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MISALIGNMENT UNDER DIFFERENT EXCHANGE RATE REGIMES: THE CASE OF TURKEY

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Abstract

The paper examines misalignment of the Turkish lira between 1998 to 2008. Misalignment, specifically overvaluation has been linked to fixed exchange rate regimes. By studying the case of Turkey during this period which covers both a fixed and floating exchange rate regime, we contribute to the literature on the relation between misalignment and exchange rate regimes. We first estimate the equilibrium real exchange rate for Turkey, then compute misalignment and finally test for structural breaks in the misalignment series. Through our tests we find three structural regimes which we call the pre-crisis period, the transition period and the post-crisis period. We find considerable overvaluation in first regime, which is when Turkey had a fixed exchange rate regime. This was not the case for the periods that had floating exchange rates. Thus, we conclude that overvalued currencies that have been linked to financial crises are a more serious concern for fixed exchange rate regimes.

Keywords: Cointegration, equilibrium real exchange rate, misalignment, structural breaks, Turkey

JEL Classification: C32, F31, F32 and F41

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I. INTRODUCTION

An important decision for an open developing economy is the choice of the exchange rate regime. Floating exchange rate regimes provide more flexibility and thus are thought to lead to a more efficient allocation of resources. However, floating exchange rate regimes can be problematic for developing countries. The increased flexibility in such regimes comes with a greater degree of uncertainty and volatility. Fixed regimes on the other hand are considered more stable (in terms of macroeconomic indicators such as inflation). Unfortunately, the rigidity of the regime could lead to a misaligned exchange rate. An overvalued exchange rate contributes to large trade and current account deficits which in turn have been associated with financial crises. The Mexican peso crisis in 1994 and the East Asian financial crisis in 1997-98 were linked to high current account deficits. Given that the 1994 and 2001 crises were preceded by high current account deficits, it is important for Turkey to be concerned about an overvalued lira.

The appreciating real effective exchange rate (REER) index[1] has fueled these concerns. Togan and Berument (2007) who provide a framework for understanding Turkish current account sustainability argue that the real exchange rate has to depreciate significantly to keep the current account sustainable. However, they note that if fundamentals change (such as high productivity growth) the required depreciation would be modest. Also, Oğuş Binatlı and Sohrabji (2008) who analyze the impact of the REER (among other factors) on Turkey's current account deficit for two crisis and three non-crisis periods between 1992 and 2007 found that the rapidly appreciating REER index was not a good differentiator between crisis and non-crisis episodes. As they note, this is because an appreciating REER index does not necessarily imply an overvalued real exchange rate.

[1] The REER index is calculated by the IMF as the geometric weighted average of the Turkish price index relative to the price of its trading partners.

Appreciation indicates that the value of the currency is rising, while overvaluation implies that the value of the currency is greater than its equilibrium. Thus, to study the latter, we must first estimate the equilibrium real exchange rate. We use Edwards (1989) model which was extended by Elbadawi (1994) and cointegration and error correction methodology to determine the equilibrium real exchange rate for Turkey. This theoretical framework and methodology have been widely used to compute equilibrium real exchange rates for several countries including Feyzioğlu (1997) for Finland, Mkenda (2001) for Zambia, MacDonald and Ricci (2003) for South Africa, Mathisen (2003) for Malawi, Égert and Lahrèche-Révil (2004) for Czech Republic, Hungary, Poland Slovakia and Slovenia, Eita and Sichei (2006) for Namibia, Paiva (2006) for Brazil, Zalduendo (2006) for Venezuela, Iossifov and Loukoianova (2007) for Ghana and Sohrabji (2011) for India. The Turkish equilibrium real exchange rate has been estimated by Alper and Saglam (1999) and Atasoy and Saxena (2006).[2]

Our analysis however, covers the recent period when the real effective rate index is appreciating significantly and the current account deficit is deteriorating rapidly. Thus, we add to the discussion of whether the concerns of the appreciating lira are justified. Moreover, our sample period also includes a shift from a fixed to a floating exchange rate regime. This is important because there is theoretical support and some empirical evidence that misalignment of the exchange rate is more strongly linked with fixed exchange rate regimes compared with more flexible ones. Goldfajn and Valdés (1999) find that currencies can appreciate significantly under fixed exchange rate regimes. More recent studies by Kemme and Roy (2005), Coudert and Couhard (2008), Holtemöller and Mallick (2008) and Caputo and Magendzo (2009) find that misalignment is more strongly associated with fixed regimes compared with floating ones. Our

[2] Civcir (2003) and Sarno (2000) also estimate the Turkish equilibrium real exchange rate but they use purchasing power parity.

paper adds to this literature by analyzing the Turkish real exchange rate from 1998 to 2008 which had a fixed exchange rate at the start of the sample period and following the 2001 crisis shifted to a floating regime. Thus, our analysis of Turkey's real exchange rate dynamics over this period can shed further light on real exchange rate misalignment behavior in different exchange rate regimes.

