Journal of Applied Finance & Banking, vol. 2, no.6, 2012, 41-54
ISSN: 1792-6580 (print version), 1792-6599 (online)
Scienpress Ltd, 2012

Long-Run Relation between Interest Rates and Inflation: Evidence from Turkey

Dilek Teker[1], Elçin Aykaç Alp[2] and Oya Kent[3]

Abstract

The relationship between nominal interest rates and inflation has been frequently explored in both its theoretical and empirical dimensions by many scholars. Most of these studies focus on the influence of inflation on interest rates, while others investigate the effect of interest rates on price levels. The relevant literature begins with the well-known theory of Fisher (1930). According to Fisher's hypothesis, inflation is the main determinant of interest rates, and as the inflation rate increases by one per cent, the rate of interest increases by the same amount. Following the Fisher Theory, many scholars have sought to examine the interaction between inflation and interest rates. This study examines the relationship between deposit interest rates and the consumer price index in Turkey, employing the threshold vector error correction (T-VEC) analysis. In the first step, a threshold autoregressive (TAR) unit root analysis is applied for the period (2002:01-2011:03) of both variables. Traditional unit root tests are used to test the unit root structure before the cointegration analysis. In the second stage, the Caner and Hansen (2001) TAR unit root test is applied. After determining that the variables are nonstationary, the T-VEC analysis is implemented.

JEL classification numbers:
Keywords: Fisher effect, interest rates, inflation

---

[1]Okan University, Department of Banking and Finance, 34959 Akfırat-Tuzla / İstanbul, Turkey
Tel: +90216 677 16 30, e-mail: dilek.teker@okan.edu.tr
[2]İstanbul Commerce University, Department of Economics, 34445 Beyoğlu / İstanbul, Turkey
Tel: +90212 221 19 29, e-mail:ealp@iticu.edu.tr
[3]Okan University, Department of Banking and Finance, 34959 Akfırat-Tuzla / İstanbul, Turkey
Tel: +90216 677 16 30, e-mail:oya.kent@okan.edu.tr

Article Info: *Received :* September 27, 2012. *Revised :* October 29, 2012.
Published online : December 20, 2012

1 Introduction

The relationship between interest rates and inflation has been frequently explored in both its theoretical and empirical dimensions by many scholars. Although the definitions of interest rates differ to include real interest rates, nominal interest rates, deposit rates, and money market rates, many studies try to define the interaction between the rates and the inflation. Most of these studies focus on the influences of inflation on interest rates. Wilcox (1983), Benhabib, Schmitt-Grohe and Uribe (2002), Berument and Jelassi (2002), and Fahmy and Kandil (2002) investigate the effect of inflation on interest rates. On the other hand, Barshky and Delong (1991) examine the influence of interest rates on inflation. An increase in inflation is undesirable. Economic authorities in developing countries and emerging economies develop monetary policies that promote stable growth and low inflation. There is a very close relationship between interest rates and the inflation level. Any change in interest rates will likely have an impact on consumption and, therefore, will create a shift in inflation levels. On the other hand, any increase in price levels will oblige central banks to adjust interest rates. This phenomenon forms the basic equation of regulation for central banks. The relevant literature starts with the well-known theory of Fisher (1930). According to Fisher's hypothesis, inflation is the main determinant of interest rates, and as the inflation rate increases by one per cent, the rate of interest increases by the same amount. Fama (1975) and Fama and Schwert (1977) test whether the Fisher effect holds in the US, and they find evidence in favor of approximately constant real interest rates, as implied by the Fisher hypothesis. In contrast, Summers (1983) rejects the Fisher hypothesis for the period before the 1990s, a period for which the Fisher hypothesis has been subjected to empirical tests that take the potential nonstationarity and cointegration of the involved time series explicitly into account (Mishkin 1992).

Many contributions to the literature test for the existence of the Fisher effect and also try to determine the relationship between interest rates and inflation. Better information on the behavior of interest rates would greatly benefit economists. In this study, similar to other studies in the literature, we examine whether an interaction between interest rates and inflation exists. However, we follow a different methodology. Our study examines the relationship between the deposit interest rate and the consumer price index in Turkey and employs a T-VEC analysis. In the first step, a TAR unit root analysis is applied for the period (2002:01-2011:03) of both variables. We use the traditional unit root tests to test the unit root structure before the cointegration analysis. In the second stage, the Caner and Hansen (2001) TAR unit root test is applied. After determining that the variables are nonstationary and integrated at the same order (I(1)), a T-VEC analysis is implemented. The following section explains the related literature on the relationship between interest rates and inflation. The paper then discusses the data and methodology, our empirical results, and our conclusions in the subsequent sections.

