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IS THERE A CHICKEN-AND-EGG RELATIONSHIP BETWEEN INTEREST AND INFLATION RATES FOR THE TURKISH CASE?

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Abstract

There is still a hot debate about the causal relationship between interest and inflation rates. On the one hand, through Fisher Effect, it is expected that inflation is the cause while the interest rate is the result. On the other hand, among policymakers in Türkiye, it is expected opposite as inflation is the result and interest rate is the cause since it is argued that inflation is the result mostly stemming from the high-interest rates constituting the high cost of the credits. However, it is strongly argued that low interest rates—which the government has lowered below inflation—rather than high interest rates are the real cause in the Turkish case. In this regard, the key purpose of the paper is to investigate the causal relationship between the interest and inflation rates for the Turkish case for the period of 2004M01-2022M03. The findings reveal that there is a bi-directional Granger causality relationship between the interest rate and the inflation rate for the Turkish case for the relevant period. This result promotes the chicken-and-egg relationship between interest and inflation rates.

Keywords: The Interest Rates and Inflation Rates, Fisher Effect, Causal Relationship, Turkish Case
JEL Classification: E44, E43, F30, G15

TÜRKİYE ÖRNEĞİ İÇİN FAİZ VE ENFLASYON ORANLARI ARASINDA TAVUK-YUMURTA İLİŞKİSİ VAR MI?

Öz

Faiz ve enflasyon oranları arasındaki nedensellik ilişkisi konusunda halen sıcak bir tartışma sürmektedir. Bir taraftan, Fisher Etkisi ile enflasyonun neden, faiz oranının ise sonuç olması beklenmektedir. Öte yandan, Türkiye'deki politika yapıcılar arasında enflasyonun çoğunlukla kredilerin yüksek maliyetini oluşturan yüksek faiz oranlarından kaynaklanan bir sonuç olduğu ileri sürüldüğünden bunun tam tersi, enflasyon sonuç faiz sebep olarak beklenmektedir. Ancak, Türkiye örneğinde gerçek nedenin yüksek faizler değil hükümetin enflasyonun altına indirdiği düşük faizler olduğu güçlü bir şekilde ileri sürülmektedir. Bu bağlamda, makalenin temel amacı faiz ve enflasyon oranları arasındaki nedensellik ilişkisini 2004A01-2022A03 dönemi için Türkiye örneğinde araştırmaktır. Bulgular ilgili dönemde Türkiye örneği için faiz oranı ile enflasyon oranı arasında iki yönlü Granger nedensellik ilişkisinin olduğunu ortaya koymaktadır. Bu sonuç, faiz ve enflasyon oranları arasında tavuk-yumurta ilişkisini desteklemektedir.

Anahtar Kelimeler: Faiz Oranları ve Enflasyon Oranları, Fisher Etkisi, Nedensellik İlişkisi, Türkiye Örneği
JEL Sınıflandırması: E44, E43, F30, G15

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1. Introduction

Several empirical studies have recently discussed the connection between inflation and nominal rate of interest. This empirical relationship is of utmost importance in monetary economics because it addresses a key question concerning monetary authorities of whether monetary policy affects the real rate of interest. Monetary authorities and central banks consider it as imperative to grasp the complex interaction among exchange rates, interest rates, and various macroeconomic indicators, including inflation rates (Bal *et al.*, 2019). This is because the central banks place a premium on the synchronization of these variables when formulating monetary policy and managing foreign exchange. The activities of speculators, arbitrageurs, investors, and other participants in the international money market are impacted by changes in these factors.

There is still a hot debate about the causal connection among rate of interest and rate of inflation both in literature and practice (Bal *et al.*, 2019). On the one hand, through Fisher Effect, it is expected that inflation is the cause and the interest rate is the result. On the other hand, in practice, especially among recent policymakers in Türkiye, it is expected opposite as the inflation is the result and the interest rate is the cause. They maintain that inflation is the result mostly because of the high-interest rates, which constitute the high cost of the credits. On the other hand, in literature, it is strongly maintained that it is not the high-interest rates but rather the low-interest rates reduced to below the inflation rate by the authorities are the cause in the Turkish case. In this regard, the central purpose of the paper is to investigate the causal connection between the interest and inflation rates, specifically focusing on short-term nominal interest rates and expected inflation rates, taking Türkiye as a case study for the period of 2004M01-2022M03. Furthermore, with the Turkish government's recent monetary policies, understanding this topic has become increasingly vital for Türkiye. In response to this pressing need, recent data were employed and a detailed and comprehensive approach was adopted to examine the subject. The methodology and analysis of this paper are distinct from previous literature by providing a new perspective and a more through and detailed understanding of the situation. The paper's structure can be outlined as follows. After the introduction, the Fisher Hypothesis' theoretical foundation is presented. An overview of interest and inflation rates in Türkiye is followed by a comprehensive literature review in the fourth section. The fifth section delves into the methodologies and data set utilized for the empirical analysis, leading up to the conclusion.

2. Theoretical Framework of the Fisher Hypothesis

Irving Fisher (1930) was the first economist to demonstrate the link among the rate of nominal interest and expected inflation, a concept now known as the Fisher Hypothesis. This hypothesis posits that the nominal interest rate for any given term is a composite of the real interest rate and the expected inflation rate. The hypothesis also proposed splitting the nominal interest rate into two distinct components: A real rate and a rate of expected inflation. According to Fisher's seminal work in 1930, a direct and one-to-one correlation exists among nominal interest rates and inflation. He argued that real interest rates remain unaffected of the projected inflation rate and are primarily influenced by economic real variables, such as the temporal preferences of investors and capital productivity (Cooray, 2003, p. 135). In this regard, Fisher's postulation has the immediate consequence that an increase or decrease in inflation permanently communicates an equivalent transformation in the rate of nominal interest. This implies that monetary policy does not exert an immediate influence on the actual (or real) interest rate; instead, the real interest rate is primarily influenced by long-term real shocks (Uyaebo *et al.*, 2016, p. 334).

Hawtrey (1997) points out various reasons that why the Fisher Hypothesis has remained so influential in the literature. First of all, it emphasizes the critical part played by the real interest rate in determining the level of investment, savings, and economic growth in a country. The real interest rate directly impacts the real exchange rate, which in turn influences trade and capital movements. Second, a significant amount of evidence indicates that future inflation expectations can be determined using nominal interest rates. Third, the Fisher hypothesis is an essential concern for central banks. One of the most pressing issues confronting central banks is whether monetary policy can influence the real interest rate (Mitchell-innes *et al*., 2007, p. 694).