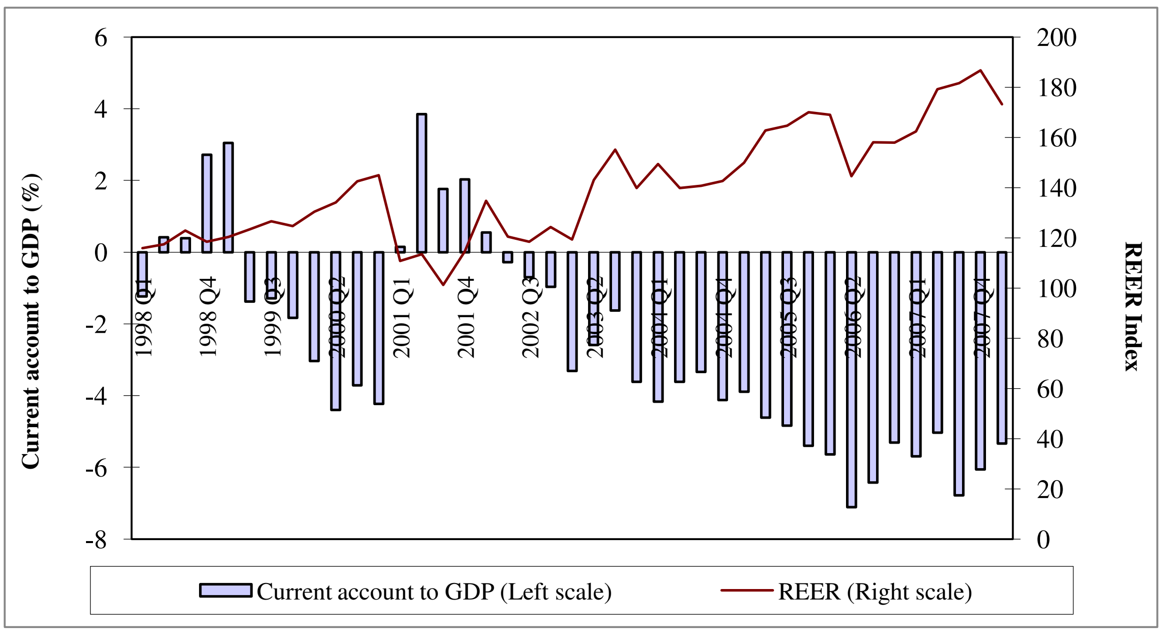
We test for structural breaks in the misalignment series using the Bai and Perron (1998) procedure. We find three structural regimes with the first one having a fixed exchange rate regime while the other two had floating exchange rates. This allows us to examine trends in the lira under different exchange rate regimes. As expected, volatility was a concern in the floating regimes with the transition period exhibiting high volatility which was significantly reduced in the post-crisis period. The fixed exchange rate regime (pre-crisis period) was marked by a consistently high level of overvaluation in the lira. This was not the case in the floating regimes. Thus, based on the Turkish case we conclude that misalignment is a more serious concern for fixed exchange rate regimes.

The paper is organized as follows: the next section discusses the background on the Turkish real exchange rate and current account position. Section III provides the theoretical and econometric methodology for equilibrium real exchange rate determination. Sections IV and V estimate and analyze the equilibrium real exchange rate and real exchange rate misalignment respectively and the last section concludes.

II. BACKGROUND

Turkey embarked on large-scale liberalization of foreign trade and finance in the late 1980s. Soon after that, Turkey began experiencing large trade and current account deficits. In addition to these deficits, a fragile banking sector, large fiscal deficits and a heavy dependence on short-term capital flows contributed to the 1994 crisis. The 1994 crisis resulted in a structural adjustment program including exchange rate stabilization and fiscal discipline. As expected, there was a current account correction. However, loose monetary and fiscal policy undermined the program and by the late 1990s the current account deficit began deteriorating again (figure 1). This worsening of the current account deficit coincided with an appreciating REER index (figure 1). As we show later, this appreciation represented an overvaluation in that period. Excessive dependence on short-term capital flows to finance these deficits put increasing pressure on the banking sector and by early 2001 Turkey was once again in the midst of a crisis.

FIGURE 1: TURKISH CURRENT ACCOUNT TO GDP AND REAL EFFECTIVE EXCHANGE RATE INDEX [1998:Q1 TO 2008:Q1]



Notes: The GDP series was expressed in current Turkish lira and the current account series in U.S. dollars. The latter was converted to Turkish lira (using the indicator selling nominal exchange rate).From this we get the ratio of current account to GDP in percentage form. The real effective exchange rate (REER) index is calculated by the IMF as the geometric weighted average of the Turkish price index relative to the price of its trading partners. We use the CPI based index which includes 19 countries including Austria, Belgium, Brazil, Canada, China, France, Germany, Greece, Iran, Italy, Japan, Netherlands, South Korea, Spain, Sweden, Switzerland, Taiwan, U.K. and U.S.A. The base year for the series is 1995. An increase in the index indicates an appreciation. Both series are seasonally adjusted.

Source: IMF, International Financial database.

The 2001 crisis led to several policy reforms such as the focus on reduced budget deficits, improvements in the banking sector and a switch to a floating exchange rate regime. There have been some improvements in Turkey's external position.[3] Since 2004, Turkey's export to GDP ratio has been high (30%) and increasing. Also, the composition of the current account deficit in the mid-2000s differs from the period prior to the earlier crisis. The ratio of short term inflows to the deficit improved (declining to 18% from much higher levels in earlier periods) and there was an increase in both foreign direct investment as well as long term capital flows. In fact, Turkey's reserves increased significantly in the 2000s because of large capital inflows. Towards the end of the decade, Turkey was also able to make debt payments to the IMF which signaled improved conditions despite the high levels of deficit.

