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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 and 2011. 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. Our results show that the lira was considerably overvalued in the first regime, which is when Turkey had a fixed exchange rate regime. This was not the case for the periods that had a floating exchange rate. Thus, we confirm that overvalued currencies that have been linked to financial crises are a more serious concern for fixed exchange rate regimes. More importantly, we find that volatility which is a bigger concern in floating regimes is a significant problem for Turkey in the last few years. In fact, the recent dangerously large and rising current account deficits may be a result of volatility rather than overvaluation.

JEL Classification: C32; F31; F32; F41.
Keywords: Cointegration; Exchange Rate Misalignment; Structural Breaks; S2S Estimator; Turkey.

RÉSUMÉ. Cet article traite des mésalignements de change en Turquie sur la période 1998-2001. Après une estimation du taux de change d'équilibre, nous calculons les mésalignements et testons l'existence de ruptures structurelles dans la série ainsi obtenue. Trois ruptures sont trouvées. Alors que la lire était considérablement surévaluée durant le premier régime caractérisé par un système de parité fixe, ce n'est pas le cas durant les périodes de change flexible. Par conséquent, la surévaluation dans des pays qui ont connu une crise financière constitue un problème plus important dans le cas de régimes de changes fixes. En outre, la volatilité est particulièrement marquée en Turquie ces dernières années, causée en grande partie par les déficits croissants de solde courant.

Classification *JEL* : C32 ; F31 ; F32 ; F41.
Mots-Clefs : Cointégration ; mésalignement ; ruptures structurelles ; estimateur en deux étapes ; Turquie.

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1. 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 (Ghosh et al., 1997, 2003). However, floating exchange rate regimes can be problematical for developing countries. The increased flexibility in such regimes comes with a greater degree of uncertainty and volatility (Cavallo, 2005) which sometimes reverses the potential benefit of greater efficiency. Fixed regimes on the other hand are considered more stable in terms of macroeconomic indicators such as inflation (Ghosh et al., 2003 and Ghosh, et al., 1997). Unfortunately, the rigidity of the regime could lead to a misaligned exchange rate. If the misalignment is an overvaluation it can contribute to large trade and current account deficits which in turn, can lead to 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 Turkish crises were preceded by high current account deficits, it is important to pay attention to the value of the lira.

The appreciating Turkish real effective exchange rate (REER) index[4] in recent years 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, Binatlı and Sohrabji (2008) analyze the impact of the REER (among other factors) on Turkey's current account deficit between 1992 and 2007 and conclude that the rapidly appreciating REER index was not a good differentiator between crisis and non-crisis episodes because an appreciation of the REER index does not necessarily imply overvaluation.

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's (1989) framework which was extended by Elbadawi (1994) to model the equilibrium real exchange rate for Turkey and estimated it using cointegration and the vector error correction methodology.[5] These theoretical framework and methodology have been widely used to compute equilibrium real exchange rates for several countries including Feyzio lu (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

4 . 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.
5 . Cline and Williamson (2011) question the appropriateness of this method if on average the real exchange rate is not in equilibrium over the estimation period. We have no evidence that the lira was on average in equilibrium over our sample period. One solution would be to use the fundamental equilibrium exchange rate (FEER) approach used by Jeong, et al. (2010) and others which does not require this assumption. However, the full benefit of this approach is realized in a multi-country framework. Thus, for our single-country estimation we find no other feasible method to analyze overvaluation of the Turkish lira.

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 (2000) and Atasoy and Saxena (2006).[6]

Our analysis however, covers the recent period when the REER 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 which can shed light on real exchange rate behavior under different exchange rate regimes. 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 Couharde (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 paper adds to this literature by analyzing the Turkish real exchange rate from 1998 to 2011 which was fixed at the start of the sample period and following the 2001 crisis shifted to a floating regime. Thus, our analysis of the Turkish case 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 (1998a) procedure. We find three structural regimes and examine trends in the lira during these regimes. The first regime covers the fixed exchange rate regime period before Turkey switched to a floating regime. The fixed exchange rate regime (pre-crisis period) was marked by a consistently high level of overvaluation in the lira. After the shift to a floating regime overvaluation has not been the chief concern with the lira. More recently, Turkey faces a significantly volatile lira which shows that the shift to a flexible regime has not been altogether positive.

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.

2. 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

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

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.

