The Validity of the International Fisher Hypothesis in Turkish Economy: Generalized Method of Moments

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Türkiye Ekonomisinde Uluslararası Fisher Hipotezi'nin Geçerliliği: Genelleştirilmiş Momentler Metodu

Özet

Uluslararası Fisher Hipotezi, enflasyon oranında meydana gelen bir değişimin faiz oranı üzerinde pozitif yönlü bir etki yaratacağı ve böylece ulusal paranın değer kaybedeceğini öne sürmektedir. Bu bağlamda, Uluslararası Fisher Hipotezi'nin Türkiye ekonomisinde 1975-2014 dönemi için geçerliliğini test edebilmek amacıyla Genelleştirilmiş Momentler Metodu kullanılmıştır. GMM analiz sonuçları, araç değişken olarak dikkate alınan gecikmeli enflasyon, faiz ve döviz kurlarının cari ve bir dönem gecikmeli enflasyon ve döviz kurları üzerinde pozitif etkiler yarattığını göstermiştir. Ayrıca, araç değişkenler iki dönem gecikmeli faiz oranları üzerinde pozitif etkiler yaratmasına karşın, cari ve bir dönem gecikmeli faiz oranları üzerinde ise negatif etkiler ortaya çıkarmış ve buna bağlı olarak da ulusal paranın değer kaybettiğini ortaya koymuştur. Analiz bulguları, Türkiye için Uluslararası Fisher Hipotezi'nin geçerli olduğunu göstermiştir.

Anahtar Kelimeler: *Uluslararası Fisher Hipotezi, Genelleştirilmiş Momentler Metodu, Johansen-Juselius Eşbütünleşme Testi, Granger Nedensellik Testi*

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Abstract

International Fisher Hypothesis asserts that a change in the inflation rate impacts a positive effect upon the interest rate and thus the national currency would depreciate. In this context, Generalized Method of Moments is applied to test the validity of International Fisher Hypothesis for Turkish economy in the period of 1975-2014. The results of GMM analysis show that one lagged values of interest, inflation and exchange rates, which are instrumental variables, have a positive effect on current and one lagged inflation and exchange rates. Besides, instrumental variables have a negative impact on current and one lagged interest rate, while they have a positive effect on two lagged interest rate and depending on this phenomenon national currency depreciates. The findings of the analysis show that International Fisher Hypothesis is valid for Turkey.

Keywords: *International Fisher Hypothesis, Generalized Method of Moments, Johansen-Juselius Cointegration Test, Granger Causality Test*

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1. Introduction

One of the most interesting issues in economics is the determination of the relations between inflation, interest and currency rates. Since the dynamic relations among the macroeconomic variables mentioned above were systematically analyzed by the American economist Irving Fisher (1896, 1930), it was named as the "Fisher Hypothesis" in economic literature. Fisher Hypothesis suggests that the rate of changing growth in money supply in long-run equilibrium level will be reflected to the nominal interest rates. The most significant point in this structure is that a change in the expected levels of inflation will affect the nominal interest rates, but not *vice versa* (Payne and Ewing, 1997: 683).

Fisher Hypothesis is analyzed with the help of three approaches: "Domestic Fisher Hypothesis", "Generalized Fisher Hypothesis" and "International Fisher Hypothesis". Domestic Fisher Hypothesis suggests that the nominal interest rate in an economy is equal to the sum of the real interest rate and the expected inflation rate. However this hypothesis may not be true at all times when the real interest rates may be affected by a changes in the economy policy. When the other conditions are constant, *ceteris paribus*, the relations between the nominal rate of interest, real rate of interest and the rate of inflation can be denominated by means of the following equation numbered (1) (Granville and Mallick, 2004: 87)

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

In equation numbered (1), i_t denominates the nominal interest rate, π_t shows the rate of inflation and r_t implies the rate of real interest. In order to find the value of r_t, the following equation numbered (2) can be used:

$$r_t=\frac{i_t-\pi_t}{1+\pi_t} \qquad (2)$$

In equation numbered (2), when the denominator is neglected, the basic determinants of the nominal interest rate consist of the rate of real interest and the rate of expected inflation $\left(\pi_t^e\right)$ at the start of the period. In this context, the rate of nominal interest is equal to the sum of real interest rate and the expected inflation rate:

$$i_t = r + \pi_t^e \tag{3}$$

The second way of interpreting Fisher Hypothesis is called as "Generalized Fisher Effect" or "Fisher Open" which is based on foreign trade-oriented countries. The Generalized Fisher Effect argues that the nominal interest rate differences between two countries are equal to the expected rate of inflation differences in the relevant countries (Seyidoğlu, 2009: 414). When two countries namely *X* and *Y* are taken into consideration, the Generalized Fisher Condition may be denominated as follows:

