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THE CASUAL RELATIONSHIP BETWEEN INFLATION UNCERTAINTY AND INTEREST RATE IN TURKEY: ROLLING WINDOW CAUSALITY TEST

TÜRKİYE'DE ENFLASYON BELİRSİZLİĞİ İLE FAİZ ORANI ARASINDAKİ NEDENSELLİK İLİŞKİSİ: KAYAN PENCERE NEDENSELLİK TESTİ

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Öz

Bu çalışmanın amacı enflasyon belirsizliğinin piyasa faiz oranı (benchmark) üzerindeki etkisini analiz etmektir. Bu çerçevede ekonomide genel faiz düzeyini gösteren ve para piyasasında karar birimlerinin tercihleri sonucunda oluşan iki yıllık devlet tahvilinin faiz oranı temel değişken olarak alınmıştır. Enflasyon belirsizliği Tüketici Fiyat Endeksi'nden (TÜFE) Friedman'ın yaklaşımına dayalı olarak GARCH yöntemi kullanılarak koşullu varyanstan türetilmiş ve açıklayıcı değişken olarak kullanılmıştır. Piyasa faiz oranının kullanılması, enflasyon ve enflasyon belirsizliğine karşı piyasa karar birimlerinin davranışına ait bilgiyi içerdiğinden, elde edilen bulgular politika önerisi açısından önem kazanmaktadır.

Bu çalışmada 2005:04-2016:11 dönemine ait veri seti kullanılarak enflasyon belirsizliğinin piyasa faiz oranı üzerindeki etkisi Hill (2007)'nin geliştirdiği zamana bağlı nedensellik yaklaşımına dayalı olarak incelenmiştir. Çalışmanın bulgularına göre 2005:04 ve 2006:05 dönemleri arasında enflasyon belirsizliğinden faiz oranlarına doğru nedensellik ilişkisi söz konusudur. Diğer yandan, 2013:03 ve 2015:12-2016:09 dönemlerinde faiz oranlarından enflasyon belirsizliğine doğru nedensellik ilişkisi gözlemlenmiştir.

Anahtar Kelimeler: Enflasyon Belirsizliği, Faiz Oranı, Zaman Bağlı Nedensellik Testi.

Abstract

The aim of this study is to analyse the impact of inflation uncertainty on the volatility of benchmark interest rate which is the market indicator. In this context, the interest rate of two-year government bonds, which shows general interest rate in the economy and which occurs as a result of the preferences of decision-making units in the money market is considered as a basic variable. Inflation uncertainty is derived from Consumer Price Index (CPI) depending on Friedman's Approach and is used as an explanatory variable. Because the use of benchmark interest rate includes the knowledge regarding the behaviour of the market decision-making units to inflation and inflation uncertainty, the results obtained are of great importance with regards to the policy proposals.

In this study, the effect of inflation uncertainty on the volatility of benchmark interest rate is examined by the volatility and structural break models for the period of 2005:04-2016:11. The findings of the study have shown that there is a causal relationship from inflation uncertainty to interest rates between 2005:04 and 2006:05. Additionally, a causal relation from interest rates to inflation uncertainty is observed in the periods of 2013:03 and 2015:12-2016:09.

Keywords: Inflation Uncertainty, Interest Rate, Time-Varying Causality Test

GENİŞLETİLMİŞ ÖZET

Çalışmanın Amacı:

Bu çalışma enflasyon belirsizliği ile faiz oranı arasındaki nedenselliğin zaman boyutunda incelenmesi ve böylece ele alınan dönem içerisinde TCMB'nin uyguladığı para politikası stratejileriyle birlikte kriz dönemlerinin parametreler üzerindeki etkisini dikkate alması açısından literatüre katkı sunmaktadır.

Çalışmanın Soruları:

Enflasyon belirsizliği ile piyasa faiz oranları arasında bir ilişki var mıdır? Eğer bir ilişki varsa faiz oranlarından enflasyon belirsizliğine mi yoksa enflasyon belirsizliğinden faiz oranlarına mı nedensellik ilişkisi vardır. Enflasyon belirsizliği ile faiz oranları arasındaki ilişki doğrusal mı yoksa asimetrik midir? Türkiye' de enflasyon ve faiz oranı çerçevesinde para politikası etkin midir?

Literatür:

Literatürde enflasyon ve enflasyon bekleyişleri arasındaki ilişkinin varlığı, geliştirilen ekonometrik yaklaşımlara göre her zaman üzerinde analiz yapılan bir konu olmuştur. Bundan dolayı söz konusu değişkenler arasında ilişkiye yönelik ampirik çalışmalar farklılık göstermektedir. Bu bağlamda literatürde enflasyon ve faiz oranları arasında ilişki bulamayan, negatif ilişki bulan ve pozitif ilişki bularak Fisher hipotezini destekleyen çalışmalar bulunmaktadır. Enflasyon belirsizliği kaynakların etkin dağılımını bozarak faiz oranlarını arttırarak risk primini arttırmaktadır. Bu çerçevede literatürde genellikle enflasyon belirsizliğinin faiz oranlarını arttırdığı tespit edilmiştir. Ödünç verilebilir fonlar teorisine dayanan literatür enflasyon belirsizliği ve faiz oranları arasındaki ilişkiyi negatif tespit etmiştir. Sonuç olarak literatürde enflasyon belirsizliği ile faiz oranları arasında pozitif ilişki olduğunu ortaya koyan çalışmalar olduğu gibi negatif bir ilişkiyi bulgulayan çalışmalar da mevcuttur. Sonuç olarak literatürde ele alına dönem ve örneklem farklıları ile birlikte ampirik literatürün gelişmesiyle farklı sonuçlar elde edilmiştir.

