POLICY REGIME CHANGES AND TESTING FOR THE FISHER AND UIP HYPOTHESES: THE TURKISH EVIDENCE

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1. INTRODUCTION

The interest rate determination process will be different under alternative degrees of openness of an economy (not necessarily only the openness of capital account but also depends on the trade factors with the rest of the world). In the case of a fully open economy, some form of an interest arbitrage will hold, with domestic interest rate depending on world interest rates, expected inflation, depreciation of the exchange rate, and perhaps some risk factors. In contrast, in the case of a closed economy, nominal interest rate will be determined by domestic money market conditions and expected inflation.

In this study a framework is proposed for empirically analyzing the determination of interest rates in Turkey. To this end, two interrelated postulates, the Fisher hypothesis and uncovered interest parity (UIP) hypothesis are investigated in the context of policy regime changes in Turkey during the post-1980 period.

The Turkish economy has witnessed important financial liberalization attempts since 1980. Two important steps in the liberalization attempts were the abolition of interest rate regulations in June 1981, and the introduction of foreign exchange deposits (FXD) within the domestic banking system in January 1984. With the domestic interest rates being freely determined, the introduction of FXD can be expected to put an

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1 For a detailed discussion of this subject see Altinkemer and Ekinci (1992).
upward pressure on domestic interest rates through the expected changes in the exchange rates as implied by the asset market equilibrium condition. Thus we expect the Fisher hypothesis and the UIP to hold for the post-1980 and post-1984 periods, respectively.

In the literature, existence of a cointegration between the nominal interest rate \((i)\) and the inflation rate \((\Delta p)\) is interpreted as an evidence supporting the Fisher hypothesis. Under a maintained hypothesis that changes in inflation expectations are stationary (i.e. the agents do not make systematic errors in the long run), this cointegration implies the stationarity of the real interest rates possibly around an attractor. Uncovered Interest Parity (UIP), on the other hand, relates the interest rates of two countries to expected changes in exchange rates. For the UIP hypothesis, the necessary condition is the stationarity of the deviations of domestic interest rates \((i)\) from the relevant alternative foreign interest rates \((i^*)\) in domestic currency units.

This paper examines the relationship between prices and interest rates for their long-run equilibrium properties using the statistical notion of cointegration. In this study, considering the Turkish quarterly data for the post-1980 period, cointegration between the variables in the system \((\Delta p, i)\) and \((i, i^*)\) is tested by employing Johansen (1988) procedure.
II. THE FISHER RELATION AND UNCOVERED INTEREST PARITY

II.1. The Fisher Relation

Fisher (1930) states that in the long-run equilibrium a change in the rate of growth of money supply leads to a fully perceived change in inflation and an adjustment of nominal interest rates. In this statement it is implicitly assumed that, real interest rates will not respond to movements in expected inflation in the long-run. Changes in inflation will be absorbed in nominal interest rates, leaving real rate constant, ceteris paribus. This does not necessarily mean that the real rates are constant over time; the changes in many economic factors may bring about movements in the real rates. The point is that whether there is any evidence that real rates move in response to expected inflation. If they do, then the inflationary movements are not totally absorbed in nominal rates and the Fisher effect does not hold.

In this paper we test the loglinear form of the Fisher hypothesis,

\[ i_t = r_t + \Delta p_t^* \]  \hspace{1cm} (1)

where \( i_t \) is the logarithm of the one plus nominal interest rate, \( r_t \) is the logarithm of one plus the ex ante real interest rate, and \( \Delta p_t^* \) is the logarithm of the expected change in the price level.
If we assume that the real rate of interests are stationary\(^2\), that is;

\[
r_i = r^* + u_i, \tag{2}
\]

where \(r^*\) is a positive constant and \(u_i\) is normally distributed with zero mean and constant variance \(N(0, \sigma^2_u)\). We further assume that actual and expected inflation differ by a stationary zero mean process (i.e. agents do not make systematic errors), that is;

\[
\Delta p_i = \Delta p^*_i + v_i, \tag{3}
\]

where \(\Delta p_i\) is actual change in price level and \(v_i\) is normally distributed with zero mean and constant variance \(N(0, \sigma^2_v)\). By substituting (2) and (3) in (1), the Fisher equation takes the following form\(^3\):

\[
i_i = a + b \Delta p_i + n_i, \tag{4}
\]

In order to test the Fisher hypothesis, we test the existence of co-integration between nominal interest rates (\(i_i\)) and inflation rate (\(\Delta p_i\)) in equation (4).

II.2. Uncovered Interest Parity

As Throop (1993) states, Uncovered Interest Parity (UIP) holds in the sense that the differences between domestic and foreign interest rates are offset by the expected change in the

\(^2\) For the constant real interest rate assumption see, for example Fama (1975), MacDonald and Murphy(1989). For the reversal of this assumption see, Fama and Gibson (1982) and Bonham (1991).

