Does the interest differential explain future exchange rate return? a re-examination of the UIP hypothesis for the Turkish economy

Levent, Korap
Istanbul University Institute of Social Sciences, Besim Ömer Paşa Cd. Kaptan-ı Derya Sk. 34452 Beyazıt /ISTANBUL

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Cem Saatcioglu

Asst. Prof., Istanbul University Faculty of Economics

E-mail: saatcic@istanbul.edu.tr

Levent Korap

Economist, Marmara University

E-mail: korap@e-kolay.net

Abstract

In our paper, we investigate the empirical validity of the uncovered interest parity (UIP) hypothesis of contemporaneous open economy macroeconomics relating expected exchange rate return to the interest rate differentials considering TL/US$ nominal exchange rate return and the short-term Turkish and the US interest rates. Based on the multivariate cointegration methodology of same order integrated variables, our results give support to the validity of the UIP hypothesis in the long-run for the Turkish economy such that positive interest differentials in favor of domestic interest rates require nearly one-to-one increase in the expected exchange rate return. We conclude that official interventions applied by the policy makers should be designed based on the possibility that changing the spot exchange rate relative to the expected future spot rate may also require domestic interest rates to be changed so as to affect interest differentials in line with *ex-ante* policy purposes.

Keywords: Exchange rates; Interest differentials; Uncovered interest parity; Turkish economy;

JEL Classifications: C32; F31; F41;

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1. Introduction

The Turkish economy had been subject to a chronic two-digits inflationary framework over a 20 years period till the early-2000s. Such a process canalized the controversies in Turkish economy politics upon the *ex-ante* reasons of the inflationary framework and *ex-post* implementations of the stabilization policies constructed against domestic inflation. These all endogenized by the economy in turn constituted one of the main stylized facts identifying the course of the Turkish business cycles (Aslan and Korap, 2007). By the beginning of 2000, an anti-inflationary stabilization program based on a quasi-currency board was established to fight domestic inflation and policy makers aimed at mainly forming the expectations of economic agents following the policy issues based on nominal exchange anchor. Although seemed to be successful in bringing inflation down as one-half of the initial level for the first 10 months realization, the subsequent two economic crisis periods ended the program with a depreciating real income. Among many others, Dornbusch (2001), Eichengreen (2001), Uygur (2001), Alper (2001), Ertugrul and Yeldan (2002), Akyuz and Boratav (2003) and Ekinci and Erturk (2007) criticize the reasons behind the Turkish-2000 stabilization program. The Turkish economy has still been trying to establish an inflation targeting framework supported by free-floating exchange rate system, explicitly announcing annual targets by the Central Bank of the Republic of Turkey (CBRT), and aimed at also providing forward looking nature of the policy stance as a main characteristic of the inflation targeting (Leigh and Rossi, 2002).

In this line, revealing the extent to which discretionary policy interventions can succeed in achieving policy purposes have been of special concern for the economic agents, and the knowledge of what motives drive the construction of expectations can help policy makers conduct appropriate policies for stabilization purposes. One of the main recent issues of interest in this policy design process is to examine the fundamental building blocks of exchange rates and interest rates based on the theoretical underpinnings of exchange rate determination. As Isard (2006) emphasizes, the uncovered interest parity (UIP) condition would constitute a central focal point in contemporaneous exchange rate determination models and to the extent that the UIP is valid at short time horizons, official interventions cannot succeed in changing the spot exchange rate relative to the expected future spot rate unless the authorities choose to allow interest rates to change.