Metodoloji:

Çalışmada Hill (2007) tarafından geliştirilen ve katsayıların zamana göre değişimini dikkate alan nedensellik testi kullanılmıştır. Hill (2007)'nin ortaya koyduğu bu testin en önemli özelliği literatürde yer alan ve tüm dönemin ortalamasını dikkate alan nedensellik testlerinden farklı olarak ele alınan zaman döneminin her bir noktasındaki nedenselliğin testine olanak vermesidir. Söz konusu ilişkinin ele alınan zaman aralıkları için farklılık göstermesi zamana göre değişen bir yapıyı işaret etmektedir. Ayrıca literatürde enflasyon belirsizliği ile faiz oranları arasındaki ilişkinin yönü parametrik yöntemlerle tahmin edilmeye çalışılmıştır. Ancak nedensellik ilişkisi zamana göre değişen bir yapı için ele alınmamıştır. Bu nedenle bu çalışmada enflasyon belirsizliği ile faiz oranları arasındaki nedensellik ilişkisi ele alınan zaman aralığındaki her gözlem için tahmin edilmiştir. Çalışmada enflasyon belirsizliği ile faiz oranları arasındaki ilişki 2000M05 2016M11 dönemi aylık veriler kullanılarak incelenmiştir. Faiz değişkenini temsilen piyasa faizi olarak kabul edilen 3 ay kupon ödemeli 2 yıllık devlet tahvilinin faizi (gösterge niteliğinde faiz oranı, piyasa faiz oranı) alınmıştır. Söz konusu değişken IMF'nin veri tabanı International Financial Statistics'ten (IFS)'den elde edilmiştir. Enflasyon değişkeni ise TCMB'den elde edilen tüketici fiyat endeksinden hesaplanmıştır. Enflasyon belirsizliği değişkeni GARCH sürecine bağlı ve zamana göre değişen koşullu varyanslardan elde edilen enflasyon riskini temsil eden vekil değişken olarak elde edilmiştir. Ölçek sapması ve değişen varyansa karşı değişkenler doğal logaritmaları alınarak kullanılmıştır. 2000M05'in başlangıç dönemi olarak seçilme nedeni, yöntem kısmında açıklanan kayan pencere nedensellik testinin sabit bir pencere genişliğine dayanması ve bu genişliğin açık enflasyon hedeflemesi rejiminin etkisini yansıtacak büyüklükte seçilmesidir.

Bulgular ve Sonuçlar:

Çalışmanın bulgularına göre 2005M04 ve 2006M05 dönemleri arasında enflasyon belirsizliğinden faiz oranlarına doğru nedensellik ilişkisi söz konusudur. Bu sonuç açık enflasyon hedeflemesi stratejisi ile birlikte faiz oranlarının belirlenmesinde para politikası araçlarının etkili olduğunu göstermektedir. Ancak ilerleyen dönemde küresel kriz ile birlikte faiz oranlarının belirlenmesi konusunda para politikası etkinliğini kaybetmiştir. Küresel politikalar, sermaye akımları, risk ve belirsizlikler faiz oranlarının belirlenmesinde enflasyon dinamikleri ve bekleyişlerden daha etkili olduğu ifade edilebilir. Kriz ile birlikte ortaya çıkan bu ortam ilerleyen dönemde de söz konusu ilişkinin bozulmasına neden olmuştur. Bu süreçte enflasyon belirsizliğinden faiz oranlarına doğru nedensellik ilişkisinin eğilimi negatif yönde hareket etmiş ve giderek zayıflamıştır. Diğer yandan, 2013M03 ve 2015M12-2016M09 dönemlerinde faiz oranlarından enflasyon belirsizliğine doğru nedensellik ilişkisi gözlemlenmiştir. Bununla birlikte faiz oranlarından enflasyon belirsizliğine doğru nedensellik ilişkisinin eğilim olarak giderek güçlenmekte olduğu ortaya konmuştur. Bunun nedeni olarak enflasyon-faiz döngüsünde küresel piyasalardaki hareketler ve dolar kurunun artış eğiliminin fiyatlara yansıması nedeniyle faiz oranları üzerinden enflasyonist baskıların ortaya çıkması gösterilebilir. Bu koşullar değerlendirildiğinde Türkiye'de para politikasının fiyat istikrarı hedefi doğrultusunda etkili adımlar atabilmesi için risk ve belirsizlik ortamını stabilize edilmesi gerekmektedir. Ayrıca yerli ve yabancı yatırımcı için TCMB sözle yönlendirme politikaları gibi makro ihtiyati politikalar aracılığıyla spekülatif ortamların oluşmasını engelleyerek finansal istikrarın sağlanmasına da katkıda bulunmalıdır.

INTRODUCTION

Monetarist approaches dealing with inflation that occurred especially in 1970s as supply-side have gained importance in Economic theory. These approaches essentially adopt the monetary principles of classical and neoclassical economic theories. According to the relationship between interest rate and inflation based on the Fisher hypothesis, inflation expectations have an effect on interest rates. According to Fisher hypothesis; inflation expectations affect interest rates to some extent. The reason of this situation is the fact that inflation expectations prompt individuals to spend money in short-term and that money demand shows increase with transaction motive in economy. When considered from this point of view, the increase on interest rates is adopted as an indicator of inflation expectations in economy. Because, if there is an expectation towards an increase on inflation rates in economy, individuals increase their current demands by assuming that their future purchasing powers will fall. This demand causes an increase on interest rates by raising the money demand. In general, if there is a positive relationship between inflation uncertainty and interest rates, uncertainty will further reduce growth by decreasing consumption and investment by the interest rate channel. However, if there is a negative relationship between inflation uncertainty and interest rates, the impact of inflation uncertainty on economic activity will be uncertain.

Inflation uncertainty phenomenon was firstly explained by Friedman in 1977. Friedman (1977) argued that the increase on general level of prices leads to a successive inflation expectation and that inflation uncertainty shows increase because of this situation. Especially the short-term effects of this uncertainty on interest rates reveal a number of macroeconomic effects depending on the future value and volatility levels of interest rates. Inflation uncertainty has a cost effect on economy because of the above-mentioned effect on interest rates. While the effect of inflation on the average rate of interest rates is determined by the growth process of economy, the effect of inflation uncertainty on interest rates is adopted as an indicator of risk levels. Especially, the effect of inflation uncertainty on the interest rate volatility shows the risk level caused by inflation expectations in economy.

The above-mentioned situation is considered in the context of risk aversion and risk neutrality concepts in literature (Hartman and Makin, 1982: 1). Because inflation uncertainty increases interest rate volatility, decision units may restrict their economical behaviors. The fact that inflation uncertainty increases interest rate volatility causes an increase on uncertainty and risk levels. This situation generally creates pressure as to increasing the interest rates for Central Banks willing to control the interest rate volatility.

