Validity of Fisher effect for Turkish economy: Cointegration analysis

Ahmet İncekara\textsuperscript{a}, Selim Demez\textsuperscript{b}, Murat Ustaoğlu\textsuperscript{c}, a\textsuperscript{*}

\textsuperscript{a,b,c} Istanbul University, Beyazid/Istanbul, 34552, Turkey

Abstract

Fisher effect which can be defined as a positive relation between nominal interest rate and inflation rate without any impact upon real interest rates is something that holders of savings and investments, as well as implementers of monetary policy, pay attention to. In this study, the seasonal series between 1989:Q1 and 2011:Q4 are used to test the validity of Fisher Hypothesis for Turkish economy by Johansen cointegration analysis and VAR method. It is concluded that in the long term, Fisher impact is valid for Turkish economy.

Keywords: Fisher effect, Johansen cointegration, VAR analysis

1. Introduction

The view that the change in the nominal interest rates in the long term is in parallel with the anticipated inflation rate but does not have any impact upon the real interest rates is known as Fisher Hypothesis. The emergence of inflationist expectations out of change in the interest rates or vice versa enables intervention in the economy through monetary policies to be performed by the central bank (Ito, 2009). Under the Fisher Hypothesis, the nominal interest rate is equal to the combination of real interest rate and the anticipated inflation rate.

\[ i_t = r_t + \pi^e_t \]  

(1)

In Equation (1), it represents nominal interest rate, \( r_t \) real interest rate and \( \pi^e_t \) the expected inflation rate. The fundamental reason for this set of relationship is the fact that the rational hodlers of savings and investments do not want to be affected by the changes in the prices of goods and services. In other words,

\textsuperscript{*} Corresponding author. Tel. + 90-530-348-0908

Email address: ustaoglu@istanbul.edu.tr
they develop inflationist expectations because of the increase in the interest rates and adjust their future spending and savings based on this expectation (Innes, 2006).

Fisher Hypothesis shows that the unchanged real interest rate shows that the monetary policy does not have impact upon real interest rates. In other words, the rise in the money supply affects nominal interest rate and inflation rate whereas it does not affect the real interest rates. The real interest rates are influenced by real variables. The expression of the real interest rate by the difference between the nominal interest rates and the expected inflation rate supports this view.

\[
    r_t = i_t - \pi_t
\]

In Equation (2), because real interest rate \( r_t \) is equal to the difference between nominal interest \( i_t \) and expected inflation \( \pi_t \), it is neutral in the long and short terms. In other words, it does not change depending on the nominal changes (İkizler, 2011).

In this study, the validity of Fisher Hypothesis is tested in Turkey for the periods between 1989:Q1 and 2011:Q4 through quarterly series. The study first examines the literature works on Fisher effect. In the second part, the data set, econometric method and the findings are presented. And in the final part, the findings are evaluated and the study is concluded.

2. Literature Review

Despite numerous studies on the validity of the Fisher hypothesis based on different methods, no absolute result has been obtained in this regard. While there are many reasons for this, the most important ones could be classified as follows: use of different methods for different countries in different times; and the difficulty associated with the measurement of the expected inflation rate. For this reason, in these studies, the delayed inflation rates were used in place of the expected inflation rates in the model (Cooray, 2002). The works and accounts on Fisher Hypothesis that refers to a direct link between nominal interest rates and inflation rates in the long run support the differences in the findings of the analyses.

Ahmad (2010) tests the presence of Fisher effect by non-linear root analysis for 8 Asian countries in the long run (Ahmad, 2010). He notes that the real interest rates are stable and that the monetary policy is not applicable in the long term. The findings support the Fisher hypothesis. Granville and Mallick (2004) test the Fisher Hypothesis for Britain based on the cointegration analysis, concluding that there is a long term relationship between inflation rate and interest rates (Granville & Mallick, 2004). Şimşek and Kadılar (2006) test the hypothesis and the validity of the link between long term interest rates and inflation rate by using the data of Turkish economy through ARDL test and the cointegration analysis (Şimşek & Kadılar, 2006).

