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The Relationship between the Exchange Rate, Interest Rate and Inflation: The Case of Turkey[1]

Ercan Özen[*], Letife Özdemir[**], Simon Grima[***]

Abstract

The purpose of the study is to measure the effects of changes in exchange rates and interest rates on inflation and to determine which of the exchange rates or interest rates has a greater impact on inflation rate following the July 15, 2016 coup attempt in Turkey. Our expectation is that similar to most authors is to find that there is a long-term relationship between the inflation rates and both the exchange rate and interest rates and that the effect of the exchange rate on the Producer Price Index (PPI) is greater than that of the interest rates. Moreover, we expect to find a unidirectional causality relationship between the Interest Rate of Commercial Banks Credit (IRBC), Over Night Interest Rate (O/N) and United States Dollar (USD) and the PPI, but not between the IRBC, O/N, USD and the Consumer Price Index (CPI).

Keywords: Turkey; Foreign Exchange; Interest rate; Inflation; Fisher Effect.

JEL classification: F31; O24; E4; E31; E43; P24; P44.

1. INTRODUCTION

One of the main objectives of the central bank of a country is that of price stability, specifically ensuring that the inflation rate is controlled and maintained as low as possible. Of course, other primary objectives of are that of ensuring economic growth, equitable income distribution and employment, providing exchange stabilization and ensuring a healthy foreign trade balance (Balance of Payments). Central banks use price stability as one of the main indicators to make reliable predictions about the future. This enables economic units to make informed decisions and thereby distribute the resources more efficiently since they are using information that is more reliable.

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[*] University of Usak, Usak, Turkey; e-mail: *ercan.ozen@usak.edu.tr*.

[**] University of Afyonkocatepe, Afyonkarahisar, Turkey; e-mail: *letifeozdemir@aku.edu.tr*.

[***] University of Malta, Msida, Malta; e-mail: *simon.grima@um.edu.mt*.

A permanent decrease in inflation rate decreases the inflation risk premium and consequently the interest rates. Low interest rates will have a positive effect on investment decision and economic growth. On the other hand, a high inflation rate has significant negative effects on the economy for the opposite reasons.

When inflation rate increases, fixed income employees suffer due to having less purchasing power and income inequality increases. In addition, as suggested by the Fisher Effect Theory, this rise in inflation puts pressure on the exchange rates, which result in an increase. Production costs also increase resulting from the increase in interest rates as inflation rises.

Therefore, we will then have a cost-push inflation with a spiral effect. The rising interest rate directs the economic units to target interest yield instead of the high-risk production. Figure no. 1 below shows the trend of the USD/TRY exchange rate, the Interest Rate of Commercial Banks Credit (IRBC) and the inflation rates (PPI and CPI) during the last eleven years in Turkey.

Following the monetary expansion policy, by the FED in the US after the 2008 global financial crisis, the USD/TRY exchange rate in Turkey became stable and interest rates decreased. Significant decreases were, also experienced in the Producer Price Index (PPI). In addition, we note that the increases in PPI had a positive effect on the Consumer Price Index (CPI). This positive trend in CPI continued until mid-2016.

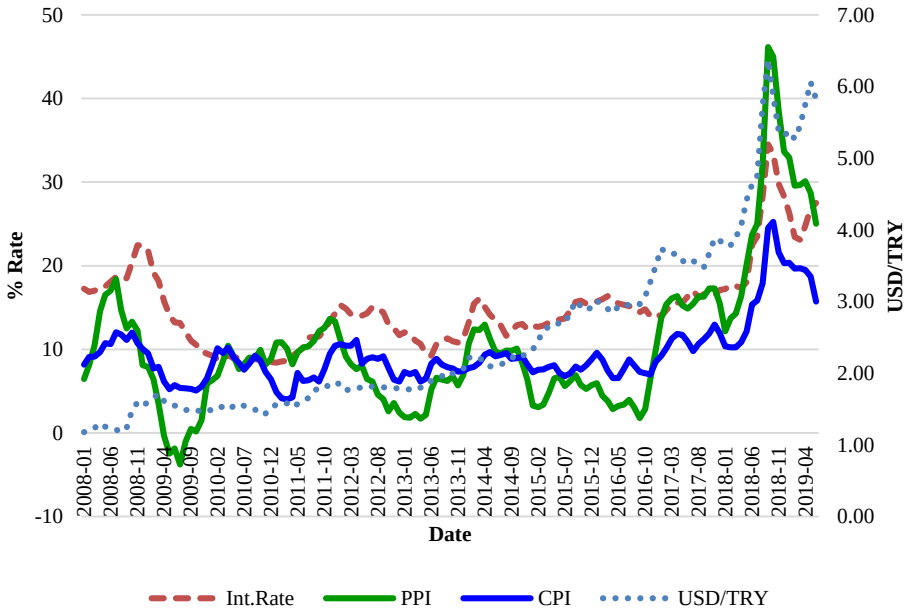

Figure no. 1 – Rate of PPI and CPI in Turkey During the Last Decade
Source: Adopted from Central Bank of the Republic of Turkey (2019)