In this context, the interest rate that the bank pays is the rates of nominal interest, whereas the actual (or real) interest rate represents the increase in purchasing power. If (i) stands for the rate of nominal interest, (r) indicates the rate of actual (or real) interest, and π for the inflation rate, then the connection between these variables may be expressed as (Mankiw, 2009, p. 94):

$$r = i - \pi \quad (1)$$

Fisher characterizes the nominal interest rate for a specific time frame as the combination of the actual (real) interest rate and the anticipated inflation rate. This relationship is expressed in the Fisher Equation, which is formulated as follows (Mishkin, 2015, p. 41):

$$i_t = r_t + \pi_t^e \quad (2)$$

In equation number (2), (i_t) shows the rate of nominal interest, (r_t) demonstrates the rate of real interest, and (π_t^e) shows the anticipated inflation rate.

Under the rational expectation hypothesis, the anticipated rate of inflation is equal to the actual rate of inflation (π_t) plus a random error term (ε_t), formulized as below (Altunöz, 2018, p. 29):

$$\pi_t^e = \pi_t + \varepsilon_t \quad (3)$$

Several studies suggest three approaches for examining the Fisher Hypothesis: The Domestic Hypothesis of Fisher, the Generalized Fisher Effect, and International Fisher Effects. According to the Domestic Fisher Effects, the actual (real) interest rate plus the anticipated rate of inflation equals the nominal rate of interest in a specific economy. Domestic Fisher Hypothesis, however, may not be valid at all times when changes in economic policy impact real interest rates. When all other variables are constant, the links between both the real and nominal rates of interest and the inflation rates may be expressed as follows (Akıncı & Yılmaz, 2016, p. 70):

$$1 + r_t = \frac{1+i_t}{1+\pi_t} \quad (4)$$

In equation number (4), (i_t) illustrates the nominal rate of interest, π_t demonstrates the inflation rate, and r_t denotes the rate of actual (real) interest. If we solve equation (4) for (r_t), we will achieve equation (5) as below:

$$r_t = \frac{i_t - \pi_t}{1 + \pi_t} \quad (5)$$

When the denominator is ignored in equation (5), the nominal interest rate's primary determinants are the real interest rate and anticipated rates of inflation (π_t^e) at the beginning of the period. In this case, we can achieve equation (6) as follows:

$$i_t = r_t + \pi_t^e \quad (6)$$

The second approach for examining the Fisher Effects is the Generalized Fisher Hypothesis, where the disparities in nominal interest rates between the two nations are equal to the anticipated inflation rate disparities between the mentioned nations. Generalized Fisher Effects address the interactions across nations and argue that actual returns are equalized across nations through arbitrage. The hypothesis is illustrated as follows when two nations, X and Y, are taken into account:

$$i_x - i_y = \pi_x^e - \pi_y^e \quad (7)$$

In equation number (7), (i_x) and (i_y) express the nominal interest rates of X and Y nations or the nominal interest rates of home and foreign country, (π_x^e) and (π_y^e) show the anticipated inflation rates in X and Y countries, respectively. According to the hypothesis, the country that has a higher rate of inflation should have higher rates of interest than the lower interest rate nation. Without governments intervene, capital will flow to the nation with a greater projected return until the projected real returns are equalized. Capital market integration is an essential condition for the Generalized Fisher Effect since there should be no limitations on capital mobility, allowing capital to move freely across borders (Ersan, 2008, p. 8). The fundamental premise of the concept is based on the arbitrage process across financial and real assets. When the inflation rate is predicted to be high and the interest rates are lower, households are more likely to invest in real assets rather than financial assets (Akıncı & Yılmaz, 2016, p. 71).

The International Fisher Effect is the third type of Fisher Effect. This hypothesis operates under the assumption that real rates of return are equalized globally, implying that foreign currencies with notably high nominal interest rates would experience depreciation as they reflect anticipated inflation. However, an expected fluctuation in the exchange rate among any pair of currencies corresponds to the difference in nominal interest rates between the two respective nations at that moment (Abla El Khawaga *et al.*, 2014, p. 2). The International Fisher Hypothesis posits a particular association between a difference in nominal rates interest among two nations at the start of a period and the expected exchange rate movement over that term. It explains how to calculate expected inflation rates using each country's nominal interest rate and how the disparity in projected inflation rates across two nations reflects an expected adjustment to the exchange rate (Madura, 2020, p. 268). The International Fisher Effect can be seen as a sum of the Generalized Fisher Effect and the Relative Purchasing Power Parity (PPP), which illustrates that the difference in expected inflation rates across two nations is equivalent to the changes in anticipated exchange rates. Equation (8) represents this condition:

$$\pi_x^e - \pi_y^e = \frac{S_{t+1} - S_t}{S_t} \tag{8}$$

In equation number (8), S_t and S_{t+1} represent the spot exchange rates for the current and upcoming periods, respectively. When the equations numbers (7) and (8) are linked, the International Fisher Hypothesis may be represented as follows:

$$\pi_x^e - \pi_y^e = i_x - i_y = \frac{S_{t+1} - S_t}{S_t} \tag{9}$$

Equation (9) illustrates that the difference between inflation and the rates of nominal interest reflects the changes in anticipated exchange rates. Based on equation (9), a country with higher rates of inflation causes interest rates to rise. As a result of this circumstance, the rates of exchange will increase, and the value of the national currency will decrease (Akıncı & Yılmaz, 2016, p. 72). The extent of expected currency devaluation corresponds to the disparity in nominal interest rates, implying that the benefits of investing in savings accounts in a nation with a high interest rate should be offset by the anticipated depreciation (Madura, 2020, p. 268).

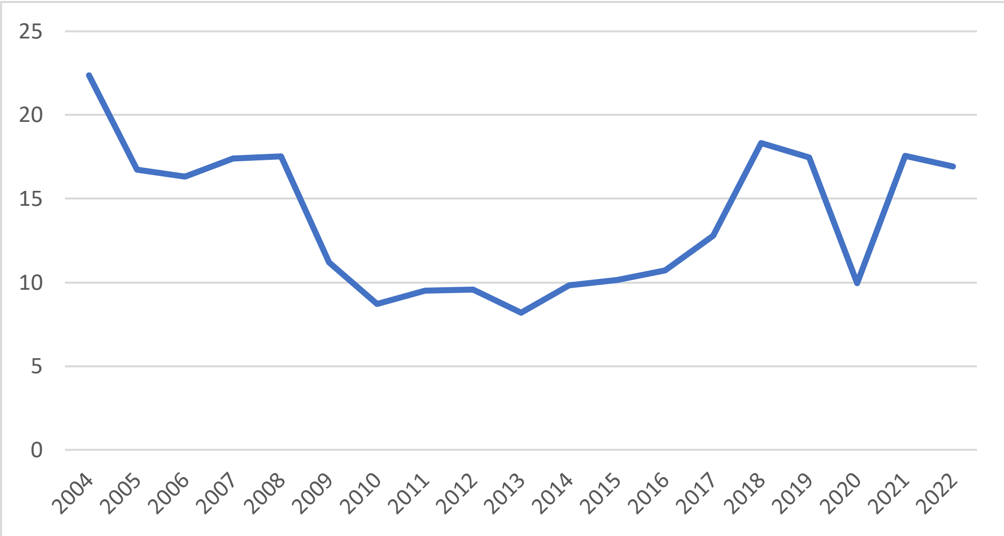
According to some existing empirical studies, there is a difference between the "strong" and "weak" forms of the Fisher Hypothesis. The weak type of the Fisher Hypothesis is compatible with a longer-term coefficient among inflation and nominal rates of interest smaller than one. On the other hand, the strong version of the Fisher hypothesis defines a long-term coefficient that is bigger than or equal to one. In the long term, the strong type of the Fisher Hypothesis indicates that rates of real interest will not react to changes in anticipated inflation (Aksoy *et al.,* 2012, p. 476).

