

## INVESTIGATION OF LONG-RUN REAL EXCHANGE RATES: THE CASE OF TURKEY

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### ABSTRACT

In this study movement of Turkey's long-run real exchange rates are investigated within the alternative theoretical framework developed by Anwar Shaikh. The basic hypothesis in this model is that, the long run real exchange rates move in such a direction to equalize profit rates, rather than price levels among trading nations which empirically necessitates establishing a cointegration relation among long run real exchange rates, real unit labor cost ratios and real interest rate differentials. Empirical results of this application for the quarterly data of Turkey and her main trade partners spanning from 1970 to 2004 are quite satisfactory.

**Keywords:** Real Effective Exchange Rates, Real Unit Labor Costs, Real Interest Rate Difference, Equalization of Profit Rates.

### ÖZET

Bu çalışmada Türkiye'nin uzun dönem reel döviz kurlarının hareketi Anwar Shaikh tarafından geliştirilmiş olan alternatif teorik çerçeve içinde incelenmiştir. Ampirik olarak; uzun dönem reel döviz kurları, reel birim emek maliyet rasyoları ve reel faiz oranları arasında kointegrasyon ilişkisinin kurulmasını gerektiren bu modelin temel hipotezi, uzun dönem reel döviz kurlarının ticaret yapan ülkeler arasında fiyat düzeylerinden ziyade kar oranlarını eşitleyecek yönde hareket ettiğidir. Türkiye'nin 1970' den 2004'e uzanan çeyrek dönemlik verileri için yapılmış olan bu uygulamanın ampirik sonuçları oldukça tatmin edicidir.

**Anahtar Kelimeler:** Reel Efektif Döviz Kurları, Reel Birim Emek Maliyetleri, Reel Faiz Oranı Farkı, Kar Oranlarının Eşitlenmesi.

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## INTRODUCTION

Since the collapse of the Bretton-Woods System in 1973, there has been an exponential interest in the determination of exchange rates, almost all of which are based on Ricardo's trade theory and its extensions, claiming that even if there is an absolute cost advantage/disadvantage among nations, it will turn into the comparative one in the long run. The orthodox version of the QTM is a complementary part of these models, according to which prices are determined by the exchange of goods in the market instead of being an outcome of the cost of production. A closer examination of the models in the literature would also reveal that the LOP (law of one price) developed by Gustav Cassel in 1916, is one of the important components of these models, which states that, ignoring the transportation costs and official barriers to trade, identical tradable goods in different countries must be sold for the same price when their prices are expressed in terms of the same currency.

All of these components provide a consistent theoretical ground to show that, even if there is an absolute cost advantage/disadvantage in the production of tradable goods, this will turn into the comparative one, which eventually makes all nations equally competitive. Thus, while the real exchange rates are being determined, the trade imbalances will simultaneously be eliminated through this mechanism. Although there has been an extensive literature about the exchange rate determination within this theoretical ground during the last three decades, orthodox economists have expressed an increasing disappointment over their failure to explain the exchange rate movements. Empirical results of mainstream applications to the data of Turkey showed that these models are insufficient to explain the determination of long run real exchange rates in Turkey. For example Yıldırım (2003), Mohsen (1998) and Erlat (2003) tested the validity of PPP for Turkey and rejected the relationship between the PPP and the exchange rates. In addition, Aynur Yıldırım (2007) examined the B-S hypothesis, which is a modified version of the PPP approach, for Turkey, Germany, France, UK and USA and the empirical results showed that the B-S

hypothesis is invalid. Although Yamak and Korkmaz (2007), Mohsen Bahmani - Oskooee and Orhan Kara (2000) found the relationship between the persistent monetary expansion and exchange rates in Turkey, these findings are not sufficient to support the M-M.

Nevertheless there has been a pretentious approach developed by Anwar Shaikh (1980, 1991 and 1995) as an alternative theoretical model to the ones prevailing in the literature. Shaikh demonstrated, in his studies, that the long run real exchange rates move in such a direction to equalize profit rates, rather than price levels among trading nations. This approach finds its roots in the Marxian theory. In contrast with the neo-classical theory and the Ricardian trade theory, the Marxist theory implies that international relative prices are determined by the appropriate relative real costs of production (Shaikh, 2002: 3). Thus, instead of the comparative one, international trade is regulated by absolute costs and the price mechanism cannot adjust international relative prices to ensure the trade balance among nations. Consequently trade imbalances are neither the anomalies of a competitively functioning international world market system, nor are they temporary.

The findings of the empirical studies, performed by Shaikh (1998) for the data of the USA and Japan, by Roman (1997) for the data of Spain and by Antonopoulos (1997, 1999) for the data of Greece and her trading partners, showed that this model provides a sufficient theoretical and empirical framework for the explanation of movements in real exchange rates in the long run. In this study Shaikh's model is presented and examined empirically for the case of Turkey. In section two, the alternative theoretical model is formed mathematically for the empirical application. In this section we concluded that under the absolute cost differences, free competition determines the long run real exchange rate to ensure that some nations have persistent trade deficits while others have persistent trade surpluses. Furthermore this process of real exchange rate determination is not provided through the LOP and its special version of PPP, but it is provided by the mechanism of profit rate equalization among trading nations. The empirical hypothesis of our alternate model is that, the long run real effective exchange rates are determined

by the ratio of vertically integrated real unit labor costs of tradable goods of trading partners. This hypothesis necessitates empirically a cointegration relation among long run real exchange rates, real unit labor cost ratios and real interest rate differences. Therefore in section three we applied unit root tests, cointegration and ECM (Error Correction Mechanism) test techniques in order to investigate the relationship between long run real effective exchange rates, real unit labor cost ratios and real interest rate difference among Turkey and her main trading partners. In order to investigate the theoretical hypothesis under consideration for the case of Turkey, we applied unit root tests, cointegration and error correction techniques to the quarterly data of Turkey and her main trade partners spanning from 1970 to 2004. The empirical results we obtained in this section appeared highly significant and consistent with our theoretical statements.

### I. THEORETICAL PRESENTATION OF THE MODEL

In our model we do not reject that for identical goods, putting aside the transportation costs and trade barriers, international common currency prices are roughly equal to each other. But this equalization does not appear within the mechanism which Ricardo presented. Instead of that, LCP (Law of Corresponding Prices) takes the role to equalize the common currency price level within the same sector on an international scale. More specifically in the determination process of long-run real exchange rates leading dynamic is the profit rate equalization instead of price level equalization, in international trade across international regulating capitals (Shaikh,1999:10).

