Lag Length Selection Criteria

Lag	LL	df	p-value	FPE	AIC	HQIC	SBIC
0	291.912	–	–	1.7×10^{-11}	-4.9406	-4.5801	-4.0507
1	499.695	49	0.000	8.0×10^{-13}	-7.9941	-7.1288*	-5.8583*
2	555.787	49	0.000	7.1×10^{-13} *	-8.1305*	-6.7605	-4.7488
3	597.784	49	0.001	8.6×10^{-13}	-7.9959	-6.1210	-3.3682
4	624.040	49	0.340	1.4×10^{-12}	-7.5585	-5.1789	-1.6849

Note: An asterisk indicates the lag order selected by the corresponding information criterion. Based on the AIC, the maximum lag length is set to 2.

Source: Author's own calculations.

of parameter stability is rejected, providing statistically significant evidence of a structural break in the estimated model. The break date is identified as 2009Q2. This timing may be associated with changes in Türkiye's macroeconomic and monetary policy environment following the global financial crisis. Accordingly, a structural-break dummy corresponding to 2009Q2 is included in the ARDL model to control for the potential effect of this regime change on the estimated parameters.

5.4. ARDL model estimation and diagnostic tests

Before estimating the ARDL model, an appropriate maximum lag length must be determined. To this end, several lag-order selection criteria are considered, including the final prediction error (FPE), Akaike information criterion (AIC), Hannan–Quinn information criterion (HQIC), and Schwarz Bayesian information criterion (SBIC). Table 5 reports the lag-order selection results.

Table 5 presents the lag-order selection criteria used to determine the maximum lag length for the subsequent ARDL specification search. The likelihood-ratio comparisons are statistically significant for lag 1 ($p < 0.001$), lag 2 ($p < 0.001$), and lag 3 ($p = 0.001$), but not for lag 4 ($p = 0.340$). Regarding the information criteria, the AIC and FPE attain their minimum values at lag 2, whereas the HQIC and SBIC attain their minimum values at lag 1. Since the AIC is adopted as the primary model-selection criterion and its selection is also supported by the FPE, a maximum lag length of 2 is used in the subsequent ARDL analysis. The final variable-specific lag structure is then determined by minimizing the AIC across the admissible ARDL specifications.

5.5. Estimation of the ARDL model

Following the maximum-lag selection and the variable-specific AIC search, the ARDL(2,1,0,2,0,0,1) specification was selected for Infa, en, dov, sa, bi, GDP, and m1, respectively. The model has an R^2 of 0.6269, indicating that approximately 62.69%

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of the variation in the dependent variable is explained by the included regressors. The adjusted R^2 is 0.5598 after accounting for the number of estimated parameters. The root mean squared error is 0.0848, representing the typical magnitude of the model residuals in the units of the dependent variable.

The estimation results of the selected ARDL(2,1,0,2,0,0,1) error-correction specification, including the adjustment coefficient and the long- and short-run dynamics, are reported in Table 6.

Table 6 presents the adjustment coefficient and the long- and short-run estimates of the ARDL error-correction model. The adjustment coefficient is negative and statistically significant (-0.1576 , $p < 0.001$), indicating convergence toward the long-run equilibrium. Its magnitude suggests that approximately 15.76% of the disequilibrium from the previous quarter is corrected in each subsequent quarter.

The long-run results show that inflation has a positive and statistically significant coefficient (14.2451, $p < 0.001$). Industrial