2 Literature Review

Many studies have taken empirical and theoretical perspectives to analyze the relationship between nominal interest rates and inflation, and a great deal of work has examined and evaluated different methodologies for forecasting inflation. For example, Fama (1975, 1977) develops an interest rate model to predict the 1-month-ahead rate of inflation using the consumer price index (CPI). The size of the response of nominal interest rates to changes in expected inflation is broadly known as the Fisher effect, the idea having been introduced by Irving Fisher (1930). Fisher hypothesized that there should be a long-run relationship in the adjustment of the nominal interest rate corresponding to changes in expected inflation. He postulated that the nominal interest rate consists of an expected "real" rate plus an expected inflation rate. The real rate of interest is determined largely by the time preference of economic agents and the return on the real investment. These factors are believed to be roughly constant over time, and therefore, a fully perceived change in the purchasing power of money should be accompanied by a one-for-one change in the nominal interest rate.

Mishkin and Simons (1995) test the positive relationship between the expected inflation rate and the interest rate. Based on the inflation and interest rate studies, Cox, Ingersoll, and Ross (1985) developed arbitrage-free bond pricing models that explore the effect of inflation on the term structure of interest rates. These theoretical models provided a framework for a number of empirical studies, such as Stambaugh (1988) and Gibbons and Ramaswamy (1986). The research conducted by Kugler (1982) models the dynamic relationship between short term interest rates and inflation for the US, the UK, France, Germany, and Switzerland for the period 1974-1980. The research strongly suggests the variation of the nominal interest rate and that the nominal interest rate and inflation help to predict the ex ante real interest rate.

Pennachi (1991) also examines the relation between real interest rates and inflation. He employs a model that is estimated as a state-space system that includes observations on Treasury bills with different maturities and NBER-ASA survey forecasts of inflation for the period between 1968 and 1988. The study supports the idea that real interest rates and expected inflation are significantly negatively correlated. Furthermore, real interest rates also display greater volatility and weaker mean reversion than does expected inflation. Crowder and Hoffman (1996) use quarterly data (the three-month T-bill rate and the implicit price deflator for total consumption expenditure) for the US to test the long-run relationship between nominal interest rates and inflation through cointegration analysis. They find that a 1 percent increase in inflation yields a 1.34 percent increase in the nominal interest rate. After adjusting for tax effects, this effect is found to be 0.97, which is almost equal to unity. Panopoulou (2005) examines the existence of a long-run Fisher effect in which interest rates move one-to-one with inflation by using both short-term and long-term interest rates for 14 OECD countries. An autoregressive distributed lag (ADL) model is employed separately for all countries, and the effect of anticipated inflation on predicting nominal interest rates is found to be around unity, e.g., 0.959 for Canada, 0.860 for Switzerland, 0.912 for the UK, and 0.787 for Germany.

Gül and Ekinci (2006) empirically analyze the interaction between nominal interest rates and inflation for Turkey over the period of 1984-2003. Initially, they ascertain the existence of the unit root and then imply the Johansen cointegration test. Their evidence supports the idea that there is a long-run relationship between interest rates and inflation for Turkish markets. To conclude their study, they employ a Granger Causality test and find that causality exists in only one direction from nominal interest rates to inflation. Herwartz and Reimers (2006) employ a VEC model to examine the relationship between inflation and interest rates for 114 economies over a 45 year period using monthly data. Interest rates and inflation are found to exhibit a long-run equilibrium relationship for numerous economic states. However, in states with large positive changes of inflation, high inflation risk or high interest rates, a long-run equilibrium relationship may not exist.

Using error correction model (ECM) based panel cointegration tests, Westerlund (2006) provides evidence in favor of the Fisher hypothesis for 20 OECD economies for the period 1980-2004. Ling et al. (2008) test the Fisher hypothesis for East Asian economies using panel unit root tests and find empirical evidence to support the validity of the Fisher hypothesis in this context. Sathye et al. (2008) test the same relationship in the context of the Indian financial market. They find that expected inflation and nominal short-term interest rates are co-integrated in the Indian context.

A variety of econometric techniques is implemented in the different studies. Some of the studies test whether a long-run relation exists between these macro-parameters, while others implement the nonlinear models, which are also employed in this study. Some of the key studies that investigate the interaction between these variables with nonlinear framework are Weidmann (1997), Million (2004), Koustas and Lamarche (2006), Dutt and Ghosh (2007), Jumah and Kunst (2008), and Phiri and Lusanga (2011). Weidmann (1997) was one of the first studies to utilize threshold cointegration in this context. This study revealed the importance of using threshold models for this subject and the necessity of using threshold models for the relationship between interest rate and inflation. Million (2004) examines the long-run relationship between nominal interest rates and inflation using Smooth Transition Autoregressive (STAR) models. As the study notes, a policy change that fell within the analyzing period changes the dynamics of the data between the two regimes. Million, applied Augmented Dickey Fuller (ADF), Dickey Fuller–GLS (DF-GLS), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests to identify the unit root structure of the data and modeled an ECM with the logistic smooth threshold autoregression (LSTAR) process. Consequently, they examined the threshold process for the long-run relationship between interest rates and inflation for the US. The appropriate model for this relationship is shown to be among the STAR models. One of the policy implications of this study is to show that the behavior of the policy maker depends on the level of inflation. In this context, they denote that when the inflation rate decreases below a level of tolerable inflation, the policy maker is unwilling to use an active policy.