$$i_X - i_Y = \pi^e{}_X - \pi^e{}_Y \tag{4}$$

In equation numbered (4), i_X and i_Y denominate the nominal rates of interest in countries X and Y respectively, π_X and π_Y imply the expected rate of inflation in countries X and Y. In this context, equation numbered (4) suggests that in an economy where expected rate of inflation is high, the rate of nominal interest will be proportionately high. The basic reason of the idea depends on the arbitrage mechanism between the real and the financial assets. In case when the expected rate of inflation is high and the rate of interest is low, the household are mostly steered for the real assets instead of financial assets. On the contrary, in the case when the expected rate of inflation is low and interest rate is high, investing to financial assets is preferred. Therefore, the return on the financial assets accurately reflects the rate of expected inflation. Moreover, in the case of higher real interest return, the short-run funds will be transferred from countries with lower interest rates to countries with higher interest rates. When the real interests are equalized, the nominal interest rate difference between two countries will be equal to the differential of the expected inflation.

Fisher states that the nominal interest rate differences between the two countries reflect the information about expected changes of exchange rate. In this context, the relations between the interest rates and exchange rates are called as "International Fisher Effect". International Fisher Effect consists of the Generalized Fisher Effect and the relative purchasing power parity. The relative purchasing power parity interprets that differential of the expected rate of inflation between two countries is equal to the changes in expected rate of exchange:

$$\pi^{e}{}_{X} - \pi^{e}{}_{Y} = \frac{S_{t+1} - S_{t}}{S_{t}} \qquad (5)$$

In the equation numbered (5), S_t and S_{t+1} denote current and subsequent period's spot exchange rates, respectively. When the equations numbered (4) and (5) are combined, the International Fisher Relation can be expressed as follows:

$$\pi^{e}{}_{X} - \pi^{e}{}_{Y} = i_X - i_Y = \frac{S_{t+1} - S_{t}}{S_{t}} \qquad (6)$$

The equation numbered (6) shows that differential of inflation rates and the nominal interest rates reflect the changes in the expected exchange rates. In this context, in a country with high inflation rate, the interest and exchange rates will increase in the same rate and proportion and hence the national currency would be depreciated (Demirag and Goddard, 1995: 76).

The International Fisher Hypothesis asserts that the main determinants of exchange rate are current inflation, expected inflation and interest rate. Furthermore, it suggests that there is a one-to-one relationship between interest rate and inflation, causing exchange rate to increase. During the period which is subject to the analysis, the chronically high inflation caused the pressure on the nominal interest rate. For the purpose of preventing the high inflation rate the fixed exchange rate system applied until 2001 and the inflation rate was not reflected to exchange rate, hence the official exchange rate was appreciated. However, because the sustainability of the appreciated exchange rate was not carried on anymore, the devaluations became inevitable. After the year 2001, although the basis of the economy policy was determined as high interest rate-low exchange rate policy, the fragile economic structure revealed the depreciated exchange rate status in recent years. Besides, after the crisis of 2001 disinflation program of Turkey was introduced and there were some fundamental factors fostering the current success in the disinflation program such as easing the public sector fiscal disequilibrium, high-level private sector fixed capital formation and raising the total factor productivity. Moreover, a positive global conjuncture increased the foreign capital inflows to Turkey at an accelerating pace. Therefore, it can be said that such a process relatively strengthened the value of domestic currency and lowered the interest rate. As a matter of fact Turkey's ability to withstand inflation has begun to strong. Therefore, the stable decreases in both interest rate and exchange rate have been determined by some factors of Turkish economy, disinflation program and the positive global conjuncture.

This study encompasses the data from the Turkish economy between 1975 and 2014, because of availability of the data set. In this context, the validity of International Fisher Hypothesis is tested using Generalized Method of Moments (GMM) analysis. The aim of this study is to test International Fisher Hypothesis which has not been taken into consideration for Turkey before. Besides, the studies investigating the validity of Fisher Effect for Turkish economy mainly apply the various co-integration tests. Additionally, the superiority of this study compared with the other studies is that it tests the validity of International Fisher Hypothesis by using GMM analysis, providing dynamic and robust results, as well as the co-integration tests. In general, the findings of the GMM analysis point out that in order to estimate current exchange rate value, both current and one lagged values of inflation and exchange rates need to be taken into consideration. As well as these indicators, current and various lagged values of interest rates should be made allowance for estimating current value of exchange rate.

To this end, the paper consists of five sections. In the second section, the literature review is mentioned and in the third section, the methods and data set relating to the econometric application are introduced. Following the fourth section in which the research findings are pointed out, the study comes to an end with the conclusion section where a general evaluation is conducted.