In conclusion, they argue that there is strong relation between the two variables. Turgutlu (2004) studies the Fisher effect by fragmented cointegration analysis and compares it with the Engle-Granger cointegration analysis (Turgutlu, 2004). He concludes that the Engle-Granger rejects Fisher effect whereas the fragmented stability analysis takes it. This proves that a change in the method affects the validity of Fisher effect. Mishkin (1992), in reference to the rational expectations theory, argues that the changes in the interest rates bring about inflationist expectations based on the long term relationship between the interest rates and inflation rates as spelled out in Fisher Hypothesis (Mishkin, 1992).

Berument and Jelassi (2002), in a study on 26 developed and developing countries where they run a panel cointegration analysis conclude that the Fisher Hypothesis is valid (Berument & Jelassi, 2002).
Yılancı (2009) tests the Fisher test through the non-linear times series analysis and concludes that the hypothesis is not applicable for the terms between 1989:01 and 2008:01 (Yılancı, 2009). Ersan (2008), in a study focusing on G-5 countries and Turkey, tests the differences in the nominal interest rates between the countries and the attitudes of the currency rates in these countries in long term. The findings support the Fisher effect (Ersan, 2008). Panapoulou (2005) test the Fisher hypothesis by using the long and short term interest rates of 14 OECD countries, concluding that there is strong relation between the variables that are analyzed (Panapoulou, 2005). Toyoshima and Hamori (2011) test the long term Fisher effect by Panel cointegration analysis for the US, Britain and Japan (Toyoshima & Hamori, 2011). They indicate that there is strong linkage between interest rates and inflation rates.

3. Data and Methodology

3.1. Data Collection

The series employed in this study are retrieved from the Central Bank Electronic Data Distribution System (EVDS) (TCMB, 2011). Two types of variables, inflation series (CPI) and interest rates (i) are utilized. The quarterly series are used between 1989:Q1 and 2011:Q4. The inflation series is based on the wholesale commodity price index whereas the interest rates are based on the average saving interest rates. In the study, Eviews 6.0 software program is utilized.

3.2. Methodology

This study investigates as to whether Fisher effect is valid for Turkish economy. First, the stability of the series is analyzed through ADF unit root test. It is viewed that the inflation series is I (1) and the interest rates series I (0). To work with these series, the first degree differences of both are calculated to make them stable at the same level. By utilization of Johansen cointegration test, whether the series are cointegrated is tested; it is viewed that there are two cointegrations between the series. Subsequently, VAR analysis is run for the series. In the VAR analysis, the direction of the relationship between the variables is detected by the Granger causality Wald test. The effect of the one unit error shock in the delayed values at the series by the impulse-response and variance decomposition is tested; it is concluded that the findings support each other.

3.3. ADF Unit Root Test

Augmented Dickey-Fuller (ADF) test is usually called Dickey-Fuller test.

\[
\Delta Y_t = \gamma Y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t
\]  

(3)

\[
\Delta Y_t = c + \gamma Y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t
\]  

(4)

\[
\Delta Y_t = c + \gamma Y_{t-1} + \delta_2 t + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t
\]  

(5)

The rejection of the H0 hypothesis at the unit root test means that \( Y_t \) series does not carry unit root and that it is stable. This means that \( Y_t \) series is I(0) at level value. If \( Y_t \) series is not stable, the first
difference of the series is taken. If Y<sub>t</sub> series is stable at the first difference, the series is I(1). The Equation 3 represents the non-trend model, the equation 4 the stable model and the equation 5 the intercept and trend model. At the ADF test, the high degree auto-correlation process models are used. In the DF test, first degree auto-correlation process is taken. To make sure that the error term shows the characteristic of white noise, there should be higher level auto-correlation process models. For this, ADF test is used (Sever & Demir, 2007).