3. An Overview of the Interest Rates and Inflation Rates of Türkiye for the Period of 2004-2022

According to Figure 1 that shows the short-term interest rates (up to 1 year deposit rates) of Türkiye for the era of 2004-2022, it seems that for the sub-period of 2009-2014 it started to decrease gradually. This is because of the expansionary policies for the recovery of the 2008 financial crisis, which Türkiye suffered from mainly in the year of 2009. After that period, with the same reasons the bottom point matches with the year of 2020, which is the starting year of the

COVID-19 Pandemic Crisis. In 2022, with the decreasing of the policy interest rates of the Central Bank stemming from the new heterodox policies of the government it started to decrease again.

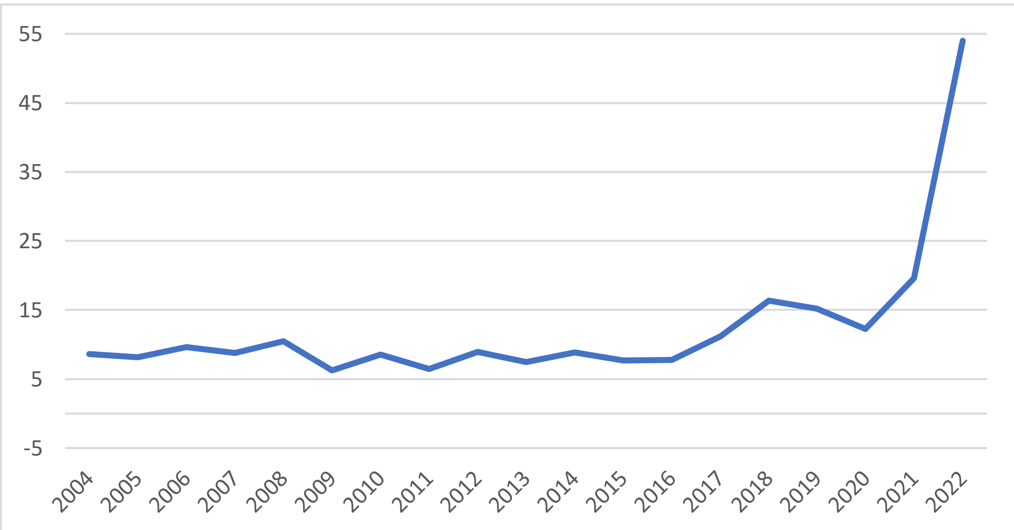
Figure 1: **The Short Term Interest Rates in Türkiye (2004-2022, Percentage)**



Source: Prepared by the Authors based on the Data from The Central Bank of the Republic of Türkiye-Electronic Data Delivery System, retrived from https://evds2.tcmb.gov.tr/index.php

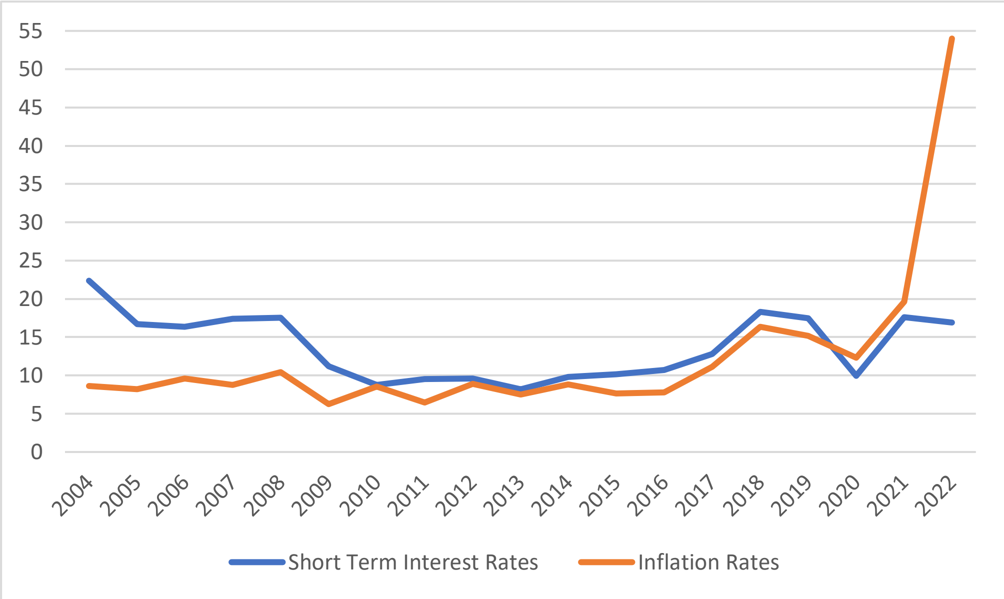
Figure 2 shows the inflation rates (which represent the annual percentage changes of the Consumer Price Index) of Türkiye for the era of 2004–2022. According to this, it clearly seems that there is an accelerating inflation issue after 2020. It is argued that it is partly related with the increasing costs of the production of the goods due to the Pandemic crisis, but it is also argued that the accelerating of the inflation issue is mostly due to the new policy of the government that led to decrease the policy interest rate of The Central Bank below the inflation rate. All this allowed to dollarization massively causing the Turkish Lira to depreciate, increasing of the compulsory imported production goods thus leading to inflation. This issue is seen in Figure 3. According to it, since 2020 the interest rates have remained below the inflation rates.

