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Master Thesis

Modeling the TRY/USD and TRY/EUR Exchange Rates

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ABSTRACT

In this thesis we examine the validity of the Purchasing Power Parity (PPP) theory in the determination of the Turkish Lira's exchange rates versus US Dollar and Euro. In our research we use quarterly data for the period 2000:1-2012:4.We formulate an empirical econometric model using cointegration and error correction models. Our analysis showed that in both cases there is a strong relationship between exchange rates and the PPP. These results provide us with more evidence on the validity of the PPP theory suggested by the economic theory. Our study using recent data has provided results compatible with the relevant economic literature.

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1 INTRODUCTION

The determination of exchange rates and the impact of the monetary fundamentals on them is one of the most interesting issues in the economic literature. In this study we will examine the validity of the Purchasing Power Parity (PPP) theory in the determination of the exchange rates. In order to achieve our aim we will formulate an empirical model using cointegration and error correction models for the exchange rates of the Turkish Lira versus US Dollar and Euro.

1.1 THE TURKISH ECONOMY IN THE PAST TWO DECADES

Turkey is an open developing country with a dynamic economy. If accepted in the EU, Turkey has the potential to become the second largest economy in Europe after Germany as well as the most populous, with its growing population of over 70 million. Turkey is a member of both G20 club of important economies and BRIC club.

The 1990's was the worst period for the Turkish economy. In that period average inflation reached 76 per cent at its highest. According to Gormez and Yigit (2009), those years were lost years for Turkey not only because of the 1998 earthquake, which heavily struck the main Turkish industrial area, but also because of the global financial spillover, such as the Russian and the Far-East crises. In addition, Turkey faced three economic crises in 1994, 2000 and 2001. The first major economic crisis in question was in 1994, when fiscal and balance of payment crisis led the country to an IMF program. In 2000-2001 due to fiscal and balance of payment crisis together with major structural problems in the banking sector, the Turkish currency collapsed and the country asked the IMF for assistance once more. Throughout that period, Turkey was faced with an extremely high inflation and major problems with the banks which were at the verge of collapsing (Onis, 2010).

After those crises, Turkey adopted a well-balanced stability program with two main aims: inflation targeting and floating exchange rate regime in addition to the independence of the Central Bank of Turkey.

Since then, the Turkish economy experienced a high growth, structural reform and a low and decreasing level of inflation. The comprehensive reform program adopted, comprising an exchange float rate, financial supervision and privatization, resulted in a notable economy growth with an annual GDP growth rate of 6.8% between 2002 and 2008. (Nathanson and Brand, 2011).

According to Kilinc M., Kilinc Z. and Turhan(2012), the Turkish economy responded very effectively to the turmoil of the 2008 international financial crisis. They established that financial factors and fundamentals were quite resilient in Turkey before the crisis, while the monetary and fiscal policies assumed responded strongly to the crisis in a countercyclical way. In addition, the movements in the country risk premium cannot explain the dynamics during the 2008 crisis.

Today, even though Turkey has a fast growing economy, still faces problems and challenges. Inflation, current account deficit and unemployment are its main problems (Nathanson and Brand 2011). Increasing domestic savings to support sustainable growth under low and stable inflation as well as maintaining domestic demand constitute the main challenges for the Turkish economy for the next years (Gormez and Yigit, 2009). According to Onis and Bayram (2008), Turkey displays the characteristics of a 'temporary star' with rapid growth in the form of spurts followed by periods of deep instability and crises. They do argue that the real characteristics of Turkey are its young population, geo-political position, levels of entrepreneurship and the quality of human capital, all characteristics of an 'emerging tiger'. Finally, they believe that the democratic deficit of Turkey prevents it from attaining a high economic growth.

1.2 PURCHASING POWER PARITY (PPP) AND EXCHANGE RATE

According to the monetary model of exchange rate determination, there is a strong correlation between the exchange rate and the monetary fundamentals. Specifically, the exchange rate depends upon the nominal money balance, the real output, the domestic price level and inflation. This monetary model assumes the following form (Karfakis, 2003):

$$e_t=(m_t-m_t^*)-a(y_t-y_t^*)+b(\pi_t-\pi_t^*) \quad (1)$$

where $(m_t-m_t^*)$ denote the relative money stock, $(y_t-y_t^*)$ the relative real income and $(\pi_t-\pi_t^*)$, the relative inflation differential.