However, in the second half of 2016 we note an increase in the USD/TRY exchange rate, the interest rate and both the PPI and CPI. It must be highlighted that during this period a Coup Attempt had occurred in Turkey. Following this event, which happened on July 15, 2016 a serious breakdown, can be observed in the data of Figure no. 1. Following this breakdown, all of the indicators during August 2018 increased to maximum negative levels. The Central Bank tried to take measures against the increasing exchange rate by increasing interest rates and the USD/TRY exchange rate spiked upwards to a high level of 7.00, together with the PPI which rose to a 46% level. In turn, the CPI approached a 25% level. Against the will of the government, the Central Bank of Turkish Republic (CBRT) in response to the increase in the exchange rate, used delaying tactics to slow down the interest rate hike.

Excessive increases in the exchange rates have a negative impact on Turkey's economy. This is due to the high import dependency ratio of production and exports. For example, in the petroleum products industry, which is an important input for the industry, the import dependency ratio is of 70.4% (Yükseler, 2019). When the prices of imported products in the industry increase due to the increase in the exchange rates, a cost-related inflation problem arises.

Although the increases in exchange rates have negative effects on inflation, the effect of the increase in interest rate on inflation rate can be either positive or negative. One of the reasons why interest rates are increased can be to balance the increasing exchange rates. In this case knowing the impact of increases in the exchange rate increases and interest rate on inflation rates becomes important.

The Turkish policy makers had two options in 2018, either:

i) to maintain the interest rate constant but as a result be unable to prevent the exchange rate increase; and end up with a resultant cost-based inflation, or
ii) to prevent the exchange rate increase by increasing the interest rates; and end up having an interest-rate based inflation.

Therefore, for this reason we aim investigate whether the exchange rate or the interest rate has a stronger influence on the level of inflation. This will help in deciding the best option of the two.

Specifically our objective is (i) to determine the causal relationship between the exchange rates, the interest rates and the level of inflation and (ii) to determine the level of influence of the exchange rate and the interest rates on the level of inflation.

2. THE RELATIONSHIP BETWEEN THE INFLATION RATE, INTEREST AND CURRENCY RATE: THE THEORETICAL FRAMEWORK

2.1 Relationship between Exchange Rate and Inflation

The arbitrage mechanism leads to the elimination of the difference between the prices of a product in different markets. In accordance with the law of one price, which is the result of this, the price of a product must be the same in all world markets. Exchange rates must be used to equalize the price of the products in different countries (purchase price parity). According to the purchasing power parity; the value of one country's national currency versus another country's currency depends on the prices of similar products and services in those countries (Seyidoglu, 2003, p. 119; Camilleri *et al.*, 2019).

Absolute purchasing power parity when the domestic price index is expressed as P_d, the exchange rate S and the foreign price index as P_f, is expressed as:

$$P_d = S\ x\ P_f \tag{1}$$

The relative purchasing power parity (RPPP) explains how the exchange rates should change, not the value of the exchange rate at a given moment. RPPP when the domestic price index is expressed as P_d, the beginning of the period exchange rate S_0, the end of the period exchange rate S_1 and the foreign price index P_f; is expressed as:

$$\frac{S_1 - S_0}{S_0} = P_d - P_f \tag{2}$$

In the event of an increase in the exchange rates at a certain level of inflation, production costs increase due to imported inputs. Increasing production cost, increases the producers' price inflation (PPI) and indirect consumer inflation (CPI). When the economy enters the "Dollarization" period, the final sellers takes the increasing exchange rates as the "anchor" for them. During these periods, the sales prices of the products are indexed to the increases in the exchange rate without the need to relate to the cost. Although there is a later decrease in exchange rates, the consumer prices do not decrease sufficiently due to "price stickiness".