There is no consensus as to the causality direction of the relationship between inflation uncertainty and interest rates in the empirical literature. In general, inflation uncertainty on interest rates is not addressed adequately in the related literature despite the fact that inflation leads to an increase in interest rates. Thus, the so-called increase in interest rates stemming from inflation uncertainty and inflation expectations may not be explained. One of the reasons of this situation is that the parameters showing the size and volume of the so-called relationship show change by time. In addition, it is necessary to deal with the related time dimension since the change in parameters. It is important for the policy makers because the relationship will change in the period of crisis or instability. Finally, economic variables are defined as non-linear with respect to the variable until time-varying parameterized models are developed. However, the response of the parameters to the shocks emerging in the economy and the changes in the parameters considered as breaks in the economy have not been considered. In this study, therefore, the relationship between inflation uncertainty and interest rates is analyzed by using Time-Varying Causality Test developed by Hill (2007) taking into account the effects.

Here, as a novel approach, the causality between inflation uncertainty and interest rate is analyzed in terms of time dimension considering the effect of crisis periods and monetary policy strategies followed by the central bank of the republic of Turkey on the coefficients. So it is expected to these aspects will contribute to the current literature. In the following part of the study; literature review will be introduced and in the third part; empirical findings will be presented. Finally the conclusion and some political suggestions will be presented.

1. LITERATURE REVIEW

In the related literature, the relationship between inflation rates and inflation expectations is often analyzed according to several econometric approaches. Thus, the empirical studies made as to the relationship between the so-called variables differ from each other. For example, Klien (1975) and Summers (1983) concluded that there is no relationship between inflation and interest rates in their studies. Hahn (1970) found that there is a negative relationship between these variables. However, Mishkin(1992) pointed out the positive relationship between these variables in the long-term and no relationship in the short-term. Boudoukh and Richardson (1993) obtained the findings supporting Fisher Hypothesis by maintaining the positive relationship between inflation and interest rates.

Inflation uncertainty disrupts the allocative efficiency of resources in both current and previous periods (Friedman, 1977). Especially, the interest-rate risk premium arising from the inflation uncertainty affects the allocation of financial resources in economy. Interest-rate risk premiums destabilize in financial sector and may cause economic fragility by increasing the volatility of capital movements depending on the free movement of capital (Blanchard, 2003).

Being positive relationship between inflation and interest rates is of great significance especially in the periods when price stability monetary policies are adopted. If the policies to reduce inflation are not adopted as the reliable factors, the adaptation process between expected inflation and inflation outturn lengthen out and it becomes difficult to forecast inflation (Berument, 1999: 207). Generally, the studies have shown that inflation uncertainty affects economy by increasing interest rates in the long-term (Wicox, 1983; Chan, 1994; Berument and Jelassi, 2003; Kandil, 2005).

According to Loanable Funds Theory; interest rate volatility caused by inflation uncertainty affects consumer confidence negatively by changing the real income level because of the changes in inflation rates. Consumers willing to protect their earnings against inflation increase their savings. In this case, inflation uncertainty affects savings negatively and interest rates positively (Juster and Watchel, 1972a; Juster and Watchel, 1972b; Juster and Taylor, 1975; Levi and Makin, 1979; Bomberger and Frazer, 1981; Hartman and Makin, 1982).

The theories against the Loanable Funds Theory are based on Markowitz (1952) Portfolio Theory. For example, risk-averse investors avoid from risk-taking by devoiding of high return and unexpected inflation rates decrease real return of treasury bills. Thus, a positive relationship between inflation uncertainty and interest rates emerges (Fama, 1975; Fama and Schwart, 1977; Mishkin, 1981; Fama and Gibbons, 1982; Brenner and Landskroner, 1983; Chan, 1994; Mehra, 2006; Ceylan, 2006; Berument et. al, 2007). In literature, as in studies specific to Turkey focuses on the effects of inflation and inflation uncertainty. In studies investigating the Fisher effect based on the relationship between inflation and interest rates, no consensus was reached in the literature. There are studies that find that the Fisher effect is valid (Kesriyeli, 1994; Berument and Jelassi, 2002; Kutan and Aksoy, 2003; Turgutlu, 2004; Simsek and Kadılar, 2006; Atgür and Altay, 2015; Akinci and Yılmaz, 2016), as well as the Fisher effect is invalid (Gül and Acıkalın, 2008; Yılancı, 2009; Bayat, 2011).

On the other hand, the effects of inflation and inflation uncertainty in Turkey are evaluated under the Friedman-Ball hypothesis. According to the results obtained, high inflation process causes high inflation uncertainty. The result is that inflation uncertainty has usually no significant impact on inflation (Yamak, 1996; Nas and Perry, 2000; Telatar, 2003; Erdogan and Bozkurt, 2004; Ozer and Turkyilmaz, 2005; Erdem and Yamak, 2013).

In the literature, the relationship between inflation and interest rates is based on Fisher 's hypothesis, and inflation uncertainty is ignored. On the other hand, studies that take inflation uncertainty into account are evaluated in the context of inflation and causality. From this point of our work, especially taking into account the relationship between interest rates and inflation uncertainty in Turkey aims to contribute to the literature.

2. METHOD: HILL TIME-VARYING CAUSALITY TEST (2007)

Time-varying causality test developed by Hill (2007) is used in this study. Unlike the causality tests considering for all horizon at a time, time-varying causality test provides to test for causal patterns over multiple horizons. Hill (2007) developed a recursive (sequential) parametric representation of causality test for three variables. This causality test is based on the Wald test statistics of zero linear parameter restriction under the null hypothesis. This test statistics used on the h-dimensional vector autoregressive (VAR) process of p order is as follows:

$$W_{t+h} = a + \sum_{k=1}^{p} \pi_k^{(h)} W_{t+1-k} + u_{t+h} \tag{1}$$

Where, $\boldsymbol{W_t}$, $\boldsymbol{m \geq 2}$ is the m-vector stationary process; $\boldsymbol{\pi_k^{(h)}}$matrix –valued coefficients; $\boldsymbol{u_t}$zero avarage and $\boldsymbol{\Omega = E\ [u_t u_t']}$ non-singular covariance matrices $\boldsymbol{mx1}$ vector shows the white noise process and $\boldsymbol{\alpha}$ constant term.