\(^3\) See for example MacDonald and Murphy (1989) and Blake and Phylaktis (1993).
exchange rate. As a result, movements in the real exchange rate can be explained by changes in the differential between home and foreign real interest.

\[ i_t - i_t^f = \Delta \epsilon^*_t \]  \hspace{1cm} (5)

where, \( i_t \) is the domestic interest rate, \( i_t^f \) is the foreign interest rate and \( \Delta \epsilon^*_t \) denotes expected annual rate of change of exchange rate. If we assume expected and actual exchange rates differ by a stationary zero mean process, and define foreign interest rate in domestic currency unit (\( i_t^* \)) as:

\[ i_t^* = i_t^f + \Delta \epsilon^*_t \]  \hspace{1cm} (6)

where \( \Delta \epsilon_t \) is the actual rate of change of exchange rate, then equation (5) takes the following form:

\[ i_t - i_t^* = \epsilon_t \]  \hspace{1cm} (7)

where, \( \epsilon_t \) is normally distributed with zero mean and constant variance (\( N(0, \sigma^2) \)).

The analysis of interest rate behavior has amounted to investigating the extent to which equation (7) holds. One way of testing equation (7) is through analysis of the time series properties of the interest parity differential. If deviations of domestic interest rate from the alternative foreign interest rate (in domestic currency unit) is stationary, that is if \( i_t \) and \( i_t^* \) are cointegrated, then UIP holds.
III. EMPIRICAL ANALYSIS

III.1. Unit Root Tests

In order to test whether \((i_t, \Delta p_t)\) and \((i_t, i'_t)\) are cointegrated, we first test for the existence of unit roots in the stochastic process generating \(i_t, \Delta p_t,\) and \(i'_t,\) using the Augmented Dickey Fuller (ADF) test recommended by Engle and Granger (1987). The critical values for the null hypothesis of a unit root are reported by Fuller (1976).

Inflation rate is calculated by using wholesale price index. For the domestic interest rate \((i_t)\), annualized 6-month time deposit rate, and for the foreign interest rate \((i'_t)\) annualized LIBOR rate on 6-month US dollar deposits are used. Finally, \(\Delta e\) is the annual rate of change of the US dollar/Turkish lira exchange rate. Sample period is 1980:1-1993:4 for the inflation and domestic interest rate, and 1984:1-1993:4 for \(i'_t\) because of the availability of the foreign exchange deposits accounts. The effective sample size depends on the dynamics of the estimated equations. Estimated equations also contain three centered seasonal dummy variables.

Table 1 lists the results of tests of one or more unit roots in inflation, domestic and foreign interest rates. The results suggest that the unit root null hypothesis cannot be rejected at the 5% level for the levels of inflation, domestic and foreign interest rates. In contrast, the unit root null, is strongly rejected at the 5% level for the first difference of all the variables.
<table>
<thead>
<tr>
<th>Variables</th>
<th>t-ratios of the Level of Variable $t_{i}^{(1)}$</th>
<th>t-ratios of the First Difference of Variable $t_{i}^{(2)}$ (Δ$x_{i}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation ($Δp_{i}$)</td>
<td>-1.02 (2)</td>
<td>-10.01 *(1)</td>
</tr>
<tr>
<td>Domestic Interest Rates ($i_{i}$)</td>
<td>-2.74</td>
<td>-6.54 *</td>
</tr>
<tr>
<td>Foreign Interest Rates ($i_{f}$)</td>
<td>2.63(4)</td>
<td>-3.42 *</td>
</tr>
</tbody>
</table>

Note: The values in parentheses are the lag lengths making residuals white noise.

(1) Estimated model is: $Δx_{i} = α + βt + αx_{i-1} + ∑_{i=1}^{k} d_{i} Δx_{i-1}$

(2) Estimated model is: $ΔΔx_{i} = α + βΔx_{i-1} + ∑_{i=1}^{k} d_{i} ΔΔx_{i-1}$

(*) Significant at the 5% level.

III.2. The Bivariate System Analysis

Johansen test statistics for cointegration vectors and the value of the vector parameters are both sensitive to the choice of lag length (k). The optimum choice of "k" is an issue still debated in the literature\(^4\). The choice is often based on the range of system diagnostics offered by the computer package used. The range of diagnostics offered by PC-GIVE (PC-FIML) 6.01 includes test for normality (skewness and kurtosis), residual serial correlation, and parameter stability for each of the equations in the system\(^5\).

