A new Test of Uncovered Interest Rate Parity: Evidence from Turkey

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Abstract

This paper examines if uncovered interest rate parity condition holds for Turkey. In this paper, an empirical analysis is provided for the dates between December 2001 and June 2007 by using monthly data for Turkey and the U.S. Main finding is that UIP does not hold for Turkey. In addition to this, UIP deviation goes up over time, AR (1) fits the data well, there is an ARCH effect and GARCH (1,1) specification is significant for Turkish case.

Keywords: Uncovered Interest Rate Parity, Unit Root Test, AR Process, ARCH and GARCH Models.

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1. INTRODUCTION

Uncovered interest rate parity (UIP) states that the nominal interest rate differential between two countries must be equal to expected change in the exchange rate. In other words, if UIP condition holds, then high yield currencies should be expected to depreciate. Thus, any finding reflecting exchange rate appreciation rather than depreciation is called Forward Premium Puzzle. UIP also postulates that, if covered interest rate parity holds, then the interest rate differential is an unbiased predictor of the ex post change in the spot exchange rate, assuming rational expectations (Chinn, 2007). This is called unbiasedness hypothesis in the UIP literature.

The fundamental assumption underlying UIP is the Efficient Market Hypothesis. Obviously, the EMH tells us the price should fully reflect all the information available to the market participants and hence no excess return will be possible in the market. Moreover, EMH can be considered as a joint hypothesis that market participants have rational expectations and that they are risk neutral (Taylor, 1995). If these assumptions are valid and UIP holds then the expected return from holding one currency rather than another is offset by the opportunity cost of holding funds in that currency versus another (Foy, 2005).

This paper is organized as follows. In the next section, we examine the theory behind UIP and look at the existing literature regarding the conventional empirical studies used to test UIP. In section 3, we describe the data set and sources. Section 4 contains an empirical work in order to see whether or not UIP holds for Turkish case. Section 5 concludes.

2. THEORY

UIP can be derived by using CIP, unbiasedness hypothesis, rational expectations and risk-neutrality assumptions. As long as no arbitrage opportunity exists, the forward discount – the difference between forward rate and spot exchange rate at time t – will be equal to the interest rate differential between two countries:

$$f_t^{(k)} - s_t = i_t - i_t^* \tag{1}$$

where $f_t^{(k)}$ is the logarithm of forward exchange rate for maturity *k* periods ahead, s_t is the logarithm of spot exchange rate at time t, i_t is the k-period yield on the domestic instrument, and i_t^* is the corresponding yield on the foreign instrument. Note that equation (1) is also called covered interest rate parity (CIP).

Equation (1) holds regardless of investor preferences. However, if the investors or market participants are risk-averse, then the forward rate will differ from the expected future spot exchange rate by a premium that compensates for the perceived riskiness of holding domestic versus foreign assets (Chinn, 2006). Thus, the risk premium, η, is defined as:

$$f_t^{(k)} = E_t s_{t+1} + \eta_{t+1} \tag{2}$$

Assuming CIP holds, substitute Eq. (2) into Eq. (1):

$$E_t s_{t+1} + \eta_{t+1} - s_t = i_t - i_t^* \tag{3}$$

Rearranging Eq. (3) gives:

$$E_t s_{t+1} - s_t = i_t - i_t^* - \eta_{t+1} \tag{4}$$

Recall UIP is based on the joint hypothesis that market participants have rational expectations and that they are risk-neutral. Therefore, the rational expectations assumption can be defined as:

$$s_{t+1} = E_t s_{t+1} + \varepsilon_{t+1} \tag{5}$$

where s_{t+1} is the logarithm of future spot exchange rate, $E_t S_{t+1}$ is the expectations of spot exchange rate at time *t* conditional upon information available at time t, and ε_{t+1} is the rational expectations forecasting error realized at time *t + 1* from a forecast of the exchange rate made at time *t*. Now, substituting Eq. (5) into Eq. (4) will enable us to apply rational expectations assumption into UIP condition:

$$s_{t+1} - s_t = i_t - i_t^* - \eta_{t+1} + \varepsilon_{t+1} \tag{6}$$

Furthermore, applying the other crucial assumption, risk-neutral behavior, $\eta_{t+1} = 0$ gives UIP relationship:

$$s_{t+1} - s_t = i_t - i_t^* + \varepsilon_{t+1} \tag{7}$$

In order to test Eq. (7), UIP, the following regression model will be estimated,

$$\Delta s_{t+1} = \alpha + \beta(i_t - i_t^*) + \varepsilon_{t+1} \tag{8}$$

where Δs_{t+1} denotes the change in the exchange rate in logarithms, α and β are the regression coefficients, $(i_t - i_t^*)$ denotes the interest rate differential, and ε_{t+1} is the forecasting error realized at time *t +1* from a forecast of the exchange rate made at time *t*.