The process with two variables (inflation uncertainty - interest rate) has been used in this study. 2-vector stationary process is described as $\boldsymbol{W_t = (S_t', R_t')}$ in the study. R is not the linear cause of S after one period for $\boldsymbol{k = 1}$ and $\boldsymbol{\pi_{RS,1}^{(h)} = 0}$. In cases where some or all of the variables are not stationary, the autoregressive process (p, h) in equation 1 can be extended by adding d additional lags to the VAR model by using the approaches of Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996). The hypothesis that there is no causality after one period can be tested with the help of a simple Wald test with linear zero constraint. Due to the low performance of the $\boldsymbol{\chi^2}$ distribution in small sample distributions, the parametric bootstrap method has been used to simulate the small sample p values suggested by Hill (2007).

3. DATA SET

In this study; the possible impact of inflation uncertainty on interest rates is analyzed covering the period 2005:04 - 2016:011 by using monthly data. Two-year government bond (market interest rate) is considered as an interest rate indicator. The data on inflation (consumer price index) and interest rates (government bond rates) are gathered from International Monetary Fund International Financial Statistics and Central Bank of the Turkish Republic. In addition, Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model is used to motivate the time varying variability of inflation uncertainty. The variables are log transformed (the logarithmic series are used in order to make the variables linear in the time dimension and to reduce the prediction errors caused by deviations in the high averages of the two variables. It is also used to estimate the sensitivity of these variables to each other's sensibilities) for the scale deviation and heteroscedasticity. The variables used in the models are seasonally adjusted by the Tramo/Seats method. Table 1 presents the variables used in this study:

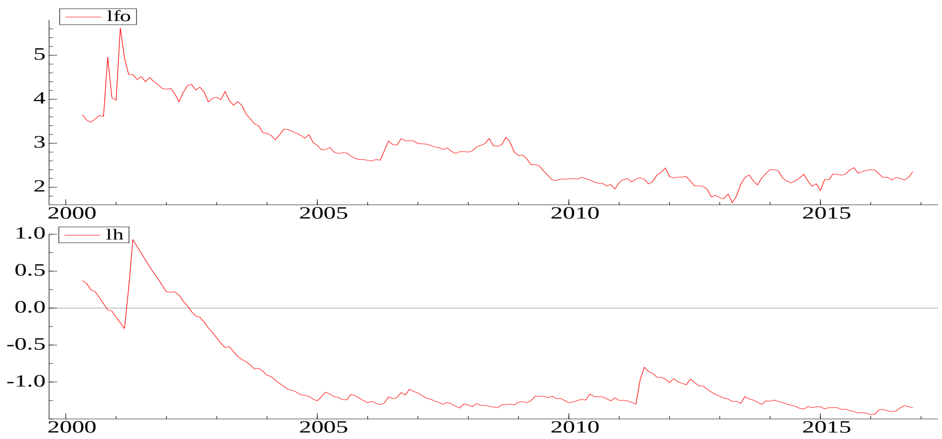
Table 1: The Variables Used in the Model

Symbol	Variables
IR	Two-year Government Bond Interest Rate
IF	Inflation Uncertainty

Optimal window size is determined as 60 because this size considers structural breaks and forecasts coefficients efficiently. Thus, this size has become the main criteria in choosing May 2005 as the initial term.

The reason of determining the year of 2005:04 as the initial term is the fact that Time-Varying Causality Test depends on the rolling window with a fixed sample size and that rolling window is chosen in a such as size reflecting the effect of open economy inflation targeting. The time-dependent tendency of the series is presented in Figure 1:

Figure 1: Time-Dependent Tendency of the Series



4. EMPIRICAL FINDINGS

Before analyzing the empirical findings related to the basic hypothesis of the study, descriptive statistics and stationary level of the used variables are investigated. Table 2 below shows the descriptive statistics for the variables from year 2005 to year 2016. According to the descriptive statistics presented in Table 2; it is seen that interest rates and inflation uncertainty variables are skewed to the right. Additionally, Table 2 has shown that the series are non-normal distributed based on skewness, kurtosis and Jarque-Bera test statistics.

Table 2: Summary of Descriptive Statistics

Variables	IR	IF
Average	2.839	-0.965
Median	2.657	-1.210
Maximum	5.620	0.927
Minimum	1.648	-1.439
Std. Deviation	0.789	0.549
Skewness	0.952	1.717
Kurtosis	3.176	4.812
Jarque-Bera	30.373***	125.144***
Observation	199	199

According to the Augmented Dickey-Fuller (ADF) (1979) and Phillips-Perron (PP) (1988) unit root test results reported in the appendix; it is seen that the logarithms of inflation uncertainty and interest rates are stationary at first difference. ADF and PP unit root tests do not consider the structural breaks. Thus; a unit root test developed by Narayan & Stephan Popp (2010) is used in determining the integration level of series in the case of two endogenous breaks. According to the test results implied in the appendix, interest rate is not stationary in the presence of two structural breaks. The results have also shown that the inflation uncertainty is stationary in the level, but not stationary in the level and trend. The presence of unit root requires determining whether there is a cointegration between the variables for analyzing the causal relationship.

Gregory-Hansen (1996) and Hatemi-J (2008) test results analyzing the relationship between the variables in the presence of one and two structural breaks respectively are reported in the appendix also.

According to Gregory-Hansen (1996) test results; it is seen that there is a cointegration relationship between interest rates and inflation uncertainty in the long-run. When evaluated the Hatemi-J (2008) cointegration test results; while ADF* test statistics developed by Engle & Granger has shown that there is no cointegration relationship between the variables and $\boldsymbol{Z_t^*}$ statistics developed by Phillips (1987) has indicated a cointegration relationship between the variables.

The extension of the Autoregressive Conditional Heteroscedasticity (ARCH) process to the Generalized ARCH process (GARCH) was introduced by Bollerslev (1986) with the aim of modeling time-varying volatility. GARCH process is formally given by:

$$\boldsymbol{h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}} \quad (2)$$

Where $\boldsymbol{\alpha_0}$ is the constant term; $\boldsymbol{\varepsilon/\psi_{t-1} \sim N(0, \sqrt{h_t})}$ is the probability density function and conditional variance ($\boldsymbol{h_t}$) of N (.) zero mean and $\sqrt{\boldsymbol{h_t}}$ is the conditional volatility of $\boldsymbol{\varepsilon_t}$ for $\boldsymbol{\alpha, \beta > 1\ and\ \alpha_0}$.

In the model, $\boldsymbol{h_t}$ is a linear function of the past values of error squares and conditional variance. In this study, GARCH (1,1) model has been used in determining inflation uncertainty. The ARCH-LM test has been applied to detect conditional heteroscedasticity of inflation series. According to the results of the ARCH-LM test statistic in Table 3, it can be seen that there is a conditional heteroscedasticity of the inflation series at the 6th and 12th lag lengths.