Figure 2: **Inflation Rates in Türkiye (2004-2022, Percentage)**



Source: Prepared by the Authors based on the data from The CBRT-EVDS, retrived from https://evds2.tcmb.gov.tr/index.php

Figure 3: **Short Term Interest Rates and Inflation Rates in Türkiye (2004-2022, Percentage)**



Source: Prepared by the Authors based on the Data from The The CBRT-EVDS, retrived from https://evds2.tcmb.gov.tr/index.php

4. Literature Review

There is numerous previous research in economics that discusses the Fisher Hypothesis, primarily attempting to discover if the Generalized Fisher Hypothesis is indeed accurate. The predominant body of research indicates that the inflation rate has a favorable effect on the rates of interest. The following studies have provided evidence supporting the accuracy of the Fisher Effect:

Toyoshma & Hamori (2011) studied the validity of the Fisher Effects for the US, Japan, and the United Kingdom (UK), employing a panel dataset comprising monthly data spanning from 1990M01 to 2010M12. The empirical findings indicated the validity of the Fisher Effects in three countries. Friesendorf *et al.* (2022) investigated the applicability of Generalized Fisher's Effect for post-unification Germany for the time period of 1991 to 2020 using continuous wavelet analysis. The findings confirmed the Generalized Fisher's Effect for post-unification Germany. Gocer & Ongan (2020) also confirmed the Fisher Effect in their analysis of the United Kingdom's interest rates and inflation. Research across Asian economies, as demonstrated by Ahmad (2010) consistently supports the Fisher Effect. Altunöz (2018) further affirmed the Fisher Effect in China's economy using the ARDL approach and covering the period of 1996M01 – 2015M03. Zainal *et al*. (2021) examined the presence of the Fisher Effect in employing the Autoregressive Distributed Lag (ARDL) cointegration technique from 2011- 2018. The results revealed that the Fisher Effect theory is accurate in Malaysia. Zhong (2022) tested the Fisher Effects among nominal interests and inflation in China for the period of 1978-2020 by using the Granger Causal Relation test. The results confirmed the Fisher Effect for China. Across a range of countries, including OECD nations (Panopoulou & Pantelidis, 2016), industrialized and emerging economies (Kasman *et al*. 2006) and even in the Romanian stock market (Oprea, 2014) studies have consistently validated the Fisher Effect. Emerging nations like Argentina, Brazil, Malaysia, Mexico, South Korea, and Turkey have also exhibited support for the Fisher Effect (Maghyereh & Al-Zoubi, 2006).

However, it is essential to acknowledge the studies that reject the Fisher Effect hypothesis. Among them, Dutt & Ghosh (1995) searched for the reliability of the Fisher Effect for Canada using The Fully Modified Least Squares (FM-OLS) techniques for weak and strong Fisher effects, respectively. According to the findings, the Fisher Hypothesis is strongly rejected. In a study of G7 nations, Ghazali & Ramlee (2003) found no long-run connection among rates of interest and inflation rates, ultimately rejecting the Fisher Effects. Asemota & Bala (2011) used co-integration and Kalman filter methodologies to reject the Fisher Effects for Nigeria.

The Turkish economy has been a subject of particular interest within the framework of the Fisher Effect Hypothesis. Several studies have investigated this relationship, yielding mixed or conditional findings. Among them, Güri *et al*. (2016) examined the Fisher Hypothesis's validity in Türkiye from 2003 to 2012 by using the Autoregresive Distributed Lag test. The findings of this research demonstrate that the Fisher Hypothesis was accurate for Türkiye. Turna & Özcan (2021), who examined the period from 2005 to 2019, and Sarı & Arslan (2022), who analyzed the data from 1971 to 2021, both utilized different methods but confirmed the Fisher Effect's validity in Turkey during their respective timeframes. Aksoy *et al.* (2012), Gedik (2021), and Demez (2021) all provided empirical evidence of the long-run connection among the exchange rate, inflation, and interest rates.

Gürsoy & Akçay (2021) examined the Fisher effect in the economy of Türkiye by using monthly data from 2005M01 to 2020M10 in which Hatemi-J asymmetric causality test was applied. The results confirmed the Fisher Hypothesis in Türkiye. Akıncı & Yılmaz (2016) investigated the legitimacy of the International Fisher Effects in the Turkish economy from 1975 to 2014 by using the Generalized Method of Moments. The outcome illustrates that the International Fisher effect was accurate for Türkiye. Sinan (2019) examined the connection among rate of inflation and interest rates in Türkiye in which the Johansen cointegration test and VAR were employed. The study points out that a strong form of Fisher Effect was valid for the Turkish economy. Başar & Karakuş (2017) studied the correlation between rate of interest and inflation rates from 2004M12 - 2016M12 by using the Johansen cointegration and VECM model. The findings revealed that all models' variables had a cointegration association. Arısoy (2013), and Alper (2017) verified that the Turkish economy exhibits the weak version of the Fisher effect. Gürel (2021) examined the reliability of the Fisher effect for an inflation-targeting nation by having used Auto Regressive Distributed Lag and Nonlinear Autoregressive Distributed Lag models for the economy of Türkiye for the period of 2006 to 2019. The Fisher Effect was found to be valid throughout the short- and long-terms using the ARDL model. In the long run, the NARDL model's results showed a robust version of the Fisher Effect, but in the near term, the Fisher impact is only real when inflation rises. However, it is crucial to remember that several researches have produced mixed or conditional results, indicating that the Fisher Effect may not be applicable in the Turkish context. Among them, Gula & Acikalin (2008) used the Johansen cointegration method to examine the Fisher Effect for Türkiye. The analysis shows that, albeit not on a one-to-one basis, it could be possible to establish a long-run association among the nominal rate of return and inflation. Tunali & Erönal (2016) utilized data from 2003M01 to 2014M02 to investigate the reliability of the Fisher's Theory for Türkiye. The outcomes show that while the Fisher Effect is invalid in the short run for Türkiye, it is valid in the long run. The following Tables (1, 2) summarize the findings of the relevant empirical literature on other areas and Türkiye, respectively.

Table 1: **A Brief Literature Review of the Studies on the Fisher Effect on other Areas**

Author(s)	**Period**	**Methodology**	**Area(s)**	**Findings**
Toyoshima & Hamori (2011)	1990-2010	Panel Data Analysis	US, UK, JAPAN	Valid
Friesendorf *et al.* (2022)	1919-2020	Continuous Wavelet Analysis	Germany	Valid
Gocer & Ongan (2020)	2008M10-2018M01	ARDL Approach	UK	Valid
Zainal *et al.* (2021)	2011-2018	Autoregressive Distributed Lag (ARDL)	Malaysia	Valid
Ahmad (2010)	1980M01-2007M02	Nonlinear Methodology	Eight Asian Countries	Valid

Table 1 (Continued): **A Brief Literature Review of the Studies on the Fisher Effect on other Areas**