2. Literature Summary

In economy literature, there are many studies testing Fisher Hypothesis and most of them are aimed to determine whether Generalized Fisher Hypothesis is valid or not. Although most of the studies reveal that the rate of the inflation has a positive effect on the rate of interest, some of them do not support such a relationship. The studies done by the following economists point out that Fisher Hypothesis is valid: Barthold and Dougan (1986), Hutchison and Keeley (1989), Gupta (1991), Pelaez (1995), Daniels et al. (1996), Choi (2002), Sun and Phillips (2004) and Million (2004) for USA economy; McDonald and Murphy (1989) for four developed countries; Woodward (1992) for British economy; Phylaktis and Blake (1993) and Carneiro et al. (2002) for three countries; Peng (1995) for five industrialized countries; Olekalns (1996) for Australian economy; Engsted (1996) for Danish economy; Crowder (1997) for Canadian economy; Junttila (2001) for Finnish economy; Berument and Jelassi (2002) for 26 countries; Atkins and Coe

(2002) and Atkins and Chan (2004) for USA and Canada economies; Lardic and Mignon (2003) for G7 countries; Wong and Wu (2003) for G7 countries and eight Asian countries; Madsen (2005) for 16 OECD countries; Herwartz and Reimers (2006) for 100 countries; Kasman et al. (2006) for 33 developed and developing countries; Berument et al. (2007) for G7 countries and 45 developing countries; Beyer et al. (2009) for 15 developed countries; Tsong and Hachicha (2014) for several selected developing countries and Etuk et al. (2014) for Nierian economy.

There are some studies showing no causality relationship between inflation and interest rates, also. The studies done by the following economists show that Fisher Hypothesis is invalid: Jaffe and Mandelker (1976), Summers (1982), Graham (1988) and Mishkin (1993) for USA economy; Cumby and Obstfeld (1980) and Kane et al. (1983) for six developed countries; Gultekin (1983) for 26 countries; Moazzami (1991) and Dutt and Ghosh (1995) for Canadian economy; Inder and Silvapulle (1993) for Australian economy; Linden (1995) for Finnish economy; Coppock and Poitras (2000) for 40 countries, Ito (2009) for Japanese economy and Sheefeni (2013) for Namibian economy.

Although there are a few studies having tested Fisher Hypothesis for Turkish economy, no common findings are obtained. The studies done by Kesriyeli (1994), Kutan and Aksoy (2003), Turgutlu (2004), Simsek and Kadilar (2006), Köse et al. (2012), Lopcu et al. (2013) Arısoy (2013), Kıran (2013) and Akçacı ve Gökmen (2014) reveal that Fisher Hypothesis is valid, although the studies done by Cakmak et al. (2002), Gul and Acikalin (2008) and Yilanci (2009) show that the rate of inflation has no effect on the rate of interest. The detailed literature summary belongs to applied studies is shown in Appendix 1.

The studies investigating the validity of Fisher Effect for Turkish economy mainly apply the various co-integration tests. Nevertheless, in the study International Fisher Hypothesis is tested using GMM analysis. In this context, the main advantages of GMM analysis and why it is applied will be introduced in the next section.

3. Method and Data

In this study, the rate of consumer price inflation, money market nominal rate of interest and the exchange rate in terms of US dollar are taken into consideration so as to test the International Fisher Hypothesis using GMM analysis for Turkish economy between 1975 and 2014. GMM analysis is a superior technique and shows more powerful outcomes compared with the other estimation methods because we only need a moment condition, we do not need to log-linearize process, we do not encounter any non-linearites problems and it always displays the robustness to heteroscedasticity and distributional assumptions. All of these structures make GMM analysis widely applicable and it is questionable small sample database. The data set are obtained from the official websites of the Central Bank of the Republic of Turkey (CBRT) and Ministry of Development (MD).

In time series analysis, the properties of the series mainly cause spurious regressions, as Granger and Newbold (1974) suggests. Hence, Augmented Dickey-Fuller (ADF) unit root test developed by Dickey-Fuller (1979, 1981) is used to determine whether the variables are stationary (Yilmaz and Akinci, 2011: 369). By means of the unit root test, both spurious regression problems would be removed and the analysis results would be more reliable (MacKinnon, 1991: 266-267). The ADF unit root process is shown in the following equation numbered (7): (Asteriou and Hall, 2007: 297).

$$\Delta Y_t = \alpha_0 + \alpha_1 t + \delta Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + u_t \quad (7)$$

In the equation numbered (7) ΔY_t denotes the variable which is analyzed for unit root test, α_0 and $\alpha_1 t$ represent the coefficients which show systematical trend within the time series and u_t implies the white-noise error term (Ergul, 2010: 111). ADF unit root test analyses whether δ equals to zero or not. If H_0 hypothesis, $\delta = 0$ is rejected, it can be said that *Y* is stationary (Yamak and Kucukkkale, 1997: 6). In the regression equation numbered (7), *t* statistic calculated for $\delta = 0$ is compared with the critical values developed by MacKinnon (1991) and it is decided whether the variable is stationary or not. If the absolute value of the calculated *t* statistic is smaller than the absolute value of the Mackinnon critical values, it is concluded that the series is not stationary and if it is greater, it is concluded that the series is stationary (Tari, 2005: 395).

