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New assessment on the Fisher hypothesis: the case of Turkey

Abstract

This paper aims at investigating the relationship between nominal interest rates and expected changes in inflation rates (Fisher Hypothesis) for Turkey. Fisher asserts that nominal interest rates adjust on a one-to-one basis to expected changes in inflation rates. However, the free market rules were not performed efficiently so interest rates were not determined in a liberalized way before the 1990s in Turkey. Therefore it is more appropriate to test FH with the data which cover 1990 and the following years for the Turkish economy. Using the recently developed autoregressive distributed lag bounds testing procedure, the results reveal a robust cointegrated relationship between nominal interest rate and inflation rates during the period of 1990:1 to 2008:4. Moreover, applied Hansen test for parameter stability clearly indicates stability of the estimated parameters of the conditional ECM during the sample period.

Keywords: Fisher effect, interest rate, inflation rate, Conditional Error Correction Mechanism.
JEL Classification: C22, C52, E40, E60.

Introduction

Effects of monetary policy determined by a developed or developing country on the interest rates constitutes one of the important discussions in economics literature. Here it becomes more critical to reveal the correlation between the anticipated inflation and interest rates. There are two different approaches about the effects of inflationary expectations on interest rates: Liquidity effect and Fisher effect. As for the approach called Fisher effect in economics literature, the changes in nominal interest rates basically result from fluctuations in anticipated inflation rates. In other words, the changes in inflation rate cause direct reaction in nominal interest rates in long run. This one-to-one and long-run correlation between inflation rate and nominal interest rate reveals that it is possible to set inflationary expectations via interest rates.

Thus, Fisher's theory provides a guide for investigating the extent to which long-term bond yields serve as reliable indicators of long-term inflationary expectations. Specifically, it implies that movements in the long-term bond yields provide useful signals of changes in inflationary expectations only if their other determinant, the long-term real interest rate, is stable (Ireland, 1996, p. 22).

The Fisher relation states that the nominal interest rate is expressed as the sum of expected constant real interest rates plus anticipated inflation. This link may not be perfect, as real interest rates can vary following policy changes. If the relation holds, the movements in short-term interest rates will reflect fluctuations in anticipated inflation and will therefore be a good indicator of future inflation. In this relation, with nominal interest rate (i_t) and inflation (π_t), the ex-post real interest rate (r_t) can be written as:

$$1 + r_t = \frac{1 + i_t}{1 + \pi_t}.$$

Solving for r_t:

$$r_t = \frac{i_t - \pi_t}{1 + \pi_t}$$

Ignoring the denominator and assuming constant real interest rates, an ex-ante definition that inflation expectations, π_t^e, determine nominal interest rates is:

$$i_t = r + \pi_t^e.$$

This relation is not estimable. Assuming efficient markets, the observed inflation can be decomposed into its expected component and a forecast error, u_t, orthogonal to all information at t:

$$\pi_t = \pi_t^e + u_t.$$

Rewriting this in a regression framework:

$$i_t = c_0 + c_1 \pi_t + e_t,$$

where c_o and c_1 are parameters to be estimated, π_t is actual inflation and e_t is a composite error term under the assumption of rational expectations. Coefficient c_0 should capture the average real interest rate and c_1 should be equal to one, which is referred by Mishkin as the full Fisher effect (Granville B. and Mallick, S., 2004, pp. 87-88).

On the other hand, in fact, two problems make the empirical analysis of the Fisher Effect difficult. First of all, the ex-ante real rate of interest depends on inflation expectations that obviously can not be directly measured. Secondly, according to many empirical studies, time series involved are apparently nonstationary (Million, 2003, p. 951).

Despite these problems, studies have been performed in many developed and developing countries in order to prove the Fisher hypothesis in econometric terms. The findings of these studies vary generally due to the period examined and econometric method followed. Generally, cointegration analysis was used for testing the Fisher hypothesis, and correlation between the two variables was found to be different in each country and the Fisher effect did not give valid results in every country handled.