Author(s)	Period	Methodology	Area(s)	Findings
Zhong (2022)	1978-2020	Granger Causal Relation Test	China	Valid
Barthold & Dougan (1986)	1902-1983	Time Series Analysis	USA	Valid
Altunöz (2018)	1996M01-2015M03	ARDL	China	Valid
Tsong & Hachicha (2014)	1995M01-2011M06	Quantiile Regression Approch	Indonesia, Russia, South Africa	Valid
Kasman *et al.* (2006)	-	Fractional Cointegration Analysis	33 Developed And Emerging Nations	Valid
Maghyereh & Al-Zoubi (2006)	1979M03-2003M12	Bierens (2000) Nonparametric Test	Argentina, Brazil, Malaysia, Mexico, Korea, and Türkiye	Valid
J.Atkins & Coe (2002)	1953M01-1999M12	ARDL Bounds Testing Analysis	USA, Canada	Valid
Wong & Wu (2003)	1958M01-1999M04	Instrumental Variables Regressions	G7 Countries, Eight Asian Countries	Valid
Dutt & Ghosh (1995)	1960-1993	Johansen-Juselius (JJ) And (FM-OLS)	Canada	Invalid
Asemota & Bala (2011)	1961M01-2009M04	Co-Integration And Kalman Filter	Nigeria	Invalid
Ito (2009)	1987M01-2006M06	Time Series Analysis	Japan	Invalid

Table 2: **A Brief Literature Review of the Studies on the Fisher Effect in Türkiye**

Author(s)	Period	Methodology	Area(s)	Findings
Sarı & Arslan (2022)	1971-2021	ARDL and Lee- Strazicich and Fourier KPSS Unit Root Tests	Türkiye	Valid
Turna & Özcan (2021)	2005-2021	ARDL Approach	Türkiye	Valid
Gedik (2021)	2009M02-2021M07	Unit Root Test: ADF, PP and Zivot Andrews	Türkiye	Long run Valid
Yılancı (2009)	1989:Q1-2008:Q1	Engle-Granger Cointegration Model	Türkiye	Invalid
Güriş *et al.* (2016)	2003-2012	Autoregressive Distributed Lag test	Türkiye	Valid
Gula &Açıkalın (2008)	1990M01-2003M12	Johansen Cointegration	Türkiye	Invalid
Akçacı & Gökmen (2014)	2003M01-2014M05	Toda-Yamamoto Causality Analysis	Türkiye	Valid
Tunalı & Erönal (2016)	2003M01-2014M02	Gregory-Hansen Test And Andrews Unit Root Tests	Türkiye	Long run: Valid Short run: Invalid
Gürsoy & Akçay (2021)	2005M01-2020M10	Hatemi-J Asymmetric Causality Test	Türkiye	Valid
Şimşek & Kadılar (2006)	1987:Q1-2004:Q4	ARDL Bounds Testing Analysis	Türkiye	Valid
Demez (2021)	2003Q3-2020Q4	Fourier ADL Cointegration Analysis	Türkiye	Valid
Akıncı & Yılmaz (2016)	1975-2014	Generalized Method of Moments (GMM)	Türkiye	Valid
Başar & Karakuş (2017)	2004M12-2016M12	Johansen Cointegration Test And VECM Model	Türkiye	Valid

Table 2 (Continued): **A Brief Literature Review of the Studies on the Fisher Effect in Türkiye**

Author(s)	Period	Methodology	Area(s)	Findings
Alper (2017)	1973-2016	Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS)	Türkiye	Valid
Gürel (2021)	2006 -2019	ARDL and NARDL	Türkiye	Valid
Aksoy *et al.* (2012)	2002-2009	Test Of Cointegrating Rank With A Trend Break And Exogeneity Tests	Türkiye	Valid
Arısoy (2013)	1987Q1-2010Q3	Time-Varying Parameters Analysis	Türkiye	Valid

5. Empirical Analysis

This research investigates the causal connection between nominal interest rates and inflation rates in Türkiye over the period of 2004M01-2022M03 within the framework of the Fisher Hypothesis. To explore this relationship, the Granger Causality test, proposed by Granger (1969), is employed. This test is widely recognized as an effective method for detecting causal relationships between variables by considering the close relationship between cause and effect.

Prior to executing the Granger causality test, it is imperative to assess the stationarity of the series. Traditionally, the Augmented Dickey-Fuller test (1981) and the Phillips-Perron (PP) test (1988) are commonly used for this purpose. However, in order to address the possibility of structural breaks in the series, more sophisticated tests that consider structural breaks in the data are implemented, specifically, the Zivot and Andrews (ZA) test (1992) and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test (1992) are employed.

Subsequently, the cointegration between variables is determined by using the Gregory and Hansen (1996) test, which aims to identify the long-term relationship between the variables being examined, while considering the likelihood of a structural break in the intercept or both the intercept and coefficient vector at an unknown time.

Finally, the Granger causality test is employed to unveil the connection between the variables under examination. This comprehensive approach ensures a thorough analysis of causality while considering stationarity, cointegration, and potential structural breaks, providing reliable insights into the causal rapport amidst interest rates and inflation rates in Türkiye.

In this research, EViews 10, a statistical software package is used to carry out the aforementioned analyses.

5.1. Data Selection

This paper employed monthly nominal interest rates and inflation rates data from 2004M01 to 2022M03, with a total of 219 observations. The data was gathered from the Electronic Data Distribution System of the Central Bank of the Republic of Türkiye (CBRT-EVDS). Short-term interest rates were used to proxy nominal interest rates, which were captured by using the Up to 1-year Weighted Average Interest Rates applied to deposits in Turkish Lira (TRY)[1], while inflation rates were computed using the Year-to-year percentage shifts in the Consumer Price Index based on 2003 (2003=100) as shown in Table 3. Before starting the application, the seasonality of the series has been checked by the relevant seasonality test, which found that the series did not include any seasonality.

[1] *It points to "the weighted average interest rate (compounded) which is calculated on the customer basis by relating the type of each deposit to the interest rate applied according to the maturity bracket" (tcmb.gov.tr).*

Table 3: **Data Description**

Symbol	Variables
INTR SHORT-TERM	Short-term Interest Rates (Up to 1 Year Turkish Lira Deposits)
INF	Expected Inflation Rate

5.2. Unit Root Test

To analyze the causality amidst the variables, it is required to first determine whether the series are stationary. From the standpoint of econometrics, there is a critical issue associated with non-stationary variables, which can lead to spurious correlations (Gujarati, 1999, p. 748). The stationarity of the time series was examined through the application of the Augmented Dickey-Fuller (ADF) (1981) and Phillips-Perron tests (PP) (1988).

The test hypotheses are constructed in the following manner:

$$H_0: \gamma = 0$$

$$H_1: \gamma < 0$$

The null hypothesis states that the series exhibits non-stationarity due to the presence of a unit root. Conversely, the alternative hypothesis asserts that the series is free from a unit root, and therefore, stationary. In other words, if the null hypothesis is not rejected, we can conclude that the time series contain a unit root and are non-stationary, however, if the null hypothesis is rejected, we can infer that the time series are free from a unit root and are stationary.