As well as ADF unit root test, KPSS unit root test is used, also. Unlike ADF test, in KPSS test the null hypothesis of no unit root defines that series is stationary (Kwiatkowski et al., 1992: 159). To test the hypothesis in question, the authors utilize form Lagrange Multiplier (LM) statistics (Yavuz, 2004: 241). KPSS statistics are basically based on error residuals that can be obtained as a result of Ordinary Least Squares (OLS) regression. This model can be illustrated with the help of equation numbered (8):

$$y_t = x_t{}'\delta + u_t \quad (8)$$

With the help of regression equation numbered (8), LM statistics can be calculated as:

$$LM = \sum_{t} S(t)^2 \Big/ \left(T^2 f_0\right) \qquad (9)$$

Where f_0 indicates the zero frequency residual spectrum value, *T* is the period number, $S(t)$ shows the cumulative residual function and it has been obtained with the help of equation numbered (10):

$$S(t) = \sum_{r=1}^{t} \hat{u}_r \qquad (10)$$

Error residuals in equation numbered (10) are formed by using the equation like $\hat{u}_t = y_t - x_t'\hat{\delta}(0)$. After all these transactions, the stationary information can be obtained both by taking LM statistic into consideration and by comparing critical values calculated by Kwiatkowski et al. (1992).

Following the unit root tests, in order to test the validity of International Fisher Hypothesis, Generalized Method of Moments (GMM) introduced first by Hansen (1982) is used. The basic point of GMM analysis is based on the prediction of the suitable moment for the observations in the model. Consequently, the first stage of implementing the analysis is based on realizing the moment condition which would assist the solution of the model. After that, it is required to realize the weighted matrix form which contains an important component in efficient GMM analysis. In order to apply GMM analysis, the *mxm* dimensional weighted matrix form need to be generated. In this context, GMM estimator tries to minimize the weighted matrices in the quadratic form where is occurred in the observation moment condition. Therefore, in order to create a more efficient estimator than OLS or Two Staged Least Squares (TSLS) estimator, it is obliged to add the past values of the explanatory variables to the model as a condition of the moment. Hence, more precise estimates can be done in the context of obtaining more accurate estimations (Wooldridge, 2001: 90-95).

While θ_0 denotes the unknown parameter factor, v_t implies the vector of random variables and f shows the vector of the function, the moment condition may be written in the form of the following equation numbered (11): (Hall, 2005: 14)

$$E\left[f\left(v_t, \theta_0 \right) \right] = 0 \tag{11}$$

GMM estimator that is based on equation numbered (11) is equal to θ that has a minimum value:

$$Q_T\left(\theta\right) = T^{-1}\sum_{t=1}^{T} f\left(v_t, \theta\right)' W_T T^{-1} \sum_{t=1}^{T} f\left(v_t, \theta\right) \tag{12}$$

In equation numbered (12) $Q_T\left(\theta\right)$ denotes GMM estimator, *T* shows the observation frequency and W_T represents the weighted matrix.

In the paper, in order to determine the long-run relationship among the variables used in the model, Johansen-Juselius Co-integration Analysis is used. The objective of applying this analysis is that all variables used in the model have volatile characteristics depending upon economic and financial process. Therefore, to analyze on moving in a certain direction trend in the long-run, it is appropriate to use a co-integration analysis. The Co-integration analysis suggest that even if the series are not stationary, these series may have a stationary linear combination which may be econometrically determined, so consequentially, a long-run relationship among the variables can occur (Tari, 2005: 405-406). The findings of the estimation provide consistent results only if the linear combination of the time series are stationary, in other words, if the series are integrated. The Johansen-Juselius co-integration process may be denoted by the following equation numbered (13): (Catik, 2006: 5)

$$\Delta X_t = A_0 + \Pi X_{t-p} + \sum_{i=1}^{p-1} A_i \Delta X_{t-i} + \varepsilon_t \tag{13}$$

Where X_t denotes the vector of variables which include the observations with number of *T* in dimension *(nx1)*, A_0 is constant term and Π denote the matrix form which shows the long-run relationship between the variables. Johansen (1988) and Johansen and Juselius (1990) suggest two different tests with the purpose of determining the numbers of co-integrated vectors, which are trace and maximum eigen values. In the trace value tests, the null hypothesis measures whether the rank of Π matrix equals to *r*; while in the maximum eigen value tests, the null hypothesis tries to determine whether the co-integrated vector number is *r*.