Koustas and Lamarche (2006) analyzed the relationship between interest rates and inflation for the G7 countries. They implement a three-regime self-exciting threshold autoregressive (SETAR) model using the three-month treasury bill rate and the CPI. The unit root process is tested for with ADF and DF-GLS tests. They also apply symmetric mirroring TAR (SMTAR), band TAR (BTAR), and TAR models. The appropriate modeling structure is found to be BTAR for Canada, France, Italy, and Japan, and the authors estimate different band ranges for the countries. In this regard, Canada and Japan are noted to have tighter band ranges, whereas France and Italy have wider ones. This result also implies the significant effect of policy interventions. Dutt and Ghosh (2007) investigate the interest rate-inflation relationship for five European countries: Belgium, France, Germany, Italy, and Sweden. They use threshold cointegration for Belgium and Germany, and they employ the Hansen and Seo (2002) procedure. Jumah and Kunst (2008) applied vector auto regressive (VAR), VARs in differences (DVAR), error correction VAR (EC-VAR) and threshold VAR (TH-VAR) methods for forecasting and the Johansen cointegration method as the main method for testing the relationship. Phiri and Lusanga (2011) analyze the Fisher hypothesis for South Africa, primarily using the Hansen and Seo (2002) test procedure in their study.

Our analysis has two main parts. The first part is the conventional and nonlinear unit root analysis, and the second part covers the T-VEC. The base studies and the developing studies comprising the relevant literature are summarized as follows. Balke and Fomby

(1997) analyze nonlinearity and nonstationarity of variables, and they use the univariate tests of Hansen (1996) and Tsay (1989) to test the error correction term. Other studies testing both nonstationarity and nonlinearity are as follows: Martens et al. (1997), O'Connell and Wei (1997), Obstfeld and Taylor (1997), Michael et al. (1997), Balke and Wohar (1998), Baum and Karasulu (1998), Enders and Falk (1998), O'Connell (1998), Taylor (2001), Baum et al. (2001), and Lo and Zivot (2001). Hansen and Seo (2002) added to this literature by examining the case of an unknown cointegrating vector. The first analysis to build on the Hansen and Seo (2002) study was that of Root and Lien (2003). By applying the method developed by Hansen and Seo (2002), studies by Esteve, Gil-Pareja, Martinez-Serrano and Llorca-Vivero (2002) have investigated the TAR cointegration relationship between goods and service inflations in the US. The effects of nonlinear structure on the long-term equilibrium have been analyzed, and it has been revealed that the equilibrium between the two inflation rate gaps coming into equilibrium in the long-term trend was possible only when a certain threshold value was obtained.

Clementsa and Galvao (2004) studied the maturity structure of the interest rates in the US and carried out nonlinear cointegration analysis between the short- and long-term interest rates. Gascoigne (2004) develops the Hanson and Seo (2002) test method for larger systems and for situations that have more than one cointegrating vector and examines the maturity structure of interest rates in Britain, managing to reduce some necessary conditions without losing efficiency. Gascoigne additionally applies a Vector Error Correction Model (VECM), which has a three-dimensional structure and two cointegrated relations, for the maturity of the interest rates in UK.

In Aslanidis and Kouretas (2005), which examines parallel and official exchange markets in Greece, short- and long-term relationships are tested with a T-VEC. Another study by Bajo-Rubio, Diaz-Rolden and Esteve (2006) carries out an analysis of government revenues and expenditures, basing a nonlinear cointegration analysis on the idea of a required intervention in the event of governmental budget deficit increase over a particular value. In this context, the sustainability of Spain's budget deficit is tested. In the Esteve (2006) study, the term structure of interest rates in Spain is studied, applying the Ng and Perron (2001) test (which is the modified alternative of the ADF and PP tests) to detect the stationarity of the interest rates in Spain. Subsequently, the Hansen and Seo (2002) method is applied as a cointegration test.

3 Data and Methodology

In this study, we investigate the relationship between interest rates and inflation for Turkey using a nonlinear framework. Deposit rates are used to investigate the relationship between interest rates (IR) and the consumer price index (π) and are modeled for the periods between 2002:01 and 2011:03. The interest rates and CPI data are obtained from the CEIC and Turkish Statistical Institute (TSI), respectively. One of the crucial points in a study such as this is the selection of the correct method of analysis. Here, a logarithmic transformation was applied to the data; then, the analysis was conducted using an Hodrick Prescott Filter (HP). After these transformations, nonlinear structures and sudden regime changes were observed when analyzing the data. Therefore, initially, the feasibility of the TAR model was tested, and then long-term analysis was conducted using the T-VEC.