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. For example, since 2003, Turkey's exports have grown by 14%.[7] Also, the ratio of short term inflows to the deficit improved and there was an increase in both foreign direct investment as well as long term capital flows.[8] This led to an increase in Turkey's foreign reserves in the 2000s. However, the overall current account deficit has continued to mount and sharply deteriorates from 2004 onwards (figure 1). This is partly due to Turkey's export structure which is dependent on imports.[9] Kayıkçı (2012) concludes that the "path of unsustainable foreign trade becomes more dangerous after 2000." 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.

As noted earlier, appreciation does not necessarily indicate an overvalued currency. Changed conditions have an effect on the equilibrium real exchange rate which may necessitate an appreciation. To carefully explore the concerns with the lira, we first determine the equilibrium exchange rate and then compare it with the actual real exchange rate. We present the theoretical and empirical framework for equilibrium real exchange rate determination in the next section.

3. METHODOLOGY

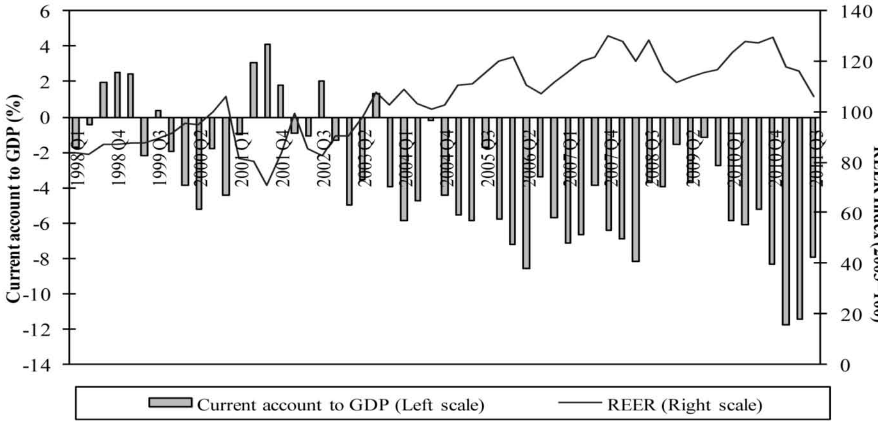
We use Edwards's (1989) theoretical framework and cointegration and the vector error correction model (VECM) to estimate the equilibrium real exchange rate for Turkey which is discussed in the following sub-sections.

7 . Compound annual growth rate (CAGR), Turkstat.

8 . Central Bank of Turkey several reports.

9 . Yükseler and Türkan (2008) show that the share of imports in the manufacturing sector in Turkey is increasing in the 2000s. Given that Turkey's exports are mostly manufacturing (over 90% for 2009-2011, Central Bank of Turkey database) this indicates the strong dependence of exports on imports. Also net energy imports make a significant part of Turkey's imports the cost of which was exacerbated in 2000s due to both strong GDP growth in the country (a CAGR of 5.2% between 2004 and 2007 and 4.2% between 2007 and 2011) and high global oil prices.

Figure 1 – Turkish current account to GDP and real effective exchange rate index [1998:Q1 TO 2011:Q3]



Source: Central Bank of Turkey.

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 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 2003. An increase in the index indicates an appreciation.

3.1. Theoretical framework

In Edwards's (1989) model the real exchange rate is defined as the ratio of the prices of traded to nontraded goods where the former is the weighted average of the price exports and imports.[10] The model shows that the real exchange rate is affected by both real and nominal factors, but only the former impacts the equilibrium real exchange rate. Edwards (1989) assumes an economy with three goods (exports, imports and nontraded goods), a dual exchange rate system[11] (fixed for trade transactions and floating for financial transactions) and a demand for holding both domestic and foreign money. Edwards's (1989) model provides equations (not reproduced here) on portfolio composition, demand and supply of traded and nontraded goods, government sector and external sector to characterize decision-making in the economy. Under steady state conditions (the nontraded goods market must clear, fiscal policy must be sustainable and there must be portfolio and external sector equilibrium) the real exchange rate is an equilibrium rate.

Based on the solution to the model, the equilibrium real exchange rate is determined to be a function of real or fundamental variables including tariff rates, terms of trade, capital flows and government consumption of nontradables. However, Edwards (1989) acknowledges that the model has simplifying assumptions which leave out important factors such as investment

10 . The model was extended by Elbadawi (1994) who uses the inverse of Edwards's (1989) definition of the real exchange rate. Thus, in his work, the real exchange rate is the relative price of nontradables to tradables. While, this changes the signs, it does not alter the theoretical relationship between the variables and the real exchange rate.