The last equation is the conventional UIP regression which has been used to test UIP in the literature. The null hypothesis of UIP can be expressed as Ho: α =0, β =1, but in fact, the literature usually focus on the slope coefficient, β [2].

The null of unity, β =1, has been mostly rejected in the literature. Isard (2006) found that the estimated intercept and the slope coefficient in equation (8) are significantly different from zero and one respectively for less than 1 year horizon. Similarly, Foy (2006) estimates equation 8 by using OLS and rejects the null of unity. He also finds that the estimated slope

[2] Flood and Rose, (2002).

coefficient is less than one and also negative. This finding also reflects the existence of Forward Premium Puzzle indicating higher interest rate currency continues to appreciate, not depreciate. Bruggemann and Lutkepohl (2005) conduct an empirical study based on unit root test and univariate analysis for the monthly market and 10 year bond rate for the period 1985-2004. They show evidence[3] of EMH and UIP to hold jointly for the U.S. and Europe. Meredith and Chinn (2002) test unbiasedness hypothesis as well as UIP. Their short horizon study[4] indicates that the unbiasedness hypothesis does not hold and UIP condition fails over short horizon. On the other hand, they find correct sign and hence do not reject the null of unity over long horizons. Kool (2006) also estimates the equation 8. His results are consistent with those of Foy (2006). Kool (2006) found that the estimated slope coefficient is negative for each of the ten countries. Flood and Rose (1997) argues that whether or not UIP holds depends on the exchange rate regime. For this aim, they perform an empirical study[5] by estimating the same conventional equation and conclude that UIP does not hold. Moreover, forward discount puzzle vanishes for fixed exchange rates. Chinn (2006) examines UIP and unbiasedness hypothesis over both short and long horizons. His empirical results suggest that the unbiasedness hypothesis as well as UIP appear to work much better over long horizon indicating zero intercept and unity cannot be rejected[6]. On the other hand, Chaboud and Wright (2003) perform a high frequency data[7] study. By using ordinary UIP regression, equation 8, they could not find evidence to reject unity for shorter horizons. Flood and Rose (2002) found an interesting result that UIP works systematically worse for fixed and flexible exchange rate countries than for

[3] B&L' s robustness check including multivariate analysis, cointegration analysis within VECM provides similar results in their paper.

[4] Quarterly data, 3-6-12 month movements in the exchange rates, and GMM estimators for the econometric analysis. Long horizon analysis is conducted for 5 year yields for Germany, UK and Canada.

[5] Flood and Rose (1997) use "seemingly unrelated regression technique" and Newey-West estimators in their econometric study.

[6] See Isard (2006) for similar results in long horizon case.

[7] Exchange rate data for every five minutes for the period 1988-2002.

crisis. The empirical results of Bekaert, Wei and Xing (2005)[8] present that UIP depends on the currency pair, not horizon. Furthermore, a random walk model for both interest rates and exchange rates fits the data marginally better than UIP model[9].

Obviously, the papers discussed above shed light on issues of data frequency, horizon selection, null of unity, forward premium puzzle and unbiasedness property. Therefore, the vast evidence for rejection of UIP makes researchers examine the joint assumption of rational expectations and risk-neutrality. For instance, Taylor (1995) and Isard (2006) confirm that possible explanations of rejecting UIP are based on rational expectations and/or risk neutrality assumptions, peso problem, self-fulfilling prophecies, rational learning under incomplete information and simultaneity bias[10]. The most common literature solutions for violation of joint hypothesis are using survey data for rational expectations and modeling risk premium for risk neutrality assumption[11]. In addition to these explanations, Marey (2004) takes rational expectations assumption seriously and concludes that different expectation models induce different slope coefficients embedded equation 8. Eventually, Chakraborty (2007) generates a monetary model with bounded rational agents who are learning and updating their knowledge. He finds that the estimated negative slope coefficient which has received so much attention in the literature is a reflection of learning dynamics.

[8] In this econometric study, Bekaert, Wei and Xing (2005) use VAR tests, implied VAR statistics, Monte Carlo Analysis, LM and Distance Metric Tests.
[9] See also Thornton (2007) for similar conclusion.
[10] See Taylor (1995) for rational expectations and risk neutrality criticization,; Flood and Rose (1997) for peso problem.
[11] See Taylor (1995), Chaboud and Wright (2003), Isard (2006), Foy (2006), Chinn (2006) for the argument.