For example, while Yuhn (1996) was reporting findings indicating existance of Fisher effect in the USA, Germany and Japan, he was not able to detect any findings for England and Canada. Mishkin (1984), on the other hand, asserted that there was a strong Fisher effect in the USA, England and Canada while stating the weakness of the same effect for Germany. In the analysis performed for Turkey Kesriyeli (1994), Berument and Jelassi (2002) reached findings reinforcing Fisher effect. Moreover, using Johansen method and making use of mountly time series data belonging to 1990 and 2003 Gul and Acikalin (2007) searched for Fisher effect and they determined validity of the hypothesis for the Turkish economy during the period examined. This study aims at searching for Fisher effect in Turkish economy making use of data covering a longer period and using ARDL approach which is a new method for searching relationships among variables for relatively longer periods.

The rest of this article is organized as follows: Section 1 describes the data and methodology. Section 2 shows the empirical results. The conclusion of this article is presented in the last section.

1. Data and methodology

1.1. Data. The free market rules were not performed efficiently so interest rates were not determined in a liberalized way before the 1990s in Turkey. Therefore it's more appropriate to test FH with the data which cover 1990 and the following years for Turkish economy.

We estimate Fisher's theory using monthly time series data, covering the period of 1990:1 to 2008:4. The data were obtained from the Central Bank of the Republic of Turkey (2000 = 100) and International Financial Statistics (2000 = 100). Inflation rates are proxied by monthly changes in the consumer price index (CPI) obtained from State Institute of Statistics. All rates are annualized percentages. By studying this period, the relationship between nominal interest rates and inflation rates during the high inflation period in Turkey was controlled.

1.2. Methodology. There are different advantages of the bounds testing approach that motivates us in our work. This procedure can be applied to models irrespective of whether the variables are $I(0)$ or $I(1)$. This is unlike other popular cointegration techniques which require pre-testing the variables to determine their order of integration such as the Engle and Granger (1987), Johansen and Juselius (1990) (Pesaran and Pesaran, 1997).

Another advantage of bounds testing for this work is that the method can be applied to cases where data set is of small sample sizes, just like the present study. Narayan (2005) has stated that the bounds testing approach to cointegration is popular in small sample sizes.

Different from this advantageous bounds test, the Engle-Granger Method and the Unrestricted Error Correction Model do not push the short-run dynamics into the residual terms. Thus, the ARDL approach has better statistical properties than the Engle-Granger cointegration test because it draws upon the Unrestricted Error Correction Model (Banerjee et al., 1998).

In this relation the conditional error correction model (ECM) of interest can be written as:

$$\Delta i_t = \alpha_0 + \alpha_1 t + \alpha_2 i_{t-1} + \alpha_3 \pi_{t-1} + + \sum_{i=1}^{p-1} \beta_i \Delta i_{t-i} + \sum_{i=0}^{p-1} \delta_i \Delta \pi_{t-i} + \varepsilon_t \quad . \tag{1}$$

The ARDL bounds approach developed by Pesaran et al. (2001) can be used to establish the short-run and long-run correlations between nominal interest rate and anticipated inflation rates.

Two separate statistics are employed in 'bounds test' for the existence of a long-run relationship: 1) an F-test for the joint significance of the coefficients on the lagged-level terms of the unrestricted error correction model (H_0: $\alpha_2 = \alpha_3 = 0$), and 2) a t-test for the significance of the coefficient associated with i_{t-1} (H_0: $\alpha_2 = 0$). Two asymptotic critical value bounds provide a test for cointegration when the independent variables are $I(d)$ (where $0 \leq d \leq 1$). The lower bound assumes that all the independent variables are $I(0)$ and the upper bound assumes that they are $I(1)$. If the test statistics exceed their respective upper critical values, the null hypothesis is rejected and we can conclude that a long-run relationship exists. If the test statistics fall below the lower critical values, we cannot reject the null hypothesis of no cointegration. If the statistics fall within the band, the statistical inference would be inconclusive. The critical values are provided by Pesaran et al. (2001).

2. Empirical results

We begin empirical results with an account of the results on the unit root test. We perform the unit root test – augmented Dickey-Fuller (ADF) test in Table 1. The first differences of these variables are stationary under the test. Hence, we conclude that these variables are integrated of $I(1)$.