Prior to this analysis, a TAR unit root analysis was applied along with conventional unit root tests (ADF, ERS DF-GLS).
In light of the traditional unit root tests, the non-stationarity hypothesis is not rejected. Before applying the T-VEC analysis, along with the unit root analysis, which is the necessary condition in cointegration as per the literature, the non-stationarity should be supported with a TAR unit root analysis as well. (For more information, see 'Bildirici, Aykaç Alp' (2008)).

3.1 TAR Unit Root Test and T-VEC

For analyzing the long-run relationship between interest rates and inflation, the first step is to investigate the existence of a unit root. We followed the Caner and Hansen (2001) unit root procedure for investigating the nonlinearity and unit root structure of these variables. After determining the nonlinear structure and unit root processes, we used the T-VEC procedure developed by Hansen and Seo (2002) to investigate the vector error correction analysis among the variables. The main reason for applying the Caner and Hansen (2001) approach is to determine the nonlinearity of variables, but another important reason for doing so is given by Pipenger and Goering (1993). In their study, they imply that the Dickey Fuller test has low power, especially for the TAR models. Other studies that modeled and applied unit root tests are Tsay (1997) and Gonzalez and Gonzalo (1998). In the Caner and Hansen (2001) study, they set up a joint hypothesis for testing a two-regime threshold autoregressive model. The TAR model can be written as follows:

$$\Delta y_t = \theta_1' x_{t-1} I\{z_{t-1} < \lambda\} + \theta_2' x_{t-1} I\{z_{t-1} \geq \lambda\} + e_t . \tag{1}$$

The Caner and Hansen (2001) test actually contains three types of tests. These tests not only give information about unit root processes but also provide information about nonlinearity. The Wald test procedure is used for testing nonlinearity. In a second stage, stationarity is tested. In this case, the null hypothesis is

$$H_0 : \rho_1 = \rho_2 = 0 . \tag{2}$$

If the hypothesis shown in number (2) holds, the model (1) can be defined as a stationary TAR process for Δy_t and y_t, defined as unit root process. In equation (1), the parameters ρ_1 and ρ_2 test the stationarity of y_t with the hypothesis defined in (2). The alternative of the null hypothesis in (2) is

$$H_1 : \rho_1 < 0 \text{ and } \rho_2 < 0 . \tag{3}$$

However, there is a partial unit root case that is mentioned in the Caner and Hansen (2001) approach. For this case, they formed the following hypothesis,

$$H_2 : \begin{cases} \rho_1 < 0 \quad \textit{and} \quad \rho_2 = 0, \\ \qquad\quad \textit{or} \\ \rho_1 = 0 \quad \textit{and} \quad \rho_2 < 0. \end{cases} \tag{4}$$

If H_2 holds, y_t process has partial unit root as Caner and Hansen (2001) mentioned. This means y_t process is nonstationary but not a classic unit root case. They suggested using a Wald statistic for testing these hypotheses. The unrestricted alternative is $\rho_1 \neq 0$ or $\rho_2 \neq 0$. In this case, the test statistic is

$$R_{2t} = t_1^2 + t_2^2 . \tag{5}$$

Alternative hypotheses H_1 and H_2 are one-sided, and a one-sided Wald statistic is used for testing the hypothesis $\rho_1 < 0$ or $\rho_2 < 0$, with

$$R_{1T} = t_1^2 I_{\{\hat{\rho}_1 < 0\}} + t_2^2 I_{\{\hat{\rho}_2 < 0\}} . \tag{6}$$

They also emphasized that the R_{1T} and R_{2T} tests have more power against the alternative hypotheses H_1 and H_2. If the test statistic is significant, H_0 is rejected, and this shows that the process has not had a unit root. Then, the second stage tests whether the process is stationary or has a partial unit root process. For this decision, they build t_1 and t_2 test statistics for testing H_0 against H_1 and H_2, respectively.

Test statistics t_1 and t_2 are one-sided Wald test statistics and are used for testing alternative hypothesis $\rho_1 < 0$ and $\rho_2 = 0$ against H_0. This test helps to determine whether the process is not stationary or whether stationarity is only in the first regime. The last test statistic is another one-sided Wald test statistic t_2, which tests the alternative hypothesis $\rho_1 = 0$ and $\rho_2 < 0$ against H_0. t_2 also helps to determine whether the process is a partial unit root process.

After employing nonlinearity and non-stationarity tests, we find that there are unit roots in the series. The implementation of the unit root test provides the sufficient condition for the cointegration tests. Therefore, we follow up with the Hansen and Seo (2002) approach. This method is usually used in the analysis of interest rates, of the term structure of the interest rates, and for the inflation subjects.