However, despite these improvements, the overall current account deficit has continued to mount. Figure 1 shows a sharply deteriorating current account deficit from 2004 onwards. This increase in deficits coincides with a major appreciation in the REER index and led to fears of an overvalued lira and the potential for another crisis. However, as noted earlier appreciation does not necessarily indicate an overvalued currency. And there are reasons to question if the lira is so significantly overvalued to contribute to these large current account deficits or in fact, if the lira is overvalued at all. As the literature notes, overvaluation is a lesser concern in floating exchange rate regimes. Also, changed conditions (discussed above) have an effect on the equilibrium real exchange rate which may necessitate an appreciation. To more carefully explore the concerns with the lira, we first need to determine the equilibrium exchange rate and then compare it with the actual real exchange rate. We present the theoretical and empirical methodology for equilibrium real exchange rate determination in the next section and estimate it in the following one.

[3] Central Bank of Turkey several reports.

III. METHODOLOGY

We use Edwards (1989) theoretical framework and cointegration and the error correction model to estimate the equilibrium real exchange rate for Turkey which is discussed in the following sub-sections.

A. Theoretical framework

Edwards' (1989) model defines the real exchange rate as the ratio of the prices of traded to nontraded goods. The model extended by Elbadawi (1994) examines the impact of various fundamentals on the price of nontraded goods and thus on the real exchange rate. Any factor that causes the price of nontraded goods to change will result in a real exchange rate appreciation or depreciation. Factors that determine the exchange rate are given in the equation below

$$e_t = \beta_0 + \beta_1\, tot_t + \beta_2\, tariff_t + \beta_3 gcons_t + \beta_4\, inv_t + \beta_5\, kflows_t + \beta_6\, roi_t + \beta_7\, tech_t + \varepsilon_t \qquad (1)$$

where e is the real exchange rate, *tot* is terms of trade, *tariff* is the tariff rate, *gcons* is government consumption, *inv* is investment, *kflows* is capital flows, *roi* is the world rate of interest and *tech* is technological progress.

Several of these variables have an ambiguous effect. *Terms of trade* changes can have a direct income effect (related to demand for nontradables) as well as an indirect substitution effect (related to supply of nontradables). An improvement in the terms of trade could lead to an increase in income which by raising demand and thus prices may result in a real exchange rate appreciation. However, an improvement in terms of trade may also result in increased resources for producers and thus increased production of all goods (including nontradables). Higher production can lead to a decline in prices and thus a real exchange rate depreciation.

An increase in *tariff rates* has two impacts. By raising the domestic price of imports, higher tariffs increase the price of traded goods and thus result in a depreciation. However, a higher tariff also leads to a substitution of demand toward domestic goods (including nontraded goods) which causes an increase in the price of nontraded goods and thus an appreciation.

The impact of *investment* on the real exchange rate depends on whether higher investment leads to greater spending on traded goods or toward nontraded goods. Increased spending of the former implies that higher investment leads to a depreciation of the real exchange rate while greater spending on nontraded goods leads to an appreciation. Similarly, increased *government consumption* directed towards nontraded goods would lead to an appreciation and if it is more geared toward traded goods we expect a depreciation. Although, this relation is theoretically ambiguous, the former scenario is more likely.

Capital flows are associated with real exchange rate appreciation. Higher capital inflows imply greater total assets, which increases general demand (including demand for nontraded goods). Therefore the price of nontraded goods increases, which results in an appreciation of the real exchange rate. For similar reasons Alper and Saglam (1999) argue that a fall in the *world rate of interest* would result in an appreciation of the real exchange rate. A decline in the world rate of interest for a debtor country like Turkey would reduce net foreign outflows which leads to increasing demand for all goods and thus raises the price of nontraded goods leading to a real exchange rate appreciation.

Finally, *technological progress* (like terms of trade) can lead to an appreciation if the increase in assets causes an increase in demand for all goods including nontraded goods. If instead technological progress leads to increasing production capabilities and thus a decline in the cost of production, prices of all goods (including nontraded goods) will fall and thus cause a depreciation.

The econometric methodology used in the estimation is discussed in the next sub-section.

B. Econometric methodology

We follow the econometric techniques used by the literature in determining the equilibrium real exchange rate. The first step when dealing with macroeconomic time series described above is to test for nonstationarity. We use several tests including the Augmented Dickey Fuller (ADF) test, the Phillips-Perron test, the Kwiatowski, Phillips, Schmidt and Shin (KPSS) test and the Zivot-Andrews test for determining unit roots in our series.

Nonstationarity implies that standard econometric techniques cannot be used. However, if these nonstationary series are cointegrated we can use the Error Correction Model (ECM) to determine the equilibrium real exchange rate. To test for cointegration we first determine the correct lag length in the VAR (using AIC), then test residuals for normality and serial correlation and heteroskedasticity. If residuals reveal no problem we test for cointegration using the Johansen procedure.