Table 6. ARDL (2,1,0,2,0,0,1) Model Results

Section	Variable	Coefficient	Std. Error	t-value	p-value	[95% Confidence Interval]
ADJ (Error Correction)	L1. Infa	-0.1576	0.0239	-6.58	0.000	[-0.2051, -0.1100]
LR (Long Run)	en	14.2451	3.1087	4.58	0.000	[8.0682, 20.4219]
	dov	-2.0189	0.8736	-2.31	0.023	[-3.7547, -0.2831]
	sa	0.1083	0.0316	3.43	0.001	[0.0455, 0.1712]
	bJ	0.1762	0.2529	0.70	0.488	[-0.3263, 0.6788]
	GDP	-5.3367	2.1553	-2.48	0.015	[-9.6193, -1.0542]
	m1	-2.9149	1.0857	-2.68	0.009	[-5.0722, -0.7576]
SR (Short Term)	1. LD. Infa	0.3081	0.0751	4.11	0.000	[0.1590, 0.4573]
	D1. en	-1.0812	0.2592	-4.17	0.000	[-1.5962, -0.5662]
	D1. sa	-0.0117	0.0029	-4.10	0.000	[-0.0174, -0.0060]
	2. LD. sa	-0.0045	0.0018	-2.54	0.013	[-0.0081, -0.0010]
	D1. m1	0.2426	0.0953	2.55	0.013	[0.0532, 0.4320]
	breaks_dumm	-0.1709	0.0300	-5.69	0.000	[-0.2305, -0.1112]
	q1	-0.0518	0.0252	-2.05	0.043	[-0.1019, -0.0017]
	q2	-0.0077	0.0251	-0.31	0.759	[-0.0576, 0.0421]
	q3	0.0125	0.0244	0.51	0.611	[-0.0360, 0.0609]
	_cons	0.5373	0.0865	6.21	0.000	[0.3654, 0.7091]

Note: The lag-order sequence in ARDL (2,1,0,2,0,0,1) corresponds to Infa, en, dov, sa, bi, GDP, and m1, respectively. The full dataset covers 1998Q1–2024Q4, while the effective estimation sample comprises 106 quarterly observations covering 1998Q3–2024Q4. $R^2 = 0.6269$, adjusted $R^2 = 0.5598$, log likelihood = 120.3514, and root MSE = 0.0848. Values reported as 0.000 by the statistical software are presented as $p < 0.001$.

Source: Author's own calculations.

production growth also has a positive and statistically significant coefficient (0.1083, $p = 0.001$). In contrast, real effective exchange rate growth (-2.0189 , $p = 0.023$), GDP growth (-5.3367 , $p = 0.015$), and M1 money supply growth (-2.9149 , $p = 0.009$) have negative and statistically significant coefficients. Although the coefficient of the BIST100 index is positive, it is not statistically significant (0.1762, $p = 0.488$). Thus, no statistically significant long-run relationship between the BIST100 index and the real interest rate is identified.

Regarding the short-run dynamics, the lagged change in the dependent variable is positive and statistically significant (0.3081, $p < 0.001$). The contemporaneous changes in inflation (-1.0812 , $p < 0.001$) and industrial production (-0.0117 , $p < 0.001$), together with the lagged change in industrial production (-0.0045 , $p = 0.013$), have negative and statistically significant short-run coefficients. By contrast, the change in M1 money supply has a positive and statistically significant coefficient (0.2426, $p = 0.013$).

The structural-break dummy is negative and statistically significant (-0.1709 , $p < 0.001$), indicating a downward shift in the dependent variable associated with the identified break. Among the quarterly dummy variables, only the first-quarter effect is negative and statistically significant (-0.0518 , $p = 0.043$). The second- and third-quarter effects are statistically insignificant ($p = 0.759$ and $p = 0.611$, respectively). Overall, the findings reveal notable differences between

the short-run adjustments and the long-run relationships underlying real interest-rate dynamics in Türkiye.

5.1. Diagnostic tests and validity analysis of the model

Econometric models should be subjected to various diagnostic tests in order to provide reliable results. In this study, stationarity, heteroskedasticity, autocorrelation and structural break tests are applied to assess the validity of the ARDL model.

5.1.1. Cointegration analysis with bounds test

The ARDL bounds test developed by Pesaran, Shin, and Smith (2001) is employed to examine whether a long-run level relationship exists among the variables. Table 7 presents the results of the bounds test. The hypotheses are specified as follows:

H_0 : There is no long-run level relationship among the variables.

H_1 : There is a long-run level relationship among the variables.

As reported in Table 7, the F-statistic (12.189) exceeds the $I(1)$ upper-bound critical values at the 10%, 5%, and 1% significance levels. Similarly, the t-statistic (-6.582) is more negative than the corresponding $I(1)$ critical values at all conventional significance levels. Furthermore, both p-values are below 0.001. Therefore, the null hypothesis of no long-run level relationship is rejected. The results provide strong evidence of a long-run

Table 7. Pesaran, Shin and Smith (2001) Bounds Test Results for Cointegration

Test statistic	Value	10% $I(0)$	10% $I(1)$	5% $I(0)$	5% $I(1)$	1% $I(0)$	1% $I(1)$	p-value
F-statistic	12.189	2.157	3.355	2.517	3.818	3.313	4.821	<0.001
t-statistic	-6.582	-2.515	-4.001	-2.835	-4.370	-3.462	-5.077	<0.001

Source: Author's own calculations.

cointegrating relationship among the variables included in the ARDL model.