3. DATA

The data set consists of monthly observations of YTL/USD exchange rate, as well as domestic and foreign interest rates for Turkey and the United States for the period 2001:12 – 2007:06. The interest rate and exchange rate data are constructed from two sources. The exchange rate data has been obtained from the Central Bank of Turkey (CBRT) and the last observations of each month have been used in the exchange rate data set in the econometric study. The domestic interest rate data is overnight interest rate data of the CBRT obtained from its simple interest rate weighted average category under interbank money market transaction summary. The original data is daily and hence has been converted to monthly observations discarding weekends. For the U.S. foreign interest rate data, we used monthly fed funds rate obtained from Federal Reserve Economic Data (FRED II). Also note that both domestic and foreign interest rates are simple annualized interest rates. Therefore, we have compounded annual rates to monthly rates. The plots of the foreign interest rate, domestic interest rate and spot exchange rate series are provided in appendix.

4. EVIDENCE

This empirical study comprises of three main steps. In the first part, we are going to look UIP deviation and run the conventional UIP regression in order to test if UIP holds for Turkey. In the second step of the study, the objective is to find a model for UIP deviation. In the third step, whether or not a volatility model may explain the UIP deviation will be discussed.

UIP deviation is basically the difference between the depreciation rate (change in the spot exchange rate) and the interest rate differential. In that sense, any deviation from UIP shows that the interest rate differential is not equal to change in the exchange rate over time.

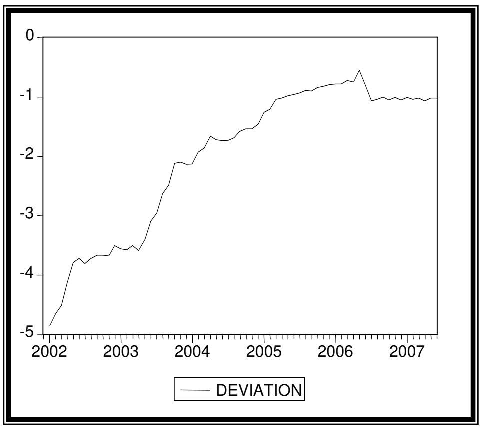

Figure 1 UIP deviation for the period 2002:01- 2007:06

Figure-1 illustrates the UIP deviation in Turkey from January 2002 to June 2007. As this figure shows, UIP deviates and goes up from 2002 to mid-2006. After that time, UIP deviation is a bit stable around the level -1's.

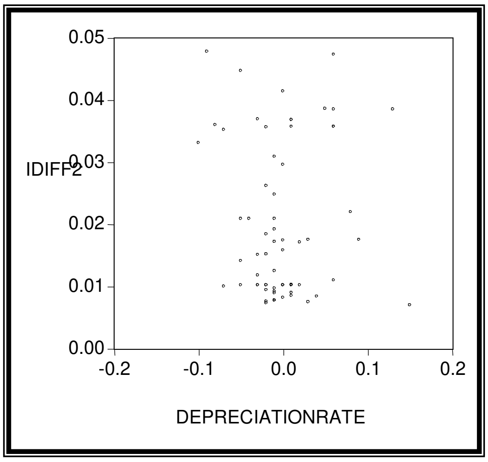

Figure 2 Scatter diagram of interest rate dif. and depr. rate

Figure-2 shows that there is no clear relationship between the interest rate differential and the depreciation rate. However, a regression analysis may provide a better explanation to understand if UIP holds.

Table-4[12] shows the regression results of the estimated conventional UIP model[13]. Recall that the null hypothesis for testing UIP is Ho: α =0, β =1. As we look at our regression results, the estimated regression coefficients are -0.0010 and -0.0015 with the probabilities of 0.91 and 0.99, respectively. Therefore, the null of zero intercept cannot be rejected at 1%, 5% and 10% significance level. Moreover, there is no evidence that the estimated slope coefficient is statistically different from zero at all 1%, 5% and 10% significance levels. An extremely low R-square, 0.000000 also suggests that variation in the interest rate differential cannot explain the variation in the depreciation rate. These results indicate that UIP does not hold for Turkey. In other words, the interest rate differential between Turkey and the U.S. is not able to explain the change in the YTL/USD spot exchange rate for the period 2001:12 – 2007:06.

Table-2 and Table-3 represent Augmented Dickey-Fuller Unit Root Tests on the interest rate differential and the spot exchange rate respectively. As Table-2 indicates if we test for unit root in 1st difference including intercept in the test equation, the ADF test statistics will be more negative than MacKinnon critical values at 5% and 10% significance level. Thus, interest rate differential is I(1)[14]. Moreover, testing for unit root in 1st difference including intercept in test equation suggests that the spot exchange rate is also I(1). In fact, these results are consistent with the UIP literature.