Besides, in the paper to determine whether any causality relationships exist or not between the variables the Granger Causality Analysis is applied. In Granger causality, the direction of the relationship between two variables namely *X* and *Y* shall be studied. If the value of *Y* can be estimated with the help of the past values of the variable *X*, Granger causality process may be mentioned from variable *X* to variable *Y* (Charemza and Deadman, 1993: 190). The following equations numbered (14) and (15) should be used to determine causality relationship between the two variables: (Kutlar, 2007: 267)

$$Y_t = \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{i=1}^{n} \beta_i X_{t-i} + \gamma_i ECM_{t-1} + u_{1t} \qquad (14)$$

$$X_t = \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{i=1}^{n} \beta_i Y_{t-i} + \gamma_i ECM_{t-1} + u_{2t} \qquad (15)$$

Where, *ECM* implies the error correction term which is obtained from co-integration equations. It is assumed that the error terms u_{1t} and u_{2t} is not related with each other. Therefore, both the equations (14) and (15) depend on the past values of the variables and they are also a function of their own past values.

4. Research Findings

In econometric models which are analyzed by using non-stationary data, it is highly probable to encounter spurious regression and hence, estimating results may reflect spurious relations. If series are not stationary in their level value, taking their difference values make the series stationary. In this way, it is possible to obtain more reliable results by solving spurious regression problem (MacKinnon, 1991: 266-276). In the paper, ADF and KPSS unit root tests are employed to determine whether the series are stationary.

To test whether inflation rate, interest rate and exchange rate are co-integrated, it is mandatory to analyze for the existence of unit roots by using various test techniques and the results of unit root tests are illustrated in Table 1. The results of the ADF and KPSS tests show that the series are stationary in their first difference values. Therefore, it is possible to say that the series are *I(1)*, in other words their integration levels are *I(1)*.

Table 1. Results of ADF and KPSS Unit Root Tests

Variable	ADF Test (Trend+Intercept)		KPSS Test (Trend+Intercept)	
	Level	First Difference	Level	First Difference
ER	-1.842(1)	-3.265(0)***	0.360(5)	0.160(0)***
ENF	-2.271(0)	-6.344(0)***	0.238(4)	0.178(1)***
IR	-1.482(0)	-6.287(0)***	0246(5)	0.181(1)***
Critical Values	***: -4.243	***: -2.632	***: 0.216	***: 0.191
	**: -3.544	**: -1.950	**: 0.146	**: 0.142
	*: -3.204	*: -1.611	*: 0.119	*: 0.107

Note: ER, INF and IR represent the exchange rate in terms of US dollar, consumer price inflation rate and money market nominal interest rate, respectively. ***, ** and * show the significance level at 1%, 5% and 10%, respectively. The values in parenthesis in ADF test are the optimum lag lengths which are determined by taking SIC criterion into consideration. In KPSS test, the values in parenthesis show the Bandwith values and these values indicate the optimum lag lengths which are determined by taking Newey-West information criterion into consideration.

Following the unit root tests, in order to determine the long-run relationships between ER, INF and IR Johansen-Juselius co-integration test is applied and the findings are illustrated in Table 2.

Table 2. Test Results of Johansen-Juselius Co-Integration Analysis

Variable Pairs	Trace Statistic	Critical Value at 5%	Critical Value at 1%	Maximum Eigen Value	Critical Value at 5%	Critical Value at 1%
ΔINF(1)-	19.397**	18.397	23.152	18.881**	17.147	21.744
ΔER(1)	3.516	3.841	6.634	3.516	3.841	6.634
ΔIR(1)-ΔER(1)	21.131**	18.397	23.152	18.881**	17.147	21.744
	1.899	3.841	6.634	3.516	3.841	6.634
ΔINF(1)-	18.452**	18.397	23.152	18.881**	17.147	21.744
ΔIR(1)	2.261	3.841	6.634	3.516	3.841	6.634

Note: ** shows the significance level at 5%. The values in parenthesis are the optimum lag lengths which are determined by taking AIC and SIC criterions into consideration. Δ implies the difference operator.

The test results of binary co-integration illustrated in Table 2 have put forward the existence of co-integration between INF, IR and ER. In this context, it is possible to say that there is a long-run relationship among the variables. In other words, inflation rate, interest rate and exchange rate have a common trend on moving in a certain direction and they can impact the each other in the long-run.

Correlation analysis does not mean causality nexus among the variables, while co-integration analysis does. Because of finding co-integration linkages among the variables, it is expected to point out at least unidirectional causal nexus among INF, IR and ER. Hence, in this step of the study, the causality relationships among the variables are tried to determine and the results of Granger causality analysis are shown in Table 3.