The null hypothesis testing for a unit root is a common approach in the time series analysis. However, it is worth noting that conventional tests like ADF and PP do not consider the potential occurrence of structural breaks within the data, which could affect the stationarity of the series.

Figure 4: **Plot of Inflation and Interest Rates**

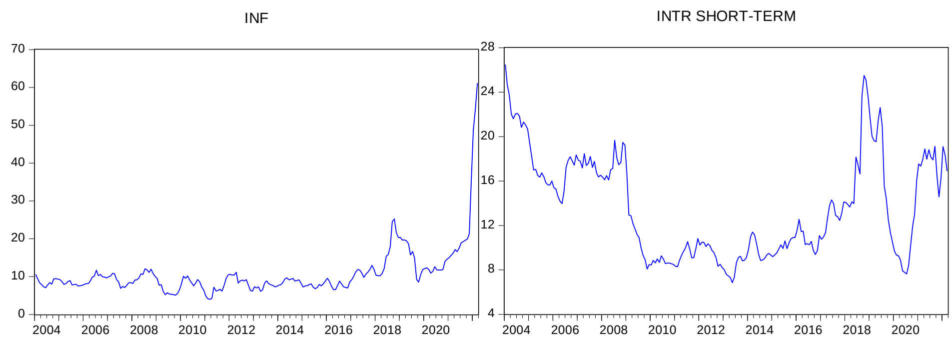


Figure 4 illustrates that both series of Inflation Rates and the Interest Rates exhibit potential structural breaks. These breaks indicate significant shifts or changes in the underlying dynamics of the data. Consequently, this implies that relying solely on traditional unit root tests like ADF and PP tests may give inaccurate results when it comes to accepting the null hypothesis.

To overcome this limitation and ensure more accurate analysis, it is necessary to consider more sophisticated tests that allow for structural breaks within the series. One such test is the Zivot and Andrews (ZA) test, which was introduced in 1992. ZA test is recognized as an advanced version and an extension of the Perron Test (1989). The ZA test employs three distinct models to investigate the presence of a unit root while considering different types of structural breaks. These models encompass various forms of structural breaks, including a shift in the intercept (referred to as Model A), a shift in the slope (referred to as Model B), and a shift in both the slope and intercept (referred to as Model C) (Zivot & Andrews, 1992). This makes it a more robust test compared to the ADF and PP tests, particularly when structural breaks are present. Another unit root test that takes into account potential breaks is Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) (1992).

5.2.1. Unit Root Test Without Considering Structural Breaks

According to the outcomes obtained based on the ADF and PP tests, as presented in Table 4, both variables are not stationary at their levels. To avoid the spurious findings resulting from regressing a non-stationary time series on another non-stationary time series, it is required to transform the non-stationary time series into a stationary form. Therefore, it is sufficient to consider the first differences of the time series in question (Gujarati, 1999, p. 760). However, it is necessary to first examine the presence of unit roots within structural breaks in order to determine if the non-stationarity is a result of these structural breakdowns.

Table 4: **Augmented Dickey-Fuller Test (ADF), and Phillips-Perron Test (PP)**

	Augmented Dickey-Fuller Test					
	Level			**First Differences**		
Variables	**Without Intercept & Trend (None)**	**Without Trend (Constant)**	**Intercept with Trend (Constant, Linear Trend)**	**Without Intercept & Trend (None)**	**Without Trend (Constant)**	**Intercept with Trend (Constant, Linear Trend)**
INF	1.871775	1.859014	1.036409	-7.362722***	-7.459193***	-7.747063***
INTR SHORT-TERM	-1.247289	-2.904596**	-2.735134	-11.30343***	-11.28615***	-11.33850***
	Phillips-Perron Test					
	Level			**First Differences**		
Variables	**Without Intercept & Trend (None)**	**Without Trend (Constant)**	**Intercept with Trend (Constant, Linear Trend)**	**Without Intercept & Trend (None)**	**Without Trend (Constant)**	**Intercept with Trend (Constant, Linear Trend)**
INF	2.237149	3.945050	2.922695	-7.208080***	-7.309679***	-7.823795***
INTR SHORT-TERM	-1.419937	-3.041092**	-2.770924	-11.32834***	-11.31170***	-11.28092***

Notes: *, **, *** denote significance at 10%, 5%, and 1%, respectively. Schwarz Information Criterion (SIC) was used to obtain the results.

5.2.2. Unit Root Test Under Structural Breaks

Structural breaks in time series data can be attributed to several factors contributing to the non-stationarity of the series. These breaks may emerge due to political events, adjustments in macroeconomic policies, economic crises, changes in the economy's structure, or technological advances. Such influences may affect the underlying patterns and dynamics of the time series, leading to changes in its statistical properties over time.

5.2.2.1. The Zivot and Andrews (ZA) Test (1992)

Unlike Perron's (1988) approach of externally determining the time of occurrence of structural breaks in the time series (i.e., exogenous structural break), the Zivot-Andrews (1992) Unit Root Test considers the breakpoint to be endogenous rather than exogenous. The null hypothesis in the Zivot-Andrews Unit Root Test states that the time series denoted as y_t exhibits a unit root without any structural break and follows a random walk process with drift. The alternative hypothesis, on the other hand, proposes a trend stationary process with a single unknown structural break (Zivot & Andrews, 1992).

The null hypothesis is as follows:

$$y_t = \mu + y_{t-1} + e_t$$

The ZA test uses three different models to investigate the existence of a unit root while considering different types of structural breaks. These models encompass a shift in the intercept (referred to as Model A), a shift in the slope (referred to as Model B), and a shift in both the intercept and slope (referred to as Model C).

The following are the models employed in the analysis:

Model A: $y_t = \mu^A + \theta^A DU_t(\lambda) + \beta^A t + \alpha^A y_{t-1} + \sum_{j=1}^{k} c_j^A \Delta y_{t-j} + e_t$

Model B: $y_t = \mu^B + B^B t + \gamma^B DT_t^*(\lambda) + \alpha^B y_{t-1} + \sum_{j=1}^{k} c_j^B \Delta y_{t-j} + e_t$

Model C: $y_t = \mu^C + \theta^C DU_t(\lambda) + \beta^c t + y_{t-1} + \gamma^C DT_t^*(\lambda) + \alpha^C y_{t-1} + \sum_{j=1}^{k} c_j^C \Delta y_{t-j} + e_t$

Table 5: **Zivot and Andrews (ZA) Test**

Variables	ZA Model	Level		First Difference		Decision
		ZA Test Statistic	Break Date	ZA Test Statistic	Break Date	
INF	A	-3.690575 (2)	2021M11	-15.46130 (1) ***	2021M11	I (1)
	B	-3.640223 (1)	2021M04	-12.46484 (1) ***	2021M09	I (1)
	C	-3.427025 (1)	2020M12	-12.31501 (1) ***	2021M07	I (1)
INTR SHORT-TERM	A	-4.587347 (1)	2008M11	-12.49379 (0) ***	2018M09	I (1)
	B	-3.742462 (1)	2012M07	-11.52424 (0) ***	2022M03	I (1)
	C	-4.638536 (9)	2017M12	-12.50762 (0) ***	2018M09	I (1)

Notes: *** denotes significance at 1% level. The numbers indicated within parentheses in ZA Test Statistics denote the lag orders.