Having seen the rejection of UIP based on regression analysis by using OLS, now, we are going to look for alternative models of UIP deviation. The Table-6 provides the correlogram Q-statistics test for residuals obtained from the regression of UIP deviation on the constant term. This table illustrates that the p-values are closed to zero and hence the null of no autocorrelation can be rejected at 1%, 5% and 10% significance level. This means that there is an autocorrelation problem between the residuals. Moreover, since the residuals are

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[12] All Tables are provided in appendix.

[13] All series are assumed I(0) in this step. The stationarity of the series as well as unit root tests will be discussed later.

[14] Interest rate differential is not stationary in 1st difference at 1% significance level,, but stationary in 2nd difference at 1% significance level.

autocorrelated as a result of regressing UIP deviation on constant term, AR(1) model can also be estimated in order to see if autocorrelation problem is eliminated. Table-7 illustrates ACF and PCF of AR(1) and it can be seen that the null hypothesis of no autocorrelation cannot be rejected at 1% and 5% significance level for the residuals of the AR(1) model. Furthermore, Table-8 provides the estimation output of AR(1) model and suggests that AR(1) fits the data well.

The last step in the empirical part is to examine ARCH and GARCH-type process for UIP deviation. Obviously, the reason to examine ARCH effect as well as GARCH specification is for considering the possible effect of volatility of UIP deviation. In order to do that, first ARCH effect has been tested for AR(1) model of UIP deviation. Then, ARCH and GARCH models have been estimated by using ML - ARCH methodology.

Table-9 presents ARCH effect test results. According to the table, the probability of F-statistics is about 0.03 and hence indicates that the null of no ARCH effect can be rejected at 5% and 10% significance level. This result shows that there is an ARCH effect for UIP deviation based on our data set. Furthermore, Table-10 illustrates both estimated ARCH and GARCH specifications. It is obvious that the coefficient of GARCH(1) specification in the variance equation is statistically significant at 5% and 10% significance level. Furthermore, the estimated slope coefficient of AR(1) is statistically significant at 1%, 5% and 10% significance level. Table-10 also reflects that the estimated slope coefficient of ARCH(1) specification in the variance equation is significant at 10% significance level. As a result, we have found the evidence of both significant ARCH effect and significant GARCH specification for the UIP deviation.

5. CONCLUSION

The vast literature shows that Uncovered Interest Rate Parity (UIP) fails empirically. The reasons for rejection of UIP might be the violation of the joint hypothesis of rational expectations and/or risk- neutrality. Moreover, empirical studies confirm that peso problem, self-fulfilling prophecies, rational learning under incomplete information and simultaneity bias might be the other reasons to reject UIP. In this paper, first, we tested UIP for Turkish case by estimating the conventional UIP regression. Then, the effect of volatility of UIP deviation has been examined in the empirical part of the study. Our results indicate that UIP does not hold for Turkey for the dates between December 2001 and June 2007. Moreover, AR(1) model of UIP deviation fits the data well, there is an ARCH effect, and GARCH specification is significant for the UIP deviation in Turkey. Further studies focusing UIP relation as well as deviation may examine volatility by using high frequent data over short or long horizon.

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Appendix

OBS	SPOT	RTR	RUS
2001:12	1.44	4.92	0.15
2002:01	1.32	4.92	0.14
2002:02	1.40	4.88	0.15
2002:03	1.33	4.61	0.14
2002:04	1.33	4.29	0.15
2002:05	1.41	4.00	0.15
2002:06	1.60	4.00	0.15
2002:07	1.68	4.00	0.14
2002:08	1.63	3.84	0.15
2002:09	1.65	3.83	0.15
2002:10	1.67	3.83	0.15
2002:11	1.54	3.71	0.11
2002:12	1.64	3.67	0.10
2003:01	1.65	3.67	0.10
2003:02	1.61	3.67	0.11
2003:03	1.71	3.67	0.10
2003:04	1.59	3.63	0.11
2003:05	1.44	3.42	0.11
2003:06	1.43	3.19	0.10
2003:07	1.43	3.04	0.08
2003:08	1.40	2.71	0.09
2003:09	1.38	2.56	0.08
2003:10	1.49	2.28	0.08
2003:11	1.47	2.17	0.08
2003:12	1.40	2.17	0.08
2004:01	1.34	2.17	0.08
2004:02	1.33	2.00	0.08
2004:03	1.31	1.92	0.08
2004:04	1.44	1.83	0.08
2004:05	1.49	1.83	0.08
2004:06	1.49	1.83	0.09
2004:07	1.47	1.83	0.11
2004:08	1.50	1.83	0.12
2004:09	1.50	1.71	0.13
2004:10	1.47	1.67	0.15
2004:11	1.42	1.67	0.16
2004:12	1.35	1.59	0.18
2005:01	1.33	1.44	0.19
2005:02	1.29	1.39	0.21
2005:03	1.37	1.32	0.22
2005:04	1.38	1.26	0.23
2005:05	1.37	1.22	0.25
2005:06	1.34	1.19	0.25
2005:07	1.33	1.19	0.27
2005:08	1.35	1.19	0.29
2005:09	1.34	1.19	0.30
2005:10	1.35	1.17	0.32
2005:11	1.35	1.15	0.33
2005:12	1.34	1.13	0.35
2006:01	1.33	1.13	0.36
2006:02	1.31	1.13	0.37
2006:03	1.35	1.13	0.38
2006:04	1.32	1.13	0.40
2006:05	1.54	1.11	0.41
2006:06	1.61	1.26	0.42
2006:07	1.50	1.44	0.44
2006:08	1.47	1.46	0.44
2006:09	1.50	1.46	0.44
2006:10	1.45	1.46	0.44
2006:11	1.46	1.46	0.44
2006:12	1.42	1.46	0.44
2007:01	1.43	1.46	0.44
2007:02	1.40	1.46	0.44
2007:03	1.40	1.46	0.44
2007:04	1.33	1.46	0.44
2007:05	1.33	1.46	0.44
2007:06	1.33	1.46	0.44