Following briely Huisman et al. (1998), the UIP condition would hold if the return on a domestic currency deposit equals the expected return from converting the domestic currency into the foreign currency, investing it in a foreign deposit and then converting the proceeds back into the domestic currency at the future expected exchange rate. Thus the UIP assumes the existence of arbitrage in international markets linking the interest and exchange rates. If the *ex-post* uncovered interest differential reflects the degree of capital mobility, then it implies that the sum of the risk premium and rational expectation error may diminish over time since the interdependence of world financial markets has increased (Sul, 1999). Or in other words, if capital is perfectly mobile, then investors around the world will be indifferent between holding their portfolios in domestic or foreign securities, which are also perfectly comparable denominated in different currencies because they obtain the same return from these assets (Bhatti and Moosa, 1995). Consequently, through the joint assumptions of rational expectations, risk neutrality, free capital mobility and the absence of taxes on capital transfers, expected excess returns in the foreign exchange markets then must equal zero on average (Baillie and Bollerslev, 2000).

However, empirical evidence yields in general contradicting results for the validity of the UIP theorem and examines why the slope coefficient in the regression of the change in the logarithm of the spot exchange rate on the forward premium is less than unity or even negative. This would imply that investors in the foreign exchange market do not behave rationally since they would not take profit of predictable excess returns (Beyaert et al., 2007). Flood and Rose (2002) attribute the failure of the UIP theorem to that the forward rate is a biased predictor of the future spot rate. Chinn and Meredith (2004) report that the UIP hypothesis holds well when considering bonds with maturity ranging from five to ten years, but fails with exchange rates and bonds which have maturities lower than one year. They relate such results to that the model's fundamentals in exchange rate determination play a more important role over longer horizons. As expressed by Sachsida et al. (2001), the *so-called* peso problem arising from the small probability of large alterations in the exchange rate in a fixed rate regime can also be considered one of the main reasons of empirical lack of the UIP theorem leading to biased estimates of the slope parameters in the UIP equations. Finally, Beyaert et al. (2007) in a recent paper express that regime shifts stemming from institutional, political, and economic changes subject to modern world economies is responsible for the UIP puzzle estimated by researchers. Since regimes switch “infrequently” at dates that are unknown, economic agents make rational forecast errors that are correlated with the forward premium or the interest rate spreads.

Considering the Turkish economy, Kesriyeli (1994) gives evidence for the validity of the UIP hypothesis while estimating also that domestic interest rates deviate farther away from the equilibrium in response to a deviation from the UIP relationship. However, Dulger and Cin (2002) identifying the exchange rate determination mechanism for the Turkish economy using multi-rank co-integrating analysis do not support the UIP hypothesis.

In this paper, our aim is to examine the empirical validity of the UIP theorem considering data from the Turkish economy. For this purpose, the next section constructs briefly a theoretical model yielding the UIP relationship. The third section deals with an empirical model upon the Turkish economy. And the final section concludes.

2. Model

Following the methodology in McCallum (1994) and Chinn and Meredith (2004), let s_t be the price of foreign currency in units of domestic currency at time t, and let f_t denote the one-period forward value of s such that f_t might be said to be an unbiased predictor of s_{t+1} if α = 0.0 and β = 1.0 in the relation:

$$\alpha + \beta f_t = E_t s_{t+1} \qquad (1)$$

where $E_t s_{t+1} = E(s_{t+1} / \Omega_t)$ is the conditional expectation of s_{t+1} formed on the basis of the information set Ω_t available at time t. Assuming that expectational error $\varepsilon_{t+1} = s_{t+1} - E_t s_{t+1}$ under rational expectations will be uncorrelated in the population with all elements of Ω_t and in turn rearranging Eq. 1 yield that:

$$s_{t+1} - s_t = \alpha + \beta(f_t - s_t) + \varepsilon_{t+1} \qquad (2)$$

which forms the unbiasedness hypothesis under the test hypothesis β = 1.0. If the conditions for risk free arbitrage exist, the ratio of the forward to the spot exchange rate will equal the interest differential between assets with otherwise similar characteristics measured in local currencies such as identical default risk, tax treatment, the absence of restrictions on foreign ownership, and negligible transaction costs. As to the covered interest parity (CIV) relationship and following the notation in Chinn and Meredith (2004), if we define $f_{t,t+k}$ as the forward value of s for a contract expiring k periods in the future, $i_{t,k}$ one plus the k-period yield on the domestic instrument, and $i_{t,k*}$ the corresponding yield on the foreign instrument, all in natural logarithms, risk-free arbitrage condition regardless of investor preferences can be written in Eq. (3) below:

$$f_{t,t+k} = (i_{t,k} - i_{t,k^*}) \tag{3}$$

To the extent that investors are risk averse, however, the forward rate can differ from the expected future spot rate by a premium that compensates for the perceived riskiness of holding domestic versus foreign assets:

$$f_{t,t+k} = s^e_{t,t+k} - rp_{t,t+k} \tag{4}$$

Expected change in exchange rate can be expressed by substituting Eq. 4 into Eq. 3, from period t to $t+k$ to be as a function of the interest differentail and risk premium:

$$\Delta s^e_{t,t+k} = (i_{t,k} - i^*_{t,k}) - rp_{t,t+k} \tag{5}$$

UIP requires that the risk-premium in Eq. (5) is zero through the assumption of risk-neutral investors.

3. Results

3.1. Preliminary Data Specification

We now conduct an empirical model to examine whether the UIP relationship can be verified for the future exchange rate return employing also short-term interest rate data from the

Turkish versus the US economy. The sample period considers quarterly frequency data and extends from 1987Q1 to 2006Q4. The exchange rate data (RETURNEXDOLLAR2) are represented by four-period ahead, i.e. annual, expected exchange rate return in natural logarithms using the formula ln(dollar(+4)/dollar), where dollar is the TL/US$ bilateral nominal exchange rate taken from the electronic data delivery system of the Central Bank of the Republic of Turkey (CBRT) and ln is the natural logarithm operator. For the interest rate differentials (DIFTURKEYSHORT), we use the Treasury interest rates for the domestic short-term interest rate data taken from the same source, which is the maximum rate of interest on the Treasury bills whose maturity are at most twelve months or less, while one-year Treasury constant maturity rate for the US economy from the Board of Governors of the Federal Reserve System is used for the foreign interest rate data. Two impulse-dummy variables concerning the financial crises occurred in 1994 and 2001 are considered as exogeneous variables as well.

As a next step, we investigate the time series properties of the variables. Spurious regression problem analyzed by Granger and Newbold (1974) and Phillips (1986) indicate that using nonstationary time series steadily diverging from long-run mean causes to unreliable correlations within the regression analysis leading to unbounded variance process. Therefore, at first by using the augmented Dickey-Fuller (ADF) unit root tests under the null hypothesis for the presence of a unit root against the stationary alternative hypothesis, we check for the stationarity condition of our variables and compare the estimated ADF statistics with the MacKinnon (1996) critical values. For the case of stationarity we expect that these statistics are larger than the MacKinnon critical values in absolute value and that they have a minus sign. The lags used for the ADF stationarity test are augmented up to a maximum of 10 lags and the choice of the optimum lag was decided on the basis of minimizing the Schwarz Information Criterion (SC).

However, due to the evidence indicated by e.g. DeJong et al. (1989) Dickey-Fuller type tests may have low power against plausible stationary alternatives and therefore KPSS unit root test of Kwiatkowski et al. (1992) is also conducted to examine the time-series characteristics of the expected exchange rate return and the short-term interest rate differential. The KPSS test differs from the ADF unit root test in that the series considered is assumed to be stationary under the null in the KPSS test. The test statistics and the critical values in Tab. 1 below are taken from the ADF procedure in EViews 5.1:

Table 1: Unit Root Tests

Variable	τ_C	τ_T	$Z(\tau_C)$	$Z(\tau_T)$
RETURNEXDOLLAR2	-1.43	-2.06	0.53	0.22
1. differences	-4.29	-8.00	0.05	0.03
DIFTURKEYSHORT	-2.55	-2.80	0.55	0.28
1. differences	-8.78	-8.86	0.25	0.08
5% critical values	-2.90	-3.48	0.46	0.15

Above, τ_C and τ_T are the test statistics with allowance for only constant and constant&trend tems in the unit root tests, respectively, and $Z(\tau_C)$ and $Z(\tau_T)$ are the relevant KPSS statistics. The results of ADF unit root tests reveal that the null hypothesis that there is a unit root cannot be rejected for all the variables in the level form, but inversely, for the first differences the stationary alternative hypothesis can be accepted. Likewise, KPSS tests under the null hypothesis of stationarity indicate that all the variables are difference-stationary.