Table 1 ADF Unit Root Test Result

|         | CPI                        | i                        |
|---------|----------------------------|--------------------------|
|         | Intercept+Trend | Intercept | None | Intercept+Trend | Intercept | None |
| Level   | -6.730(0)     | -2.840(1) | -1.912(1) | -7.679(1) | -8.089(0) | -8.135(0) |
|         | [-7.459]      | [-2.893]  | [-1.944] | [-4.063] | [-2.893] | [-1.944] |
| First Difference | -9.958(1) | -10.01(1)  | -10.063(1) | -7.813(4) | -7.864(4) | -7.911(4) |
|         | [-3.461]      | [-2.894]  | [-1.944] | [-3.462] | [-2.895] | [-1.944] |

*The figures in the parantheses show the length of the lags based on the SIC criteria.

** These are Mac Kinnon (1996) values for the ADF test within the 5 pct interval.

At Table 1, the stability of the (CPI) and (i) series is tested with the ADF root test. The findings are compared with the critical values; this shows that the CPI series is stable at I(1) whereas the (i) series is stable at the I(0). To be able to work with the variables, both series have to be stable at the same degree; and for this reason, the first difference of both series is taken into consideration.

3.4. **Johansen Cointegration Analysis**

In case the linear combinations of non-stable series at the non-trend levels become stable in the long term, cointegration linkage emerges. In case there is cointegration linkage between series, alternative cointegration analyses such as Engle-Granger (1987), Johansen (1988), Johansen-Jesulius (1990), Paseran (1999) may be run (Engle & Granger, 1987; Johansen, 1988; Johansen & Jesulius, 1990; Pesaran & Shin, 1999). The Engle-Granger (1987) approach is able to find single cointegration vector in the series whose first difference is stable (Engle & Granger, 1987).

In the Johansen (1988) and Johansen-Jesulius (1990) cointegration approach, all variables included in the model are identified as inherent; as a result, a VAR model where more than one cointegration vectors are existent (Johansen, 1988; Johansen & Jesulius, 1990). In the Paseran (2001) test, regardless of whether the variables are static at the different levels, more than one cointegration vectors may be found (Pesaran, Shin, & Smith, 2001). Because the series used in the analysis is I(1), multivariable cointegration analysis developed by Johansen-Jesulius (1990) is used to detect cointegration linkage between the variables (Johansen & Jesulius, 1990). To find the number of cointegration vectors, two likelihood ratios (LR), trace statistics (λ<sub>trace</sub>, trace statistic) and maximum Eigen statistic (λ<sub>max</sub>, maximum Eigen statistic), are used (Pazarlıoğlu & Güloğlu, 2007). These tests are used in the prediction of number of cointegrated vectors. To this end;

\[
\hat{\lambda}_{\text{trace}}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i)
\]  

(6)
\[ \lambda_{\max}(r, r+1) = -T \cdot \ln(1 - \lambda_{r+1}) \] (7)

\( \lambda_i \) is the value of characteristic roots whereas T is the number of observations. At 6, the zero hypothesis for trace statistic (\( \lambda_{\text{trace}} \)) is “There are r cointegrated vectors at most.” Zero hypothesis for maximum eigen statistic at 7 (\( \lambda_{\text{max}} \)) is “There are at r+1 cointegrated vectors at most” (Güloğlu, 2007). Johansen (1990) and Johansen- Jesulius (1990) assume that in both tests, there is optimal delay length for Var (vector autoregressive) process (Johansen, 1988; Johansen & Juselius, 1990).

Table 2 Multivariable Johansen Cointegration Test Results

| Variables | Eigenvalue | Trace Statistics | Max-Eigen Statistics | Critical value | Cointegration Hypothesis | Result |
|-----------|------------|------------------|----------------------|----------------|--------------------------|--------|
| i         | 0.356012   | 51.64879         | 39.16670             | 15.494         | 14.264                   | r=0    |
| CPI       | 0.130857   | 12.48208         | 12.48208             | 3.8414         | 3.8414                   | r\leq1 |
|           |            |                  |                      |                |                          | Rejecte |
|           |            |                  |                      |                |                          | d      |

*Based on criteria of Final Prediction Error (FPE), Akaike Information Criteria (AIC), Likelihood Ratio (LR) and Hannan-Quinn (HQ), the length of optimal lag is found as 2.