In this paper we will examine only one of the monetary fundamentals. We will try to test the validity of the Purchasing Power Parity (PPP) theory of exchange rate determination. According to the PPP theory, exchange rates between currencies are in equilibrium when their purchasing power is the same in both countries. In other words, the exchange rate between two currencies should be equal to the ratio of the countries price levels. This is the absolute PPP and has the form

$$S_t=P_t/P_t^* \quad (2)$$

where S represents the exchange rate while P and P* represent the countries price levels. Alternatively, in logarithms:

$$s_t=p_t-p_t^* \quad (3)$$

Relative PPP is a dynamic version of absolute PPP. According to the economic theory, relative PPP predicts a relationship between the inflation and the exchange rate. A country with a high inflation will experience a depreciation of its currency. The relative version of the PPP takes the form below:

$$e_t=\pi_t-\pi_t^* \quad (4)$$

The basis of the Purchasing Power Parity (PPP) theory is the law of one price. This law implies that the same good should be sold at the same price in every country where the value of the good is expressed in the same currency.

The PPP hypothesis can be violated owing to barriers to international trade or to different countries displaying different consumption preferences. PPP is the law of one price applied to a standard consumption basket. If exchange rate changes satisfy PPP, the competitiveness of the countries in question will remain unaffected by exchange rate changes. If PPP is not satisfied, then exchange rate changes will affect the relative competitiveness of these countries. Should a country appreciates -or depreciates- its currency by more than warranted by PPP, then its global competitiveness respectively suffers or is enhanced. PPP theory is better suited for predicting exchange rates on a long-term rather than on a short-term basis.

1.3 LITERATURE REVIEW

In order to examine the validity of the monetary approach for the determination of the exchange rates, Turkey can be a very interesting case study. There are several papers in the economic literature examining the empirical link between the exchange rate of the Turkish Lira with basic currencies such as the US Dollar and Euro and the monetary fundamentals. Most of them adopt co-integration and error correction models along with other empirical methods. By using those methods they conclude that there is a long-run relationship between the exchange rate and the monetary fundamentals. As for the Purchasing Power Parity (PPP) theory pertaining our study, some papers conclude that there is a co-integration relationship with the exchange rate giving more evidence on the results of our study in the following chapters.

Korap and Aslan (2008) employ data from the Turkish economy in order to research the exchange rate of TL/US$ in view of the economic fundamentals. They investigate the exchange rate for the period 1987-2006 using quarterly data. According to their estimation results, there is a strong support for the flexible price monetary model while the nominal exchange rates cointegrate with the fundamentals suggested by the economic theory. They conclude that relative money supply has a considerable positive long-run correlation with the nominal exchange rate, while relative real income has a negative one.

In another paper, Korap and Aslan (2010) re-examine the empirical validity of the Purchasing Power Parity (PPP) theory for the Turkish economy by using multivariate cointegration and VEC models. According to their research, the results provide strong support to the validity of the PPP theory for the Turkish economy.

Ari and Unal (2010) use two type continuous models in order to examine the exchange rate of USD/TRY. They develop a continuous-time autoregressive (CAR) model and continuous-time GARCH (COGARCH) model from discrete time data of exchange rate USD/TRY. They use data for the period February 2002-June 2010. Both CAR(1) and COGARCH(1,1) process was verified by comparing real data to simulated from discrete models. Their results illustrated that the continuous models used proved to be adequate models. Such models can be useful in studies about derivative pricing or Value at Risk calculations.

The impact of the exchange rate movements on domestic prices in Turkey is the issue of Leigh and Rossi (2002) study. By using a recursive VAR model they found that the pass-through from the exchange rate to prices in Turkey is over in about a year, but mostly in the first four months. In addition, the pass-through to wholesale prices is more pronounced compared to the pass-through to consumer prices and, finally, the estimated pass-through in Turkey is both shorter and larger than that estimated in other key emerging market countries.