11 . Edwards (1989) includes a dual exchange rate system to capture a parallel market that exists in developing countries.

and technological progress. Also, Elbadawi (1994) replaces tariff rates with a variable for openness which he argues can take into account "implicit" trade restrictions (such as quotas and exchange rate controls) as well as the more explicit tariff rate. Moreover, data is more easily available for openness than for tariff rates. Based on the above, the determinants of the equilibrium real exchange rate are given as,

$$e_t^{*} = f\left(tot_t,\ open_t,\ gcons_t,\ inv_t,\ kflows_t,\ tech_t\right) \quad (1)$$

where e^* is the equilibrium real exchange rate, *tot* is terms of trade, *open* is openness, *gcons* is government consumption, *inv is* investment, *kflows* is capital flows and *tech* is technological progress.

There is a theoretically ambiguous relation between the exchange rate and all the fundamental variables. However, it is generally expected that a more closed economy, higher capital flows and technological progress will lead to a real exchange rate appreciation (Edwards, 1989). A closed economy would lead to a substitution towards nontraded goods and thus lead to an increase in their price and in turn result in a real exchange rate appreciation.[12] Higher levels of capital flows imply greater total assets, which increases general demand. Therefore the price of nontraded goods increases, which results in an appreciation of the real exchange rate. Likewise, technological progress is associated with a real exchange rate appreciation (the Balassa-Samuelson effect). As noted by Atasoy and Saxena (2006), higher productivity growth in the traded goods sector increases demand and wages in that sector which leads to a trade surplus requiring an appreciation to reach equilibrium.

The relationship is not as straightforward in the case of other variables. A worsening of the terms of trade could lead to an appreciation or depreciation depending on the relative magnitude of income and substitution effects. If a terms of trade deterioration leads to a shift in demand toward nontraded goods it would lead to an increase in the price of nontraded goods and thus causes an exchange rate appreciation. However, a terms of trade deterioration could also reduce demand because of the income effect which could lead to an exchange rate depreciation.

If increased government consumption is focused on the nontraded goods sector there will be an increase in the price of nontraded goods and thus a real exchange rate appreciation. However, if government consumption is geared towards traded goods, the opposite result is expected.[13] Finally higher levels of investment could lead to increased general demand (similar to capital flows) which could raise the price of nontraded goods and thus result in an appreciation of the real exchange rate. However, as Atasoy and Saxena (2006) note, there could be a "supply-side" effect which reduces prices in affected sectors. If that includes the nontraded goods sector, it would result in a real exchange rate depreciation.

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

12 . While we do not use the same variable as Edwards (1989), the implication for a closed economy is consistent with our measure (openness).
13 . Edwards's (1989) model explicitly uses government consumption on nontraded goods and thus the variable is expected to lead to a real exchange rate appreciation. However, as Edwards (1989) does, our estimation uses government consumption as a proxy and thus, the expected relation becomes ambiguous depending on whether government consumption is directed at traded or nontraded goods.

3.2. Econometric methodology

To estimate the equilibrium real exchange rate we need an Equation that maps real exchange rate behavior. The following is a modified version of Edwards's (1989) Equation for mapping exchange rate dynamics.[14]

$$\Delta \ln e_t = \theta \left[\ln e_t^{¿} - \ln e_{t-1} \right] + \lambda \left[Z_t - Z_t^{¿} \right] + \gamma \; derr_t + \varepsilon_t \qquad (2)$$

where Z and Z^* are indices for actual and sustainable macroeconomic policies, *derr* is a dummy variable that takes on a value equal to 1 after the shift to a floating exchange rate regime (and all other variables are as previously defined).

The first term on the right hand side of Equation (2) captures the deviation between the equilibrium and actual real exchange rate. While the former is not observable, it can be estimated using the determinants noted in Equation (1). The second term captures unsustainable macroeconomic policies such as excess domestic credit which is expected to lead to an appreciating real exchange rate. The last term captures the impact of the exchange rate regime on changes in the real exchange rate where a floating regime is expected to lead to depreciation.