Table 3: Descriptive Statistics and ARCH-LM Test Statistics of Inflation Uncertainty

Mean	Standard Deviation	Skewness	Kurtosis	Jarque-Bera	ARCHLM (6)	ARCHLM (12)
1.24	1.37	2.38 (0.00)	11.15 (0.00)	776.33 (0.00)	48.7*** (0.00)	50.9 (0.00)

Akaike Information Criterion (AIC) is used in selecting the optimal lag length of the inflation uncertainty series. The optimal length of this series with the maximum lag of 12 is determined as 5 by using the Eviews 9 ARIMA Sel Add-in that perform automatic ARIMA selection.

Table 4: AR (5)-GARCH (1,1) Results of Inflation Uncertainty

$$\pi_t = 0.71 + 0.43\,\pi_{t-1} + 0.03\,\pi_{t-2} + 0.10\,\pi_{t-3} - 0.05\,\pi_{t-4} + 0.24\,\pi_{t-5} + \varepsilon_t$$

(4.77) (6.55) (0.50) (1.46) (-0.80) (3.85)

$$h_{\pi t} = 0.01 + 0.03\,\varepsilon_t^2 + 0.90\,h_{\pi,t-1}$$

(1.61) (1.98) (24.44)

$Q(6)$ =1.134(0.287) $Q(12)$ =11.280(0.127) GED =1.275(9.168)

According to Table 4; AR (5) - GARCH (1,1) estimation results show that the variance parameters provide the necessary conditions with positivity and stability with 0.03+0.90<1. This result informs that shocks are temporary. Additionally, it is seen that there is no heteroscedasticity at lag 6 and 12 according to Q test statistics results. On the other hand, the fact that the Generalized Error Distribution (GED) coefficient is below 2 shows the thickness of the tail behavior of the series. This situation implies that there may be an asymmetric distribution depending on the tail behavior. Thus, the GARCH process considering the time-varying conditional variance provides an efficient modeling in estimating the inflation uncertainty.

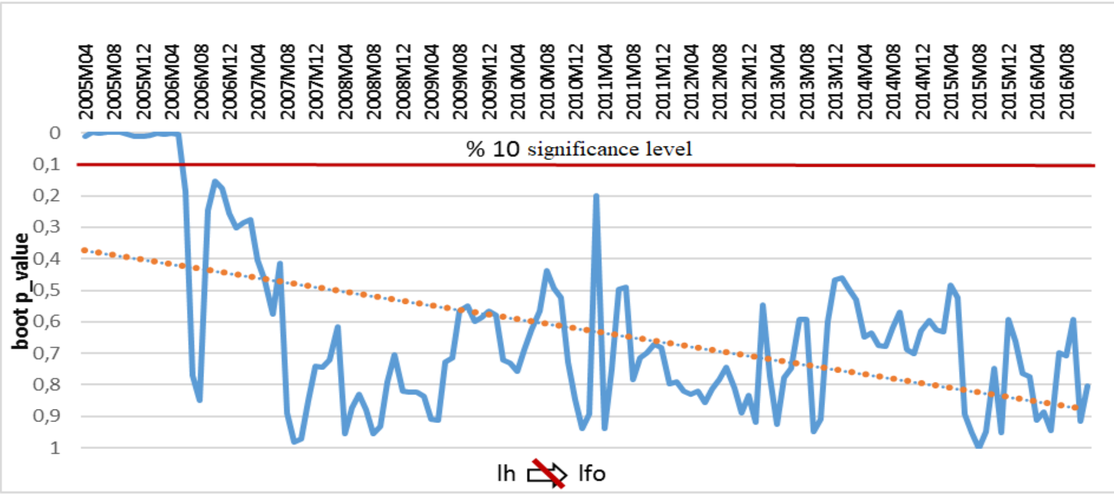
In this study; the interval corresponding to a certain time period (the size of the rolling window) has been determined by the time-varying causality test and the causal relationship has been examined by applying the bootstrap test in the time dimension. The estimation performance of model such as VARs model has been used against the possibility of bidirectional causality for examining the causal relationship between the variables. The optimal lag length has been considered according to the AIC information criterion for determining the direction of causation. The trend-free variables have been used with their level and logarithmic values by linear filtering method. In obtaining the test statistics, the bootstrap values which are especially effective against small sampling characteristics are used instead of the asymptotic values. The window size of 60 months has been chosen and 138 rolling windows have been used in the study. Inflation targeting period and stabilization conditions of VAR model (lack of autocorrelation) have been decisive in determining the so-called window size.

Table 5: Rolling Window Rejection Rates

Date	2005:M4-2016:M11
IF $\not\rightarrow$ IR	% 10 (14)
IR $\not\rightarrow$ IF	% 7.1 (10)
Total Observations	199

Table 5 shows the results of null hypothesis rejection in which there is no window causality that shifts from inflation uncertainty to interest rate and inflation uncertainty from interest rates. The rejection numbers at 10% significance level are shown in brackets. According to the results obtained, it is seen that the rate of rejection of inflation uncertainty is 10% and the number of rejection is 14, while the rate of rejection of inflation uncertainty from interest rates is 7.1% and rejection number is 10. The findings related to the number of rejections and causalities are shown in Figure 2 and Figure 3, respectively.