The Max-Eigen and Trace statistics at Table 2, at 5 pct of significance level, rejects the Ho hypothesis indicating that there is no long term relationship between (CPI) and (i) variables. In other words, there are two cointegrations between the series. And this confirms and supports the Fisher Hypothesis that claims there is long term linkage between nominal interest rates and inflation rates.

3.5. Granger Causality Analysis

Causality analysis points to a state of priority between the variables. There are a number of studies in the literature on the Granger type causality including causality analysis (Granger, 1969). However, in case linkage is detected between variables in terms of coefficient, Vector Error Correction Model (VECM) should be used for Granger causality test (Engle, Granger, 1987). VEC model shows the short term linkages between variables. The error correction model to be formed in case the (CPI) and (i) variables are stable and cointegrated will be as follows:

\[ \Delta CPI = \alpha_1 + \sum_{i=1}^{m} \beta_{1i} \Delta i_{t-i} + \sum_{i=1}^{n} \delta_{1i} \Delta CPI_{t-i} + \sum_{i=1}^{r} \phi_{1i} ECM_{r,t-i} + \varepsilon_{1t} \] (8)

\[ \Delta i = \alpha_2 + \sum_{i=1}^{m} \beta_{2i} \Delta i_{t-i} + \sum_{i=1}^{n} \delta_{2i} \Delta CPI_{t-i} + \sum_{i=1}^{r} \phi_{2i} ECM_{r,t-i} + \varepsilon_{2t} \] (9)
In error correction model, $ECM_{rt,1}$ refers to the adaptation coefficients of the delayed error terms. ECM shows the sources of the causality through the delayed error terms of $\Delta CPI$. If the prediction of (i) visibly improves when the delays of the (CPI) are added to other variables, (CPI) is the Granger cause of (i), however, if there is cointegration relation rather than stable relation between variables, Wald test is needed for Granger causality analysis (Güloğlu, 2007).

| Hypothesis | MWALD     | P value | Causality |
|------------|-----------|---------|-----------|
| CPI→i      | 5.104651  | 0.0779  | Rejected  |
| i→CPI      | 4.967641  | 0.0834  | Rejected  |

* Based on the use of Final Prediction Error (FPE), Akaike Information Criteria (AIC), Likelihood Ratio (LR) and Hannan-Quinn (HQ), optimal lag length is detected as 2.

As Table 3 shows, no two-directional Granger causality has been detected between (CPI) inflation and (i) interest rates. In other words, there is no short term linkage between the interest rates and inflation rate.

3.6. Impulse-Response Functions

The VAR analyses in the literature have three objectives:

- Detection of impulse-response functions
- Variance decomposition
- Causality analysis

Impulse-response functions may be used to support the causality analyses on the effect of inflation (CPI) rates and interest rates (i) upon each other. The impulse-response functions (prediction errors) show the response of the other variables when one unit shock is applied to each of the variables in VAR (Güloğlu, 2007; Çekerol & Gürbüz, 2007). If no part of the prediction error variance of a variable can be explained by shocks from other variables, the variable could be considered exogenous.

Impulse-response functions are classified as permanent and temporary shocks. In the permanent shocks, the impact of the shocks upon the variables may last for a long term. The effect of the temporary shocks does not last long, going away within a few terms (Güloğlu, 2007). Confidence intervals are created to test the significance of the impulse-response functions in statistical terms. The straight lines refer to punctual predictions and the discontinuous ones to the standard weekly confidence intervals.
As seen in Figure 1, the responses by the inflation and interest rates to one unit standard shock are shown in the graphs. The findings support the results at the granger causality test.