If the series are cointegrated the equilibrium real exchange rate is determined using ECM. The ECM includes nonstationary variables that are cointegrated (long-run determinants) and the stationary variables (short-run factors) that have an impact on the equilibrium real exchange rate. Once the ECM is estimated, we test the residuals for stationarity and if stationary, the coefficients of the cointegrated variables can be used to compute the equilibrium real exchange rate. Following MacDonald and Ricci (2003), Eita and Sichei (2006), Zalduendo (2006) and Iossifov and Loukoianova (2007) we use the Hodrick-Prescott filter to capture the permanent component of this series which gives us our equilibrium real exchange rate.

Through the ECM we determine the speed of adjustment parameters and thus the time it takes for the deviation in the real exchange rate to be eliminated. The next section describes the data and equilibrium real exchange rate estimation results.

IV. EQUILIBRIUM REAL EXCHANGE RATE ESTIMATION

We use quarterly data from 1998 to 2008 to estimate the equilibrium real exchange rate for Turkey based on variables in equation (1). We use two measures for the exchange rate. [4] They are described in table 1 with other variables used in the estimation.

TABLE 1: DATA AND SERIES CONSTRUCTION

Variable	Data construction	Data series
Real exchange rate (rer)	$\ln\left(E\frac{P^{U.S.}}{P^{Tur}}\right)$	E – Lira to dollar nominal exchange rate $P^{U.S.}$ – U.S. CPI (base year = 2003) P^{Tur} – Turkish CPI (base year = 2003)
Real effective exchange rate $(reer)$	$\ln(REER)$	The CPI-based *REER* index (described in figure 1)
Terms of trade (tot)	$\ln\left(\frac{P_X}{P_M}\right)$	P_X – price of exports P_M – price of imports
Openness $(open)$	$\ln\left(\frac{X+M}{GDP}\right)$	X – value of exports M – value of imports
Real world rate of interest (roi)	$i^{U.S.} - \pi^{U.S.}$	$i^{U.S.}$ – U.S. long-term interest rate $\pi^{U.S.}$ – U.S. inflation rate
Investment (inv)	$\ln\left(\frac{FC}{GDP}\right)$	FC – gross fixed capital formation GDP – gross domestic product
Capital flows $(kflows)$	$\frac{KA}{GDP}$	KA – capital balance GDP – gross domestic product
Government consumption $(gcons)$	$\ln\left(\frac{GC}{GDP}\right)$	GC – government consumption expenditures GDP – gross domestic product
Technological progress $(tech)$	$\frac{RGDP_t - RGDP_{t-1}}{RGDP_{t-1}}$	$RGDP$ – real gross domestic product (base year = 1998)

Notes: Quarterly data from 1998:Q1 to 2008:Q1 is used. Data for GDP, investment and nominal exchange rate came from Central Bank of Turkey and the rest from International Financial Statistics database. All series are seasonally adjusted using the X11 additive method.

An increase indicates a depreciation in *rer* and an appreciation in *reer*. Due to lack of data we use openness as a proxy for tariff rates. In addition to these factors we add a dummy variable

[4] We use both measures to make our analysis comparable with other work on Turkey.

to capture the change in the exchange rate regime (denoted as derr) after the 2001 crisis. Based on the econometric techniques described earlier, the above data is used to estimate the equilibrium real exchange rate.

The first task is to test our series for unit roots which are reported in table 2.

TABLE 2: UNIT ROOT TESTS

Variables	ADF	Phillips-Perron	KPSS	Zivot-Andrews
rer	-0.575 [5]	-0.485 (4)	0.618* (5)	-4.097 [5], 2001:1
Δ*rer*	-4.917* [0]	-4.773* (7)	0.142 (6)	-6.080* [2], 2002:1
reer	-0.228 [4]	-1.629 (0)	0.693* (5)	-3.374 [4], 2000:2
Δ*reer*	-5.878* [3]	-8.613* (7)	0.093 (5)	-7.205* [3], 2002:4
tot	-1.891 [1]	-1.098 (0)	0.604* (5)	-4.172 [5], 2003:3
Δ*tot*	-5.319* [3]	-3.680* (3)	0.102 (0)	-7.564* [3], 2001:2
open	-1.615 [4]	-0.685 (4)	0.691* (5)	-4.411 [0], 1999:4
Δ*open*	-4.772* [3]	-6.475* (9)	0.096 (5)	-6.139* [0], 2002:1
roi	-1.405 [8]	-1.960 (3)	0.605* (5)	-5.074** [3], 2002:2
Δ*roi*	-3.480* [3]	-7.071* (2)	0.057 (3)	-6.892* [1], 2003:2
inv	-1.975 [0]	-2.077 (1)	0.223 (5)	-4.350 [1], 2001:1
Δ*inv*	-4.651* [0]	-4.631* (3)	0.379** (0)	-7.208* [0], 2002:1
tech	-6.380* [0]	-6.382* (2)	0.232 (0)	-5.543* [3], 2002:2
kflows	-3.582* [0]	-3.742* (4)	0.483* (4)	-6.065* [0], 2000:4
gcons	-3.647* [0]	-3.442* (5)	0.406** (4)	-5.732* [0], 1999:4
RER residuals	-7.265* [0]	-7.265* (0)	0.130 (3)	-8.198* [0], 2001:4
REER residuals	-5.731* [0]	-5.734* (4)	0.075 (5)	-7.080* [0], 2003:1

*Notes: * and ** indicate statistical significance at the 5% and 10% respectively. All tests are conducted assuming a constant. Tests based on no constant or a constant and trend (not reported here but available on request) have similar conclusions. The null hypothesis for all tests except the KPSS test is that the series is nonstationary. Numbers in square brackets following the ADF and ZA tests correspond to lags where maximum lags were set at 9 and lag length was determined by AIC. The structural break periods for the ZA test are also reported. For the PP and KPSS tests, the numbers in brackets correspond to lag truncation determined by Newey-West criteria and Schwert formula respectively.*

We find that the real exchange rate (both measures), terms of trade, openness, investment and world rate of interest are nonstationary while capital flows, government consumption and technological progress are stationary.