3.2. Methodology

Granger (1986) and Engle and Granger (1987) indicate that even though economic time series may be non-stationary in their level forms, there may exist some linear combination of these variables that converge to a long run relationship over time, which also requires that there must be Granger causality in at least one direction in an economic sense as one variable can help forecast the others. That is, if the series are individually stationary after differencing but a linear combination of their levels is stationary then the series are said to be co-integrated. In such a case, they cannot move too far away from each other in a theoretical sense (Dickey, Jansen and Thornton, 1991).

In our paper, we will apply to the co-integration methodology developed by Johansen (1988) and Johansen and Juselius (1990) to search for the existence of a potential long-run stationary relationship between the expected exchange rate return and the interest rate differentials. However this methodology is well-known and widely-used in the economics literature, it can be briefly explained as follows. Let us assume a VAR of order *p*:

$$y_t=A_1y_{t-1}+...+A_py_{t-p}+Bx_t+ t \qquad (6)$$

where y_t is a *k*-vector of non-stationarity I(1) variables, x_t is a *d*-vector of deterministic variables such as constant term, linear trend, and crisis variables and ε_t is a vector of innovations, i.e. independent Gaussian variables with mean zero and variance Ω. We can rewrite this VAR as:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t \qquad (7)$$

Granger representation theorem asserts that if the coefficient matrix Π has reduced rank $r < k$, then there exist *kxr* matrices α and β each with rank *r* such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is I(0). *r* is the number of co-integrating relations and each column of β is the co-integrating vector. The elements of α are known as the adjustment parameters in the vector error correction (VEC) model and measure the speed of adjustment of particular variables with respect to a disturbance in the equilibrium relationship.

We then determined the lag length of our unrestricted VAR model considering minimized Schwarz (SC) and Hannan-Quinn (HQ) statistics which suggest one lag order to be considered. Following these econometric methodological issues, we search for a long run co-integrating relationship between the variables by using two likelihood test statistics known as maximum eigenvalue for the null hypothesis of *r* versus the alternative of *r+1* co-integrating relationships and trace for the null hypothesis of *r* co-integrating relations against the alternative of *k* co-integrating relations, for $r = 0,1,... ,k-1$ where *k* is the number of endogeneous variables. A long-run deterministic trend is restricted in the co-integrating space as well.

3.3. Estimation Results

In line with the data and econometric model specification issues highlighted so far, the UIP model for the Turkish economy is estimated using the co-integration methodology of the same order integrated variables. In Tab. 2 below are given the estimation results.

In Tab. 2, we find that it is possible to construct a stationary long-run equilibrium relationship between the expected exchange rate return and the interest differential. Both trace and max-eigen statistics indicate a possible co-integrating vector in the long-run variable space yielding also significant feedback effects correcting short-run dynamic disequilibrium process in the long-run. Rewriting the UIP equation below:

RETURNEXDOLLAR2 = -0.072206+0.742017DIFTURKEYSHORT- 0.002163TREND (8)

Our estimation results give support to the validity of the UIP hypothesis in the long-run for the Turkish economy such that positive interest differential in favor of domestic interest rates requires nearly one-to-one increase in the expected exchange rate return. Homogeneity restriction applied to the coefficient of interest differential is accepted by the chi-square test indicating positive unitary coefficient of interest differential on future exchange rate return. Besides, Johansen-Juselius type of multivariate testing stationarity under the null hypothesis verifies the non-stationary characteristics of the variables. We must note that assuming no trend in the co-integrating equation yields one significant co-integrating vector in Eq. 9 below with highly similar estimation results to those obtained above:

RETURNEXDOLLAR2 = -0.205366+0.809288DIFTURKEYSHORT (9)
Stand. Error. (0.16610)

4. Concluding Remarks

In contemporaneous macroeconomics, one of the main recent issues of interest is to examine the fundamental building blocks of exchange rates and interest rates based on theoretical underpinnings of exchange rate determination. Inferences from these controversies reveal the knowledge of what motives drive the construction of expectations and in turn highlight whether they can help policymakers for the choice of appropriate stabilization policies. In our

Table 2: Co-Integration Test

Null hypothesis	**r = 0**	**r ≤ 1**
Eigenvalue	0.28	0.02
λ-trace	26.11*	1.43
5% Critical Value	25.87	12.52
λ-max	24.68*	1.43
5% Critical Value	19.39	12.52

*** denotes rejection of the hypothesis at the 0.05 level.**

Unrestricted Co-integrating Coefficients

Returnexdollar2	**Difturkeyshort**	**Trend**
4.105142	-3.046086	0.008878
-2.944840	-0.665030	-0.051975

Unrestricted Adjustment Coefficients (alpha)

D(RETURNEXDOLLAR2)	-0.026198	0.014620
D(DIFTURKEYSHORT)	0.118258	-0.000031

1 Co-integrating Equation (standard error in parenthesis): **Log likelihood** 79.90584

Returnexdollar2	**Difturkeyshort**	**Trend**	**C**
1.000000	-0.742017	0.002163	0.072206
	(0.14884)	(0.00230)	

Adjustment coefficients

D(RETURNEXDOLLAR2)	-0.107545
	(0.05663)
D(DIFTURKEYSHORT)	0.485464
	(0.09356)

Multivariate Statistics for Testing Stationarity

	Returnexdollar2	**Difturkeyshort**
$\chi^2(1)$	18.84806 (Prob. 0.000014)	15.27431 (0.000093)

Homogeneity and Symmetry Restrictions on Co-integrating Coefficients

b(1,2)=-1, $\chi^2(1)$ = 1.328862

paper, we investigate one of the central focal points in exchange rate determination models upon the Turkish economy. For this purpose, we construct an empirical model based on uncovered interest parity (UIP) relationship relating expected exchange rate return to the interest rate differentials. Our estimation results give support to the validity of the UIP hypothesis in the long-run for the Turkish economy such that positive interest differentials in favor of domestic interest rates require nearly one-to-one increase in the expected exchange rate return. Therefore, official interventions applied by the policy makers should be designed based on the possibility that changing the spot exchange rate relative to the expected future spot rate may also require domestic interest rates to be changed so as to affect interest differentials in line with *ex-ante* policy purposes. Of course, future papers taken account of such results should be constructed so as to see whether the empirical findings verify the estimation results found in this paper.

References

Akyuz, Y. and Boratav, K. (2003). The making of the Turkish financial crisis, *World Development*, 31/9, 1549-1566.

Alper, C.E. (2001). The Turkish liquidity crisis of 2000: What went wrong, *Russian and East European Finance and Trade*, 37/6, 51-71.

Aslan, O. and Korap L. (2007). Structural VAR identification of the Turkish business cycles, *International Research Journal of Finance and Economics*, 9, 72-86.

Baillie, R.T. and Bollerslev, T. (2000). The forward premium anomaly is not as bad as you think, *Journal of International Money and Finance*, 19, 471-488.

Beyaert, A., García-Solanes, J., and Pérez-Castejón, J.J. (2007). Uncovered interest parity with switching regimes, *Economic Modelling*, 24, 189-202.

Bhatti, R.H. and Moosa, I.A. (1995). An alternative approach to testing uncovered interest parity, *Applied Economics Letters*, 2, 478-481.