In the Hansen and Seo (2002) study, the threshold model takes the following form

$$\Delta x_t = \begin{cases} A_1' X_{t-1}(\beta) + u_t, & w_{t-1}(\beta) \leq \gamma \\ A_2' X_{t-1}(\beta) + u_t, & w_{t-1}(\beta) > \gamma \end{cases}, \tag{7}$$

where the γ is the threshold parameter and

$$X_{t-1}(\beta) = \begin{pmatrix} 1 \\ w_{t-1}(\beta) \\ \Delta x_{t-1} \\ \Delta x_{t-2} \\ \vdots \\ \Delta x_{t-l} \end{pmatrix}.$$

There are two regimes defined by value of the error correction term. As described in Hansen and Seo (2002), the parameters A_1 and A_2 are coefficient matrices and dictate the dynamics in these regimes. If $P(w_{t-1} \le \gamma)$ has the relation $0 < P(w_{t-1} \le \gamma) < 1$, this shows the threshold effect; otherwise, the model describes a linear cointegration. Additionally, they form the following constraint.

$$\pi_0 \le P(w_{t-1} \le \gamma) \le 1 - \pi_0 , \quad (8)$$

where the trimming parameter is positive.

4 Results and Empirical Findings

Initially, the traditional unit root tests ADF, KPSS, and ERS DF-GLS (Elliott-Rothenberg-Stock (1996)) are applied (Appendix 1). In the ADF tests, according to the Akaike Information Criteria (AIC) it is observed that the autocorrelation problem is removed with twelve lags. In the ERS DF-GLS test, according to the criteria of MAIC (Modified AIC), the optimal length of the lag in the interest rate series is determined as two, and in the inflation series, it is determined as ten. In appendix 1, the results of a traditional unit root test indicate that both variables are integrated at the first order (I(1)). However, some of the related literature points out the weaknesses of the traditional unit root tests. Therefore, we also employ a TAR unit root test. First, the compatibility of the TAR unit root test on the series is examined. The details of the obtained results are shown in Appendix 2. The test was applied for the TAR model, which includes a constant term. For the interest rate data, the lag length has been determined as twelve and for the inflation series, the lag length has similarly been determined as ten according to AIC. As a result of the tests applied; Caner and Hansen test indicates 5 lag for IR and 4 lags for Π as m lag parameter. Following the Caner and Hansen (2001) study, the m lag length was set to the minimum Sum of Square Residual (SSR). After the effect of the threshold is tested, the results shown in Appendix 2 indicate the presence of a threshold effect on m lag. Although the presence of a threshold effect for k lag is rejected, as in the Caner and Hansen (2001) study, the results obtained from the m lag should be taken into account. In the next step after this test, R1 – R2 and t1 and t2 tests were applied. The results were obtained through a Caner and Hansen (2001) test. When the whole period and each regime are examined separately, the series are not stationary for both variables. Then, we follow with Hansen and Seo (2002) T-VEC results.

First regime "typical regime", $IR_t \le 0.34\Pi_t + 0.11$

Second regime "extreme regime", $IR_t > 0.34\Pi_t + 0.11$

Estimated T-VEC models are,

$$\Delta IR_t = \begin{cases} \underset{(0.003)}{-0.0012} - \underset{(0.055)}{0.14} w_{t-1} + \underset{(0.094)}{0.39} \Delta IR_{t-1} + \underset{(0.053)}{0.20} \Delta IR_{t-2} - \underset{(0.095)}{0.12} \Delta IR_{t-3} & \\ + \underset{(0.048)}{0.57} \Delta\Pi_{t-1} + \underset{(0.74)}{0.11} \Delta\Pi_{t-2} - \underset{(0.052)}{0.23} \Delta\Pi_{t-3} & w_{t-1} \le 0.11 \\ \underset{(0.001)}{0.26} - \underset{(0.0095)}{0.83} w_{t-1} + \underset{(0.017)}{1.67} \Delta IR_{t-1} - \underset{(0.042)}{4.73} \Delta IR_{t-2} - \underset{(0.0217)}{2.63} \Delta IR_{t-3} & \\ + \underset{(0.046)}{6.05} \Delta\Pi_{t-1} - \underset{(0.013)}{2.697} \Delta\Pi_{t-2} - \underset{(0.041)}{0.53} \Delta\Pi_{t-3} & w_{t-1} > 0.11 \end{cases}$$

$$
\Delta\Pi_t = \begin{cases}
\underset{(0.007)}{-0.0004} - \underset{(0.007)}{0.0001}w_{t-1} + \underset{(0.016)}{0.019}\Delta\Pi_{t-1} + \underset{(0.087)}{0.46}\Delta\Pi_{t-2} + \underset{(0.0209)}{0.0036}\Delta\Pi_{t-3} \\
-\underset{(0.099)}{0.037}\Delta IR_{t-1} + \underset{(0.014)}{0.021}\Delta IR_{t-2} - \underset{(0.10)}{0.19}\Delta IR_{t-3} & w_{t-1} \leq 0.11 \\
\underset{(0.00016)}{0.026} - \underset{(0.0009)}{0.179}w_{t-1} + \underset{(0.0017)}{0.149}\Delta\Pi_{t-1} - \underset{(0.004)}{0.12}\Delta\Pi_{t-2} + \underset{(0.002)}{0.49}\Delta\Pi_{t-3} \\
-\underset{(0.004)}{1.533}\Delta IR_{t-1} - \underset{(0.0013)}{0.267}\Delta IR_{t-2} + \underset{(0.004)}{0.61}\Delta IR_{t-3} & w_{t-1} > 0.11
\end{cases}
$$