Table 1 Data Set: Spot exchange rate series, domestic interest rate series, foreign interest rate series

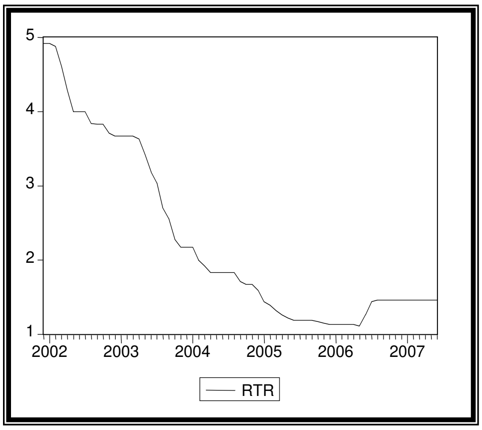

Figure 3 Monthly domestic interest rates

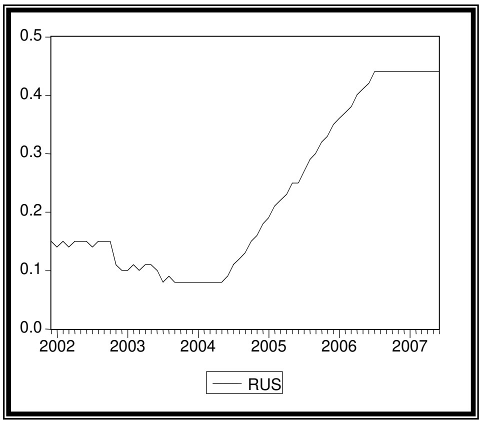

Figure 4 Monthly foreign interest rates

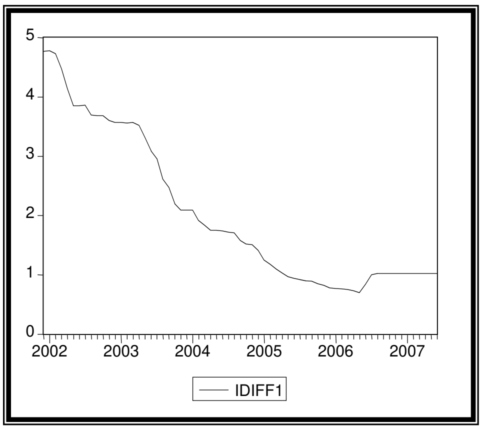

Figure 5 Monthly interest rate differential

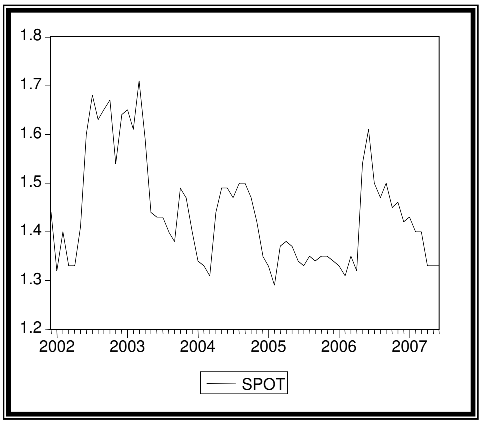

Figure 6 Monthly spot exchange rates (YTL/USD)