The equilibrium real exchange rate can be estimated using cointegration and VECM methodology.[15] First, the real exchange rate and fundamental variables are tested for nonstationarity. We use several unit root tests including Augmented Dickey Fuller (ADF), Phillips-Perron, Kwiatkowski, Phillips, Schmidt and Shin (KPSS) and Lee and Strazicich (2003) tests. If the series under study are nonstationary in levels and stationary in first differences, then the Johansen cointegration test can be used. If we find evidence of cointegration we estimate the VECM. As noted by Dreger and Wolters (2010) the standard ML estimator does not perform well in small samples and thus we follow Brüggemann and Lütkepohl (2006) and use the simple two-step (S2S) estimator. Since we have exogenous parameters, we use the two-stage estimation procedure with S2S in the first stage and GLS in the second stage.[16]

If cointegration is found the coefficients of the cointegrated (permanent) 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 VECM results 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.[17]

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14 . Edwards's (1989) Equation includes a term for the spread in the parallel market for foreign exchange. This is left out in our analysis because of lack of data. We also leave out the nominal devaluation term since we use a different definition of the real exchange rate. Finally, we include a variable to capture the shift to a floating regime which is not part of the original model.

15 . When using time series analysis there is concern of lack of consistency of exchange rate misalignment. Although the estimation is a time series analysis, our equilibrium exchange rate is obtained from a structural model for determining fundamental exchange rates. Also, Bénassy-Quéré, Lahrèche-Révil and Mignon (2011) investigate consistency of exchange rates based on 15 countries, including Turkey. They show that in general, taking world consistency into account can change the estimated real effective exchange rates. However, their analysis for Turkey, which covers the period from 1980 to 2004 shows that in this period, results are not significantly affected whether one incorporates world consistency of exchange rates into the model or not.

16 . See Lütkepohl and Krätzig (2005) for a full description of the estimation procedures.

17 . We use EVIEWS version 6, JMulTi, version 4.24 and WinRATS version 7.1 for our estimation.

4. EQUILIBRIUM REAL EXCHANGE RATE ESTIMATION

The variables used to estimate the equilibrium real exchange rate for Turkey based on Equation (1) are described in Table 1.

Table 1 – Data and series construction

Variable	Data construction	Data series
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
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)	$\ln\left(\frac{RGDP_t}{TPRGDP_{t-1}}\right)$	*RGDP* – real gross domestic product *TPRGDP* – real gross domestic product for Turkey's major trading partners (base year = 2003)
Domestic credit growth (excr)	$\Delta\ln(DC)_t - \Delta\ln(GDP)_{t-1}$	*DC* – domestic credit *GDP* – gross domestic product

In addition, we add a dummy variable, *derr*, to capture the change in the exchange rate regime after the 2001 crisis. We use quarterly data from 1998:Q1 to 2011:Q3. All data is available from Central Bank of Turkey except for GDP for Turkey's trading partners which is available from International Financial Statistics database. All series are seasonally adjusted using the X11 additive method.

The first task is to test if the series used to estimate the equilibrium real exchange rate are I(1). From the unit root test results reported in Tables 2A and 2B, we see that for some of the series we do not get clear cut conclusions from all our tests. Among the more troubling results are for the series, *inv, tech* and *kflows*. Some tests show the series to be I(0) while others show them to be I(2).[18] However for at least two of the tests we find each series to be I(1). Also, based on support in the literature, we conclude that these variables are nonstationary in levels and stationary in first differences. Based on that, we proceed to test for cointegration using the Johansen test.

18 . One reason for the problematical results is the small sample size. We recognize this as a limitation to our empirical analysis.

Table 2A – Unit root tests

	ADF		Phillips-Perron		KPSS	
	μ	μ,τ	μ	μ,τ	μ	μ,τ
reer	-2.02 [0]	-2.75 [0]	-2.00 (1)	-2.84 (1)	0.85* (5)	0.13** (4)
Δ*reer*	-5.67* [3]	-5.69* [5]	-8.24* (5)	-8.23* (5)	0.12 (4)	0.08 (5)
tot	-3.16* [4]	-3.38**[1]	-1.47 (2)	-2.01 (0)	0.75* (5)	0.11*** (5)
Δ*tot*	-	-	-4.51* (5)	-4.45* (5)	0.04 (2)	0.05 (2)
open	-2.10 [5]	-2.83 [5]	-1.03 (5)	-3.01*** (2)	0.76* (5)	0.15* (4)
Δ*open*	-3.49* [4]	-3.52* [4]	-7.03* (10)	-	0.11 (7)	0.08 (7)
inv	-2.53 [5]	-2.39 [5]	-4.60* (1)	-2.47 (1)	0.83* (5)	0.21* (5)
Δ*inv*	-0.98 [0]	-2.12 [0]	-	-4.39* (1)	0.61* (1)	0.13** (2)
tech	-2.99* [1]	-1.24 [1]	-2.92** (2)	-1.02 (1)	0.66* (6)	0.24* (5)
Δ*tech*	-	-6.83* [0]	-	-6.83* (0)	0.60* (6)	0.09 (3)
kflows	-3.94* [0]	-4.45* (0)	3.93* (4)	-4.45* (0)	0.52* (4)	0.12** (3)
Δ *kflows*	-	-	-	-	0.05 (3)	0.04 (3)
gcons	-2.13 [1]	-4.00* [0]	-1.96 (3)	-3.88* (1)	0.82* (5)	0.12** (4)
Δ *gcons*	-10.51* [0]	-	10.98* (3)	-	0.12 (13)	0.05 (3)