In the international case, the most important supposition is that while capital is fairly mobile in search of higher returns, labor is not mobile across nations. Thus the mobility of capital provides the profit rate equalization at least in the long run; immobility of labor causes a more significant and persistent real wage differences among nations. We also assume that, technology differs across nations and this creates a continuous dynamic which lead persistent profit rate differentials among nations. Finally, devaluations are not sufficient for eliminating the trade imbalances in the long

run nor is there an automatic mechanism that provides a trade balance among nations.

The regulating capital in an industry has the lowest cost of production for that commodity and this preposition gives the opportunity to determine the market price for that commodity. We also know that, many producers are in action in that sector and these producers are only price takers except from the regulating capital. Thus due to the differences in the cost of production, these firms have various rates of profit in that sector, and although they have different rate of profits these non-regulating capitals are still in action because the rate of profit is still satisfactory for them. The distribution of capital (capital movements) among these sectors by new investments is hold in accordance with the level of profitability. It is therefore, safe to say that average profit rates need not be equalized because of technical conditions in that sector. Finally, the most advanced technology which is generally available for new investments forms the regulating conditions and dominance of the lowest cost of production and makes the producer an absolute cost advantage producer.

More specifically in Shaikh's model a country's competitive position is determined by the real unit costs of its tradable goods.<sup>2</sup> The Marxist theory states that, the cost of a good consists of dead labor costs and a living labor cost. In this way, the country's competitive position is determined by the vertically integrated real unit labor costs of its tradable goods and these real costs in turn will depend on productivity and real wages. Real exchange rates do indeed move parallel to real unit labor costs, over the long run. As long as the real exchange rate of a country follows the time path of its relative real unit costs, any increase and decrease in these variables over time will cause the real exchange rates to follow a time path which is generally non-stationary.

### A. THE MODEL

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<sup>2</sup> In regards to competition we mean real competition, in the sense of business competition, not "perfect" competition. Firms utilize strategy and tactics to gain and hold market share, and price cutting and cost reductions are major feature in this constant struggle.

In this model there are two countries, two different goods, two different production conditions, (in mainstream terms production functions) and two different real wages which differentiate across countries. The country which has a high capital/labor ratio also has a high productivity which brings about high real wages as well. In the long run, in both countries the key determinants of real wages are productivity, output growth, level of unemployment, and the bargaining power of the workers. In the short run nominal wages are assumed sticky. It is assumed that there is no market clearing real wages as a result the economy is not at the level of full-employment. According to the LCP, international common currency prices for identical goods fluctuate within a band, because of tariffs, taxes, and transportation costs. If the prices get out of this band the international competition pushes them into the band. The low cost producers (regulating capital) keep prices low in order to determine the market prices thus it is assumed that the common currency prices can be well approximated by the vertically integrated unit labor costs of the regulating capitals. LCP implies that prices of a given commodity are roughly equal across nations when expressed them in common currency. Thus the ratio of the average common currency prices of tradable goods between countries will roughly be equal to the ratio of the average regulating prices of the corresponding bundle (Shaikh, 1996:71).

In our study, we supposed the countries are Turkey and her main trading partners. Turkey and her trading partners, trade with each other with currencies (TL, TR<sub>CU</sub>) and the nominal exchange rate  $e = (TL/TR_{CU})$ . Hypothetically Turkey is regulating capital in consumer goods sector and TR (her trade partners) is in capital goods sector with corresponding prices. Let's

- $p_k$  = price of capital goods
- $p_e$  = price of consumer goods
- $a$  = (circulating) capital input
- $l$  = labor input
- $r$  = the rate of profit
- $w$  = money wage

$wr$  = real wage

Turkey has both regulating and non-regulating capitals (represented with the equations (1) and (2)) in the consumer goods sector. Prices are expressed in common currency for Turkey as below;

$$p_{cT} \cdot e = (p_{kT} \cdot e \cdot a_{cT} + p_{cT} \cdot e \cdot w_{r_{cT}} l_{cT}) \cdot (1+r_T) \quad (1)$$

$$p_{kT} \cdot e = (p_{kT} \cdot e \cdot a_{kT} + p_{cT} \cdot e \cdot w_{r_{kT}} l_{kT}) \cdot (1+r_T) \quad (2)$$

Also TR (trade partners) has both regulating and non-regulating capitals (represented with the equations (3) and (4)) in capital goods sector.

$$p_{cTR} = (p_{kTR} \cdot a_{cTR} + p_{cTR} \cdot w_{r_{cTR}} l_{cTR}) \cdot (1+r_{TR}) \quad (3)$$

$$p_{kTR} = (p_{kTR} \cdot a_{kTR} + p_{cTR} \cdot w_{r_{kTR}} l_{kTR}) \cdot (1+r_{TR}) \quad (4)$$

At the beginning of free trade, each country has its own regulating capitals, its own price level and its own profit rate, for both capital goods and consumption goods in common currency. But during free trade because of the different cost structure, Turkey will become an international regulating capital in the consumption goods and the TR will become an international regulating capital for capital goods. And each country will determine the prices of those goods, in both Turkey and TR. Although Turkey is regulating capital in consumption goods and TR is regulating capital for capital goods, there are still two different profit rates. Therefore no profit rates equalization has been materialized yet. In fact, while these two countries capitals are turning into regulating ones, not just price changes appear, simultaneously capital movements arise as well. Such as, while seizing the markets of each other, capitalists also increase the amount of fixed capital in that sector by introducing new technology investment goods. Hence, below the equation (5) is representing Turkey's international regulating capital in consumption goods and equation (6) representing TR's international regulating capital in capital goods with different profit rates and different prices.

$$p_{cT} \cdot e = (p_{kT} \cdot e \cdot a_{cT} + p_{cT} \cdot e \cdot w_{r_{cT}} l_{cT}) \cdot (1+r_T) \quad (5)$$

$$p_{kTR} = (p_{kTR} \cdot a_{kTR} + p_{cTR} \cdot w_{r_{kTR}} l_{kTR}) \cdot (1+r_{TR}) \quad (6)$$

Then for consumption goods regulating price is  $p_{cT}$ , and for capital goods regulating price is  $p_{kTR}$ . Thus

we should rewrite above equations with these two internationalized prices correspondingly;

$$p_{cT}.e = (p_{kTR}.a_{cT} + (p_{cT}.e).w_{r_{cT}}l_{cT}).(1+r_T) \quad (5')$$

$$p_{kTR} = (p_{kTR}.a_{kTR} + (p_{cT}.e).w_{r_{kTR}}l_{kTR}).(1+r_{TR}) \quad (6')$$