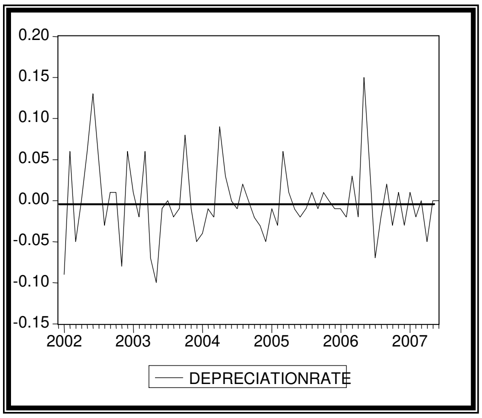

Figure 7 Depreciation rate

ADF Test Statistic	**-3.035829**	**1% Critical Value***		**-3.5380**
		5% Critical Value		**-2.9084**
		10% Critical Value		**-2.5915**
***MacKinnon critical values for rejection of hypothesis of a unit root.**				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(IDIFF1,2)				
Method: Least Squares				
Date: 08/04/07 Time: 18:43				
Sample(adjusted): 2002:05 2007:06				
Included observations: 62 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(IDIFF1(-1))	**-0.414022**	**0.136379**	**-3.035829**	**0.0036**
D(IDIFF1(-1),2)	**-0.127825**	**0.146645**	**-0.871659**	**0.3871**
D(IDIFF1(-2),2)	**-0.111747**	**0.130654**	**-0.855286**	**0.3960**
D(IDIFF1(-3),2)	**-0.043860**	**0.119512**	**-0.366993**	**0.7150**
C	**-0.017097**	**0.012577**	**-1.359319**	**0.1794**
R-squared	**0.301324**	**Mean dependent var**		**0.005323**
Adjusted R-squared	**0.252294**	**S.D. dependent var**		**0.088201**
S.E. of regression	**0.076267**	**Akaike info criterion**		**-2.231937**
Sum squared resid	**0.331552**	**Schwarz criterion**		**-2.060394**
Log likelihood	**74.19005**	**F-statistic**		**6.145720**
Durbin-Watson stat	**2.093130**	**Prob(F-statistic)**		**0.000350**

Table 2 Augmented Dickey-Fuller Unit Root Test on D(IDIFF1)

ADF Test Statistic	-4.598163	1% Critical Value*		-3.5380
		5% Critical Value		-2.9084
		10% Critical Value		-2.5915
*MacKinnon critical values for rejection of hypothesis of a unit root.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(SPOT,2)				
Method: Least Squares				
Date: 08/04/07 Time: 18:46				
Sample(adjusted): 2002:05 2007:06				
Included observations: 62 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SPOT(-1))	-1.184671	0.257640	-4.598163	0.0000
D(SPOT(-1),2)	0.306990	0.220369	1.393076	0.1690
D(SPOT(-2),2)	0.100782	0.174483	0.577602	0.5658
D(SPOT(-3),2)	0.168572	0.124263	1.356578	0.1803
C	-0.000429	0.008424	-0.050933	0.9596
R-squared	0.491792	Mean dependent var		0.000000
Adjusted R-squared	0.456129	S.D. dependent var		0.089900
S.E. of regression	0.066299	Akaike info criterion		-2.512078
Sum squared resid	0.250546	Schwarz criterion		-2.340535
Log likelihood	82.87443	F-statistic		13.78972
Durbin-Watson stat	2.070677	Prob(F-statistic)		0.000000

Table 3 Augmented Dickey-Fuller Unit Root Test on D(SPOT)

Dependent Variable: DEPRECIATIONRATE
Method: Least Squares
Date: 08/03/07 Time: 10:11
Sample(adjusted): 2002:01 2007:06
Included observations: 66 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001091	0.010794	-0.101052	0.9198
IDIFF2	0.001508	0.460469	0.003275	0.9974
R-squared	0.000000	Mean dependent var		-0.001061
Adjusted R-squared	-0.015625	S.D. dependent var		0.045476
S.E. of regression	0.045830	Akaike info criterion		-3.297915
Sum squared resid	0.134426	Schwarz criterion		-3.231562
Log likelihood	110.8312	F-statistic		1.07E-05
Durbin-Watson stat	1.876888	Prob(F-statistic)		0.997397