2.2 Relationship between Interest Rate and Inflation

According to the Fisher effect theory, the nominal interest rate (i) is equal to the sum of the real interest rate (α) and the expected inflation rate (p) in each country (Seyidoglu, 2003, p. 145). This is called the Domestic Fisher effect.

$$i = \alpha + p \tag{3}$$

Moreover, this theory implies that an increase in the inflation rate increases the nominal interest rate by the same amount under the assumption that the real interest rate is fixed. The generalized Fisher effect theory shows that the nominal interest rate difference in two countries will be equal to the inflation rate difference of these countries. In case of an inflation rate increase, the fact that nominal interest rates remain constant will decrease the real return of capital, thus the supply of capital in the country will decrease.

In contrast, interest is a price paid for using capital. Therefore, interest is one of the production costs. In this case, increasing interest rates will have an effect on increasing production costs and consequently inflation. On the other hand, if there is demand pressure in the economy, interest rate increases are made to reduce consumption and inflation is brought under control.

2.3 Relationship between Exchange Rate and Interest Rate

According to the International Fisher Effect theory, the differences between the nominal interest rates in the related countries are equal to the expected changes in the exchange rates of the related countries (Seyidoglu, 2003, p. 148). This relationship is similar to equation (2) shown above (I_d, domestic interest; I_f, foreign interest);

$$\frac{I_d - I_f}{I_f} = P_d - P_f \quad (4)$$

The decrease in the nominal interest rates lowers the return of the domestic currency, which leads to a shift in the demand for the foreign currency. In addition, foreign investors withdraw their money from the market due to falling returns. In both of these cases, there is an increase in exchange rates. On the other hand, there may be an increase in exchange rates as a result of the supply-demand imbalance caused by capital flows.

In this case, the costs of imported raw materials and other inputs required for domestic production will increase. If cost inflation is not desired, the increase in the exchange rate will be prevented by the interest rate increase in the country that does not apply a fixed exchange rate system. Although, there are many approaches explaining the formation of exchange rates (Seyidoglu, 2003, pp. 155-179), this is outside the scope of our study.

Exchange rates, interest rates, and inflation rates interact mutually. For a healthy economic growth, there should be a balanced relationship between them. Looking at the causes of inflation, one must note, two dimensions in demand and cost (Taban and Sengur, 2016).

Demand inflation arises when the increase in consumption is faster than the increase in production. Cost inflation is the result of an increase in the prices of inputs used in production. Factors leading to inflation, such as money supply (emissions) are negative effects on economic growth, exchange rates and interest rates (Ekren, 2000). The increase in emissions and economic growth creates demand, causing inflation. Increases in exchange rates and interest rates also cause inflation, as production factors increase their prices. These relationships are shown in Figure no. 2 below.

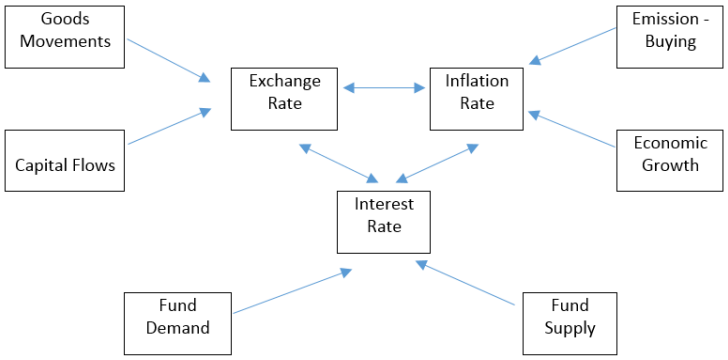

Figure no. 2 – Relationship between Currency, Inflation and Interest Rate
Source: Adopted from Ekren (2000, p. 10)

3. LITERATURE REVIEW

Several authors have studied and discussed the relationship between the exchange rates, inflation rates and interest rates, dealing with different interests and countries.

Asari *et al.* (2011) investigated the relationships between the Malaysian inflation rate, the interest rates and the exchange rates between the period 1999 and 2009. They found that an increase in interest rates would be effective in curbing exchange rate volatility and that

there is a one-way causality relationship from interest rates to inflation and from inflation to exchange rates. On the other hand, they show that there was no causality relationship between inflation and exchange rates. They also show that exchange rates are not the cause of inflation changes and inflation is not the cause of interest rates changes.

In contrast, Gül and Ekinci (2006) found a one-way causal relationship of the exchange rate toward inflation in Turkey during the period between 1984 and 2003. They explain that this is because the exchange rates increase the domestic prices of production and imported goods. They note that the exchange rate-inflation interaction varies according to the economic structure of the countries.