Figure 2: Time-Varying Causality Test



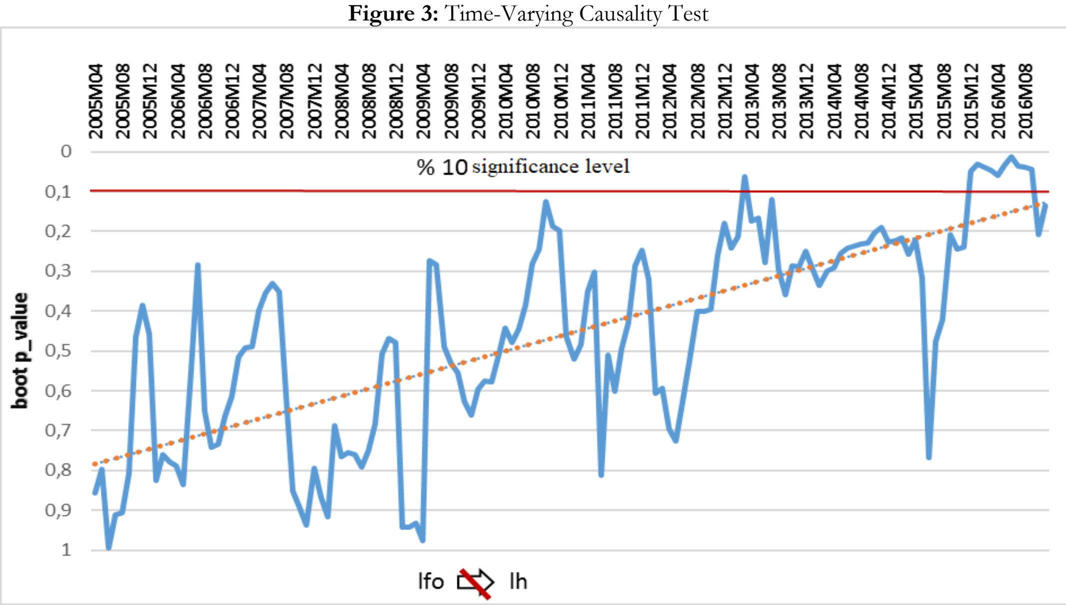
Source: Calculated by the authors (Note: The orange line is the "Causality Tendency" line)

Figure 2 shows the results of the window causality test, which shifts from inflation uncertainty to interest rates. The lines shown in blue indicate the bootstrap probability values. Orange dotted dots show the tendency of causality over time.

As can be seen in the Figure 2, there is a causality from inflation uncertainty to interest rates (the portion above the 10% significance level of the probability value) between 2005:04 and 2006:05, depending on a fixed window size (60 months). In other periods, the null hypothesis that there is no causality (LF ⇏ LR) cannot be rejected. The causality trend line shows that the causal relationship from inflation uncertainty to interest rates is gradually breaking.

At the beginning period of the open inflation targeting, there is a causality relationship from inflation uncertainty to interest rates. This can be interpreted as the transparency and predictability environment that the strategy of open inflation targeting has taken place allows the emergence of the related relationship by reducing the risks and uncertainties. However, the causality relationship removes especially with the crisis period. The 2007-2008 crises have resulted in increased risks and uncertainties due to the failure to achieve financial stability. This process has removed the validity of a causality relationship from inflation uncertainty to interest rates. It can be said that the economic policy-makers have to act depending on the conjuncture in determining the interest rates is one of the reasons why the causality relationship breaks.

Figure 3: Time-Varying Causality Test



Source: Calculated by the authors (Note: The orange line is the "Causality Tendency" line)

Figure 3 shows the results of the time-varying causality test (rolling window) from interest rates to inflation uncertainty. According to the results shown in Figure 3; it is seen that there is a causality relationship from interest rates to inflation uncertainty (the part above the 10% significance level of the probability value) in 2013:03 and 2015:12-2016:09 periods. In other periods, the null hypothesis that there is no causality (LR LF) cannot be rejected. Nevertheless, the causality trend line shows that the causality relationship from interest rates to inflation uncertainty is increasingly achieved.

In the crisis period, however, the decline in the level of the relationship has emerged, but it has showed an increase and then continued to follow a fluctuating course after the "monetary policy exit strategy" which was put into practice in the middle of 2010. The reason for this is that the recent political and economic conjuncture has prevented economic relations from progressing steadily.

Looking at the last part of Figure 3 (2015:12-2016:09), it is seen that the causality relationship from interest rates to inflation uncertainty has emerged. The reason for this situation is that the increase in the dollar exchange rate has caused the inflation rates to exceed the projected levels by affecting the market interest rates.

CONCLUSION AND POLICY RECOMMENDATIONS

The relationship between inflation uncertainty and interest rates receives a great deal of attention in the empirical literature. There are several studies finding both positive and negative relationship between the so-called variables in the literature. The fact that the concerned relationship shows difference in terms of the evaluated time intervals refers a time-varying structure. Additionally, the direction of relationship between interest rates and inflation uncertainty is also tried to be forecast with the parametric methods in the literature, but the time-varying structure is ignored when evaluating the causal relationship. Thus, the causal relationship between interest rates and inflation uncertainty is estimated for each observation in the evaluated time interval by considering the business cycles in this study.

The findings of the study show that interest rates are determined by inflation uncertainty over the 2005:4-2006:5 periods. This result shows that monetary policy instruments are efficient in determining the interest rates along with the open economy inflation targeting strategy. But then, monetary policies have lost their efficiency in determining the interest rates in the later period by the effect of global crisis. It is possible to say that global policies, capital flows, risk and uncertainties are more effective than inflation dynamics and expectations in determining the interest rates. This situation emerged with the crises has also caused the so-called relationship breakdown in the forthcoming days. In this period, the causal relationship from inflation uncertainty to interest rates has found in negative direction and decreased by degrees.

On the other hand, it is observed that there is a causal relationship from interest rates to inflation uncertainty and that the tendency of this causal relationship gradually increases in 2013:3 and over the 2015:12-2016:9 periods. The reason may be that some inflationary pressures on interest rates arose because of the movements in global markets and the reflection of increases on exchange rate in prices. Especially, the markets' pricing behaviors as to Federal Reserve Bank (Fed) policymakers' interest-rate hike policies may be shown as another reason.

Although two-way causal relationship between inflation uncertainty and interest rates is observed in certain periods, the so-called causality is not strong enough. A negative decomposition of the TL/USD exchange rate as compared to other currencies, the credit rating agencies' decisions as to lowering Turkey's credit score and internal or external political risks occurred in Turkey may be shown as the reasons of the so-called relationship breakdown. Additionally, while the causality relationship from inflation uncertainty to interest rates declines progressively, the contrast relationship becomes stronger gradually.

When evaluated these conditions, risk and uncertainty levels should be stabilized for the monetary policies implementing in Turkey to take efficient steps in accordance with inflation targeting. For this purpose, the pressure for the higher interest rate accompanying by high inflation rates may be controlled by providing the required conditions in order to protect domestic market from the external factors. On the other hand, stabilizing the macroeconomic environment provides the financial stability by the macro prudential policies such as inducement policies implemented by Turkish Central Bank.

REFERENCES

AKINCI, M., & YILMAZ, O. (2016), Enflasyon-Faiz Oranı Takası: Fisher Hipotezi Bağlamında Türkiye Ekonomisi İçin Dinamik En Küçük Kareler Yöntemi. *Sosyoekonomi*, *24*(27).