Notes: *, ** and *** indicate statistical significance at 5%, 10% and 15% respectively. All tests are conducted assuming a constant (μ) and a constant and a trend (μ, τ). The null hypothesis for ADF and PP tests is that the series is nonstationary and for the KPSS test is that the series is stationary. Numbers in square brackets following the ADF correspond to lags where maximum lags were set at 7 and lag length was determined by AIC. For the PP and KPSS tests, the numbers in brackets correspond to lag truncation determined by Newey-West criteria and Schwert formula respectively.

Table 2B – Unit root tests

	Lee-Strazicich			
	μ	T_B	μ,τ	T_B
reer	-2.27 [0]	2001:04	-3.56 [0]	2002:04
Δ*reer*	-7.03* [0]	2001:04	-5.95* [3]	2001:03
tot	-2.74 [1]	2002:04	-4.45 [1]	2002:04
Δ*tot*	-5.15* [0]	2004:03	-5.70* [1]	2001:03
open	-2.94 [3]	2010:03	-4.57* [2]	2001:1
Δ*open*	-7.73* [2]	2009:03	-	-
inv	-1.16 [4]	2004:01	-3.54 [4]	2003:01
Δ*inv*	-2.08 [4]	2003:03	-5.42* [4]	2002:04
tech	-1.13 [5]	2004:02	-3.85 [2]	2002:04
Δ*tech*	-6.28* [3]	2003:03	-7.09* [3]	2003:04
kflows	-4.27* [0]	2003:04	-4.47 [0]	2004:01
Δ *kflows*	-	-	-8.16* [0]	2008:03
gcons	-3.46 [4]	2004:02	-4.32 [4]	2000:04
Δ *gcons*	-1.92 [4]	2001:02	-5.85* [6]	2008:02

Notes: * indicates statistical significance at the 5%. T_B is the date of the estimated break. The critical value for the Lee-Strazicich test statistic for a break in the intercept only is -3.566. The critical values for a break in the intercept and trend are -4.50, -4.47, -4.45, -4.50 and -4.51 for λ equal to 0.1, 0.2, 0.3, 0.4, and 0.5 respectively where $\lambda = T_B / T$ The null hypothesis is that the series is nonstationary. Numbers in square brackets correspond to lags. Maximum lags were set at 7 and lag length is determined by sequential elimination.

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 3. We find evidence of one cointegrating relation and can thus use VECM estimation.

Table 3 – Johansen cointegration test results

No. of CE(s)	Adjusted trace value	Adjusted eigenvalue
None	133.68*	48.43*
At most 1	85.25	35.97

Notes: * denotes rejection of the null of no cointegration at 5% 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 – pk)/T* where T is the sample size, p is the number of variables and k is the number of lags.

Table 4 – VECtor error correction model results

Variable	Coefficient	SE
tot	1.900*	(0.434)
open	0.348	(0.288)
inv	-0.952*	(0.117)
gcons	-0.780*	(0.261)
kflows	0.004*	(0.001)
tech	11.631*	(1.092)
Constant	-9.716	
coint equation	-0.189*	(0.096)
constant (VAR)	-1.735	
derr	-0.008	(0.011)
excr	0.059	(0.199)

Notes: * indicates statistical significance at 5% level of significance. We use two-stage estimation with S2S in the first stage and GLS in the second stage. Computations are performed using JMulTi v. 4.24. See Lütkepohl and Kr tzig (2005) for a full description of the estimation techniques in JMulTi.