Let's rewrite these equations in terms of relative prices;

$$p_{cT}.e / p_{kTR} = (a_{cT} + (p_{cT}.e / p_{kTR}).w_{r_{cT}}l_{cT}).(1+r_T) \quad (7)$$

$$1 = (a_{kTR} + (p_{cT}.e / p_{kTR}).w_{r_{kTR}}l_{kTR}).(1+r_{TR}) \quad (8)$$

Now we have two equations with three variables,  $r_T$  (profit rate of Turkey's regulating capital),  $r_{TR}$  (profit rate of TR's regulating capital) and,  $\tau = p_{cT}.e / p_{kTR}$  (real exchange rate between Turkey and TR). But it is not possible to have two different profit rates forever, because of free trade and free capital movements (as foreign direct investments or short-term capital inflows) between these countries. As the movements of capital across countries enforce the common currency prices which equalize profit rates as  $r = r_T = r_{TR}$ , the equations above evolves into two variables and a two equation system. For this reason if we fix one of these two variables, we can find the other. Therefore, we can say that the ratio of common currency prices (real exchange rate) is roughly equal to the ratio of real wages among these countries.

$$[p_{cT}.e / p_{kTR} \approx (w_T / w_{TR})] \quad (9)$$

There is no reason to expect that when trade opens, it will already be balanced. Even if Turkey's representative regulating capital has similar conditions with the TR's representative regulating one, there are still many sectors which have different production conditions and this will eventually in the international case bring about the comparison of these two countries in terms of their national level of organic composition of capital. As we explained in the previous section the sector (now country) which has a higher organic composition of capital will be able to obtain the higher market share by competing with its rivals by price cuts. Moreover, because of the differences in the production conditions the average profit rates of Turkey and her trade partners are not equal to each other. Consequently most of Turkey's firms become non-regulating capitals

in the international area and some of them can survive with very low rates of profits. However, others which have negative profit rates will leave the international market in order to avoid negative profits. Thus if a country's organic composition of capital is lower than its trade partners, this country suffers high and persistent trade deficits.<sup>3</sup> Therefore, instead of the trade balance, the trade deficit occurs between that particular country and her trade partners.

Also the outflow of money due to an ongoing balance of trade deficit reduces liquidity at home and raises interest rates, thus attracting capital flows which would then counterbalance, rather than improve the trade balance. At the same time increases in the level of interest rates decreases investments in the trade deficit country so to decrease the level of output and deteriorates the trade balance further. Even if the real exchange rates did fall somewhat, and elasticity conditions are hold, the improvement in the trade balance is not limitless. A decrease in the real exchange rate internationally is the same as price cutting nationally and its limit is the profit rate. Finally, there is the inescapable empirical fact that international trade has generally not been balanced (Shaikh, 1999:13).

Consequently, we can conclude that real exchange rates are determined by the real unit labor cost ratios of trading countries. Also we should make an emphasis to the interest rate difference between countries. As because in the knowledge, that the interest rate is a proportion of national profit rates on new real investments, with the equalization of interest rates, also the average profit rates will be equalized at the same time among nations. Therefore we can include the real interest rate differences into our model as an explanatory variable especially in order to explain short run deviations of real exchange rates from real unit labor cost ratios. In addition, the real exchange rates and real interest rate differences affect not only the trade balance but also the dispersion of national profit rates.

<sup>3</sup> In addition the reason for the comparing Turkey and her trade partners as unique actors is not that we take these two actors in our perspective as homogenous societies. Instead our understanding necessitates, considering classes and comparing them each other. Because Turkey and her trade partners are class societies.

$$(1+r_T) = \tau / (a_c + \tau w_{r_c} l_c) \quad (10)$$

$$(1+r_{TR}) = 1 / (a_k + \tau w_{r_k} l_k) \quad (11)$$

According to the above equations a decline in real exchange rates in Turkey will reduce this country's realized national profit rates and increase realized profit rates in TR. Since negative profit rates are not sustainable, all feasible variations in the real exchange rate must be confined between the points defined by  $r_T, r_{TR} > 0$ , or perhaps by the even narrower range  $r_T - i_T, r_{TR} - i_{TR} > 0$  where  $i$  is the interest rate (Shaikh, 1999:10). This last point will be investigated in the next study as a value transfer mechanism among Turkey's working class and capitalist class with their international companions.

## II. EMPIRICAL TEST

In order to test the Shaikh's hypothesis for the case of Turkey and her trading partners<sup>4</sup> we will follow the path, Antonopoulos followed in her study for Greece and OECD (12) countries (Antonopoulos, 1997). Antonopoulos (1997) mentioned in her unpublished PhD dissertation that, there were two modifications for the original model, first one is the real unit labor cost ratio, and second one is interest rate differential as an ancillary explanatory variable of capital flows. The importance of the capital flows appear clearly in Shaikh's study (1999) in which the links between profit rate differentials and interest rate differentials explained among trading countries (Shaikh, 1999:10).<sup>5</sup> Therefore we will introduce the interest rate differential into our model as Shaikh (1999) did before.

In our investigation we will use the quarterly data of Turkey and her 9 main trading partners for the periods of 1970-2004. In spite of the fact that the representative power of the sample is directly connected to the share of Turkey's trade with each trade partner and

the quantity of trade partners, we had to set a limit to the quantity of trade partners in our sample because of the data availability problem. It is also clear that, those trading partners' share in Turkey's trade must be quite high in order to give sufficiently high explanatory power to the data in empirical sense. The shares of trade partners in Turkey's trade are derived yearly for the periods of 1970-2004 in order to increase the representative power of data set.

In TCMB's (Central Bank of Turkey) data source there are two different real effective exchange rates one is based on CPI for 19 main trade partners the other is based on WPI for 17 main trade partners. But the same shares of the trade partners are used for the entire data which available since 1982. Therefore as we expressed above, our preference was deriving a detailed share position for trade partners to compensate the smallness of our sample. The original model should be tested for each country's tradable goods because the international common currency prices and vertically integrated real unit labor costs are determined in the same league in the international area. But because of the data availability problem we used some specific variables of manufacturing sector as proxy of tradable goods sector. The details of these modifications will be explained in the data description section.