Table 1. Test results for unit roots

	i_t	Δi_t	π_t	$\Delta \pi_t$
ADF Intercept	-0.99(2)	-5.13 (2)*	-1.75 (1)	-5.28 (2)*
Intercept and trend	-2.75(1)	-5.29 (2)*	-3.08 (2)	-6.17 (3)*

Notes: * denotes statistical significance at 1% level. H0: the series has a unit root. AIC is used to select the lag length. Values in parentheses are the lag length used in the estimation of the unit root test statistics.

The calculated F-statistics together with the critical values are reported in Table 2. The results strongly support the existence of a long-run relationship between nominal interest rate and anticipated inflation rate.

Overall, the results suggest that the null hypothesis of no cointegration cannot be accepted irrespective of whether the regressors are purely I(0), purely I(1), or mutually cointegrated. There exists a unique cointegration relationship between nominal interest rate and its determinant only when nominal interest rate is the dependent variable.

Table 2. *t*- and *F*-statistics for testing the existence of a long-run relationship

Hypothesis	Test statistic	$p = 4$
		With deterministic trends
H0: $\alpha_2 = 0$	t_I	-4.0867*
H0: $\alpha_1 = \alpha_2 = \alpha_3 = 0$	F_I	6.1585*
H0: $\alpha_2 = \alpha_3 = 0$	F_I	8.9478*
I		Without deterministic trends
H0: $\alpha_2 = 0$	t_I	-3.5484*
H0: $\alpha_3 = 0$	F_{III}	6.3179*

Notes: * indicates 5% level of significance. Critical values are extracting: Pesaran et al. (2001). *p* is the lag order of the underlying VAR model for the conditional ECM (1). The highest lag order selected is 8. A lag length of one is based on both Akaike info criterion (AIC) and Schwarz criterion (SC) from 1 to 8 lags. The estimator is OLS (ordinary least squares). t_I is the *t*-statistic for testing H$_0$: $\alpha_2 = 0$ in Equation 1 with a deterministic trend. The 5% critical value bounds for t_I is (-3.41, -3.69). F_I is the *F*-statistic for testing H$_0$: $\alpha_1 = \alpha_2 = \alpha_3 = 0$ in Equation 1 with a deterministic trend. The 5% critical value bounds for F_I is (4.68, 5.15). F_{II} is the *F*-statistic for testing H$_0$: $\alpha_2 = \alpha_3 = 0$ in Equation 1 with a deterministic trend. The 5% critical value bounds for F_{II} is (6.56, 7.30). t_{II} is the *t* statistic for testing H$_0$: $\alpha_2 = 0$ in Equation 1 without a deterministic trend. The 5% critical value bounds for t_{II} is (-2.86, -3.22). F_{III} is the *F*-statistic for testing H$_0$: $\alpha_2 = \alpha_3 = 0$ in Equation 1 without a deterministic trend. The 5% critical value bounds for F_{III} is (4.94, 5.73).

The regression results for the conditional ECM of Δi_t are shown in Table 3 with several desirable statistical features. All the coefficients are statistically significant at the 10% level. The regression specification fits remarkably well and passes the diagnostic tests against abnormal residuals, serial correlation, heteroskedasticity, autoregressive conditional heteroskedasticity and functional misspecification.

Using the results reported in Table 3, the estimated long-run equilibrium relationship in levels is given by:

$$11.8816 + 0.0249trend - 0.6356i_t + 0.4312\pi_t = 0 \,. \quad (2)$$

Table 3. Short-run and long-run results for the conditional ECM of Δi_t

Regressor	Coefficient	SE	*p*-value
Intercept	11.8816	2.4956	0.0018*
Time trend	0.0249	0.0105	0.0196*
i_{t-1}	-0.6356	0.0371	0.0003*
π_{t-1}	0.4312	0.3504	0.0309**
Δi_{t-1}	-0.0920	0.0657	0.0630***
$\Delta \pi_t$	1.2943	0.2027	0.0000*
$\Delta \pi_{t-2}$	0.3763	0.2634	0.0547**
$\Delta \pi_{t-3}$	0.5567	0.2122	0.0094*
$\bar{R}^2$ = 0.66 $\hat{\sigma}$ = 0.053 AIC = 6.8994 SBC = 7.1058 $\chi^2_{Norm}(1)$ = 3.8277 $\chi^2_{Auto}(1)$ = 1.5219 $\chi^2_{Auto}(12)$=1.4928 $\chi^2_{White}(1)$ = 1.5893 $\chi^2_{ARCH}(2)$ = 0.4822 $\chi^2_{RESET}(1)$ = 1.8782			