Table 3. Test Results of Granger Causality Analysis

Variable Pairs	Direction of Causality	*F* Statistic	*Prob* Statistic	EC_{t-1} (Prob)
ΔINF-ΔER(1)	→	4.779^{**}	0.015	-0.657^{**} (0.024)
ΔER-ΔINF(1)	-	0.540	0.588	0.115 (0.844)
ΔIR-ΔER(1)	→	3.638^{**}	0.038	-0.736^{***} (0.005)
ΔER-ΔIR(1)	-	0.109	0.896	-0.553 (0.427)
ΔINF-ΔIR(1)	→	2.992^{*}	0.083	-0.691^{***}(0.000)
ΔIR-ΔINF(1)	-	0.009	0.958	0.474 (0.602)

Note: ** and * show the significance level at 5% and 10%, respectively. The values in parenthesis are the optimum lag lengths which are determined by taking AIC and SIC criterion into consideration. Δ implies the difference operator. *EC* is the error correction term which is obtained from co-integration equations.

The results of Granger causality analysis show that there is a one-way causality relationship runs from INF and IR to ER and from INF to IR. In other words, a change in the inflation and interest rate affects the exchange rate, but not *vice versa*. Similarly, a change in the inflation rate causes an effect on the interest rate, but not *vice versa*. Besides, since the co-integration relationships are found among the variables, the error correction term (*EC)* obtained from co-integration models needs to be included in the causality model. The error correction terms, *EC*, are found to be negative and statistically significant, it can be said that the variables converge to their equilibrium level, and short-run imbalances will be overcome in the long-run.

Following causality test, GMM analysis is applied. The approach suggested by Brouwe and Gilbert (2005) is taken into consideration for determining instrumental variable in GMM analysis. The authors suggest that the correlation between instrumental and independent variables should be over minimum 0.30 for determining the instrumental variables. With the help of instrumental variables GMM analysis make the results more reliable. The lagged values of instrumental variables are determined by using information criterions such as AIC, SIC and HQ. In this context, AIC and SIC information criterions are used to determine optimum lagged values and according to both of the criteria the optimum lag length of instrumental variables is determined as 1. The correlation coefficients between instrumental and independent variables are illustrated in Table 4.

Table 4. The Correlation Coefficients between Instrumental Variables and Independent Variables

Variable	ΔINF	ΔIR	ΔER	ΔINF(-1)	ΔIR(-1)	ΔER(-1)
ΔINF	1.000					
ΔIR	0.747	1.000				
ΔER	0.774	0.712	1.000			
ΔINF(-1)	0.796	0.699	0.692	1.000		
ΔIR(-1)	0.709	0.884	-0.775	*0.749*	1.000	
ΔER(-1)	0.793	0.775	0.711	*0.697*	*0.796*	1.000

Note: The values in parenthesis are the optimum lag lengths which are determined by taking AIC and SIC criterion into consideration. Δ implies the difference operator.

Following the determination of instrumental variables, GMM analysis is applied to test whether International Fisher Hypothesis is valid for Turkish economy. The test results of GMM analysis are shown in Table 5.

Table 5. Test Results of GMM Analysis

Dependent Variable: ΔER
Instrumental Variables: C ΔINF(-1) ΔIR(-1) ΔER(-1)

Variable	Coefficient	*t*-Statistic	*t* (Prob)
Constant (C)	1.066***	2.447	0.000
ΔINF	0.017***	2.425	0.000
ΔINF(-1)	0.009**	2.110	0.035
ΔINF(-2)	-0.044	-1.012	0.267
ΔINF(-3)	-0.004	-1.320	0.216
ΔIR	-0.005***	-2.500	0.000
ΔIR(-1)	-0.036*	-1.986	0.075
ΔIR(-2)	0.044*	2.127	0.058
ΔER	0.011**	2.230	0.018
ΔER(-1)	0.036*	1.912	0.084
ΔER(-2)	0.152	0.984	0.416
ΔER(-3)	-0.007	-0.677	0.689
ΔER(-4)	-0.022	-0.840	0.463
EC(-1)	-0.549***	-2.681	0.000
Model Statistics			
R^2: 0.637	$\overline{R}^2$: 0.584	**DW:** 1.946	***J*-Statistic:** 0.047
F*-Statistic:** 2.661	**Prob (F):** 0.000	χ^2_{BG} : 5.201 (0.294)	$\chi^2_{WHITE}(3)$: 22.749 (0.200)

Note: ***, ** and * show the significance level at 1%, 5% and 10%, respectively. Newey-West procedure is used for eliminating the serial correlation in the error terms and heteroskedasticity. The values in parenthesis are the optimum lag lengths which are determined by taking AIC and SIC criterion into consideration. Δ implies the difference operator. *EC* is the error correction term which is obtained from co-integration equations.