Although, different results can be seen in various countries (such as Rana and Dowling, 1985 and Kholdy and Sohrabian, 1990), foreign exchange increases in countries with high import dependency, increase inflation. According to Leigh and Rossi (2002), the increase in exchange rate increases inflation in Turkey. This effect begins to appear in the first four months and lasts for 1 year. Between 1994 and 2002, exchange rates affected the PPI more than the CPI. The exchange rate effect on the PPI is 0.60 points, while the effect on the CPI is 0.45 points. The reason for this situation is particularly dependent on energy imports to Turkey's production. It is seen that the exchange rate-inflation relationship has also changed according to the period. Besides, Sever and Mızrak (2007) inform us that fluctuations in the exchange rate have an important effect on the domestic inflation and interest rates in Turkey.

Rittenberg (1993) in his study, on the Turkish economy after 1980, determined that there is a one-way relationship from inflation to the exchange rate. He found that the devaluations seen after 1980 were not the main determinant of domestic prices, and that inflation was effective in the formation of the exchange rates. In contrast, Rana and Dowling (1985) determined in their study on 9 Asian countries that the exchange rate policy was not effective on inflation. Kholdy and Sohrabian (1990) found a bidirectional causality relationship between the general level of prices and the exchange rate for other countries except Canada in the Granger causality analysis, which they applied in the econometric study covering Germany, Canada and Japan. Iscan and Kaygisiz (2019), in their study addressing the exchange rate in Turkey during the period between 2009 and 2017 investigated the relationship between inflation and interest rates. They found that the exchange rates are the cause of both inflation and interest rates and that there is a one-way relationship from inflation to interest rate. Oner (2018), on the other hand could not find a causality relationship from inflation rates to the exchange rate. Akinci and Yilmaz (2016) studies find results consistent with Iscan and Kaygisiz (2019) and Oner (2018).

While the inflation rate increases the interest rate in the short term, studies for the long term show that the interest rate has an effect on inflation (Amaefula, 2016). The reason for this is the cost of capital, which is one of the production factors of interest rates. The fact that the interest rates are high for a long time increases the production costs and thus increases the inflation.

Various studies show the Fisher Hypothesis to be valid, amongst these are studies by Lardic and Mignon (2003), who studied the G7 countries between 1970 and 2001; Wong and Wu (2003) who carried out their studied on the G7 and eight Asian countries; Madsen (2005), who studied 16 OECD countries; Herwartz and Reimers (2006) who studied 100 countries; Kasman *et al.* (2006) who studied 32 developed and developing countries; Berument *et al.* (2007) who studied the G7 and 45 developing countries between the period 1957 and 2004 and Beyer *et al.* (2009) who studied 15 developed countries between the period 1957 and 2007.

However, there are also studies such as those of Dutt and Ghosh (1995) for the Canadian economy, Inder and Silvapulle (1993) for the Australian economy, Linden (1995) for the Finnish economy, Coppock and Poitras (2000), Ito (2009), that demonstrate the contrary that the Fisher Hypothesis is not valid.

When the relations between the inflation rate, the interest rate and the exchange rates are analysed, it is seen that the relations change according to the period, country and economic conditions. For this reason, it is important to develop healthy policies for financial and economic balances with correct analysis for each country.

4. EMPIRICAL METHOD

The long-term relationship between the exchange rate, the interest rate, and the inflation rate was tested using the Johansen co-integration test, followed by the fully modified least squares (FMOLS) estimation method, which was applied to see the long-term effect of the exchange rate and the interest rate on inflation. In the last stage, the direction of causality between the variables was determined by the Granger causality test.

4.1 Co-integration

Co-integration means that the variables move together in the long-run. If all variables are stationary at the same level, co-integration methods are used to test whether there is a long-term relationship between the series. The existence of a long-term equilibrium relationship between variables was investigated according to the co-integration method developed by Johansen (1988) and Johansen and Juselius (1990). The Johansen co-integration test is based on the vector auto-regression model (VAR) analysis. The VAR model is shown as follows (Brooks, 2008).

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_k y_{t-k} + u_t \quad (5)$$

$$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \cdots + \Gamma_{k-1} \Delta y_{t-(k-1)} + u_t \quad (6)$$

Γ and Π represent coefficient matrices. Coefficient matrix Π contains information about long-term relationships. In Johansen and Juselius co-integration method, two different test statistics, trace test statistics, and maximum eigenvalue test statistics, have been developed to reveal the existence of the co-integration relationship and the number of a co-integrated vector. These test statistics are as follows;

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} ln(1 - \hat{\lambda}_i) \quad (7)$$

and

$$\lambda_{max}(r, r+1) = -T\, ln(1 - \hat{\lambda}_{r+1}) \quad (8)$$

The co-integration vector number is represented by r. Trace test statistics investigate the co-integration relationship as r and maximum eigenvalue test statistics investigate the co-integration relationship as r + 1 (Brooks, 2008).