Before we estimate the error correction models (referred to as *RER* and *REER* models) we test for cointegration between the nonstationary variables. Based on AIC we find the appropriate lag length for the underlying VAR to be 2 lags. Diagnostic tests (normality, homoskedasticity and no serial correlation) are conducted on the residuals and the results are reported in table 3. Except for skewness in the *RER* model, there are no significant problems of non-normality, serial correlation or heteroskedasticity in the results. Thus, we can use the Johansen test for cointegration.

TABLE 3: DIAGNOSTIC TEST RESULTS

	***RER* model**		***REER* model**	
Test	**Test statistic**	**p-value**	**Test statistic**	**p-value**
Serial correlation (*LM* statistic)	17.828	0.850	14.096	0.960
White heteroskedasticity test (χ^2)	24.283	0.112	26.073	0.128
Skewness test (χ^2)	3.633	0.057**	1.332	0.248
Kurtosis (χ^2)	0.304	0.582	1.381	0.240
Normality (*Jarque-Bera* statistic)	3.934	0.140	2.713	0.258

*Notes: The null hypothesis for tests are that the residuals do not have serial correlation, are homoskedastic and normally distributed. Serial correlation test is conducted with two lags. We use the White heteroskedasticity test with no cross terms. ** indicates rejection of the null hypothesis at 10% level of significance.*

The cointegration test is conducted assuming a constant and no trend in the cointegrating equation. There is a concern (noted in the literature) of false rejection of no cointegration in small samples. To remedy this, we follow Baharumshah, Lau and Fountas (2003) in using the Reinsel and Ahn (1988) correction method and these adjusted results are reported in table 4. We find evidence of one cointegrating relation for both models. We also perform a chi-square test for exclusion of each variable. Results (not reported) show that all variables should be included in the cointegration. Thus, we estimate the error correction models which includes both the long-run (nonstationary cointegrated variables) and the short-run determinants (stationary variables and the exchange rate regime dummy variable).

TABLE 4: JOHANSEN COINTEGRATION TEST RESULTS

	No. of CE(s)	Adjusted trace value	Adjusted eigenvalue
RER model			
	None	69.41*	36.38*
	At most 1	31.16	12.49
REER model			
	None	66.21**	38.24*
	At most 1	27.97	12.55

Notes: * *and* ** *denotes rejection of the null of no cointegration at 5% and 10% level of significance respectively. Adjusted values are computed by multiplying the Johansen test statistics with the small-sample correction factor noted in Reinsel and Ahn (1988). The correction factor is* $(T - p\,k)/T$ *where T is the sample size, p is the number of variables and k is the number of lags.*

Unit root tests on the residuals of ECM (reported in table 2) show that the residuals are stationary. Thus we can use the ECM results which are reported in table 5.

We find terms of trade to be negatively associated with *rer* and *reer*. As discussed earlier, terms of trade has a theoretically ambiguous relationship. Our results for the *RER* model show that an improvement in the *terms of trade* results in a real exchange rate appreciation while we get the opposite result for the *REER* model. This implies that the direct (income) effect of a terms of trade improvement dominates the indirect (substitution) effect for *rer* and the reverse is true for *reer*. Interestingly this result in the *RER* model is similar to Alper and Saglam (1999) who use the same measure of the real exchange rate while the *REER* model results are similar to Atasoy and Saxena (2006) who use *reer* in their estimation. This variable is statistically significant at 5% for the *REER* model. However, it is only statistically significant at 15% for the *RER* model.

A higher level of *openness* (which corresponds to lower tariffs in the model) results in an appreciation of the currency for both models. While the relationship is theoretically ambiguous, several researchers have found that increased openness results in a depreciation of the real exchange rate. Our findings contradict the expected results. The variable is statistically significant in both models.

TABLE 5: ERROR CORRECTION MODEL RESULTS

	***RER* model**		***REER* model**	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**
tot	-0.660**	(0.471)	-1.172*	(0.316)
open	-1.178*	(0.290)	0.408*	(0.192)
roi	0.118*	(0.024)	-0.081*	(0.016)
inv	-1.033*	(0.138)	0.815*	(0.094)
constant	-3.994		7.015	
coint equation	-0.242*	(0.113)	-0.402*	(0.186)
constant (*VAR*)	-0.445		1.211	
derr	0.049+	(0.044)	-0.104*	(0.056)
tech	-1.068*	(0.551)	1.178**	(0.798)
kflows	-0.159+	(0.196)	0.235+	(0.285)
gcons	-0.208+	(0.235)	0.543*	(0.323)
R^2	0.418		0.295	

Notes: * *and* ** *indicates statistical significance at 5% and 10% level of significance.* + *indicates that although the variable is not statistically significant, exclusion of it is rejected based on adjusted* R^2 *and AIC.*

The *world rate of interest*, leads to an expected and statistically significant depreciation of the currency in the two models. An increase in *investment* is associated with a statistically significant appreciation of the exchange rate in both models. This indicates that the increased investment is associated with higher spending on nontraded goods.