In Table 5, three instrumental variables are utilized to estimate the coefficients belonging to inflation, interest and exchange rates. It is found that one lagged values of interest, inflation and exchange rates, instrumental variables, have a positive effect on current and one lagged inflation and exchange rates. Besides, instrumental variables have a negative impact on current and one lagged interest rate, while they have a positive effect on two lagged interest rate. In this context, it is possible to say that a unit change in the current and one lagged inflation and exchange rate affects the exchange rate positively, whereas a unit change in current and one lagged interest rate affects the exchange rate negatively. In addition, a positive effect of two lagged interest rate on exchange rate is observed, also. Such a conclusion can be verified by investigating the correlation matrix in Table 4. Therefore, it can clearly be said that in order to estimate current exchange rate value, both current and one lagged values of inflation and exchange rates need to be taken into consideration. As well as these indicators, current and lagged values of interest rates should be made allowance for estimating current value of exchange rate. In general, it is possible to say that the inflation rate has a positive impact on interest rate and a change in interest rate makes uptrend pressure on the exchange rate. Therefore, the findings show that International Fisher Hypothesis is valid in the period of 1975-2014 in Turkish economy.

In addition, the error correction terms, *EC*, are found to be negative and statistically significant, it is said that the variables converge to their equilibrium level, and short-run imbalances will be overcome in the long-run. Besides, R^2 is found as 63%, which is as high as expected. Also, J–statistic that provides an opportunity to identify the validity of the results of hypothesis states that there is no excessive determination in the model.

5. Conclusion

In this study, the relationship among the exchange rate, inflation rate and interest rate in the context of International Fisher Hypothesis for the period of 1975 and 2014 in Turkey is investigated by using GMM, Johansen-Juselius co-integration and Granger causality analysis.

First of all, the stationary information of the variables is determined and the results of the ADF and KPSS tests show that the series are stationary in their first difference values. Following the unit root tests, in order to determine the long-run relationships among ER, INF and IR Johansen-Juselius co-integration test is applied and the Co-integration analysis reveals the existence of a long-run relationship among the variables. In order to determine causal nexus among the variables, Granger causality analysis is employed and the results of Granger causality analysis show that a change in the inflation and interest rate affects the exchange rate, but not *vice versa*. Similarly, a change in the inflation rate causes an effect on the interest rate, but not *vice versa*. In the next step, GMM analysis is applied to test whether International Fisher Hypothesis is valid for Turkish economy. In general, it can clearly be said that in order to estimate current exchange rate value, both current and one lagged values of inflation and exchange rates need to be taken into consideration. As well as these indicators, current and lagged values of interest rates should be made allowance for estimating current value of exchange rate. In other words, a positive change in inflation rates makes upward pressure on interest rates and hence exchange rates are depreciated. As a whole, the findings show the validity of International Fisher Effect in the period of 1975-2014 in Turkish economy.

For the period which is subject to the analysis, it can be suggested that the monetary policies implementing in Turkey do not have significant effects on the rates of interest, we can even state that the changes in the rate of interests is parallel to changes in the rate of inflation. This finding has an important policy implication for policy makers. The monetary policy does not affect the real interest rate because any change in inflation partially cancels out a change in the nominal interest rate and exchange rate. In light of past experiences in Turkey and as a result of findings in this study, exchange rate pressure on the economy could be prevented by making marginal adjustments on inflation and interest rate. As a whole, the changing inflation and the floating interest rate cause the changes on the exchange rate in the same direction, hence it can be said the validity of Fisher Hypothesis in Turkish economy. In addition, this study can be improved by using newly developed econometric analysis such as robust and ridge regression techniques or else time-varying parameters procedures etc., by adding some control variables such as taxes, budget balance and current account balance etc., and extending time period.

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Appenddix 1. The Literature Summary on the Empirical Studies of the Fisher Hypothesis