4.2 Estimation for Long-Run Relationship

Following this, the existence of a long-term relationship between the variables is tested. Different estimation methods are used to estimate the long-term parameters of the variables. While there is a co-integration relationship between variables, there is a problem of correlation and endogeneity between explanatory variables and error terms. In this case, variables lose their asymptotic properties (Berke, 2012).

The Fully Modified Least Squares (FMOLS) estimation method was obtained by Phillips and Hansen (1990) with the development of the Least Squares method. The FMOLS estimation method is a semi-parametric correction method that takes into account the correlation and endogeneity problems arising from the co-integration relationship between the variables (Phillips and Hansen, 1990; Shahbaz, 2009; Priyankara, 2018). The FMOLS estimator is expressed as follows.

$$\hat{\theta}_{FMOLS} = \begin{bmatrix} \hat{\beta} \\ \hat{\gamma}_1 \end{bmatrix} = \left(\sum_{t=2}^{T} Z_t Z_t' \right)^{-1} \left(\sum_{t=2}^{T} Z_t y_t^{+} - T \begin{bmatrix} \hat{\lambda}_{12}^{+\prime} \\ 0 \end{bmatrix} \right) \tag{9}$$

y_t^+ and $\hat{\lambda}_{12}^+$ are the correction terms for endogeneity and series correlation, respectively. The FMOLS estimator is asymptotically neutral and has an asymptotically normal distribution (Adom *et al.*, 2015).

4.3 Causality

Granger Causality test is used to determine whether there is a cause-effect relationship between variables and to determine the direction of causality relationship if any. The Granger causality test equations are as follows (Gujarati, 2001).

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i Y_{t-i} + \sum_{j=1}^{m} \beta_j X_{t-j} + u_{1t} \tag{10}$$

$$X_t = \alpha_0 + \sum_{i=1}^{m} \lambda_i X_{t-i} + \sum_{j=1}^{m} \delta_j Y_{t-j} + u_{2t} \tag{11}$$

Here m indicates the length of the lag and u_{1t} and u_{2t} error terms are supposed to be white noise, which is distributed with null average and constant variance and whose common variance is null. Equation (10) indicates the causality from X to Y, Equation (11) indicates the causality from Y to X. In Equation (1) if the null hypothesis (H_0) is $\beta_j = 0$, X is not the cause of Y; if hypothesis 1 (H_1) is $\beta_j \neq 0$, X is the cause of Y. In Equation (2) if the null hypothesis (H_0) is $\delta_j = 0$, Y is not the cause of X; if hypothesis 1 (H_1) is $\delta_j \neq 0$, Y is the cause of X.

5. DATA

The purpose of the study is to measure the effects of changes in exchange rates and interest rates on inflation and to determine which of the exchange rates or interest rates has a greater impact on inflation following the July 15, 2016 coup attempt in Turkey. In this study, the Dollar selling rate, CBRT overnight interest rates, Credit interest rates used by the banks and the Producer Price Index and Consumer Price Index both used to represent inflation, were used as variables. Monthly data between July 2016 and June 2019 were used in the analyses. Data were obtained from the Turkey Statistical Institute and CBRT. The variables and their abbreviations included in the study are shown in Table no. 1.

Table no. 1 – Variables and Abbreviations

Variables	Abbreviations
Producer Price Index	PPI
Consumer Price Index	CPI
Dollar Selling Rate	USD
CBRT Overnight Interest Rates	O/N
Interest Rates of the Commercial Banks Credit	IRBC

To examine the relationship between variables, it is necessary to first determine whether the time series is stationary.

The unit root properties of the time series used in the study were investigated by unit root tests developed by Dickey and Fuller (1979) (Augmented Dickey-Fuller, ADF) and Phillips and Perron (1988) (PP). Unit root test results are given in Table no. 2.

Table no. 2 – Unit Root Test Results

Variables	Augmented Dickey-Fuller (ADF) Test		Phillips Perron (PP) Test		Stationary Level
	Level	Difference	Level	Difference	
PPI	-2.086868	-3.314075**	-1.522155	-3.142270**	I(1)
CPI	-1.820089	-3.440166**	-1.231477	-3.440166**	I(1)
IRBC	-1.107310	-3.718342***	-0.804512	-3.702393***	I(1)
O/N	-0.352614	-6.002059***	-0.375913	-5.998954***	I(1)
USD	-1.066545	-4.761490***	-0.816353	-3.277764**	I(1)

, ** and * indicates statistical respectively significance at the 10, 5 and 1percent levels.*

When Table no. 2 is examined, according to ADF and PP unit root test results, the series have a unit root. Thus, it is concluded that the null hypothesis that there is a unit root in the series is accepted and the level values of the series are not stable. When the first difference of the series was taken, the null hypothesis was rejected at 1% significance level. Thus, the series became stationary at the first difference I (1).