In order to test the hypothesis that the real effective exchange rates are determined by the real unit labor cost ratio of tradable goods between trading countries in the long run, the implicit functional relationship is derived as  $RXR = f(RULC, R)$ . This functional relationship is formed econometrically in the logarithmic form as,

$$LRXR_t = \beta_0 + \beta_1 LRULC + \beta_2 R + u_t \quad (12)$$

Where, LRXR stands for log of real effective exchange rate, LRULC is the log of real effective unit labor cost ratio and  $R$  is the interest rates difference (real interest rate of Turkey- real interest rate of trade partners) between Turkey and her trade partners.

### A. DATA DESCRIPTION AND SOURCES

1. RXR is the real exchange rate, and equal to the nominal exchange rate deflated by the related price

<sup>4</sup> Turkey's traditional and main trade partners are in this study Austria, Belgium, France, Germany, Netherlands, USA, UK, Italy, and Spain.

<sup>5</sup> The profit rate effect follows from the fact that any fall in country A's terms of trade would lower  $r_A$  and rises  $r_B$ . Since negative profit rates are unsustainable, all feasible variations in the real exchange rate must be confined between the points defined by  $r_A, r_B > 0$ , or perhaps by the even narrower range  $r_A - i_A, r_B - i_B > 0$ , where  $i$  is the interest rate (Shaikh, 1999:10).

index ratio of Turkey to the 9 TR (trade partners of Turkey).

$$RXR = (P_T/e) / P_{TR} = PPI_{TR} / (e \cdot PPI_T) \quad (13)$$

$$e = YTL \text{ per } TR_{CU} \quad (14)$$

In the process of the generating the real effective exchange rate series we first obtained nominal exchange rate series for each country as defined local currency per USD (United State Dollar). In order to express each country's price level of tradable goods in terms of USD we deflated individual price indexes which generated in terms of local currency (nominal prices), with each country's nominal exchange rate. So it is possible to express common currency price index of Turkey as  $PPI_T/(TL/USD)$ , and common currency price index of trade partners as  $PPI_{TR}/(P_{CU}/USD)$ . Therefore we derived these two ratios and divided the former by the latter to create an effective real exchange rate series.

The calculation method of the trade weighted geometric average of the related variables is shown in equation (15) and mathematical interpretation of this method is shown in equation (16) below:

$$RXR_{\text{trade weigh.}} = TW_{C1} [RXR_{C1}] + TW_{C2} [RXR_{C2}] + TW_{C3} [RXR_{C3}] + \dots \quad (15)$$

$$\text{Index}_{it} : 100 \exp \left( \sum w_i \log_e X_{rit} \right) \quad (16)$$

In the equations (14),(13) and (15), RXR denotes real effective exchange rate, e denotes nominal effective exchange rate,  $P_T$  and  $P_{TR}$  denote related price index of Turkey and trade partner of Turkey, PPI denotes producer price index, TR denotes trade partner, CU denotes national currency unit, TW denotes trade weight, C1, C2, etc. denotes trade partner countries. All trade partner country's series are weighted geometric averages of related variables. In the equation (16),  $w_i$  denotes the weight assigned to the RULC of each country,  $X_{rit}$  denotes RULC of each trade partner,  $\log_e$  is natural log and exp is anti log.

As we mentioned above there are two different real exchange rate series in the TCMB's statistical databank one is based on consumer price index and the other one is based on wholesale price index. But both of these series are prepared annually and available

since 1982, and it is impossible to obtain the part of the series from 1970 to 1982. As it is obvious, there are several methods for constructing the real exchange rate variable, we compared the series obtained from IMF, IFS and TCMB's (The Central Bank of Turkey). Especially for the effective real exchange rate, each data source uses its own definition and there are quite significant inconsistencies among them. Therefore instead of using short time series or relying on the data sources of IMF, IFS (International Financial Statistics), OECD and World Bank (WDI) and TCMB's (The Central Bank of Turkey), we constructed a new real effective exchange rate series according to the method described above. Nevertheless it was inevitability to obtain the raw data form IMF, IFS (International Financial Statistics) or OECD (Statistical Compendium) for constructing the real effective exchange rate for Turkey in accordance with the selected country group as trade partner. Although all inconsistencies among data sources, comparing our real effective exchange rate series with the OECD's one, we saw that they are quite similar with each other. All nominal exchange rate series are official and obtained from OECD (Statistical Compendium) data sources. The OECD's trade share based real effective exchange rate series as weighted average of main trade partners of Turkey and autor's trade share based real effective exchange rate series as weighted average of 9 main trade partners of Turkey.

2. Real unit labor cost ratio (RULC\*) is equal to the RULC of Turkey divided by the weighted geometric average of the trade partners' RULC.

$$RULC^* = RULC_T / RULC_{TR} \quad (17)$$

In the study of Shaikh & Antonopoulos (1998) nominal unit labor cost in manufacture, consumer price index, and producer price index are used according to the formula below RULC.

$$RULC = (ULC_{MFG}/CPI) \cdot (CPI/PPI) \quad (18)$$

Where, PPI denotes producer price index,  $ULC_{MFG}$  denotes unit labor cost in manufacture, and CPI denotes consumer price index. In our application considering the data availability, we used same definition of RULC. Thus the real effective unit labor cost ratio becomes,

$$RULC^* = (ULC_T/PPI_T) \cdot (PPI_{TR}/ULC_{TR}) \quad (19)$$

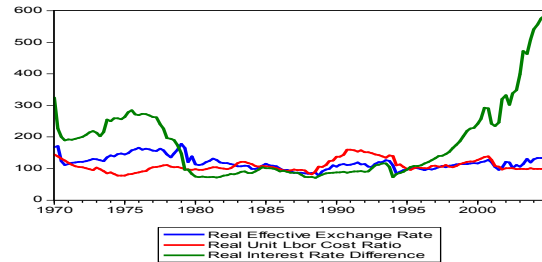
3. In the process of testing the model for Turkey and her trade partners we have a difficulty of constructing the capital inflow variable for Turkey. Therefore we decided to use interest rate differential between Turkey and her trade partners as a proxy of capital inflow data. Firstly we obtained the quarterly relevant interest rate series for each country from OECD Statistical Compendium. For some countries interest rate series were available only in the IMF (IFS (International Financial Statistics)) data source. Thus our additional source is IMF (IFS) data base in order to construct a complete set of interest rate series. Then we calculated geometric average of this set of interest rate series for trade partners using same method as it is illustrated before. In this study the period spans from 1970Q1-2004Q4 and all series used in index form with 1995=100. Main data sources are OECD Statistical Compendium, and IMF (IFS). The original data series are modified and constructed according to the related equations interpreted above. Finally again all trade partners' (TR) variables are geometric weighted averages.