Table 4 Estimated UIP regression model results

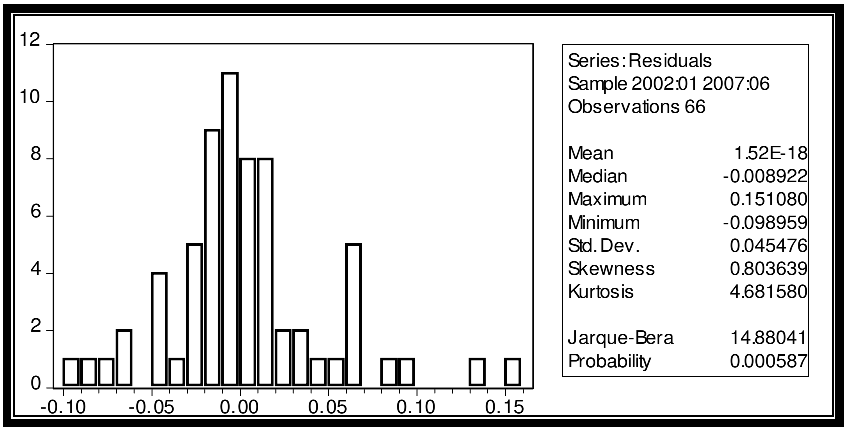

Table 5 UIP regression residuals histogram analysis

Date: 08/05/07 Time: 10:01
Sample: 2002:01 2007:06
Included observations: 66

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******|</td><td>. |*******|</td><td>1</td><td>0.948</td><td>0.948</td><td>62.000</td><td>0.000</td></tr>
<tr><td>. |*******|</td><td>. | . |</td><td>2</td><td>0.896</td><td>-0.021</td><td>118.27</td><td>0.000</td></tr>
<tr><td>. |*******|</td><td>. | . |</td><td>3</td><td>0.845</td><td>-0.019</td><td>169.10</td><td>0.000</td></tr>
<tr><td>. |****** |</td><td>. | . |</td><td>4</td><td>0.801</td><td>0.046</td><td>215.57</td><td>0.000</td></tr>
<tr><td>. |****** |</td><td>. | . |</td><td>5</td><td>0.765</td><td>0.051</td><td>258.66</td><td>0.000</td></tr>
<tr><td>. |****** |</td><td>. | . |</td><td>6</td><td>0.729</td><td>-0.023</td><td>298.43</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>.*| . |</td><td>7</td><td>0.688</td><td>-0.064</td><td>334.43</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. | . |</td><td>8</td><td>0.647</td><td>-0.011</td><td>366.85</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. | . |</td><td>9</td><td>0.606</td><td>-0.024</td><td>395.78</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>10</td><td>0.563</td><td>-0.053</td><td>421.18</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>11</td><td>0.517</td><td>-0.056</td><td>443.02</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>12</td><td>0.476</td><td>0.010</td><td>461.84</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>.*| . |</td><td>13</td><td>0.429</td><td>-0.084</td><td>477.41</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>.*| . |</td><td>14</td><td>0.376</td><td>-0.100</td><td>489.60</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>15</td><td>0.323</td><td>-0.035</td><td>498.80</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>.*| . |</td><td>16</td><td>0.265</td><td>-0.100</td><td>505.09</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>17</td><td>0.208</td><td>-0.048</td><td>509.04</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>18</td><td>0.156</td><td>-0.009</td><td>511.32</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>19</td><td>0.105</td><td>-0.037</td><td>512.37</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>20</td><td>0.062</td><td>0.024</td><td>512.75</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>21</td><td>0.021</td><td>-0.012</td><td>512.79</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>22</td><td>-0.010</td><td>0.078</td><td>512.80</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>23</td><td>-0.043</td><td>-0.026</td><td>512.99</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>24</td><td>-0.077</td><td>-0.045</td><td>513.62</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>25</td><td>-0.113</td><td>-0.029</td><td>515.01</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>26</td><td>-0.144</td><td>0.027</td><td>517.32</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>27</td><td>-0.173</td><td>-0.025</td><td>520.75</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>. | . |</td><td>28</td><td>-0.196</td><td>0.015</td><td>525.29</td><td>0.000</td></tr>
</table>

Table 6 Correlagram of residuals obtained from the regression of UIP deviation on constant term

Date: 08/05/07 Time: 10:07
Sample: 2002:02 2007:06
Included observations: 65
Q-statistic probabilities adjusted for 1 ARMA term(s)