5.1.2. Heteroskedasticity test

The Breusch-Pagan/Cook-Weisberg test examines whether there is heteroskedasticity in the model. The hypotheses of the test are as follows:

H_0 : There is constant variance (homoskedasticity).

H_1 : There is variance (heteroskedasticity).

Table 8 presents the results of the Breusch-Pagan/Cook-Weisberg Heteroskedasticity Test.

As reported in Table 8, the Breusch-Pagan/Cook-Weisberg test produces a chi-square statistic of 1.86 and a p-value of 0.1725. Since the p-value exceeds conventional significance levels, the null hypothesis of constant error variance cannot be rejected. Thus, the test provides no statistically significant evidence of heteroskedasticity, and the residual variance is consistent with the homoskedasticity assumption.

5.1.3. Autocorrelation (serial correlation) test

Breusch-Godfrey LM test is applied to test for autocorrelation in the error terms of the model.

The hypotheses of the test are as follows:

H_0 : There is no autocorrelation in the error terms.

H_1 : There is autocorrelation in the error terms.

Table 9 presents the results of the Breusch-Godfrey Autocorrelation Test.

As reported in Table 9, the Breusch-Godfrey LM test produces a chi-square statistic of 2.331 and a p-value of 0.1268 at lag 1. Since the p-value exceeds the 5% significance level, the null hypothesis of no serial correlation cannot be rejected. Therefore, the test provides no statistically significant evidence of first-order serial correlation in the model residuals.

Table 8. Breusch-Pagan/Cook-Weisberg Heteroskedasticity Test

Test Statistics	Value	Degrees of Freedom (df)	p-value
χ^2 (Chi-square)	1.86	1	0.1725

Source: Author's own calculations.

Table 9. Breusch-Godfrey Autocorrelation Test

Number of Lags (p)	χ^2 (Chi-square)	Degrees of Freedom (df)	p-Value
1	2.331	1	0.1268

Source: Author's own calculations.

Table 10. CUSUM and CUSUMSQ Test Results

Test Statistic	Test Value	1% Critical Value	5% Critical Value	10% Critical Value
Recursive	0.2952	1.1430	0.9479	0.8499

Source: Author's own calculations.

5.1.4. Structural break and model stability test

The CUSUM test (Cumulative Sum Test for Parameter Stability) is applied to test whether the model is stable over time. If the red statistical lines of CUSUM and CUSUMSQ are within the 5% significance level, the model is stable. The hypotheses of this test are as follows:

H₀: Parameters do not change over time (stable).

H₁: Parameters change over time (there is a structural break). Table 10 presents the results of the CUSUM test.

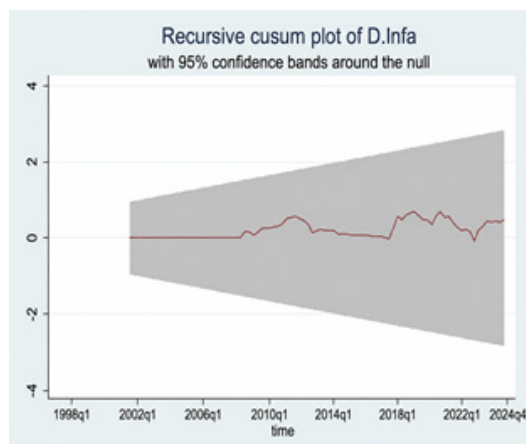
Graph 1 shows the statistical graph of the CUSUM and CUSUMSQ test.

As shown in Table 10, the recursive CUSUM test statistic (0.2952) is lower than the critical values at the 1%, 5%, and 10% significance levels (1.1430, 0.9479, and 0.8499, respectively). Therefore, the null hypothesis of parameter stability cannot be rejected at conventional significance levels. This result is also supported by Graph 1, where the CUSUM and CUSUMSQ statistics remain

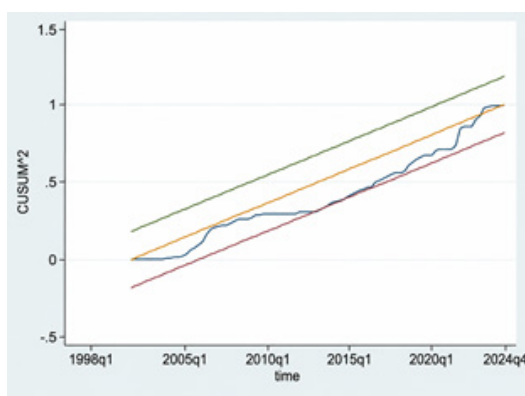
within the 5% critical bounds throughout the 1998Q1–2024Q4 period. Taken together, these findings indicate that there is no evidence of systematic parameter instability in the estimated ARDL model over the sample period. Accordingly, the estimated coefficients and dynamic relationships appear to remain stable over time, supporting the reliability of the model results.