VECM results are reported in Table 4. As expected, increased capital flows and technological progress have a statistically significant positive relationship with the exchange rate which means that rising capital flows and technological progress are associated with an appreciation of the lira. Contrary to expectations we find increased openness associated with an appreciation of the exchange rate. While the relationship is theoretically ambiguous (Edwards, 1989) the general consensus (as noted earlier) is that increased openness is associated with a depreciation of the real exchange rate. Our findings contradict the expected results which suggests that increased openness has not led to a decline in demand (and thus price) of nontraded goods. However, since the variable is not statistically significant at usual levels of significance we do not conclude that increased openness leads to a lira appreciation.

We also find a statistically significant positive relation between the exchange rate and terms of trade. As discussed earlier, terms of trade has a theoretically ambiguous relationship. Our results (contrary to Edwards, 1989 and others) show that an improvement in the terms of trade results in a real exchange rate appreciation. This implies that for Turkey in this period, the income effect of a terms of trade improvement dominates over the substitution effect. An increase in investment and government consumption is associated with a statistically significant depreciation of the exchange rate. This indicates that increased investment and government consumption are geared towards traded goods.

Expectedly, we find that a shift in the exchange rate regime is associated with a depreciation of the currency. Also, excess domestic credit is positively related to the exchange rate. This indicates that unsustainable monetary policy leads to a real exchange rate appreciation. These two variables are not statistically significant at usual levels of significance.

Table 5 reports the error correction term coefficient for our estimation as well as those estimated by others for several countries including Turkey. Our error correction term coefficient falls within the estimates seen in the literature. Following Mathisen (2003) we use this coefficient to compute the speed of adjustment and find that 50% of the deviation in the Turkish real effective exchange rate can be eliminated in approximately 5 quarters. This is twice the amount of time for eliminating exchange rate deviation compared with Alper and Saglam (2000). Our results vary significantly from those of Atasoy and Saxena (2006) where a much longer adjustment is necessary.

Table 5 – Error correction term coefficients

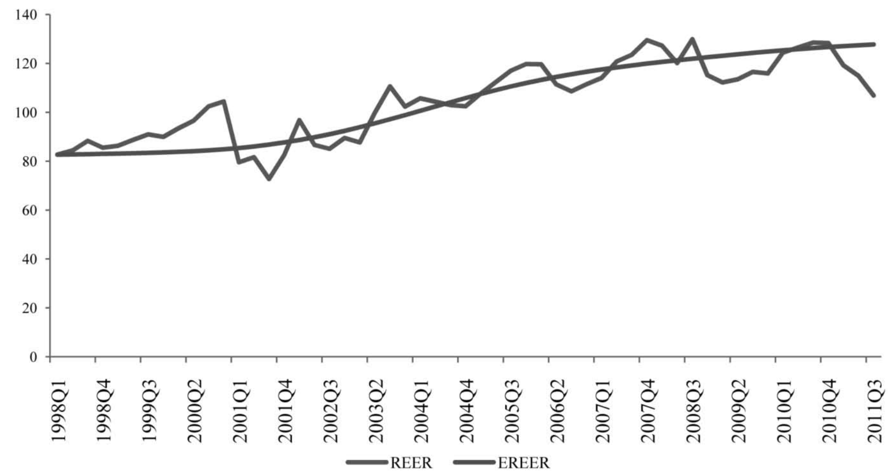
Country	Coefficient	Source
Brazil	-0.460#	Paiva (2006)
Ghana	-0.141	Iossifov and Loukoianova (2007)
Malawi	-0.270	Mathisen (2003)
Namibia	-0.399	Eita and Sichei (2006)
South Africa	-0.080	MacDonald and Ricci (2003)
Turkey	-0.390	Alper and Saglam (2000)
Turkey	-0.027#	Atasoy and Saxena (2006)
Venezuela	-0.243	Zalduendo (2006)
Zambia	-0.800#	Mkenda (2001)
Our results	**-0.189**	

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. # Paiva (2006), Atasoy and Saxena (2006) and Mkenda (2001) estimate several models. We report results of a representative model.

Using our VECM results 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 of our fundamental variables. We use this to compute the equilibrium real exchange rate. The actual and equilibrium real exchange rates are plotted in Figure 2.