**B. DATA GENERATING PROCESS AND EXAMINATION OF THE SERIES**

In order to test the model in terms of the time series econometric techniques, first of all, we examine the graphs and ARIMA structure of the variables to determine the characteristics of the series. After that we test and make it clear, whether the series are stationary or non-stationary by applying ADF (Augmented Dickey Fuller) unit roots test. Then we find out whether there is a cointegration relation between the series or not, by using the Engle & Granger test procedure Durbin-Watson (CRDW) test procedure and also using Johansen cointegration procedure. Following cointegration test we apply (ECM) Error Correction Estimation in order to examine the characteristic of cointegration relationship between the series. The variables in this study are RULC\* (real unit labor cost ratio), RXR (Real effective exchange rate) and R (real interest rate difference). We will use the relevant statistical forms of any variable in all test procedures. For

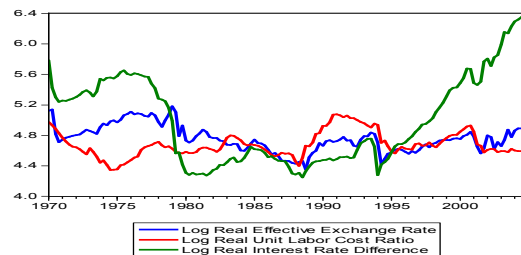
all test procedure we will use the logarithmic form of any variable.

**Figure1.** Interest rate difference, real unit labour cost ratio and real effective exchange rate in level.



**Source:** OECD Statistical Compendium

**Figure2.** Real interest rate difference, real unit labour cost ratio and real effective exchange rate in log level.



**Source:** OECD Statistical Compendium

In time series econometrics ARIMA models (or other time series model) predict future values of the time series from past values of original time series and past values of the errors. According to the test results RXR series has a data generating process with ARIMA (5,1,5) model, which implies that, this series is stationary in first difference, its own lagged values has effect with five lag, and past period random shocks affect time series with five lag of the variable. RULC\* series has a data generating process with ARIMA (5,1,5) model, which implies that, this series is stationary in first difference, its own lagged values has effect with five lag and past period random shocks affect the series with five lag. R (real interest rate difference) series has a data generating process with ARIMA (1,1,5) model, which implies that, this series is stationary in first difference, its own lagged values has effect with



one lag and past period random shocks affect the series with five lag.

### C. UNIT ROOT TEST

The stationarity of the error process is a substantial test for the validity of the long run equilibrium of economic theory. In the discussion of stationarity and non-stationarity we need to test for the presence of unit roots in order to avoid the problem of spurious regression.<sup>6</sup> In our investigation we applied the ADF test procedure in order to test stationarity and non-stationarity. ADF regression is estimated by considering the optimal combinations of time series modeling, which means that we run the ADF regressions with constant term, trend and other components of time series.

First of all, by considering that the RXR, RULC and R series have constant term, constant term and trend, and no constant term and trend, we estimated ADF under these different assumptions. In our investigation, for all of these assumptions, ADF test results for RXR, RULC and R, show that all variables are stationary in first difference I(0), and, non-stationary in level I(1). The results for the assumption of no trend and constant term and absolute value of t-statistics are lower than MacKinnon critical values for 1%, 5%, 10%, in level. Because of these results of ADF test we cannot reject the unit root hypothesis, thus it is safe to reject the stationarity of the RXR, RULC and R, in level under the assumption of no trend and intercept. Also with the trend and intercept assumptions in the series we reach same results as explained above. It means that, even we estimate ADF with trend and intercept, the absolute value of t-statistics is still lower than MacKinnon critical values for 1%, 5%, and 10% in level.

Additionally, we estimated ADF under both existence of constant term, trend and constant term and non-existence of the trend and constant term in 1<sup>st</sup> difference of RXR, RULC and R series. The results are quite significant and absolute value of t-statistics is higher than MacKinnon critical values for 1%, 5%,

10%, in 1<sup>st</sup> difference of the series. Because, these results of ADF test do not reject the unit root hypothesis, it is safe to reject the non-stationarity of the RXR in 1<sup>st</sup> difference.

Secondly we applied same conventional test and estimated ADF, on the logarithmic forms of the series (LRXR, LRULC and LR) in level and in 1<sup>st</sup> difference. Absolute value of t-statistics is lower than the MacKinnon critical values, thus the series have unit root (then we cannot reject the null hypothesis) and we can reject the stationarity of the LRXR, LRULC and LR in the level. In another words the logarithmic forms of the series are non-stationary in the level. Then we replied the ADF test procedure for the 1<sup>st</sup> difference form of the LRXR, LRULC and LR series. According to test results observed absolute value of t-statistic is higher than the MacKinnon critical values, thus there is no unit root in the series (then we can reject the null hypothesis) and we cannot reject the stationarity of the LRXR, RULC and LR in the 1<sup>st</sup> difference. In another words the logarithmic forms of the series are stationary in 1<sup>st</sup> difference.

### D. Cointegration Test

The unit root test results showed that all three variables named LRXR, LRULC and LR are non-stationary in level; stationary in 1<sup>st</sup> difference. This shows that these variables contain stochastic (i.e., random) trends, and since random trends in the data can lead to spurious correlations, this leads to the question of whether there is a causal long-run relationship between these variables (Harris & Sollis, 2003:15). In general, if two or more economic series move closely in the long run even if they are trended, the difference between them might be constant. Therefore, there will be an observed equilibrium (or cointegration) relationship between the variables. According to Engle and Granger (1987) definition of cointegration, which provides long-run causal relationship among the variables, if two or more series are linked to form an equilibrium relationship in the long-run, then even if the series themselves may contain stochastic trends (i.e., be non-stationary), they will nevertheless move closely together over time and the difference between them is constant (i.e., stationary) (Harris & Sollis, 2003:15).

<sup>6</sup> But for testing the long run cointegration relation within the Engle & Granger test procedure the problem of spurious regression would not be problem technically.

Then the economic interpretation of the cointegration asserts a long-run equilibrium to which the economic system converges over time.