Table 2.a and Table 2.b records some of the properties of the reduced form equation estimates for each of the systems

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\(^4\) See, Banerjee et al. (1993).
(\(i_t\), \(\Delta p_t\)) and (\(i_t\), \(i_t^*\)) defining the VARs with the lag lengths \(k=2,3,4\); equation standard deviations (\(\sigma\)), the normality (N(2)), and serial correlation (AC(16)) test statistics.

**TABLE 2.a**

**DIAGNOSTIC TESTS OF THE FISHER EQUATION**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(i_t)</td>
<td>Standard Dev.((\sigma))</td>
<td>0.026</td>
<td>0.022</td>
<td>0.022</td>
</tr>
<tr>
<td>Normality N(2)</td>
<td>47.990*</td>
<td>1.347</td>
<td>1.065</td>
<td></td>
</tr>
<tr>
<td>Autocorrelation AC(16)</td>
<td>13.940</td>
<td>10.802</td>
<td>8.314</td>
<td></td>
</tr>
<tr>
<td>Standard Dev.((\sigma))</td>
<td>0.031</td>
<td>0.028</td>
<td>0.028</td>
<td></td>
</tr>
<tr>
<td>(\Delta p_t)</td>
<td>Normality N(2)</td>
<td>4.857</td>
<td>3.880</td>
<td>2.011</td>
</tr>
<tr>
<td>Autocorrelation AC(16)</td>
<td>23.400</td>
<td>21.365</td>
<td>16.836</td>
<td></td>
</tr>
</tbody>
</table>

Note: The test statistics for normality and autocorrelation are asymptotically distributed as \(\chi^2(2)\) and \(\chi^2(16)\) under the relevant nulls, respectively. The corresponding one-tail 5% critical values are \(\chi^2_{0.05(2)} = 5.99\) and \(\chi^2_{0.05(16)} = 26.3\).

(*) Significant at the 5% level.

The residuals of the domestic interest equation (\(i_t\)), fail to pass the normality test estimated in (\(i_t\), \(\Delta p_t\)) system with \(k=2\), and in (\(i_t\), \(i_t^*\)) system with \(k=3\). On the other hand, domestic interest equation estimated for each of the systems with \(k=4\) appear to be white noise, and normally distributed, as suggested by the insufficiency of the corresponding tests N(2), and AC(16). The inflation equation (\(\Delta p_t\)) passes all the diagnostics estimated in (\(i_t\), \(\Delta p_t\)) system for all lags. The foreign interest rate (\(i_t^*\)) equation, fails to pass normality test for \(k=2\) and passes all the diagnostics for \(k=3\) and \(k=4\).
These results suggest that, for the \((i_t, \Delta \rho_t)\) system both \(k=3\) and \(k=4\) appear to be valid since equations pass all the diagnostics. However, for the system \((i_t, \Delta i_t)\), \(k=4\) is the appropriate lag because of the insignificance of the corresponding tests \(N(2),\) and \(AC(16)\).

**TABLE 2.b**

**DIAGNOSTIC TESTS OF THE UIPE EQUATION**

<table>
<thead>
<tr>
<th>SYSTEM VAR(k) EQUATION</th>
<th>DIAGNOSTICS</th>
<th>VAR(2)</th>
<th>VAR(3)</th>
<th>VAR(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i_t)</td>
<td>Standard Dev. ((\sigma))</td>
<td>0.0481</td>
<td>0.0427</td>
<td>0.0337</td>
</tr>
<tr>
<td></td>
<td>Normality (N(2))</td>
<td>12.51*</td>
<td>2.307</td>
<td>0.782</td>
</tr>
<tr>
<td></td>
<td>Autocorrelation AC(16)</td>
<td>16.21</td>
<td>16.304</td>
<td>16.639</td>
</tr>
<tr>
<td></td>
<td>Standard Dev. ((\sigma))</td>
<td>0.026</td>
<td>0.0254</td>
<td>0.0239</td>
</tr>
<tr>
<td>(i_t)</td>
<td>Normality (N(2))</td>
<td>2.98</td>
<td>15.872*</td>
<td>4.214</td>
</tr>
<tr>
<td></td>
<td>Autocorrelation AC(16)</td>
<td>22.3</td>
<td>15.89</td>
<td>17.02</td>
</tr>
</tbody>
</table>

Note: The test statistics for normality and autocorrelation are asymptotically distributed as \(\chi^2(2)\) and \(\chi^2(16)\) under the relevant nulls respectively. The corresponding one-tail 5% critical values are \(\chi^2_{0.05}(2) = 5.99\) and \(\chi^2_{0.05}(16) = 28.3\).

(*) Significant at the 5% level.