6. EMPIRICAL RESULTS

PPI and CPI variables were used to represent inflation. Therefore, the analysis has been performed in two ways to measure the effects of changes in exchange rates and interest rates on inflation.

6.1 Relationship between the PPI and IRBC-O/N-USD

In order to determine the relationship between the stationary series in the first difference, it is necessary to first examine whether there is a co-integration relationship between the series. The existence of a long-term equilibrium relationship between the series was investigated according to the co-integration method developed by Johansen (1988) and Johansen and Juselius (1990). Before applying the co-integration test, it requires determining the appropriate delay length. The appropriate lag length for the co-integration test was determined using the conventional VAR model. The optimal lag length was determined as 3 according to Akaike (AIC) and Hannan-Quinn (HQ) information criteria. Johansen (1988) and Johansen and Juselius (1990) co-integration test results are given in Table no. 3.

Table no. 3 – Co-integration Test Results

Hypothesis	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
r=0*	98,90755	55,24578	0,0000	43,30401	30,81507	0,0009
r≤1*	55,60354	35,01090	0,0001	39,81934	24,25202	0,0002
r≤2	15,78420	18,39771	0,1118	12,66755	17,14769	0,1997
r≤3	3,116652	3,841466	0,0775	3,116652	3,841466	0,0775

Note: Trace test indicates 2 co-integrating eqn(s) at the 0.05 level
** denotes rejection of the hypothesis at the 0.05 level*
***MacKinnon-Haug-Michelis (1999) p-values*

As a result of the comparison of maximum eigenvalue and trace statistics obtained by the Johansen co-integration test with critical values, it is seen that there are 2 co-integration vectors with 5% significance level. According to these results, it is possible to say that a long-term equilibrium relationship between variables is valid during the analysis period.

After the long-term relationship between the PPI and the IRBC, the O/N, the USD was determined, the FMOLS estimator was used to estimate the long-term coefficients of each variable. The FMOLS model equation is as follows.

$$\text{Model 1: } PPI = \alpha_2 + \alpha_{21} IRBC + \alpha_{22} O/N + \alpha_{23} USD + \varepsilon \quad (12)$$

In the equation, ε represents the error term of the model. At the end of the test, we checked and examined which variables were effective on CPI and the effect size of the variables affecting CPI. The results of the analyses are presented in Table no. 4.

Table no. 4 – FMOLS Test Results

PPI	FMOLS	
Variables	**Coefficient**	**t-statistic**
C	-76,76483	-4,617723***
IRBC	25,09229	2,223027**
O/N	-6,043962	-1,006651
USD	26,83105	1,967313*
R^2 = 0.899246	Adj. R^2 = 0.889495	

*Note: *, ** and *** indicates statistical significance respectively at the 10, 5 and 1 percent levels.*

When the FMOLS test results in Table no. 4 are examined, it is seen that there is a statistically significant and positive relationship between the dollar sales rate (USD) and PPI in the long-run. The 1% increase in the dollar sales rate affects the PPI increased by 26.83%.

On the other hand, a statistically significant and positive relationship was found between IRBC and PPI in the long-term at 1% significance level. 1% increase in IRBC variable affects the PPI increase by 25.09%. The fact that the coefficient of the O/N variable is not significant, it can be interpreted as not having a sufficient effect on the PPI during the relevant period.

The high R^2 value (0.89), which is among the diagnostic tests of the model, shows that 89% of the changes in the dependent variable can be explained by the changes in the independent variables. This is evidence of the suitability of the models.

Finally, we investigated whether there is a causal relationship between the variables. Granger (1988) stated that when there is a long-term relationship between variables, Standard Granger Causality will not be valid and in this case, it is more appropriate to carry out the causality analysis between the series within the error correction model. Granger causality test applied to the error correction model is given in Table no. 5.

Table no. 5 – Granger Causality Test Results.