Cointegration test technique provides an estimation of the long run, or equilibrium, parameters in relation with unit root variables, and also allows a direct test of the validity of an economic theory imposing restrictions. The objective of the cointegration approach is to find cointegration vector and to decompose the set of variables into stationary and non-stationary components. Thus the cointegration vector refers to the stationary combinations, whereas the remaining components represent the common trends. Therefore at the beginning the cointegration relation (long-run equilibrium) should be tested through the Engle & Granger or Augmented Engle & Granger test technique.

**1. Engle & Granger (EG) or Augmented Engle-Granger (AEG) Test Results**

The hypothesis in our study is that the real effective exchange rate of a country follows the time path of its relative real unit labor costs in the long run. The relevant regression equation is as following:

$$LRXR_t = \beta_1 LRULC_t + \beta_2 R_{TRt} + u_t \quad (20)$$

In this equation if the mean of error is zero,  $E(u_t)=0$ , and stationary, LRXR might deviate in its exact value in the short run, but an equilibrium relationship of LRULC and LR with LRXR is expected to be in the long run. Before testing for the stationarity of the residual term of the regression (20) we should remind that all of the series in consideration are non-stationary (that is it is I(1)) in level and stationary (that is it is I(0)) in first difference according to ADF test results. Meanwhile although LRXR, LRULC and LR are not stationary in level it is possible to apply ordinary least square test to these variables to derive a residual term.

**Table 1.** Estimation of the cointegration equation by OLS.

Dependent Variable: LRXR Method: Least Squares		Sample: 1970Q1 2004Q4 Included observations: 140		
	Coefficient	Std. Error	t-Statistic	Prob.
LRULC	0.343677	0.058608	5.863985	<b>0.0000</b>
LR	0.137617	0.015195	9.056852	<b>0.0000</b>
DMY	0.288059	0.022693	12.69355	<b>0.0000</b>

C	2.396497	0.295896	8.099119	<b>0.0000</b>
R-squared	<b>0.678083</b>	Mean dependent var		4.758589
Adjusted R-squared	<b>0.670982</b>	S.D. dependent var		0.173542
S.E. of regression	0.099544	Akaike info criterion		1.748279
Sum squared resid	1.347625	Schwarz criterion		1.664232
Log likelihood	126.3795	Hannan-Quinn criter.		1.714124
F-statistic	<b>95.48974</b>	<b>Durbin-Watson</b>		<b>0.669503</b>
Prob(F-statistic)	0.000000	<b>Statistic</b>		

We estimated the equation (results shown in table (1)) in log form to avoid autocorrelation and then applied the ADF unit root test to the residual of estimated equation in level (table (2)). As we know that if residual of the estimated regression is stationary then we safely conclude that there is a cointegration vector in this regression equation. In spite of the non-stationarity of the individual variables in level, there is possibility of a linear combination of them. Estimation results of the regression (20) is illustrated in the following equation:

$$LRXR_t = 2.39 + 0.34 LRULC_t + 0.13 R_{TRt} + 0.28 DMY + u_t \quad (21)$$

$$R^2 = 0.67 \quad d = 0.66$$

**Table 2.** ADF Test Results for the residual of estimated equation.

Augmented Dickey-Fuller Test Results, Null Hypothesis: RESIDUAL has a unit root Exogenous: None, Lag Length: 0 (Automatic based on SIC, MAXLAG=13)				
		t-Statistic	Prob.*	
		<b>-5.602715</b>	<b>0.0000</b>	
Test critical values:	1% level			
	5% level		-2.581705	
	10% level		-1.943140	
	level		-1.615189	

\*MacKinnon (1996) one-sided p-values.

In order to test the stationarity of residual term we applied ADF unit root test to the residual of the regression (20) and we found that it is stationary in level; that is, it is I(0). The ADF unit root test results are;

$$t = (-5.60)$$

$$R^2 = 0.18 \quad d = 1.89$$

The ADF test results (are summarized in table (2)) show that the residual of the estimated equation does not have a unit root. The Engle–Granger 1 percent critical  $\tau$  value is  $-2.5899$  and because the computed  $\tau$  ( $= t$ ) value is much more negative than this, our conclusion is that the residual series from the regression of (21) is  $I(0)$ ; that is, it is stationary (Gujarati, 1999:727). Hence, (21) is a cointegrating regression and this regression is not spurious, even though individually the two variables are nonstationary. This means that we can reject the non-stationarity of the residual and this shows that there is possibility of a linear combination (cointegration relationship) of LRXR, LRULC and LR.

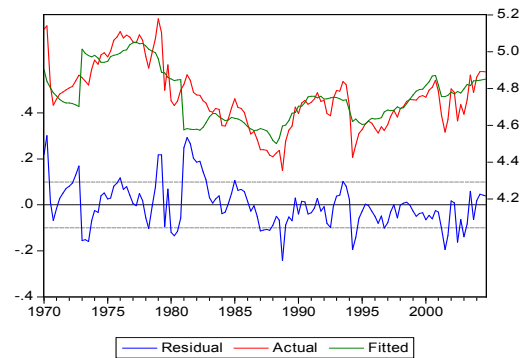
Although LRXR, LRULC and LR time series are individually  $I(1)$ , that is, they have stochastic trends, their linear combination (21) is  $I(0)$ . Thus the linear combination canceled out the stochastic trends in these series and it is possible to say that these variables are cointegrated. In economical sense, if there is a long-term, or equilibrium, relationship between the variables these are cointegrated. In the cointegration theory, a regression such as (21) is known as a cointegrating regression and the slope parameters of  $\beta_1$  and  $\beta_2$  are known as the cointegrating parameter (Gujarati, 1999:727).

## 2. Cointegrating Regression Durbin-Watson (CRDW) Test Results

Another, method of cointegration is the CRDW test, in which we use the Durbin–Watson  $d$ , obtained from the cointegrating regression, such as  $d = 0.66$  given in 4.10. But the null hypothesis is that,  $d = 0$  rather than the standard  $d = 2$ . On the basis of 10,000 simulations formed from 100 observations, each, the 1, 5, and 10 percent critical values to test the hypothesis that the true  $d = 0$  are 0.511, 0.386, and 0.322, respectively. Thus, if the computed  $d$  value is smaller than, say, 0.511, we reject the null hypothesis of cointegration at the 1 percent level. In our example, the value of 0.5316 is above this critical value, suggesting that LRXR, LRULC and LR are cointegrated, thus reinforcing the finding on the basis of the EG test. Although they individually exhibit random walks, there seems to be a stable long-run relationship between

them; they will not wander away from each other (Gujarati, 1999:728).