**III.3. Cointegration Analysis**

Having determined the integration properties and the lag structure, the cointegration properties of the series are analyzed using Johansen estimation procedure in the context of two-dimensional system\(^6\)

\[
\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \lambda D_t + \varepsilon_t
\]

---

\(^6\) For the computational details of this procedure see, Johansen (1988) and Johansen and Juselius (1990).
where; $X_t$ contains I(1) series (here $(i_t, \Delta p_t)$ for the Fisher hypothesis, and $(i_t, \hat{i}_t)$ for the UIP hypothesis), $D_t$ contains three centered seasonal dummies, $\Pi=\pi_1-\pi_2-\ldots-\pi_k$, and $\Gamma_i$'s are linear combinations of the $\pi_i$'s. Since $\Delta X_t$ is stationary and individual levels in $X_t$ are non-stationary, a relation between $\Delta X_t$ and $\Pi X_{t-1}$ implies one or more stationary linear combinations. If rank of $\Pi$ is $r$, with $0 < r < p$, then we can write $\Pi=\alpha\beta'$ where $\beta$ is a matrix of cointegrating vectors and $\alpha$ is a matrix of error correction coefficients.

In Table III, the results of the cointegration analysis obtained by the estimation of equation (8) with the lag length $k=4$ is presented for the Fisher and UIP hypothesis. The hypothesis of at most one cointegrating vector $(H_0 : r \leq 1)$ is in no case rejected, while the hypothesis of zero cointegrating vector $(H_0 : r=0)$ is strongly rejected in every case at the 5 % level.

Rejection of the null hypothesis of no cointegration for the system $X_t=(i_t, \Delta p_t)$ implies that there is one statistically significant cointegration vector ($\beta$) for the nominal interest rates and inflation at the 5 % significance level. The cointegration relation normalized by $\Delta p_t$ is, $\Delta p_t = 0.36 i_t$, and the corresponding normalized adjustment parameters are $\alpha_{adj} = 0.20$ and $\alpha_{it} = -0.65$. The adjustment coefficient $\alpha_{it}$ indicates a rapid adjustment of domestic interest rates in response to the
deviations from the equilibrium condition represented by the cointegration relation $\Delta p_t = 0.36i_e$.

The results for the system $X_t = (i_t, i'_t)$ indicate that the null hypothesis of no cointegration can be rejected in favor of one cointegration vector. The cointegration relation normalized by $i_t$ is $i_t^* = 0.52i_t$ and corresponding normalized adjustment parameters are $\alpha_d = 0.64$ and $\alpha_d' = 0.08$. Foreign interest rates in domestic currency units ($i_t^*$) adjusts rapidly to the cointegration relation $i_t^* = 0.52i_t$, as indicated by the corresponding adjustment coefficient, while the domestic interest rate deviates more from the equilibrium as indicated by the positive adjustment coefficient. Since a small open economy, like Turkey, cannot affect the foreign rates $i_t'$, the adjusting variable is better to be interpreted as being the nominal exchange rate, $\Delta e_t$ in $i_t^* = i_t' + \Delta e_t$, equation.

**IV. CONCLUSIONS**

In this paper, long-run relationship between inflation and interest rates are examined using the statistical notion of cointegration. In this context, the Fisher and the UIP hypothesis are investigated for the post-1980 period. The results suggest that there is a long-run relationship between inflation and nominal interest rates implying the validity of the Fisher hypothesis. Furthermore, the non-rejection of a cointegration between the domestic and foreign interest rates suggest the validity of the UIP hypothesis. Domestic interest rates rapidly
adjust to the equilibrium in response to a deviation from the equilibrium defined by the Fisher equation, while, they deviate farther away from the equilibrium in response to a deviation from UIP.
KAYNAKLAR


<table>
<thead>
<tr>
<th>Series</th>
<th>Sample</th>
<th>Eigenvalues</th>
<th>Johansen Test</th>
<th>$\beta^{0}$</th>
<th>$\beta^{1/2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>a. Max Eigenvalue</td>
<td>r=1</td>
<td>r=2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Trace</td>
<td>$\Delta p$</td>
<td>$i$</td>
</tr>
<tr>
<td>$\Delta p_t$</td>
<td>i</td>
<td>1981:2 1993:4</td>
<td>0.252 0.069</td>
<td>a.14.83*</td>
<td>a. 3.67</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td></td>
<td>b. 16.50*</td>
<td>b. 3.67</td>
<td>(-1.00)</td>
</tr>
<tr>
<td>$i_t$</td>
<td>i</td>
<td>1985:1 1993:4</td>
<td>0.538 0.032</td>
<td>a. 27.82*</td>
<td>a. 1.19</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td></td>
<td>b. 29.01*</td>
<td>b. 29.01</td>
<td>(0.51)</td>
</tr>
</tbody>
</table>

(1) The values in parentheses are the normalized estimates.

(*) denotes rejection of the null hypothesis of no cointegration.