Expectedly, we find that a *shift in the exchange rate regime* is associated with a depreciation of the currency. While this variable is not statistically significant in the *RER* model (at usual levels of significance), exclusion of the variable based on adjusted R^2 and Akaike and Schwarz criterion is rejected. We find that in both models *technological progress* results in a statistically significant appreciation which indicates that the demand effect (increased consumption) dominates over the supply (increased productivity) effect. If technological progress can be seen as a proxy for productivity growth then it implies that higher productivity leads to a currency appreciation (Balassa-Samuelson effect). As expected, increased *capital flows* and *government consumption* both lead to an appreciation of the currency. While these are not statistically significant variables in the *RER* model exclusion of the variables are rejected.

Table 6 reports the speed of adjustment parameters for our two models as well as those estimated by others for different countries.

TABLE 6: SPEED OF ADJUSTMENT COEFFICIENTS

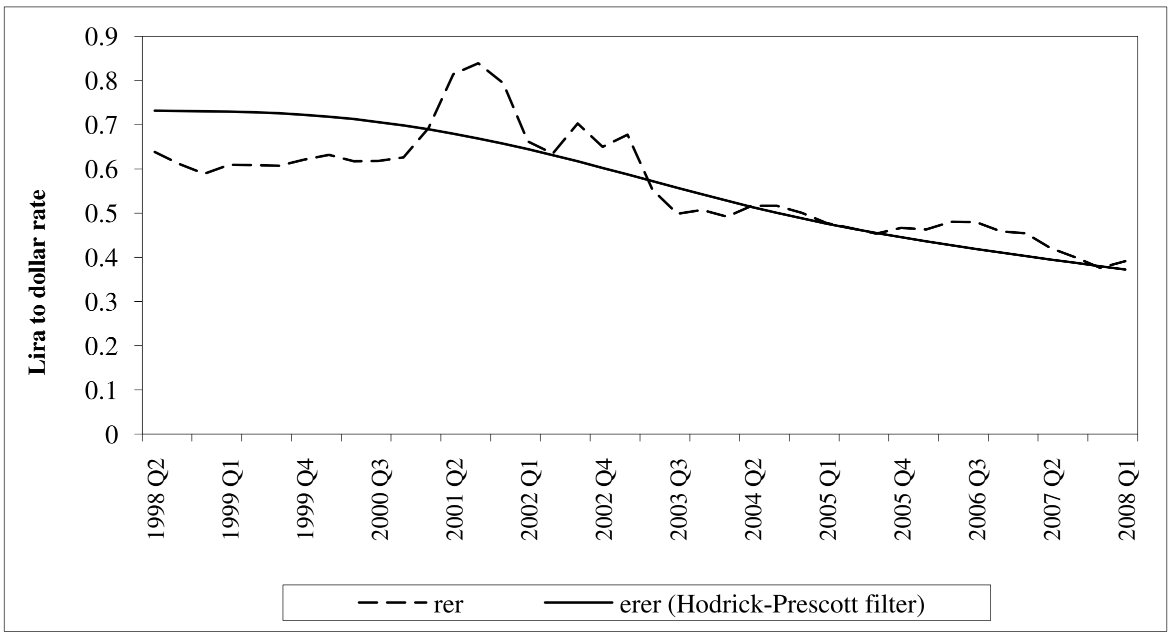
Country	Coefficient	Source
Brazil	-0.46[a]	Paiva (2006)
Ghana	-0.141	Iossifov and Loukoianova (2007)
Malawi	-0.270	Mathisen (2003)
Namibia	-0.399	Eita and Sichei (2006)
South Africa	-0.080	MacDonald and Ricci (2003)
Turkey	-0.390	Alper and Saglam (1999)
Turkey	-0.027[b]	Atasoy and Saxena (2006)
Venezuela	-0.243	Zalduendo (2006)
Zambia	-0.800[c]	Mkenda (2001)
***RER* model**	-0.242	
***REER* model**	-0.402	

Notes: Annual data was used for Brazil, Namibia, Venezuela and Zambia. Ghana, Malawi, South Africa and Turkey (both papers) used quarterly data as we did. [a]Paiva (2006) estimates four models. We report the coefficient of model 1. [b]Atasoy and Saxena (2006) estimate five models. The coefficient reported is that of model 2 which they use as their baseline model. [c]Mkenda (2001) uses three exchange rates for Zambia, one for exports, one for imports and the other an internal real exchange rate. We report the coefficient for the last one.

We find the *speed of adjustment* parameter to be -0.242 and -0.402 for the *RER* and the *REER* model respectively. Our results fall within the estimates seen in the literature. From the coefficient, following Mathisen (2003) we find that 50% of the deviation in the Turkish *rer* can be eliminated in about a year, while it takes about 2 and ½ quarters for the same level of deviation in the real effective exchange rate to be eradicated. This is relatively quick adjustment similar to Alper and Saglam (1999) for Turkey and Mathisen (2003) for Malawi.

Using the results of the ECM we compute the equilibrium real exchange rate. Following the literature we use the Hodrick-Prescott filter to remove the cyclical portion so that only the "permanent" components remain. The actual and the equilibrium real exchange rate are plotted in figures 2 and 3 for the two exchange rate measures.