Hypothesis	**X^2 Statistic**	**Probability**	**Direction of Causality**
IRBC does not Granger cause PPI	7,340228	0,0618	
PPI does not Granger cause IRBC	0,918882	0,8209	IRBC ⟶ PPI
O/N does not Granger cause PPI	21,26472	0,0001	
PPI does not Granger cause O/N	0,830945	0,8421	O/N ⟶ PPI
USD does not Granger cause PPI	16,76795	0,0008	
PPI does not Granger cause USD	3,193900	0,3625	USD ⟶ PPI

*Note: *, ** and *** indicates statistical significance respectively at the 10, 5 and 1percent levels.*
⟶ *means a one-way causality relationship.*

Empirical results show that the null hypothesis that the IRBC variable is not the Granger cause of the PPI variable is rejected at 5% significance level and that there is a unidirectional Granger causality relationship from the IRBC variable to the PPI variable.

It was also determined that the null hypothesis that the O/N variable is not a Granger cause of the PPI variable was rejected at 1% significance level, and therefore there was a unidirectional Granger causality relationship from the O/N variable to the PPI variable.

On the other hand, it was found that the null hypothesis that the USD variable was not a Granger cause of the PPI variable was rejected at 1% significance level and that there was a unidirectional Granger causality relationship from the USD variable to the PPI variable.

6.2 Relationship between the CPI and IRBC-O/N-USD

In order to determine the relationship between the stationary series in the first difference, it is necessary to first examine whether there is a co-integration relationship between the series. The existence of a long-term equilibrium relationship between the series was investigated according to the co-integration method developed by Johansen (1988) and Johansen and Juselius (1990). Before applying the co-integration test, it requires determining the appropriate delay length. The appropriate lag length for the co-integration test was determined using the conventional VAR model. The optimal lag length was determined as 3 according to Akaike (AIC) and Hannan-Quinn (HQ) information criteria. Johansen (1988) and Johansen and Juselius (1990) co-integration test results are given in Table no. 6.

Table no. 6 – Co-integration Test Results

Hypothesis	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
r=0*	91,80395	55,24578	0,0000	41,58081	30,81507	0,0017
r≤1*	50,22314	35,01090	0,0006	33,91553	24,25202	0,0020
r≤2	16,30761	18,39771	0,0957	13,21459	17,14769	1,1709
r≤3	3,093024	3,841466	0,0786	3,093024	3,841466	0,0786

Note: Trace test indicates 2 co-integrating eqn(s) at the 0.05 level
** denotes rejection of the hypothesis at the 0.05 level*
***MacKinnon-Haug-Michelis (1999) p-values*

As a result of the comparison of maximum eigenvalue and trace statistics obtained by the Johansen co-integration test with critical values, it is seen that there are 2 co-integration vectors with 5% significance level. According to these results, it is possible to say that a long-term equilibrium relationship between variables is valid during the analysis period.

After the long-term relationship between CPI and IRBC, O/N, USD was determined, the FMOLS estimator was used to estimating the long-term coefficients of each variable. The FMOLS model equation is as follows.

$$\text{Model 2: } CPI = \alpha_1 + \alpha_{11} IRBC + \alpha_{12} O/N + \alpha_{13} USD + \varepsilon \quad (13)$$

In the equation, ε represents the error term of the model. At the end of the test, it was tried to determine which variables were effective on CPI. The effect size of the variables affecting CPI was examined. The results of the analyses are presented in Table no. 7.

Table no. 7 – FMOLS Test Results

CPI	FMOLS	
Variables	**Coefficient**	**t-statistic**
C	-0,201920	-0,398836
IRBC	0,517299	1,504859
O/N	0,024432	0,133619
USD	0,819461	1,972939*
R^2 = 0.901298	Adj. R^2 = 0.891747	

*Note: *, ** and *** indicates statistical significance respectively at the 10, 5 and 1percent levels.*

When the FMOLS test results in Table no. 7 are examined, it is seen that there is a statistically significant and positive relationship between the dollar sales rate (USD) and the CPI in the long run. The 1% increase in the dollar sales rate affects the CPI increase by 0.81%.

The coefficients of the IRBC and the O/N variables were not significant. This result can be interpreted as showing that the variables did not have a sufficient effect on the CPI in the relevant period.

The high R^2 value (0.90), which is among the diagnostic tests of the model, shows that 90% of the changes in the dependent variable can be explained by the changes in the independent variables. This is evidence of the suitability of the models.

Finally, we investigated whether there is a causal relationship between the variables. Granger (1988) stated that when there is a long-term relationship between variables, Standard Granger Causality will not be valid and in this case, it is more appropriate to carry out the causality analysis between the series within the error correction model. Granger causality test applied to the error correction model is given in Table no. 8.

Table no. 8 – Granger Causality Test Results.