From Figure 2 we see that the equilibrium real exchange rate is increasing over the period. This indicates that the fundamentals in the economy require the exchange rate to appreciate. There appears to be a shift in the trajectory of the equilibrium real effective exchange rate since 2001 which likely captures the shift to a floating regime. Overall the actual real effective exchange rate is also on an upward trend although there is much more volatility in this series. REER is above equilibrium levels prior to the 2001 crisis which indicates an overvaluation. The next couple of years show undervaluation of the exchange rate reflecting the adjustments taking place as the lira shifted to a floating regime. Transitions of this sort are generally associated with depreciations and in the lira's case it also represents an undervaluation. There is significant volatility in mid-2000s with overvaluation once again becoming a concern. The trend in the real effective exchange rate is likely linked to the global financial crisis. We analyze real exchange rate misalignment more thoroughly in the next section.

Figure 2 – Actual and equilibrium REER [1998 to 2011]



Source: Central Bank of Turkey database and authors' computation.

5. Real exchange rate misalignment

From the estimates of the equilibrium real exchange rate, we can compute misalignment as:

$$Misalignment = \frac{Actual\ REER - Equilibrium\ REER}{Equilibrium\ REER} \tag{3}$$

We test for a structural break in the misalignment series. Testing and identifying structural breaks allows us to more carefully examine misalignment in the real exchange rate under different conditions (including different exchange rate regimes). We use the Bai and Perron (1998a) procedure to test for structural breaks. Bai and Perron (1998a) develop Wald type tests which allow testing for multiple structural breaks in linear regression models against the alternative of no change. Their procedure tests for m structural breaks which indicate $m + 1$ structural regimes. Bai and Perron (1998b, 2003) provide empirical applications and the procedure has also been used for examining structural breaks in U.S. inflation by Jouini and Boutahar (2003) and Hoarau, Ahamada and Nurbel (2007) for the Australian exchange rate. We apply their methodology to our misalignment series.[19] If there are b breaks and b+1 regimes and assuming misalignment is denoted as mt we get the following:

$$\begin{aligned} m_t &= \delta_1 + \beta\ m_{t-1} + u_t \quad t = 1, \ldots T_1 \\ m_t &= \delta_2 + \beta\ m_{t-1} + u_t \quad t = T_1 + 1, \ldots T_2 \\ &\vdots \\ m_t &= \delta_{b+1} + \beta\ m_{t-1} + u_t \quad t = T_b + 1, \ldots T_2 \end{aligned} \tag{4}$$

where ä$_j$ $(j=1, \ldots b+1)$ is the average misalignment in the j^{th} regime and u_t is a classical error term. The procedure involves estimating least squares regressions for all possible partitions and choosing the model that gives the best fit by applying the sup$F_T(b+1|b)$ test.[20]

We find two structural breaks, 2000:Q4 and 2003:Q2 which give us three structural regimes. These regimes correspond to the three stages of exchange rate transition described for Poland, Czech Republic, Slovakia and Hungary by Josifidis et al. (2009) namely, nominal anchor, intermediate regime and free/floating regime. Descriptive statistics of the three regimes are provided in Table 6.

The first regime, when the lira was fixed is the period prior to the crisis. Notably, in this period the real exchange rate was overvalued for the entire period (TABLE 6).[21] Similar to Atasoy and Saxena (2006) we find significant overvaluation of the lira prior to the 2001 crisis. In the four quarters of 2000, on average the lira was overvalued by approximately 18%. These levels of misalignment have not been seen in Turkey for any other period including 2011 when Turkey experienced high levels of undervaluation (average of 11% for the three quarters in the year).

The second regime covers the crisis. Following the crisis, the lira began floating and this regime captures the adjustment in the lira taking place in that period. In general a floating currency experiences depreciation and in Turkey's case was also correcting for significant overvaluation in the lira. There is some evidence that the "correction" in the lira overshoots so that the depreciation led to undervaluation of the lira in that period. This undervaluation lasts for most of the time in the second regime (with only one quarter, 2002:Q1, of significant

19 . This procedure is applicable to small samples likes ours. Bai and Perron (2003) apply this procedure to UK CPI inflation for a small sample (1947-1987) and show that the procedure is applicable to small samples.
20 . See Bai and Perron (1998a) for details.
21 . Note: a positive misalignment corresponds to an overvaluation and a negative misalignment to an undervaluation of the exchange rate.

overvaluation). Similar to the second regime, there is a "correction" of misalignment. However, this regime differs from the earlier one because there are episodes of both, over- and under-valuation of the lira. Misalignment ranges from -16.41% to 14.06% (Table 6) and averages to only -0.31%.