Notes: *, ** and *** denote statistical significance at 1, 5 and 10% levels, respectively. The OLS regression is based on the conditional ECM given by Equation 1 with dependent variable Δi_t, estimated over the period 1990:1 to 2007:12. $\bar{R}^2$ is the adjusted squared correlation coefficient, $\hat{\sigma}$ is the SE of the regression, AIC and SBC are Akaike's and Schwarz's Bayesian information criteria respectively. χ^2_{Norm} refers to the Jarque-Bera statistic of the test for normal residuals, $\chi^2_{Auto}(1)$ and $\chi^2_{Auto}(12)$ are the Breusch-Godfrey Lagrange Multiplier test statistics for no first and twelve order serial correlation, respectively, $\chi^2_{White}(1)$ denotes the White's test statistic to test for homoskedastic errors χ^2_{ARCH} is the Engle's test statistic for no autoregressive conditional heteroskedasticity, and χ^2_{RESET} is the Ramsey's test statistic for no functional misspecification.

The coefficient associated with i_t, which measures the speed of adjustment back to the long-run equilibrium value, is statistically significant at the 1% level and correctly signed (negative). By normalizing the coefficient of i_t to one, the long-run equilibrium relationship between i_t and π_t can be described as:

$$i_t = 18.6935 + 0.0391 trend + 0.6784\pi_t . \quad (3)$$

The elasticity of i_t with respect to π_t is found to be 0.6784 in the long run, suggesting a positive long-run relationship between nominal interest rate and inflation rate.

Here it should be stated that, the test for parameter stability is crucial in the case of Turkey because Turkey has experienced several domestic shocks, such as coups in 1994 and 2001. All variables in our model are integrated of order one. Thus, the parameter non-constancy test advocated by Hansen (1992) was employed as a checking tool for parameter stability.

Hansen proposes three tests – Sup *F*, Mean *F* and L_C – all of which have the same null hypothesis but differ in their choice of alternative hypothesis. The Sup *F*-test is predicated on ideas inherent in the classical Chow *F*-tests. The alternative hypothesis is a sudden shift in regime at an unknown point in time, and amounts to calculating the Chow *F*-statistic. This test statistic takes the following form: Sup *F* = Sup $F_{t/T}$, where $F_{t/T}$ is the *F*-test statistic. To perform the Sup F-test requires truncation of the sample size *T*. The Mean *F*-test is appropriate when the question under investigation is whether or not the specified model captures a stable relationship (Hansen, 1992). It is computed as an average of the $F_{t/T}$. Finally, the L_C statistic is recommended if the likelihood of parameter variation is relatively constant throughout the sample (see Narayan and Narayan, 2007, p. 2596).

The test results and their probability values are reported in Table 4. They show evidence for parameter stability, since the probability values for each test are greater than 0.05.

Table 4. Hansen test for parameter stability

Lc	Mean F	Sup F
0.9995 (> 0.20)	1.3065 (> 0.20)	6.4058 (> 0.20)

Conclusion

In this research paper, we used the bounds testing approach to cointegration in order to investigate the relationship between interest rates and expected changes in inflation rates for Turkey, by using monthly data from Turkish economy.

Using a longer time span and ARDL method, this paper finds robust long-run relationships between nominal interest rate and inflation rate in Turkey. The findings of a robust long-run cointegrated relationship between nominal interest rate and inflation rate suggest that any change in inflation rate will be closely associated with a change in nominal interest rate, however, the hypothesis that nominal interest rates adjust on a one-for-one basis with the change in anticipated inflation cannot be rejected.

On the other hand, the ECM_{t-1} is strong over the 1990:1-2008:4 period, taking the value of -0.6356. It takes only about 1.5 years to achieve long-run equilibrium whenever there is a deviation from equilibrium. Moreover, applied tests clearly indicate stability of the estimated parameters of the conditional ECM during the sample period. Consequently, this paper clearly shows that inflation rate does cause nominal interest rate in the short run and long run over the period.

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