ATGUR, M., & ALTAY, O. N. (2015), Enflasyon ve Nominal Faiz Oranı İlişkisi: Türkiye Örneği (2004-2013), *Journal of Management and Economics,* 22(2), 521-533.

BAYAT, T. (2012), Türkiye'de Fisher Etkisinin Geçerliliği: Doğrusal Olmayan Eşbütünleşme Yaklaşımı, *Erciyes University, Journal of Economics and Administrative Sciences,* 38, 47-60.

BERUMENT, H. & JELASSI, M.M. (2002), The Fisher Hypothesis: A Multi-Country Analysis, *Applied Economics*, 34: 1645-1655.

BERUMENT, H. & JELASSI, M.M. (2002), The Fisher Hypothesis: A Multi-Country Analysis, *Applied Economics*, (34), 1645-1655.

BERUMENT, H., (1999), The Impact of Inflation Uncertainty on Interest Rates in the UK, *Scottish Journal of Political Economy,* 46(20), 207-18.

BERUMENT, H., CEYLAN, N. B., & OLGUN, H. (2007), Inflation uncertainty and interest rates: is the Fisher relation universal? *Applied Economics*, 39(1), 53-68.

BERUMENT, KILINÇ, H., Z. & OZLALE, U. (2005), The Missing Link between Inflation Uncertainty and Interest Rates, *Scottish Journal of Political Economy*, 52: 222-241.

BLANCHARD, O. (2003), Monetary Policy and Unemployment. In Remarks at the Conference" Monetary Policy and the Labour Market: A Conference in Honor of James Tobin", *New School University*.

BOLLERSLEV, T. (1986), Generalized Autoregressive Conditional Heteroscedasticity, *Journal of Econometrics*, 31: 307-327.

BOMBERGER, W. A., & FRAZER, W. J. (1981), Interest rates, Uncertainty and the Livingston Data*, The Journal of Finance*, 36(3), 661-675.

BOUDOUKH, J. & RICHARDSON, M. (1993), Stock Returns and Inflation: A Long Horizon Perspective*, American Economic Review,* 83: 1346-55.

BOZKURT, H., & ERDOĞAN, S. (2004), Türkiye'de 1983-2003 Döneminde Enflasyon ile Enflasyon Belirsizliği İlişkisi, *Journal of Iktisat Isletme ve Finans*, 19(219), 62-71.

BRENNER, M., & LANDSKRONER, Y. (1983), Inflation Uncertainties and Returns on Bonds, *Economica*, 50(200), 463-468.

CEYLAN, N., B. (2006), Faiz Oranı ve Enflasyon Belirsizligi Iliskisi, *Journal of Iktisat Isletme ve Finans,* (240), 98.

CHAN, L. K.C. (1994), Consumption, Inflation Risk, and Real Interest Rates: An Empirical Analysis, *Journal of Business*, 67 (1): 69-96.

DOLADO, J. J., & LUTKEPOHL, H. (1996), Making Wald Tests Work for Cointegrated VAR Systems, *Econometric Reviews*, 15(4), 369-386.

ERDEM, H. F., & YAMAK, R. (2013), Türkiye'de Enflasyon ve Enflasyon Belirsizliği: Kalman Filtre Yaklaşımı*, Journal of Cukurova University Faculty of Economics and Administrative Science*, 17(2).

FAMA, E. F. (1975), Short-term Interest Rates as Predictors of Inflation, *The American Economic Review,* 269-282.

FAMA, E. F., & GıBBONS, M. R. (1982), Inflation, Real Returns and Capital Investment, *Journal of Monetary Economics*, 9(3), 297-323.

FAMA, E. F., & SCHWERT, G. W. (1977), Asset Returns and Inflation, *Journal of Financial Economics,* 5(2), 115-146.

FRIEDMAN, M. (1977), Nobel Lecture: Inflation and Unemployment, *Journal of Political Economy,* 85: 451–72.

GÓMEZ, V. A. & MARAVALL, (1997), Programs TRAMO and SEATS, Instructions for User (Beta Version: September 1996), *Working Paper 9628*, Bank of Spain.

GREGORY, A. & W., HANSEN, B. (1996). Residual-Based Tests for Cointegration in Models with Regime Shifts, *Journal of Econometrics*, 70: 99-126.

GUL, E. & AÇIKALIN, S. (2007), An Examination of the Fisher Hypothesis: The Case of Turkey. *Applied Economics*, 10(1), 1-5.

HAHN, F. H. (1970), Savings and Uncertainty, *Review of Economic Studies*, 37: 21–4.

HARTMAN, R. & MAKIN, J. H. (1982), Inflation Uncertainty and Interest Rates: Theory and Empirical Tests, *NBER Working Paper 906*.

HATEMI-J, (2008). Tests for Cointegration with Two Unknown Regime Shifts with an Application to Financial Market Integration, *Empirical Economics*, 35: 497-505.

HILL, J. B. (2007), Efficient Tests of Long-Run Causation in Trivariate VAR Processes with a Rolling Window Study of the Money-Income Relationship, *Journal of Applied Econometrics,* 22: 747–765.

JUSTER, F. T. & TAYLOR, D. (1975), Towards a Theory of Saving Behavior, *American Economic Review*, 65: 203–9.

JUSTER, F. T. & WACHTEL, P. (1972a), Inflation and The Consumer, *Brookings Papers on Economic Activity*, 1: 71–114.

JUSTER, F. T. & WACHTEL, P. (1972b), A Note on Inflation and the Saving Rate, *Brookings Papers on Economic Activity,* 3: 765–78.

KANDIL, M. (2005), Money, Interest, and Prices: Some International Evidence, *International Review of Economics & Finance,* 14(2), 129-147.

KESRIYELI, M. (1994), Policy Regime Changes and Testing for the Fisher and UIP Hypotheses: The Turkish Evidence, *The Central Bank of the Republic of Turkey, Discussion Paper* No: 9411.

KLIEN, B. (1975), Our New Monetary Standard: The Measurement and Effects of Price Uncertainty 1880-1973, *Economic Inquiry*, 13: 461-484.

KUTAN, A. M., & AKSOY, T. (2003), Public Information Arrival and the Fisher Effect in Emerging Markets: Evidence from Stock and Bond Markets in Turkey. *Journal of Financial Services Research*, 23(3), 225-239.