Chinn, M.D. and Meredith, G. (2004). Monetary policy and long-horizon uncovered interest parity, *IMF Staff Papers*, 51/3, 409-430.

DeJong, D. N., Nankervis, J. C., Savin, N. E. and Whiteman, C. H. (1989). Integration versus trend-stationarity in macroeconomic time-series, *University of Iowa Working Paper Series*, No. 89/31, December.

Dickey, D. A., Jansen, D. W. and Thornton, D. L. (1991). A primer on cointegration with an application to money and income, *The Federal Reserve Bank of St. Louis Review*, March/April, 58-78.

Dornbusch, R. (2001). A primer on emerging market crises, *NBER Working Paper*, 8326, June.

Dulger, F. and Cin, M.F. (2002). Monetary approach to determining exchange rate dynamics in Turkey and a test for co-integration (in Turkish), *METU Studies in Development*, 29/1-2, 47-68.

Eichengreen, B. (2001). Crisis prevention and management: Any new lessons from Argentina and Turkey?, *Background Paper Written for the World Bank's Global Development Finance 2002,* University of California, Berkeley.

Ekinci, N.K. and Erturk, K.A. (2007). Turkish currency crisis of 2000-2001, revisited, *International Review of Applied Economics*, 21/1, January, 29-41.

Engle, R. F. and Granger, C. W. J. (1987). Co-integration and error correction: Representation, estimation, and testing, *Econometrica*, 55, 251-276.

Ertugrul, A. and Yeldan, E. (2002). On the structural weakness of the post-1999 Turkish disinflation program, *Turkish Studies Quarterly*, 4/2, 53-67.

Flood, R.P. and Rose, A.K. (2002). Uncovered interest parity in crisis, *IMF Staff Papers*, 49/2, 252-266.

Granger, C. W. J. (1986). Developments in the study of cointegrated economic variables, *Oxford Bulletin of Economics and Statistics*, 48/3, 213-228.

Granger, C.W.J. and Newbold, P. (1974). Spurious regressions in economics, *Journal of Econometrics*, 2/2, 111-120.

Huisman, R., Koedijk, K., Kool, C., and Nissen, F. (1998). Extreme support for uncovered interest parity, *Journal of International Money and Finance*, 17, 211-228.

Isard, P. (2006). Uncovered interest parity, *IMF Working Paper*, WP/06/96.

Johansen, S. (1988). Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control*, 12, 231-254.

Johansen, S. and Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration-with applications to the demand for money, *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

Kesriyeli, M. (1994). Policy regime changes and testing for the Fisher and UIP hypothesis: The Turkish experience, *CBRT Research Department Discussion Paper*, No. 9411, December.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin, Y. (1992). Testing the null hypothesis of stationary against the alternative of a unit root, *Journal of Econometrics*, 54, 159-178.

Leigh, D. and Rossi, M. (2002). Exchange rate pass-through in Turkey, *IMF Working Paper*, WP/02/2004.

MacKinnon, J.G. (1996). Numerical distribution functions for unit root and cointegration tests, *Journal of Applied Econometrics*, 11, 601-618.

McCallum, B. T. (1994). A reconsideration of the uncovered interest parity relationship, *Journal of Monetary Economics*, 33, 105-132.

Phillips, P. (1986). Understanding spurious regressions in econometrics, *Journal of Econometrics*, 33, 311-40.

Sachsida, A., Ellery Jr., R. and Teixeira, J.R. (2001). Uncovered interest parity and the peso problem: The Brazilian case, *Applied Economics Letters*, 8, 179-181.

Sul, D. (1999). Does ex-post uncovered interest differential reflect the degrees of capital mobility?, *Applied Economics Letters*, 6, 97-102.

Uygur, E. (2001). From crisis to crisis in Turkey: 2000 November and 2001 February crises (in Turkish), *Turkish Economic Association Discussion Paper*, 2001/1.