**Figure 3. The actual fitted residual graph**



However, if a single equation system has more than two variables then there might be more than one cointegration vectors. This problem has been solved by the cointegration technique developed by Johansen (1988, 1990).

## 3. Johansen Cointegration Test Results

Johansen's approach has received much attention as one of the cointegration system analysis, because of its outstanding advantages. Therefore a more reliable cointegration vector estimation method is the Johansen Maximum Likelihood Approach (ML) for our long run model. Johansen proposes a maximum likelihood (ML) method estimating long run relationship, or cointegration vectors.

In the Johansen cointegration technique the lag structure is very important because this method is extremely sensitive to the lag length. Therefore at the beginning we should find a suitable lag length shown in table (3). After that we selected lag structure for our VAR estimation. In this process there are several criteria to select the lag structure. In this application we prefer Schwarz Criteria ( $-9.268186^*$ ) shown in the table (4), that the Johansen Maximum Likelihood method must be applied with the components of intercept, no-trend with lag of 1-1.

**Table 3.** Lag Order Selection Criteria for VAR.

**Table 4.** Lag selection criterias for the Johansen Cointegration test.

Sample: 1970Q2 2004Q4	Series: LRXR LRULC LR
Included observations: 138	Lags interval: 1 to 1
<b>Selected (0.05 level*) Number of Cointegrating Relations by Model</b>	

<b>VAR Lag Order Selection Criteria</b>						Sample: 1970Q2 2004Q4
Endogenous variables: LRXR LRULC LR						Included observations: 139
Exogenous variables: C						* indicates lag order selected by the criterion
Lag	LogL	LR	FPE	AIC	SC	HQ
0	13.36076	NA	0.000173	-0.149076	-0.085742	-0.123339
<b>1</b>	<b>569.6866</b>	<b>1080.633*</b>	<b>6.57e-08*</b>	<b>-8.024268*</b>	<b>-7.770932*</b>	<b>-7.921319*</b>
Data						
Trend:	None	None	Linear	Linear	Quadratic	
Test Type	<b>No Intercept</b>	Intercept	Intercept	Intercept	Intercept	
	<b>No Trend</b>	No Trend	No Trend	Trend	Trend	
Trace	<b>1</b>	1	1	1	0	
Max-Eig	<b>1</b>	1	1	1	0	
*Critical values based on MacKinnon-Haug-Michelis (1999)						
Information Criteria by Rank and Model						
Data						
Trend:	None	None	Linear	Linear	Quadratic	
Rank or	No Intercept	Intercept	Intercept	Intercept	Intercept	
No. of Ces	No Trend	No Trend	No Trend	Trend	Trend	
Log Likelihood by Rank (rows) and Model (columns)						
0	657.9394	657.9394	659.4408	659.4408	671.7713	
1	676.4592	676.9552	677.2117	677.3974	682.5355	
2	676.7290	681.5875	681.8230	682.7450	687.1646	
3	676.7338	681.8530	681.8530	687.2232	687.2232	
Akaike Information Criteria by Rank (rows) and Model (columns)						
0	-9.404918	-9.404918	-9.383200	-9.383200	-9.518424	
1	-9.586366	-9.579060	-9.553793	-9.541991	-9.587471*	
2	-9.503319	-9.544746	-9.533667	-9.518044	-9.567602	
3	-9.416432	-9.447144	-9.447144	-9.481496	-9.481496	
Schwarz Criteria by Rank (rows) and Model (columns)						
1	<b>-9.268186*</b>	-9.239668	-9.171977	-9.138963	-9.142019	
2	-9.057868	-9.056870	-9.024579	-8.966532	-8.994879	
3	-8.843708	-8.810785	-8.810785	-8.781501	-8.781501	

Johansen table (5) log-likelihood ratio test, based on both trace test and max-eigenvalue test and these tests indicate that there is one cointegration vector for variables. According to the table (5) the trace test statistics (37.58) is higher than its critical value (24.27)

at %5 significance level. In addition the maximum eigenvalue statistics (37.03) is higher than its critical value (17.79) at %5 significance level. Thus the variables are cointegrated in the long run.

**Table 5.** Johansen Cointegration Test Results.

Sample (adjusted): 1970Q3 2004Q4		Series: LRXR LRULC LR		
Included obs.: 138 after adjustments		Lags interval (in first differences): 1 to 1		
Trend assumption: No deterministic trend				
<b>Unrestricted Cointegration Rank Test (Trace)</b>				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.235401	<b>37.58885</b>	<b>24.27596</b>	<b>0.0006</b>
At most 1	0.003903	0.549144	12.32090	0.9997
At most 2	6.91E-05	0.009529	4.129906	0.9364
<b>Trace test indicates 1 cointegrating eqn(s) at the 0.05 level</b>				
<b>Unrestricted Cointegration Rank Test (Maximum Eigenvalue)</b>				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.235401	<b>37.03971</b>	<b>17.79730</b>	<b>0.0000</b>
At most 1	0.003903	0.539615	11.22480	0.9995
At most 2	6.91E-05	0.009529	4.129906	0.9364
<b>Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level</b>				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Estimated Cointegration vector is, shown in the table (6). The results show that, the variables of LRULC and LR affect LRXR positively. The coefficient of the LRULC, measures the long run elasticity of LRXR with respect to LRULC is positive and quite significant. But the coefficient of LR is very low and close to zero while having also positive sign and insignificant. If we write the equation with its coefficients;

$$LRXR = 0.68 LRULC + 0.32 LR \quad (22)$$

**Table 6.** Estimated Cointegration Vector for the Variables

<b>Normalized cointegrating coefficients : 1 Cointegrating Equation(s):</b>				
LRXR	LRULC	LR	Log likelihood	
1.000000	-0.683551	-0.323434	676.4592	
	(0.04892)	(0.04579)		

**Table 7.** Stability test for VAR.

Roots of Characteristic Polynomial	Exogenous variables: C
Endogenous variables: LRXR LRULC	Lag specification: 1 1

LR	
Root	Modulus
0.958468 - 0.017057i	<b>0.958620</b>
0.958468 + 0.017057i	<b>0.958620</b>
0.894314	<b>0.894314</b>
No root lies outside the unit circle. (VAR satisfies the stability condition.)	

Then we can conclude in economical sense that there is a long-run equilibrium among the variables to which the economic system converges over time. In addition the stability test results are shown in figure (3) and in table (7) which also show that the system is stable in the long-run.