Table 6 – Volatility of exchange rate misalignment

	Regime 1 [1998:1 – 2000:3]	Regime 2 [2000:4 – 2003:1]	Regime 3 [2003:2 – 2011:3]
Range (%)	2.01 to 21.38	-16.36 to 23.22	-16.41 to 14.06
Average (%)	8.63	-2.20	-0.31
Standard Deviation (%)	5.94	10.88	6.31
Adj. Coefficient of Variation	0.69	4.97	20.50
Normality (*Jarque-Bera* p-value)	0.45	0.17	0.84

Notes: Using the Bai and Perron (1998a) procedure we find two structural break points in the misalignment series and thus three structural regimes noted above. The coefficient of variation is the standard deviation divided by the absolute value of average misalignment (multiplied by $\left(1+\frac{1}{4n}\right)$ to adjust for a small sample). The null hypothesis for the Jarque-Bera test is that the series is normally distributed.

From Figure 2 it is clear that overvaluation was a major problem when the lira was fixed. The shift to a floating regime however raises the fear of volatility. This might also impact trade and current account deficits. Table 6 also reports the coefficient of variation in exchange rate misalignment which measures volatility in the series. In addition, the Jarque-bera test results (ALSO PRESENTED IN TABLE 6) show that the null hypothesis of normality cannot be rejected for the three regimes.

The lowest level of volatility is observed in the first period. As expected the level of volatility is higher in the second (crisis) period (compared with the first). The standard deviation of the second regime is higher than that in the third regime (10.88 and 6.31 respectively from Table 6). However, the coefficient of variation is significantly higher in the last regime since the episodes of over- and under- valuation cause misalignment to cancel out and result in a low average misalignment.

The coefficient of variation results show that the third period is highly volatile. This could at least partially be attributed to the 2008 global financial crisis which impacted exchange rates in all of Turkey's major trading partners. It is thus no wonder that the real effective exchange rate index has experienced such significant instability. However, this instability coefficient is also capturing the trend seen in floating exchange rate regimes where the misalignment in the lira is being "corrected".

6. Conclusion

This paper aims to analyze misalignment of the Turkish lira over different exchange rate regimes. Using quarterly data from 1998 to 2011 we employ Edwards's (1989) theoretical framework and cointegration and VECM 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 (1998a) procedure and find two breaks which indicate three structural regimes. We analyze misalignment in these three regimes and confirm for the Turkish case that overvaluation of the currency is a significant concern during a fixed exchange rate regime while shifting to a floating regime increases instability.

Comparing the real exchange rate misalignment to current account deficits in these regimes shows that overvaluation was a factor in deteriorating current account deficits in the first regime (which had a fixed exchange rate). There has been considerable concern regarding an overvalued lira in since the mid-2000s when the lira has been appreciating and Turkey has witnessed rising current account deficits. However, our results show that while the lira was overvalued in some quarters during this period rising current account deficits also coincide with an undervalued lira.

Thus, as problematical as an overvalued lira might be (and has been) the bigger concern today appears to be an unstable lira. Volatility makes the lira an unpredictable signal for investment in the traded goods sector. Given the movement from undervalued to overvalued and back in the last regime, it is likely that investment in the traded sector is likewise volatile. This might explain Kayıkçı's (2012) conclusion about Turkey's unsustainable trade path. Thus, while an overvalued lira contributed to unsustainable current account deficits in the fixed regime, we conclude that more recently, volatility is exacerbating trade and current account deficits.

The choice between fixed and flexible appears to have been settled in favor of the latter. With most of the crises (the global 2008 crisis and eurozone crisis notwithstanding) related to countries with fixed exchange rate regimes, this conclusion makes sense. However, as our paper shows a floating regime comes with its own set of problems. Firstly, as expected misalignment is not eliminated with a switch in regimes. Moreover, volatility becomes a significant problem. High volatility is not necessarily a signal of problems because after all, the point of a flexible regime is to make corrections to the exchange rate to reach equilibrium. However, this increased volatility can lead to uncertainty in investment and diminish the potential benefits of the flexible regime as might be happening in Turkey. After the global crisis in 2008-2009 we have started to see central banks extend their policy framework to include financial stability (aside from price stability). As this implies stronger efforts to control volatility in local markets (foreign exchange being a primary one) we welcome this change in monetary policy for Turkey.

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