LEVI, M. D., & MAKIN, J. H. (1979), Fisher, Phillips, Friedman and the Measured Impact of Inflation on Interest, *The Journal of Finance*, 34(1), 35-52.

MARAVALL, A. (2005), An Application of the TRAMO-SEATS Automatic Procedure; Direct Versus Indirect Adjustment, *Documento de Trabajo 0524*, Banco de España.

MEHRA, Y. P. (2006), Inflation Uncertainty and the Recent Low Level of the Long Bond Rate, *Federal Reserve Bank of Richmond Economic Quarterly*, 92(3), 225.

MISHKIN, F. S. (1981), The Real Interest Rate: An Empirical Investigation, *In Carnegie-Rochester Conference Series on Public Policy* (Vol. 15, pp. 151-200). North-Holland.

MISHKIN, F.S. (1992), Is the Fisher Effect for Real? A Re-Examination of the Relationship between Inflation and Interest Rates, *Journal of Monetary Economics*, 30: 195-215.

NARAYAN, P.K. & POPP, S. (2010), A New Unit Root Test with Two Structural Breaks in Level and Slope at Unknown Time, *Journal of Applied Statistics*, 37:9, 1425-1438

NAS, T. F., & PERRY, M. J. (2000), Inflation, Inflation Uncertainty, and Monetary Policy in Turkey: 1960–1998, *Contemporary Economic Policy*, 18(2), 170-180.

OZER, M., & TURKYILMAZ, S. (2005), Türkiye'de Enflasyon ile Enflasyon Belirsizliği Arasındaki İlişkinin Zaman Serisi Analizi, *Journal of Iktisat Isletme ve Finans*, *20*(229), 93-104.

SIMSEK, M. & KADILAR, C. (2006), Fisher Etkisinin Türkiye Verileri ile Testi, *Doğuş University Journal*, 7(1), 99-111.

SUMMERS, L.H. & WATSON, M.W. (1993). The Non-Adjustment of Nominal Interest Rates: A Study of the Fisher Effect, in: J. Tobin (ed.), *A Symposium on Honour of Arthur Okun,* Washington, DC: Brookings Institution.

TELATAR, F. (2003), Türkiye'de Enflasyon, Enflasyon Belirsizliği ve Siyasi Belirsizlik Arasındaki Nedensellik İlişkileri, *Journal of Iktisat Isletme ve Finans,*18(203), 42-51.

TODA, H. Y., & YAMAMOTO, T. (1995), Statistical Inference in Vector Autoregressions with Possibly Integrated Processes, *Journal of Econometrics*, 66(1-2), 225-250.

TURGUTLU, E. (2004), Fisher Hipotezinin Tutarlılığının Testi: Parçalı Durağanlık ve Parçalı Koentegrasyon Analizi. *Journal of Dokuz Eylül University Faculty of Economics and Administrative Science*, 19(2).

WILCOX, J.A. (1983), Why Real Interest Rates Were So Low In The 1970's, *American Economic Review*, 78: 44-53.

YAMAK, R. (1996), Türkiye"de Enflasyon ve Enflasyon Belirsizliği, *Journal of Iktisat Isletme ve Finans 11*(121), 37-46.

YILANCI, V. (2009), Fisher Hipotezinin Türkiye İçin Sınanması: Doğrusal Olmayan Eşbütünleşme Analizi, *Atatürk University, Journal of Economics and Administrative Sciences,* 23(4), 205-213.

APPENDIX

ADF and PP Unit Root Test Results

Variables	ADF Unit Root Test		PP Unit Root Test	
	Stationary	Stationary and Trend Stationary	Stationary	Stationary and Trend Stationary
IR	-1.854 (0)	-3.400* (0)	-1.854(0)	-2.997(5)
IF	-2.390 (0)	-1.847 (0)	-2.351(3)	-2.042(3)
Critical Values	%1: -3.46 %5: -2.87 %10:-2.57	%1: -4.00 %5: -3.43 %10:-3.14	%1: -3.46 %5: -2.87 %10: -2.57	%1: -4.00 %5: -3.43 %10: -3.14

Narayan & Stephan Popp (2010) Unit Root Test Results

	Level Break Values				Level and Slope Break Values			
Variables	Test Statistic	TB1	TB2	k	Test Statistic	TB1	TB2	k
IR	-2.78	2006M05	2013M05	0	-3.769	2006M05	2013M05	0
IF	-5.378	2011M05	2011M07	11	-4.889	2011M05	2013M06	11

Critical Values: for T=100 Sabitte Kırılma %10:-3.980, %5:-4.316, %1:-4.958
For T=100 structural break in average and trend %10:-4.596, %5:-4.937, %1:-5.576

Gregory-Hansen Cointegration Test

Level shift		**Critical Values**			**Break Date**
Test Statistic	Estimated test value	%1	%5	%10	TB1
ADF^*	-6.008	-5.13	-4.61	-4.34	2009M04
Z_t^*	-6.023	-5.13	-4.61	-4.34	2009M04
Z_a^*	-59.246	-50.07	-40.48	-36.19	2009M04

Gregory-Hansen Cointegration Test

Regime shift where intercept and slope coefficients change		**Critical Values**			**Break Date**
Test Statistic	Estimated test value	%1	%5	%10	TB1
ADF^*	-6.558	-5.47	-4.95	-4.68	2009M04
Z_t^*	-6.575	-5.47	-4.95	-4.68	2009M04
Z_a^*	-67.781	-57.17	-47.04	-41.85	2009M05

Hatemi-J Cointegration Test

Level shift		**Critical Values**			**Break Date**	
Test Statistic	Estimated test value	%1	%5	%10	TB1	TB2
ADF^*	-4.539	-6.503	-6.015	-5.653	2003M09	2006M11
Z_t^*	-6.936	-6.503	-6.015	-5.653	2003M08	2006M11
Z_a^*	-74.226	-90.794	-76.003	-52.232	2003M09	2006M11

Hatemi-J Cointegration Test

Regime shift where intercept and slope coefficients change		**Critical Values**			**Break Date**	
Test Statistic	Estimated test value	%1	%5	%10	TB1	TB2
ADF^*	-5.307	-6.503	-6.015	-5.653	2003M09	2006M11
Z_t^*	-7.158	-6.503	-6.015	-5.653	2003M09	2006M10
Z_a^*	-77.773	-90.794	-76.003	-52.232	2003M09	2006M10