#### 4. Error Correction Model's (ECM) Application

As summarized above Cointegration technique gives us information about the behaviours of variables for the long run. But it is also of interest to consider the short run evolution of the variables under consideration. The economic information for the short run can be obtained from considering the dynamics of adjustment. The adjustment process often occurs as a change in the value of the dependent variable Y being determined not only by the current value of some explanatory variable X but also by past values of X. In addition, as Y evolves through time in reaction to current and previous values of X, past (lagged) values of itself will also enter the short run (dynamic) model.

More suitable approach is to adopt the short run adjustments of a long run model is error correction model (ECM). ECM describes the long run equilibrium relationship between cointegrated non-stationary series. ECM has several distinct advantages. First, and assuming that X and Y are cointegrated, the ECM incorporates both short and long run effects. Another implication of the ECM is that not only does a cointegrated system has an error correcting form but also every error-correcting model must also be cointegrated. Finally, all the terms in the model are stationary so standard regression techniques are valid.

**Table 8.** Adjustment Coefficients for the Estimated Cointegration Vector and Error Correction Mechanism (ECM).

Vector Error Correction Estimates, Sample (adjusted): 1970Q3 2004Q4 Included observations: 138 after adjustments, Standard errors in ( ) & t-statistics in [ ]			
Cointegrating Eq:	CointEq1		
LRXR(-1)	<b>1.000000</b>		
LRULC(-1)	<b>-0.683551</b>		
	(0.04892)		
	<b>[-13.9729]</b>		
LR(-1)	<b>-0.323434</b>		
	(0.04579)		
	<b>[-7.06413]</b>		
D(LRXR(-1))	-0.146190	0.105676	-0.110425
	0.04849)	(0.04986)	(0.08895)
	<b>[-3.01495]</b>	<b>[ 2.11958]</b>	<b>[-1.24146]</b>
D(LRULC(-1))	0.120847	0.237767	-0.036950
	(0.07026)	(0.07224)	(0.12889)
	<b>[ 1.71999]</b>	<b>[ 3.29120]</b>	<b>[-0.28669]</b>
D(LR(-1))	0.762630	0.248443	0.225213
	(0.04444)	(0.04570)	(0.08152)
	<b>[ 17.1605]</b>	<b>[ 5.43692]</b>	<b>[ 2.76256]</b>

The adjustment coefficients shown in table (9), which error correction mechanism runs and depends on the value of coefficient, adjustment speed can be changed but ultimately it is possible to converge to the equilibrium level. The speed of adjustment for LRXR is 2.74, for LRULC is 3.93 and for LR is -3.07.

**Table 9.** Adjustment Coefficients for the Estimated Cointegration Vector and Error Correction Mechanism (VECM).

Error Correction:	D(LRXR)	D(LRULC)	D(LR)
<b>CointEq1</b>	0.052276	0.077133	-0.107692
	(0.01906)	(0.01960)	(0.03497)
	<b>[ 2.74204]</b>	<b>[ 3.93480]</b>	<b>[-3.07935]</b>

#### IV. CONCLUSION AND SUMMARY

Seeing that the failure of the modern orthodox models in the analysis of the long-run real exchange rate determination in general and for the case of Turkey, we attempted to investigate the accomplishment of the alternative model developed by Shaikh (1980, 1991 and 1995) which is based on the Marx's value theory.

In this study, in the light of our theoretical framework, we investigated also the empirical results of mainstream applications to the data of Turkey and concluded that these models are insufficient to explain

the determination of long run real exchange rates in Turkey. For example Yıldırım (2003), Mohsen (1998) and Erlat (2003) tested the validity of PPP for Turkey and rejected the relationship between the PPP and the exchange rates. In addition, Aynur Yıldırım (2007) examined the B-S hypothesis, which is a modified version of the PPP approach, for Turkey, Germany, France, UK and USA and the empirical results showed that the B-S hypothesis is invalid. Although Yamak and Korkmaz (2007), Mohsen Bahmani - Oskooee and Orhan Kara (2000) found the relationship between the persistent monetary expansion and exchange rates in Turkey, these findings are not sufficient to support the M-M.

The failure of the modern orthodox models both theoretically and empirically directed us to search for an alternative model which is enabling to explain the determination of long-run real exchange rates more successfully. Therefore we evaluated the alternative model which was developed by Shaikh (1980, 1991 and 1995) within its roots in the Marxist value theory, as an extension of the basic results of competition within a country to the competition between countries. According to this model competition between countries characterized by the absolute cost advantage instead of comparative cost advantage and it asserts that instead of making them equally competitive, international common currency prices reflects the relative competitive positions of countries which is measured by their relative real unit labour costs.

The main implication of this model to the determination of long-run real exchange rates is that the long-run real exchange rates are determined among countries by the relative real unit labour costs of them with the principle of profit rate equalization rather than price level equalization.

In order to investigate the theoretical hypothesis that the long-run real exchange rates are determined by the relative real unit labor costs among countries we applied unit root tests, cointegration techniques and error correction techniques to the quarterly data of Turkey and her main trade partners for the period spanning from 1970 to 2004. The empirical results showed that the long-run real effective exchange rate series, real

unit labor cost ratio series and real interest rate differential series and their logarithmic values are non-stationary in level and stationary in first difference. In addition the Engle-Granger cointegration test results and Johansen cointegration test results showed that there is a quite significant cointegration relation between the variables and error correction mechanism works for the variables.

In regards to our empirical findings, it must be pointed out that the long-run real effective exchange rates exhibit non-stationary characteristics with the persistent trade imbalances which reveals that the orthodox framework and its modern considerations are invalid empirically for the case of Turkey. Secondly the significant cointegration relation among the variables and non-stationary characteristics of the long-run real effective exchange rates with the persistent trade imbalances are consistent with the statements of the alternative model under consideration in this study. The causality test results are consistent with the statements of our model especially for the lag 1, but for other lags it exhibits mixed evidences hence these results necessitate more meaningful explanation in the economical sense. Granger causality test captures the short-run interactions among the variables and the speeds of the responses of the variables are quite different from one another. However, for the long-run, the cointegration relation among these variables is an evidence for causality relationship.

Finally all these results show that in spite of the difficulties in the data generation process which is explained previously, Shaikh's model is quite adequate to explain the determination of long-run real exchange rates. Moreover within the theoretical framework developed by Shaikh there are several topics which remain untouched for Turkey such as the issue of value transfer. This will be investigated in our further studies.

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