The Studies Showing the Validity of the Fisher Hypothesis			
Author(s)	**Method**	**Period**	**Country**
Barthold and Dougan (1986)	Time Series Analysis	1902-1983	USA
Hutchison and Keeley (1989)	Time Series Analysis	1953-1986	USA
McDonald and Murphy (1989)	Vector Error Correction Model	1955-1986	Four Developed Countries
Gupta (1991)	Time Series Analysis	1968:Q4-1985:Q4	USA
Woodward (1992)	Time Series Analysis	1982:04-1990:08	United Kingdom
Phylaktis and Blake (1993)	Vector Error Correction Model	1971:Q1-1991:Q3	Argentina, Brazil, Mexico
Kesriyeli (1994)	Johansen Cointegration Analysis	1985:Q1-1993:Q4	Turkey
Peng (1995)	Time Series Analysis	1957:Q1-1994:Q2	Five industrialized countries
Pelaez (1995)	Johansen Cointegration Analysis	1959:Q1-1993:Q4	USA
Olekalns (1996)	Time Series Analysis	1965-1990	Australia
Daniels et al. (1996)	Johansen Cointegration Analysis	1957:Q1-1992:Q4	USA
Engsted (1996)	VAR Analysis	1948-1989	Denmark
Crowder (1997)	Johansen Cointegration Analysis	1960-1991	Canada
Junttila (2001)	Johansen Cointegration Analysis	1987:01-1996:12	Finland
Atkins and Coe (2002)	ARDL Bounds Testing Analysis	1953:01-1999:12	USA, Canada
Choi (2002)	Time Series Analysis	1947:01-1997:12	USA
Carneiro et al. (2002)	Johansen Cointegration Analysis	1980:01-1997:12	Argentina, Brazil, Mexico
Berument and Jelassi (2002)	Time Series Analysis	1957:04-1998:05	26 Countries
Lardic and Mignon (2003)	Time Series Analysis	1970:Q1-2001:Q3	G7 Countries
Wong and Wu (2003)	Instrumental Variables Regressions	1958:01-1999:04	G7 Countries, Eight Asian Countries
Kutan and Aksoy (2003)	GARCH	1986:12-2001:03	Turkey
Turgutlu (2004)	ARFIMA	1978:Q4-2003:Q4	Turkey
Sun and Phillips (2004)	Time Series Analysis	1934:Q1-1999:Q4	USA
Million (2004)	Threshold Autoregressive Analysis	1951:01-1999:12	USA

Appendix 1. The Literature Summary on the Empirical Studies of the Fisher Hypothesis (Continue)

The Studies Showing the Validity of the Fisher Hypothesis			
Author(s)	**Method**	**Period**	**Country**
Atkins and Chan (2004)	ARDL Bounds Testing Analysis	1950:Q1-2000:Q2	USA, Canada
Madsen (2005)	Panel Data Analysis	1958-1999	16 OECD Countries
Simsek and Kadilar (2006)	ARDL Bounds Testing Analysis	1987:Q1-2004:Q4	Turkey
Herwartz and Reimers (2006)	Panel Data Analysis	1960:01-2004:06	100 Countries
Kasman et al. (2006)	ARFIMA Analysis	1957:01-2004:07	33 Developed and Developing Countries
Berument et al. (2007)	ARCH-GARCH Analysis	1957:01-2004:08	G7 and 45 Developing Countries
Beyer et al. (2009)	Johansen Cointegration Analysis, Dynamic OLS	1957:Q1-2007:Q4	15 Developed Countries
Köse et al. (2012)	Inoue Cointegration Analysis	2002:01-2009:03	Turkey
Arısoy (2013)	Time-Varying Parameters Analysis	1987:Q1-2010:Q3	Turkey
Lopcu et al. (2013)	ARDL Bounds Test, Gregory-Hansen Cointegration Test	1990:01-2011:11	Turkey
Kıran (2013)	Fractional Cointegration Analysis	1990:01-2010:03	Turkey
Etuk et al. (2014)	Fractional Cointegration Analysis	1970-2003	Nigeria
Akçacı and Gökmen (2014)	Toda-Yamamoto Causality Analysis	2003:01-2014:05	Turkey
Tsong and Hachicha (2014)	Quantile Regression Approach	1995:01-2011:06	Indonesia, Malaysia, Russia, South Africa
The Studies Showing the Invalidity of the Fisher Hypothesis			
Jaffe and Mandelker (1976)	Time Series Analysis	1875-1970	USA
Summers (1982)	Time Series Analysis	1860-1971	USA
Kane et al. (1983)	Time Series Analysis	1974:01-1979:12	Six Developed Countries
Gultekin (1983)	ARIMA	Post World War II	26 Countries
Graham (1988)	Time Series Analysis	1953-1978	USA
Mishkin (1993)	Time Series Analysis	1964:02-1986:12	USA
Inder and Silvapulle (1993)	Vector Error Correction Model	1965-1990	Australia
Dutt and Ghosh (1995)	Johansen Cointegration Analysis, FM-OLS	1960-1993	Canada
Linden (1995)	Johansen Cointegration Analysis	1987:01-1995:03	Finland
Coppock and Poitras (2000)	Cross-Section Analysis	1976-1988	40 Countries
Cakmak et al. (2002)	VAR	1989:01-2001:07	Turkey
Gul and Acikalin (2008)	Johansen Cointegration Analysis	1990:01-2003:12	Turkey
Yilanci (2009)	Engle-Granger Cointegration Model	1989:Q1-2008:Q1	Turkey
Ito (2009)	Time Series Analysis	1987:01-2006:06	Japan
Sheefeni (2013)	Johansen Cointegration Analysis	1992:01-2011:12	Namibia