6. Conclusions and recommendations

This study provides a comprehensive analysis of the dynamic effects of key macroeconomic variables on real interest rates in Türkiye from 1998Q1 to 2024Q4. Using the ARDL methodology and the Supremum Wald structural break test, the analysis identifies 2009Q2 as a structural break, reflecting shifts in the monetary transmission mechanism following the global financial crisis. The findings indicate that inflation positively influences real interest rates, consistent with the Fisher effect, while exchange rate movements exert a smaller but statistically significant effect. Industrial



(a)



(b)

Graph 1. CUSUM (a) and CUSUMSQ (b) Stability Plots

Source: Generated by the author using EViews.

production and economic growth are found to reduce real interest rates, in line with the Taylor rule, suggesting that the central bank accommodates growth by maintaining lower interest rates. The money supply negatively affects real interest rates, consistent with Keynesian liquidity preference theory. These results are robust and confirmed by CUSUM and CUSUMSQ tests, demonstrating reliable long-run relationships.

The study's findings carry several important implications for both policymakers and researchers. First, price stability should remain the cornerstone of monetary policy. Coordinated monetary and fiscal actions are essential to mitigate inflationary pressures and prevent destabilization of real interest rates, particularly in emerging economies such as Türkiye where external shocks and exchange rate volatility are prevalent (Cevik & Erduman, 2020). Second, exchange rate management is critical for effective monetary transmission. Strong reserve management, targeted interventions, and policies to stabilize capital flows are necessary to shield the domestic economy from international financial shocks, supporting the objectives of both short- and long-term monetary policy (Berber & Bayraktar Daştan, 2020; Samour, Isiksal, & Resatoğlu, 2020). Third, strengthening the credit channel is vital for amplifying the effects of monetary policy. This can be achieved by promoting productive investment, implementing structural reforms to increase industrial productivity, and ensuring efficient allocation of credit toward sectors that directly influence output and growth (Günbegi & Karahan, 2021; Keskin & Akkaya, 2023; Özdemir, 2024). Fourth, deepening and developing financial markets will enhance the responsiveness of the economy to policy changes. Expanding market depth, facilitating

access to financing for the real sector, and providing sophisticated financial instruments can increase both the speed and the magnitude of monetary transmission.

Furthermore, to maximize the efficiency of all monetary transmission channels including interest rates, credit, asset prices, and expectations the Central Bank of the Republic of Türkiye (CBRT) should pursue predictable, transparent, and communication-focused policies. Clear forward guidance and credible policy signals reduce uncertainty, shape economic agents' expectations, and improve investment and consumption decisions (Kaçar, 2019; Serel & Güvenoğlu, 2020). Effective liquidity management and well-coordinated open market operations are also essential to control money supply fluctuations, stabilize interest rates, and achieve both cyclical and structural policy objectives.

Beyond immediate policy implications, the study underscores the broader relevance of structural breaks, expectations, and external factors in shaping monetary policy effectiveness in Türkiye. By incorporating long-run dynamics and structural shifts, it offers insights that can inform comparative research in other emerging economies facing similar challenges. Additionally, the findings provide a foundation for future studies examining the interaction between macroeconomic variables, financial stability, and monetary policy under conditions of heightened uncertainty.

In conclusion, this study not only highlights the dynamic interactions between macroeconomic variables and real interest rates in Türkiye but also delivers actionable, evidence-based recommendations for policymakers. By addressing structural shifts, strengthening transmission channels, enhancing transparency, and promoting

predictable monetary strategies, the findings provide a roadmap to enhance the effectiveness of monetary policy, support sustainable economic growth, and improve the resilience of the Turkish economy to both domestic and external shocks. The results emphasize the importance of a holistic and forward-looking approach to monetary policy, where price stability, financial stability, and economic growth are pursued in an integrated manner.

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