The estimated cointegration relation is $w_t = IR_t - 0.34\Pi_t$, and the threshold value is obtained as $\gamma = 0.11$. Therefore, compared to the first regime inflation rates, there is an 11% increase in the interest rate. In the estimated period, the first observation covers 91% and is defined as $IR_t \leq 0.34\Pi_t + 0.11$. In this model, the first regime can be called the typical regime. The second regime, on the other hand, comprises the 9% share of below normal and is called the extreme regime. The second regime is realized when the difference between inflation and interest rates is less than 11% and can be defined as

$$IR_t \leq 0.34\Pi_t + 0.11.$$

From the results, it is observed that the error correction mechanism is functioning for both the first regime defined as a typical regime that contains 91% of the observed values and the second regime (the extreme regime) contains 9% of the observation values. It is concluded that the cointegration relationship exists in both regimes, thus showing an increase in the interest rates as a result of an increase in the inflation rates.

5 Conclusions

This paper concludes that if the percentage change in the difference between inflation and interest rates is more than 11%, this status distinguishes the effect of error correction. We determined that if the percentage change in the difference between these variables is less than 11%, the ECM coefficient is found to be -0.14. If the percentage change in the difference is more than 11%, the ECM coefficient is -0.83. Therefore, in situations where the difference is above the threshold value, a shock experienced in interest rates rapidly converges to equilibrium. When the ECM is examined for inflation, it is observed that in the typical regime, the return to equilibrium is very slow and statistically insignificant. However, in the case that the gap between inflation and interest rates in the extreme regime (second regime) is further increased, it is observed that the ECM coefficient is still significant and is higher than it is in the typical regime. According to the T-VEC equations; the interest rate and the inflation are positively affected by their past two and one periods respectively.

References

[1] Aslanidis, N., Kouretas, G., Testing for two-regime threshold cointegration in the parallel and official markets for foreign currency in greece. Economic Modelling **22** (4), (2005) 665–682.

[2] Bajo-Rubio, O., Díaz-Roldán, C., Esteve, V., Is the budget deficit sustainable when fiscal policy is non-linear? the case of spain. Journal of Macroeconomics **28** (3), (2006) 596–608.

[3] Balke, N., Fomby, T., Threshold cointegration. International Economic Review, (1997) 627–645.

[4] Balke, N., Wohar, M., Nonlinear dynamics and covered interest rate parity. Empirical Economics **23** (4), (1998) 535–559.

[5] Barsky, R., De Long, J., Forecasting pre-world war i inflation: the fisher effect and the gold standard. The Quarterly Journal of Economics **106** (3), (1991) 815.

[6] Baum, C., Barkoulas, J., Caglayan, M., Nonlinear adjustment to purchasing power parity in the post-bretton woods era. Journal of International Money and Finance **20** (3), (2001) 379–399.

[7] Baum, C., Karasulu, M., Modelling federal reserve discount policy. Computational Economics **11** (1), (1997) 53–70.

[8] Benhabib, J., Schmitt-Grohé, S., Uribe, M., Chaotic interest-rate rules. The American Economic Review **92** (2), (2002) 72–78.

[9] Berument, H., Jelassi, M., The fisher hypothesis: a multi-country analysis. Applied Economics **34** (13), (2002) 1645–1655.

[10] Bildirici, M., Alp, E., The relationship between wages and productivity: Tar unit root and tar cointegration approach. International Journal of Applied Econometrics and Quantitative Studies **5** (1), (2008) 93–110.

[11] Caner, M., Hansen, B., Threshold autoregression with a unit root. Econometrica **69** (6), (2001) 1555–1596.

[12] Clements, M., Galvão, A., A comparison of tests of nonlinear cointegration with application to the predictability of us interest rates using the term structure. International Journal of Forecasting **20** (2), (2004) 219–236.

[13] Cox, J., Ingersoll Jr, J., Ross, S., A theory of the term structure of interest rates. Econometrica: Journal of the Econometric Society, (1985) 385–407.

[14] Crowder, W., Hoffman, D., The long-run relationship between nominal interest rates and inflation: the fisher equation revisited. Journal of Money, Credit and Banking **28** (1), (1996) 102–118.