According to Table 5, in all three models A, B, and C, when the calculated t-statistics values and critical values are compared at level, it is seen that the t-statistics values for both variables INF and INTR SHORT-TERM are lower than the critical values at 1% and 5% significance levels. In this case, the null hypothesis of a unit root with an existing breakpoint cannot be rejected. Therefore, after taking the first difference, the ZA test indicates that the variables INF and INTR SHORT-TERM are stationary at the first difference I (1), as the t-statistics levels are above the critical values at 1% and 5% significance levels, leading to the rejection of the null hypothesis that posits a unit root with a structural break.

According to the Model A results of the ZA unit root test, the breakpoints were determined in November 2021 for INF and September 2018 for INTR SHORT-TERM. As for Model B, the results show that INF has a breakpoint in September 2021 and the INTR SHORT-TERM has a breakpoint in March 2022. When Model C is considered, it is seen that the INF rate broke down in the July 2021 and the INTR SHORT-TERM has a breakpoint in the September 2018.

5.2.2.2. Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) (1992)

According to the findings reported in Table 6, the KPSS unit root test indicates that the null hypothesis of stationarity is not accepted for both series, the INF and INTR SHORT-TERM. This rejection is based on the observation that the KPSS test statistics exceed the critical values at all levels of significance (1%, 5%, and 10%). Therefore, it can be concluded that the INF and INTR SHORT-TERM series are not stationary at level, and it is necessary to transform the data by taking the first difference.

Table 6: **KPSS Unit Root Test**

	KPSS Test			
	Level		First Differences	
Variables	**Without Trend (Constant)**	**Intercept with Trend (Constant, Linear Trend)**	**Without Trend (Constant)**	**Intercept with Trend (Constant, Linear Trend)**
INF	0.956253	0.296374	0.442611***	0.140208***
INTR SHORT-TERM	0.409765**	0.344657	0.231053***	0.037804***

Note: *** denotes significance at 1% level.
Source: Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Upon differencing the series, the subsequent results demonstrate that the test statistics for both the INF and INTR SHORT-TERM series fall below the critical values at all significance levels. Consequently, the null hypothesis, which states that the series is stationary after taking the first difference I (1), can be accepted.

The findings from the ADF, PP, and ZA tests align with the results obtained from the KPSS test, providing additional evidence that both series exhibit stationarity after being differenced to I (1).

5.3. Cointegration Test

The paper has revealed that the variables under study are integrated in the same order (order one). Consequently, the subsequent analysis aimed to determine the possibility of co-integration among these variables. Given that all the variables exhibit stationarity in their first differences and there are just two variables with structural breaks, the decision is to employ the Gregory and Hansen Cointegration Test (1996) methodology for this objective.

5.3.1. Cointegration Under Structural Breaks: Gregory and Hansen Cointegration Test

The cointegration tests developed by Gregory and Hansen in 1996, referred to as GH tests, extend the existing residual-based tests by incorporating the potential of a single unknown structural break in either the intercept or both the intercept and coefficient vector (Gregory & Hansen, 1996, pp. 99-126).

The GH test proposes a null hypothesis stating a non-existing cointegration in the presence of a structural break, conversely, the alternative hypothesis suggests the presence of cointegration with a structural break. Gregory and Hansen emphasize the importance of considering the possibility of a regime shift in cointegration analysis, as employing the standard ADF test without accounting for this can lead to misleading conclusions regarding the long-term relationship between the dependent variable and the explanatory variables.

To address this issue, Gregory and Hansen (1996) suggest three models that consider the potential structural break. These models provide a more comprehensive framework for analyzing cointegration, enabling researchers to obtain more accurate and reliable results regarding the presence or absence of long-run relationships (Gregory & Hansen, 1996, pp. 99-126).

The proposed models are:

Model 2: Level shift (C):

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau}+\alpha^T y_{2t}+e_t \qquad t=1, \ldots, n.$$

In this model, μ_1 is the intercept before the break, while μ_2 is the constant (intercept) at the time of the break.

Model 3: Level shift with trend (C/T):

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \beta t + \alpha^T y_{2t} + e_t \qquad t = 1, \ldots, n.$$

In this model, breaks in both constant and trend (slope) are taken into account.

Model 4: Regime shift (C/S):

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \alpha_1^T y_{2t} + \alpha_2^T y_{2t}\varphi_{t\tau} + e_t \qquad t = 1, \ldots, n.$$

In this model, both μ_1, and μ_2 are identical to those in the level shift model, the coefficient α_1 denotes the cointegrating slope prior to the occurrence of a regime shift, while $\alpha_2$represents the magnitude of the change in the slope coefficients.

Table 7: **Gregory and Hansen Cointegration Test Results**

Model	5% Critical value	Test Statistic	Break Date
Model 2: C	-4.61	ADF= -2.056 (5)	2019m03
	-4.61	Zt= 0.111	2019m04
	-40.48	Za= 1.001	2019m04
Model 3: C/T	-4.99	ADF= -2.297 (6)	2019m09
	-4.99	Zt= 0.819	2019m04
	-47.96	Za= 7.745	2019m04
Model 4: C/S	-4.95	ADF= -2.993 (6)	2019m04
	-4.95	Zt= -0.839	2019m04
	-47.04	Za= -8.451	2019m04

Notes: The Table 7 presents the outcomes of a test conducted to estimate the null hypothesis of no cointegration against the alternative of cointegration, allowing for a potential change in the cointegrating vector at a single unknown break point. The test utilizes three different statistics, as proposed by Gregory and Hansen in 1996. The analysis covers the full period of 2004M01-2022M03. The maximum lag length for the ADF test is 12. The critical values at the 5% significance level are obtained from Gregory and Hansen's work (1996, p. 109). m=1 one regressor. The numbers indicated within parentheses in ADF Test Statistics denote the lag orders.

The cointegration test under structural break was examined using the GH Cointegration Test, and Table 7 shows the break dates of the models as well as the ADF, Zt, and Za test statistics results. The break dates for models 2 (C), 3 (C/T), and 4 (C/S) were almost identical, occurring in 2019m04. Further, according to the results, the test statistic calculated for all of Models 2, 3, and 4 has an absolute value less than the critical values at the 5% significance level. This implies that these results are not statistically significant, leading not to reject the null hypothesis stating a non-existing cointegration in the presence of a structural break. In other words, in this case, according to the GH Cointegration Test, it is evident that there is no existent cointegration between the variables; specifically, there is no long-term relationship or association between inflation and interest rate.