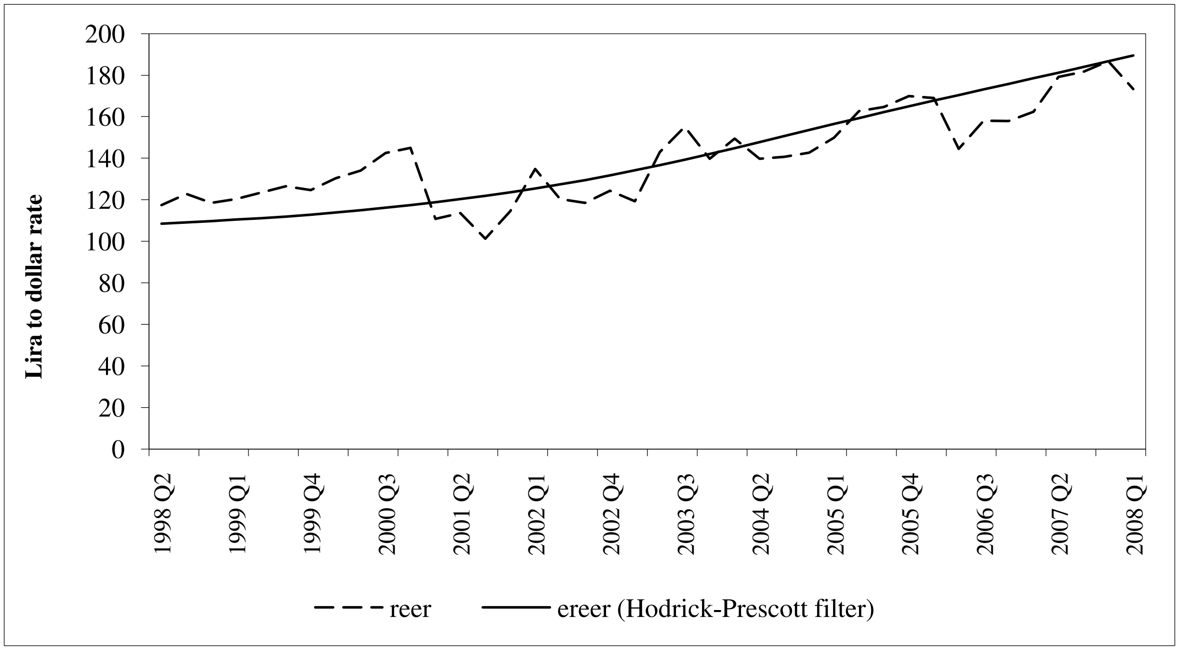
FIGURE 2: ACTUAL AND EQUILIBRIUM REAL EXCHANGE RATE [1998:Q2 TO 2008:Q1]



Source: Central Bank of Turkey and authors' computation.

We find that the *rer* is below and *reer* is above the respective equilibrium levels prior to the 2001 crisis. This indicates an overvaluation. The next several quarters witness a major undervaluation in both cases which suggests adjustment in the exchange rate following the crisis and the reforms undertaken. For the remainder of the sample period the actual real exchange rate fluctuates around its equilibrium not deviating significantly for a major period of time. We analyze this misalignment more thoroughly in the next section.

FIGURE 3: ACTUAL AND EQUILIBRIUM REAL EFFECTIVE EXCHANGE RATE [1998:Q2 TO 2008:Q1]



Source: IMF, International Financial Statistics database and authors' computation.

V. REAL EXCHANGE RATE MISALIGNMENT

Misalignment is computed as,

$$Misalignment = \frac{Actual\,ER - Equilibrium\,ER}{Equilibrium\,ER} \qquad (2)$$

Once we compute real exchange rate misalignment we test for a structural break in the series. This is important given that our sample period includes both a fixed and a floating exchange rate. Testing and identifying structural breaks allows us to examine if the regimes matter for misalignment of the real exchange rate. Bai and Perron (1998) propose a procedure for identifying multiple structural breaks which tests for *m* structural breaks which indicates *m*+1 structural regimes. This procedure has been used for examining structural breaks in U.S. inflation by Jouini and Boutahar (2003) and by Hoarau, Ahamada and Nurbel (2008) for the Australian exchange rate.

We apply the Bai and Perron (1998) procedure on our misalignment series, but constrain the number of breaks to be no more than two based on our short sample period. We find two structural breaks using both measures of the real exchange rate. This implies that the misalignment series can be broken up into three structural regimes which are determined to be (1) 1998:Q3 to 2000:4, (2) 2001:Q1 to 2002:Q4 and (3) 2003:Q1 to 2008:Q1. The first period which is prior to 2001 crisis corresponds to a fixed exchange rate regime. The second regime encompasses the 2001 lira crisis and includes the movement to a floating regime (denoted as the transitional period). The third regime can be thought of as the post-crisis period covers the period after Turkey begins recovering from the crisis.The trend in misalignment is seen in figures 2 and 3 and table 7 reports descriptive statistics.