[15] Enders, W., Falk, B., Threshold-autoregressive, median-unbiased, and cointegration tests of purchasing power parity. International Journal of Forecasting **14** (2), (1998) 171–186.

[16] E.Panopoulou, A resolution of the fisher effect puzzle: A comparison of estimators. Economics, Finance and Accounting Department Working Paper Series n1500205, Department of Economics, Finance and Accounting, National University of Ireland - Maynooth (2005).

[17] URL http://ideas.repec.org/p/may/mayecw/n1500205.html

[18] Esteve, V., A note on nonlinear dynamics in the spanish term structure of interest rates. International Review of Economics & Finance **15** (3), (2006) 316–323.

[19] Esteve, V., Gil-Pareja, S., Martinez-Serrano, J., Llorca-Vivero, R., Threshold cointegration and nonlinear adjustment between goods and services inflation in the united states. Economic Modelling **23** (6), (2006) 1033–1039.
[20] Fahmy, Y., Kandil, M., The fisher effect: new evidence and implications. International Review of Economics & Finance 12 (4), (2003) 451–465.
[21] Fama, E., Short-term interest rates as predictors of inflation. The American Economic Review **65** (3), (1975) 269–282.
[22] Fama, E., Interest rates and inflation: the message in the entrails. The American Economic Review **67** (3), (1977) 487–496.
[23] Fama, E., Schwert, G., Asset returns and inflation. Journal of Financial Economics **5** (2), (1977) 115–146.
[24] Fisher, I., The Theory of Interest. New York Macmillan (1930).
[25] Gascoigne, J., Estimating threshold vector error-correction models with multiple cointegrating relationshipsWorking Paper, Deparment of Economics. The University of Sheffield (2004).
[26] Ghosh, D., Dutt, S. B., A threshold cointegration test of the fisher hypothesis: Case study of 5 European nations. Southwestern Economic Review , Journal of the Southwestern Society of Economists **341**, (2007) 41–50.
[27] Gibbons, M., Ramaswamy, K., The term structure of interest rates: empirical evidence. (1988) Working Papers.
[28] Gonzalez, M., Gonzalo, J., Threshold unit root modelsWorking Paper, U. Carlos III de Madrid (1997).
[29] Gul, E., Ekinci, A., The causal relationship between nominal interest rates and inflation: The case of turkey. Scientific Journal of Administrative Development **4**, (2006) 54–69.
[30] Hansen, B., Inference when a nuisance parameter is not identified under the null hypothesis. Econometrica: Journal of the Econometric Society **64** (2), (1996) 413–430.
[31] Hansen, B., Seo, B., Testing for two-regime threshold cointegration in vector error-correction models. Journal of Econometrics **110** (2), (2002) 293–318.
[32] Herwartz, H., Reimers, H.,. Modelling the fisher hypothesis: World wide evidence. (2006) Economics Working Papers (4).
[33] Jumah, A., Kunst, R.,. Optimizing time-series forecasts for inflation and interest rates using simulation and model averaging. Inst. für Höhere Studien (IHS) (2008).
[34] Koustas, Z., Lamarche, J., Serletis, A., Threshold random walks in the us stock market. Chaos, Solitons & Fractals **37** (1), (2008) 43–48.
[35] Kugler, P., The dynamic relationship between interest rates and inflation: An empirical investigation. Empirical Economics **7** (1), (1982) 125–137.
[36] Ling, T., Liew, V., Wafa, S., Wafa, S., Does fisher hypothesis hold for the east asian economies an application of panel unit root tests. Comparative Economic Studies **52** (2), (2010) 273–285.
[37] Lo, M., Zivot, E., Threshold cointegration and nonlinear adjustment to the law of one price. Macroeconomic Dynamics **5** (4), (2001) 533–576.
[38] Martens, M., Kofman, P., Vorst, T., A threshold error-correction model for intraday futures and index returns. Journal of Applied Econometrics **13** (3), (1998) 245–263.
[39] Michael, P., Nobay, A., Peel, D., Transactions costs and nonlinear adjustment in real exchange rates; an empirical investigation. Journal of Political Economy **105** (4), (1997) 862–879.