3.7. Cholesky Variance Decomposition

Cholesky variance decomposition is a matrix process. There might be a linkage between the shocks in impulse-response functions. In the impulse-response functions with prediction errors, in case there is linkage between VAR—most probably, there is—the effect of one shock cannot be discerned from the other. For this reason, in detecting the impulse-response functions, the shocks should be delinked from each other. The way to do is use of Cholesky decomposition. In the Cholesky decomposition, k.(k-1)/2 restrictions are placed upon sub-triangle matrix. In this way, the structural shocks are decomposed. However, when the sequence of the variables changes in the Cholesky decomposition, the coefficients of the impulse-response functions will also change; for this reason, they should be used very carefully (Güloğlu, 2007).

Table 4 Variance Decomposition of Interest Rate

| Periods | S.E   | D(i)    | D(CPI)   |
|---------|-------|---------|----------|
| 1       | 5.866395 | 100.0000 | 0.000000 |
| 2       | 6.826962 | 99.99994 | 0.11E-05 |
| 3       | 6.881635 | 99.44563 | 0.554375 |
| 4       | 6.903716 | 98.92554 | 1.074464 |
| 5       | 6.907085 | 98.91436 | 1.085638 |
| 6       | 6.909827 | 98.85890 | 1.141103 |
| 7       | 6.911136 | 98.83507 | 1.164932 |
| 8       | 6.911244 | 98.83503 | 1.164969 |
Table 4 shows that the interest rates \( i \) are strongly affected by the delayed values over the terms and periods; and it also becomes evident by the table that they are affected by the inflation rate \( CPI \) by 1.1 pct. The table shows that the interest rate is influenced by its own rate by 100 pct. This supports the findings based on the Granger causality analysis. In the findings based on the Granger causality test, no causality has been located from the interest rates to the inflation, and from inflation to interest rates. In other words, that rejected the presence of a short term relation between \( CPI \) series and \( i \) series. Likewise, we see the same in the impulse-response function graphs. Figure 1 shows that the interest variable responds to its own delayed rates whereas it remains indifferent to the response by the inflation series.

Table 5 Variance Decomposition of Inflation Rate

| Periods | S.E | D(i)  | D(CPI)   |
|---------|-----|-------|----------|
| 1       | 19.47891 | 0.043680 | 99.95632 |
| 2       | 21.98947 | 9.752758 | 90.24724 |
| 3       | 22.66423 | 12.26797 | 87.73203 |
| 4       | 22.98197 | 12.37111 | 87.62889 |
| 5       | 23.12302 | 13.42024 | 86.57976 |
| 6       | 23.16114 | 13.44025 | 86.55975 |
| 7       | 23.16966 | 13.50033 | 86.49967 |
| 8       | 23.17661 | 13.52102 | 86.47898 |
| 9       | 23.17722 | 13.52117 | 86.47883 |
| 10      | 23.17789 | 13.52360 | 86.47640 |
| 11      | 23.17807 | 13.52339 | 86.47661 |
| 12      | 23.17812 | 13.52371 | 86.47629 |

Table 5 shows that the inflation rate is affected by the delayed figures and values. It could be argued that the inflation rate \( CPI \) is affected by the interest rates by 11-12 pct on average in all terms. As indicated above, it could be further argued that the findings are consistent with the Granger causality analysis and the impulse-response functions.

4. Conclusion

In this study, the Fisher hypothesis is tested by Johansen cointegration analysis and VAR model for the periods between 1989:Q1 and 2011:Q4. It is concluded that the Fisher effect is valid in Turkey for the identified period. In other words, there is long term relationship between nominal interest rates and inflation rate whereas such a link is not detected in short term. The findings confirm the previous studies performed based on different methods and different periods. In light of past experiences in Turkey and as a result of findings in this study, inflationary pressures on the economy could be prevented by making marginal adjustments on interest rates. In other words, empirical results -could be used an effective
manner- for monetary policy makers reveal the fact that nominal interest rates extent in combating inflation by adjustment. Fisher hypothesis in the theory of economics and the interest rates are already expected / actual (as ex-ante/ex-post look separately) shows that it is relevant by inflation rates.

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