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |** |</td><td>. |** |</td><td>1</td><td>0.203</td><td>0.203</td><td>2.7918</td><td></td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>2</td><td>0.069</td><td>0.030</td><td>3.1242</td><td>0.077</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>3</td><td>0.017</td><td>-0.003</td><td>3.1446</td><td>0.208</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>4</td><td>0.038</td><td>0.034</td><td>3.2451</td><td>0.355</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>5</td><td>-0.034</td><td>-0.050</td><td>3.3268</td><td>0.505</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>6</td><td>-0.001</td><td>0.013</td><td>3.3269</td><td>0.650</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>7</td><td>-0.099</td><td>-0.102</td><td>4.0574</td><td>0.669</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>8</td><td>-0.047</td><td>-0.011</td><td>4.2283</td><td>0.753</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>9</td><td>-0.138</td><td>-0.121</td><td>5.7130</td><td>0.679</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>10</td><td>-0.069</td><td>-0.020</td><td>6.0921</td><td>0.731</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>11</td><td>-0.178</td><td>-0.153</td><td>8.6435</td><td>0.566</td></tr>
<tr><td>**| . |</td><td>.*| . |</td><td>12</td><td>-0.200</td><td>-0.155</td><td>11.943</td><td>0.368</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>-0.052</td><td>0.032</td><td>12.166</td><td>0.432</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>14</td><td>0.054</td><td>0.054</td><td>12.412</td><td>0.494</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>-0.017</td><td>-0.034</td><td>12.437</td><td>0.571</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>16</td><td>0.104</td><td>0.096</td><td>13.396</td><td>0.572</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>17</td><td>0.113</td><td>0.072</td><td>14.547</td><td>0.558</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>18</td><td>0.045</td><td>-0.035</td><td>14.738</td><td>0.614</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>19</td><td>0.004</td><td>-0.041</td><td>14.740</td><td>0.680</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>20</td><td>0.017</td><td>-0.030</td><td>14.769</td><td>0.737</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>21</td><td>-0.033</td><td>-0.078</td><td>14.875</td><td>0.784</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>22</td><td>0.026</td><td>0.009</td><td>14.945</td><td>0.826</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>23</td><td>-0.029</td><td>-0.064</td><td>15.032</td><td>0.861</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>24</td><td>0.011</td><td>0.002</td><td>15.045</td><td>0.893</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>25</td><td>0.005</td><td>0.053</td><td>15.048</td><td>0.919</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>26</td><td>-0.089</td><td>-0.079</td><td>15.929</td><td>0.917</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>27</td><td>-0.094</td><td>-0.048</td><td>16.934</td><td>0.911</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>28</td><td>-0.074</td><td>-0.012</td><td>17.584</td><td>0.916</td></tr>
</table>

Table 7 Correlogram of residuals obtained from the AR(1) model of UIP deviation

Dependent Variable: DEVIATION
Method: Least Squares
Date: 08/05/07 Time: 18:33
Sample(adjusted): 2002:02 2007:06
Included observations: 65 after adjusting endpoints
Convergence achieved after 4 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.622906	0.493088	-1.263275	0.2111
AR(1)	0.957440	0.011302	84.71612	0.0000
R-squared	0.991298	Mean dependent var		-1.955385
Adjusted R-squared	0.991160	S.D. dependent var		1.191284
S.E. of regression	0.112006	Akaike info criterion		-1.510243
Sum squared resid	0.790356	Schwarz criterion		-1.443339
Log likelihood	51.08290	F-statistic		7176.821
Durbin-Watson stat	1.594068	Prob(F-statistic)		0.000000
Inverted AR Roots	.96			

Table 8 Estimated AR(1) model results

ARCH Test:				
F-statistic	2.996140	Probability		0.037962
Obs*R-squared	8.319080	Probability		0.039858
Test Equation:				
Dependent Variable: RESID^2				
Method: Least Squares				
Date: 08/05/07 Time: 19:07				
Sample(adjusted): 2002:05 2007:06				
Included observations: 62 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.008157	0.003294	2.476317	0.0162
RESID^2(-1)	0.130386	0.125591	1.038181	0.3035
RESID^2(-2)	0.319694	0.120481	2.653477	0.0103
RESID^2(-3)	-0.149345	0.125367	-1.191262	0.2384
R-squared	0.134179	Mean dependent var		0.011994
Adjusted R-squared	0.089395	S.D. dependent var		0.019488
S.E. of regression	0.018597	Akaike info criterion		-5.069293
Sum squared resid	0.020059	Schwarz criterion		-4.932058
Log likelihood	161.1481	F-statistic		2.996140
Durbin-Watson stat	2.055066	Prob(F-statistic)		0.037962

Table 9 ARCH Test of UIP deviation

Dependent Variable: DEVIATION				
Method: ML – ARCH				
Date: 08/05/07 Time: 19:11				
Sample(adjusted): 2002:02 2007:06				
Included observations: 65 after adjusting endpoints				
Convergence achieved after 39 iterations				
	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.384017	0.335510	-1.144576	0.2524
AR(1)	0.949655	0.007124	133.2955	0.0000
	Variance Equation			
C	0.001141	0.000853	1.337222	0.1812
ARCH(1)	0.531462	0.301554	1.762410	0.0780
GARCH(1)	0.468985	0.191401	2.450272	0.0143
R-squared	0.990859	Mean dependent var		-1.955385
Adjusted R-squared	0.990249	S.D. dependent var		1.191284
S.E. of regression	0.117635	Akaike info criterion		-1.568260
Sum squared resid	0.830283	Schwarz criterion		-1.401000
Log likelihood	55.96846	F-statistic		1625.874
Durbin-Watson stat	1.505745	Prob(F-statistic)		0.000000
Inverted AR Roots	.95			

Table 10 Estimated AR(1), ARCH(1) and GARCH(1) model