5.6. Granger Causality Test

For the Granger causality test, two stationary time series such as X_t and Y_t should be found as follows (Granger, 1969, p. 431):

$$\boldsymbol{X_t = \sum_{j=1}^{m} a_j X_{t-j} + \sum_{j=1}^{m} b_j Y_{t-j} + \varepsilon_t}$$

$$\boldsymbol{Y_t = \sum_{j=1}^{m} c_j X_{t-j} + \sum_{j=1}^{m} d_j Y_{t-j} + \mu_t}$$

From the above-mentioned definition, it can be said that Y_t is causing X_t if the b_j is not equal to zero, on the other hand, X_t is causing Y_t if c_j is not equal to zero, if both occur at the same time, it is then said that there is bi-directional causality between the two variables X_t and Y_t. The findings of the Granger Causality Test, conducted based on the VAR model, are given in Table 8. The lag length was chosen as 2 based on LR, FPE, and AIC statistics. The results indicate the rejection of the null hypothesis (H_0) that suggests no Granger causality. The chi-square statistics demonstrate statistical significance at both the 5% and 1% significance levels. Therefore, the research findings indicate the presence of a bi-directional causality relationship between the variables being studied, namely the interest rate and the inflation rate.

According to Table 8, since there is a bi-directional Granger causality relationship between the interest rate and the inflation rate, it can be concluded that for the Turkish case for the 2004M01-2022M03 period, both situations are valid; the inflation rate is the cause and the nominal interest rate is the result and the vice versa. The findings are found to be consistent with the main argument of Egilmez (2022) which addressed the issue in terms of the "vicious circle" that was created between inflation and interest rates by the government policies as follows: "High Risk→ High Foreign Exchange Rate →Increase in the Costs of the Imported Inputs→ Expensive Production→ Price Increase → Inflation Increase→ Interest Rate Increase →High Risk →High Foreign Exchange Rate →…"

Table 8: **Granger Causality Test Results**

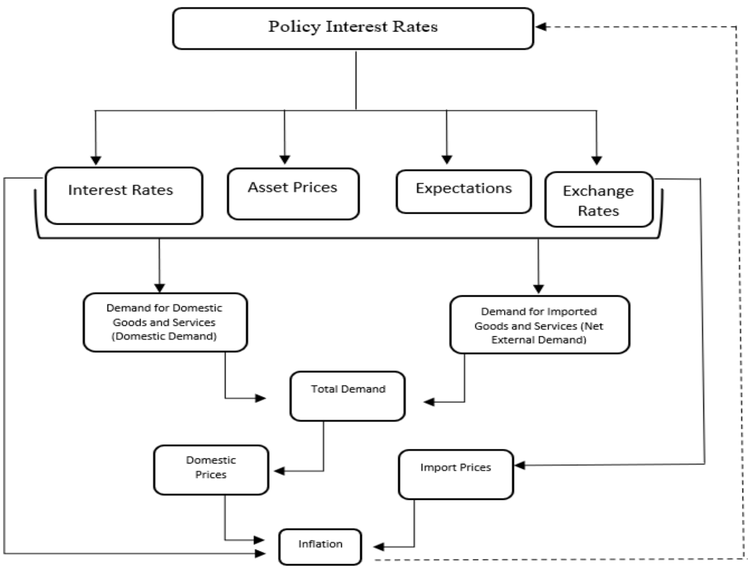
VAR Granger Causality/Block Exogeneity Wald Tests			
Sample: 2004M01 2022M03			
Included observations: 217			
Dependent variable: Δ INF			
Excluded	**Chi-sq**	**Df**	**Prob.**
Δ INTR_SHORT_TERM	**9.400574**	**2**	**0.0091*****
All	**9.400574**	**2**	**0.0091**
Dependent variable: Δ INTR_SHORT_TERM			
Excluded	**Chi-sq**	**Df**	**Prob.**
Δ INF	**8.399854**	**2**	**0.0150****
All	**8.399854**	**2**	**0.0150**

Notes: **, *** Denote significance at 5%; and 1% respectively.

5.7. Interpretation of the Empirical Results

The findings promote the chicken-and-egg relationship between interest and inflation rates since there is still a hot debate among policymakers in Türkiye arguing that inflation is the result stemming from the high-interest rates constituting the high cost of the credits. On the other hand, it is argued that it is not the high-interest rates, rather, it is the low-interest rates reduced to the below inflation rate by the authorities are the cause in the Turkish case (Ozkan, 2022).

Figure 5: **Monetary Transfer Mechanism**



Source: CBRT, https://www.tcmb.gov.tr/wps/wcm/connect/4e99834e-179b-4a08-820c-f2b259032afd/ParasalAktarim.pdf?MOD=AJPERES

The bi-directional causality relationship between the interest rate and the inflation rate can be explained through both the Fisher Effect and the Policy effect of Central Banks as shown in Figure 5.

6. Conclusion

There is still a hot debate about the causal relationship between interest and inflation rates. On the one hand, through Fisher Effect, it is expected that inflation is the cause and the interest rate is the result. On the other hand, among policymakers in Türkiye it is expected opposite as the inflation is the result and the interest rate is the cause since it is argued that inflation is the result mostly stemming from the high-interest rates constituting the high cost of the credits. However, it is strongly maintained that it is not the high-interest rates, rather, it is the low-interest rates reduced to below the inflation rate by the authorities are the cause in the Turkish case. Since the main purpose of the paper has been to investigate the causal relationship between the short-term nominal interest rates and expected inflation rates for the Turkish case, it was reached at the result that there was a bi-directional Granger Causality relationship between the interest rate and the inflation rate for the Turkish case for the period of 2004M01-2022M03, namely, both situations are valid such as inflation rate is the cause and the nominal interest rate is the result and the nominal interest rate is the cause and inflation rate is the result. This result promotes the chicken-and-egg relationship between the interest and inflation rates in Türkiye.

Since the results point out that it is a more complex issue than expected, a number of policies should be implemented to overcome the problem. In this regard, it can be said that first of all, the policies towards decreasing the riskiness of Türkiye should be on the agenda, which Egilmez (2022) addressed within the framework of the “vicious circle” that was created between inflation and interest rates by the government policies as follows: “High Risk→ High Foreign Exchange Rate →Increase in the Costs of the Imported Inputs→ Expensive Production→ Price Increase → Inflation Increase→ Interest Rate Increase →High Risk →High Foreign Exchange Rate →…”. Last but not least, this study can be regarded as a starting point for future studies in which a panel time series approach can be conducted for developing countries in order to investigate the issue in a more comprehensive manner or “riskiness” issue can be analysed through its relationship with inflation.

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