HYPOTHESIS	X^2 Statistic	Probability	Direction of Causality
IRBC does not Granger cause CPI	2,243188	0,5235	
CPI does not Granger cause IRBC	4,166229	0,2441	IRBC ⟶/⟵ CPI
O/N does not Granger cause CPI	1,393593	0,7070	
CPI does not Granger cause O/N	0,186103	0,9798	O/N CPI
USD does not Granger cause CPI	2,971316	0,3961	
CPI does not Granger cause USD	0,991995	0,8032	USD CPI

*Note: *, ** and *** indicates statistical significance respectively at the 10, 5 and 1percent levels.*
means a one-way causality relationship.

When the causality test results are examined, it is seen that the null hypothesis that there is no Granger cause between the CPI and the IRBC, the CPI and the O/N, the CPI and the USD at 1%, 5%, and 10% significance levels is not rejected. According to these results, there is no Granger causality relationship between the CPI and the IRBC, the CPI and the O/N, the CPI and the USD variables.

7. CONCLUSIONS

For a healthy economy, one needs to maintain a balance between the Inflation rate, the interest rates and the exchange rates. Changes in production and trade between countries or some instability cause these variables to change as well. Interest rates and exchange rates affect the economy in different ways. The interest, the exchange rate and the inflation level required to have a healthy economy are always the subject of debate.

In this study, were we have investigated (i) the causal relationship between the inflation rates and both exchange rate and interest rate and (ii) whether the interest rate or the exchange rate between 2016 July and June 2019 in Turkey, has more effect on Inflation; it was determined that there was a long-term equilibrium relationship between the inflation rate and exchange rate and interest rates as a result of the Johansen co-integration test during the analysis period.

The results of the FMOLS regression model show that the effect of the USD exchange rate on PPI is more than that of bank loan interest rates. In addition, as a result of causality analysis, a unidirectional causality relationship was determined from credit interest rates to the PPI, from the O/N interest rates to the PPI and from the USD exchange rates to the PPI.

Analyses for the CPI give different results. According to the FMOLS test results, no significant relationship was found between the CPI and interest rates. However, the USD exchange rate has a statistically significant effect on the CPI. There was no causal relationship between the credit interest rates and the CPI, between the O/N and the CPI, and between the USD and the CPI.

It is possible to say that the difference of the results of the analysis on the PPI and the CPI, due to the retail companies could not relate the purchase costs to the sales prices.

The most important finding of the study is that the exchange rate has a greater effect than the interest rate on inflation in the relevant period. This is due to the fact that the production in Turkey is significantly dependent on imports. Therefore, Turkey's economy does not have enough defence systems against exchange rate attacks. Accordingly, it is important that policymakers should in the short, medium and long term take measures to reduce the dependence of production on import.

Findings of this study corroborate to the findings of some former studies such as those carried out by Akinci and Yilmaz (2016); Coppock and Poitras (2000); Dutt and Ghosh (1995); Gül and Ekinci (2006); Inder and Silvapulle (1993); Iscan and Kaygisiz (2019); Ito (2009); Leigh and Rossi (2002); Linden (1995); Oner (2018).

However, our findings do not validate the Fisher Effect theory and are different from the findings of studies carried out by Berument *et al.* (2007); Beyer *et al.* (2009); Herwartz and Reimers (2006); Kasman *et al.* (2006); Lardic and Mignon (2003); Madsen (2005); Rittenberg (1993); Terzi and Zengin (1996); Wong and Wu (2003), whose findings verify the validity of the Fisher effect theory.

On the other hand, there are some studies, such as Asari *et al.* (2011), on the relationship between inflation and the exchange rate, which comply with the Fisher Effect theory in reverse and provide complex results. Another study by Amaefula (2016), where the fisher effect theory is accepted in the short term but loses its validity in the long term, revealed that inflation increased interest rates in the short term, but interest rate has an effect on inflation in the long term.

Moreover, we note from literature that the validity of the Fisher Effect theory relates mainly to developed countries. Developing countries, on the other hand are more vulnerable to the exogenous factors due to their weak economy and therefore do not validate the Fisher Effect theory. Any fluctuation on capital movement, on oil prices, global supply and demand and even slight manipulative attacks affect their economy easily.

The Fisher effect theory differs based on time, economic circle and the economic structure of a country. For this reason, each country should correctly identify its own customised economic problem and implement the right custom policies.

In fact, our findings are of utmost importance for economists or anyone in Turkey who are/is involved in determining the monetary policies of the country and for investors who are or are thinking of investing in Turkish sovereigns.

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