[40] Million, N., Central bank's interventions and the fisher hypothesis: a threshold cointegration investigation. Economic Modelling **21** (6), (2004) 1051–1064.
[41] Mishkin, F., Is the fisher effect for real? : A reexamination of the relationship between inflation and interest rates. Journal of Monetary Economics **30** (2), (1992) 195–215.
[42] Mishkin, F., Simon, J., An empirical examination of the Fisher effect in Australia. Economic Record **71** (3), (1995) 217–229.
[43] Ng, S., Perron, P., Lag length selection and the construction of unit root tests with good size and power. Econometrica **69** (6), (2001) 1519–1554.
[44] Obstfeld, M., Taylor, A., Nonlinear aspects of goods-market arbitrage and adjustment: Heckscher's commodity points revisited. Journal of the Japanese and International Economies **105** (4), (1997) 441–479.
[45] O'Connell, P., Market frictions and real exchange rates1. Journal of International Money and Finance **17** (1), (1998) 71–95.
[46] O'Connell, P., Wei, S., The bigger they are, the harder they fall: Retail price differences across us cities. Journal of International Economics **56** (1), (2002) 21–53.
[47] Pennacchi, G., Identifying the dynamics of real interest rates and inflation: Evidence using survey data. Review of Financial Studies **4** (1), (1991) 53–86.
[48] Phiri, A., Lusanga, P., Can asymmetries account for the empirical failure of the fisher effect in South Africa? Economics Bulletin **31** (3), (2011) 1968–1979.
[49] Pippenger, M., Goering, G., Practitioners corner: A note on the empirical power of unit root tests under threshold processes. Oxford Bulletin of Economics and Statistics **55** (4), (1993) 473–481.
[50] Root, T., Lien, D., Impulse responses in a threshold cointegrated system: the case of natural gas markets. Applied Financial Economics **13** (1), (2003) 23–35.
[51] Sathye, M., Sharma, D., Liu, S., The fisher effect in an emerging economy: The case of india. International Business Research **1** (2), (2009) p.99.
[52] Stambaugh, R., The information in forward rates: Implications for models of the term structure. Journal of Financial Economics **21** (1), (1988) 41–70.
[53] Summers, L., The nonadjustment of nominal interest rates: A study of the fisher effect. In: Tobin, J. (Ed.), Prices and quantities: A macroeconomic analysis. Brookings Inst. Pr., (1984) 201–246.
[54] Taylor, A., Potential pitfalls for the purchasing-power-parity puzzle? sampling and specification biases in mean-reversion tests of the law of one price. Econometrica **69** (2), (2001) 473–498.
[55] Tsay, R., Testing and modeling threshold autoregressive processes. Journal of the American Statistical Association **84**, (1989) 231–240.
[56] Tsay, R., Unit root tests with threshold innovations. Preprint, University of Chicago (1997).
[57] Weidmann, J., New hope for the fisher effect?: A reexamination using threshold cointegration. University of Bonn, (1996) SFB 303 Discussion Paper B-385.
[58] Westerlund, J., Panel cointegration tests of the fisher effect. Journal of Applied Econometrics **23** (2), (2008) 193–233.
[59] Wilcox, J., Why real interest rates were so low in the 1970s? The American Economic Review **73** (1), (1983) 44–53.

Appendix

Table 1: Traditional unit root tests

IR	**Test Statistic**	**1%**	**5%**	**10%**
ADF(12)	-3.1786	-3.490210	-2.887665	-2.580778
ERS DF-GLS(2)	-1.86527	-2.585962	-1.943741	-1.614818
Π	**Test Statistic**	**1%**	**5%**	**10%**
ADF(12)	-1.991073	-3.490210	-2.887665	-2.580778
ERS DF-GLS(10)	-1.21892	-2.585962	-1.943741	-1.614818
First Difference				
D(IR)	**Test Statistic**	**1%**	**5%**	**10%**
ADF(12)	-7.422481	-3.490210	-2.887665	-2.580778
ERS DF-GLS(0)	-5.864774	-2.585962	-1.943741	-1.614818
D(Π)	**Test Statistic**	**1%**	**5%**	**10%**
ADF(12)	-4.726127	-3.490210	-2.887665	-2.580778
ERS DF-GLS(5)	-4.901254	-2.585962	-1.943741	-1.614818

Table 2: Caner and Hansen (2001) test results

	Variable	Wald Stat	Boot p-val.	Asimp. p-val.
Bootstrap Threshold Test	IR(m=5)	41.50	0.09	0.08
	IR(k=12)	16.6	0.92	0.90
	Π (m=4)	34.70	0.04	0.025
	Π (k=10)	25.24	0.24	0.23
Two - Sided Wald Test for UR (R_2)	IR(m)	7.26	0.31	0.36
	IR(k)	10.62	0.17	0.13
	Π (m)	10.19	0.11	0.15
	Π (k)	12.92	0.05	0.06
One - Sided Wald Test for UR (R_1)	IR(m)	2.39	0.13	0.11
	IR(k)	10.53	0.14	0.11
	Π (m)	10.19	0.075	0.12
	Π (k)	12.92	0.04	0.05
t_1 Test for Stationary	IR(m)	2.39	0.13	0.28
	IR(k)	3.24	0.05	0.05
	Π (m)	2.92	0.05	0.11
	Π (k)	2.94	0.06	0.11
t_2 Test for Stationary	IR(m)	1.23	0.44	0.80
	IR(k)	-0.29	0.82	0.95
	Π (m)	1.3	0.39	0.78
	Π (k)	2.07	0.21	0.43

(Bootstrap raplication:10000)