In general, we find that misalignment exhibits no skewness and/or kurtosis and the series is normal (table 7).[5] From figures 2 and 3 we see that lira is consistently overvalued in the pre-crisis period. In addition, this misalignment is significant with an average overvaluation of 14.68% for *rer* and 14.26% for *reer* (table 7). These results confirm findings by Atasoy and Saxena (2006) of high levels of overvaluation prior to the 2001 crisis. The average misalignment in the transitional period is in the opposite direction meaning that the real exchange rate is undervalued on average (11.24% and 6.18% for *rer* and *reer* respectively). The third regime has a lower magnitude of misalignment. However, we find that the lira is undervalued on average (3.27% and 3.08% for *rer* and *reer* respectively). It is likely that this trend is capturing movement in the world's major currencies. Thus, it does not provide irrefutable evidence of undervaluation. However, this is not our focus. Rather, we are arguing that our evidence shows that the lira is not overvalued in the period following the shift to a floating regime. Overall, our

[5] One concern is that the Jarque-Bera test for normality is rejected in the *REER* model at 10% level of significance for the transitional period.

results confirm those of Kemme and Roy (2005), Coudert and Couhard (2008), Holtemöller and Mallick (2008) and Caputo and Magendzo (2009) that find lower misalignment in more flexible exchange rate regimes.

TABLE 7: DESCRIPTIVE STATISTICS OF EXCHANGE RATE MISALIGNMENT

	***RER* model**	***REER* model**
Pre-crisis period (1998:Q3 to 2000:Q4)		
Average misalignment (standard error)	-14.68 (0.87)	14.26 (1.72)
[95% confidence interval]	[-16.33 to -13.03]	[11.00 to 17.52]
Skewness test (p-value)	0.99	0.33
Kurtosis test (p-value)	0.77	0.91
Jarque-Bera normality test (p-value)	0.91	0.51
Transitional period (2001:Q1 to 2002:Q4)		
Average misalignment (standard error)	11.24 (3.45)	-6.18 (2.39)
[95% confidence interval]	[4.69 to 17.80]	[-10.72 to 1.64]
Skewness test (p-value)	0.88	0.47
Kurtosis test (p-value)	0.51	0.23
Jarque-Bera normality test (p-value)	0.55	0.09**
Post-crisis period (2003:Q1 to 2008:Q1)		
Average misalignment (standard error)	3.27 (1.53)	-3.08 (1.42)
[95% confidence interval]	[0.63 to 5.91]	[-5.53 to -0.64]
Skewness test (p-value)	0.98	0.77
Kurtosis test (p-value)	0.65	0.89
Jarque-Bera normality test (p-value)	0.87	0.94

*Notes: Using the Bai and Perron (1998) procedure we find two structural break points in the misalignment series and thus three structural regimes noted above. A positive misalignment for rer implies an undervaluation and a positive misalignment for reer implies an overvaluation. Null hypothesis for tests conducted are that there is no skewness, no kurtosis and the series is normal. ** denotes rejection of the null at 10% level of significance.*

The standard deviations of the three regimes show that the greatest volatility is observed in the transitional period while the other two are more stable with similar levels of standard deviations (table 7). It is not surprising that we find the transitional period to be highly volatile. Instability in the exchange rate is to be expected when there is a crisis and a country switches from one exchange rate regime to another. This volatility is reflected in the bigger range of the 95% confidence interval which covers both undervaluation and overvaluation (table 7).

As expected there is less volatility in the post-crisis period compared with the transitional period. However, we find confirmation for the concern that flexible regimes are more volatile than fixed regimes. While the standard deviations are similar for the pre-crisis and post-crisis periods, figures 2 and 3 show that the post-crisis period includes periods of overvaluation and undervaluation. This reflects volatility in the lira in the post-crisis period which is not captured by just the standard deviation.

Overall, we find in Turkey's case that overvaluation of the currency is a significant concern during a fixed exchange rate regime. Volatility is a bigger concern for floating regimes. However, it is important to note that the post-crisis period which exhibits volatility in the lira is not significantly more unstable than the period when Turkey had a fixed exchange rate regime (pre-crisis period).

VI. CONCLUSION

This paper aims to analyze misalignment of the Turkish lira over different exchange rate regimes. Using quarterly data from 1998-2008 we employ Edwards (1989) theoretical framework and cointegration and ECM methodology to compute the equilibrium real exchange rate and misalignment. In addition, we test for structural breaks in the misalignment series using the Bai and Perron (1998) procedure and find two breaks which indicate three structural regimes denoted as pre-crisis period, transitional period and post-crisis period. We analyze misalignment in these three regimes and as expected, find that on average the lira was significantly overvalued prior to the 2001 crisis. The transitional period is marked by significant undervaluation and considerable volatility. Again, this was expected since the period covers the crisis and the shift to a floating regime. While the lira is also overvalued in the last period, the magnitude is significantly lesser than the pre-crisis period. We also find that the post-crisis period is less volatile than the transitional period, but since it includes both periods of overvaluation and undervaluation it is more volatile than the pre-crisis period.

Comparing the real exchange rate misalignment to current account deficits in these three regimes shows that overvaluation was a factor in deteriorating current account deficits in the first regime (which had a fixed exchange rate). While the real exchange rate has appreciated in recent years, so have the fundamentals that impact the equilibrium real exchange rate. Thus, overvaluation is a lesser concern in the latter part of the decade. This means that unlike the 1990s, an overvalued lira is not the contributing factor to exploding current account deficits in recent years.

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