Volkan, Saatcioglu and Korap (2007) examined the extent to which changes in exchange rates resulted in changes in Turkish domestic inflation. They developed a model describing the process through which exchange rate changes reflect on and affect the Turkish inflationary context during the pre- and post- 2003 periods. They established that exchange rate shocks feed into domestic inflation; they do so, initially at the level of manufacturers' prices before reaching consumer prices. They also confirmed that the impact of the shocks on the price variables of the various stages of the supply chain may vary. According to the authors, the pass-through of exchange rate changes are essential in determining the domestic inflationary process and should be taken into consideration to ensure control over domestic inflation.

Bahmani-Oskoee and Kara (2000) have used an error correction model to determine how the exchange rate of Turkish Lira is overshooting both in the short run and in the long run. They researched the period 1973-1998 and found that, first, the lira followed

the monetary approach in the determination of the exchange rate, and second it overshot itself in response to rapid rise in Turkish relative money supply both on a short and on a long term basis.

The relationship between the monetary fundamentals and the exchange rate of the Turkish Lira-US dollar was examined by Civcir (2003) for the period 1987:1-2000:12. He found a co-integration relationship between the exchange rate, the monetary fundamentals and relative prices. According to Civcir, monetary fundamentals affect exchange rates in the long run. He also found that the lira was overvalued before the 2001 crisis.

Civcir(2003) in another paper examines four versions of the monetary model for Turkish Lira/US Dollar for the period 1986:1-2000:12. These models are: the standard flexible price monetary model, the sticky price monetary model, the tradable-no-tradable model and the net international reserves model. With the first model there is not a cointegration relationship between the monetary fundamentals and the exchange rate but with the other three models there are statistically significant co-integrating vectors among them. The results of this paper prove that exchange rates are predictable on a short-term basis.

In order to examine the long-run PPP hypothesis for the exchange rate of Turkish Lira with four currencies, Tastan (2005) used five different unit root tests in addition to the conventional unit root test. He used efficient point-optimal test, extended M tests and GLS-detrended variants of DF tests. He examined the German DM, Italian Lira, UK £ and USD for the period 1982:1-2003:12. The results of his research indicate that the PPP hypothesis hold strongly for the US Dollar based real exchange rate.

Idil Uz and Natalya Ketenci (2008) used panel version of various cointegration tests in order to examine the long-run relationship between the exchange rate and the monetary fundamentals for ten new EU members and Turkey. The ten countries are: Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic, and Slovenia. They used quarterly data for the period 1993:1-2005:4. They found that nominal exchange rates were co-integrated with monetary

fundamentals and provided significant support for the monetary model using panel procedures.

Cicek(2014) examines the efficiency of the Turkish foreign exchange markets by testing the cointegration relationship between the current forward rate and its corresponding spot rate in the cases of the Turkish lira versus US dollar and the Turkish lira versus Euro. He used nominal daily spot and one-month forward exchange rates expressed in units of TRY/USD and TRY/EUR. According to his results there is market efficiency but in a weak form.

2 MODELING THE TRY/USD EXCHANGE RATE

2.1 DATA

In order to examine the relationship between the changes in the exchange rates of the TRY with the basic currencies USD and EURO as well as changes in their price levels, we will use quarterly data for the period 2000:1-2012:4.This data, the price levels in Turkey, the USA and the Eurozone along with the exchange rates between their currencies, was drawn from the International Statistical Yearbook database. Our aim is to test the Purchasing Power Parity (PPP) theory, which prescribes that changes in exchange rates and price levels are proportionate.

2.2 METHODOLOGY

The first step in our research is to determine whether there is a long-term relationship between the nominal exchange rate and the Purchasing Power Parity (PPP). If cointegration between the exchange rate and the PPP can be established, then a long-term relationship between the two variables can be identified. We will examine this case both for the TRY/USD and the PPP of Turkey and USA, and subsequently for the TRY/EUR and the PPP of Turkey and the Eurozone.

According to Engle and Granger (1987) and Johansen (1988, 1995), when two variables are cointegrated, then there is a long-term equilibrium relationship between them. On a short-term basis, these variables may be in disequilibrium, which can be formulated with an Error Correction Model (ECM). Two cointegrated variables should be integrated of the same order while a linear combination of them should be stationary.

Consequently, we will begin by studying the stationarity of the time series of the variables (unit root tests). Then, by means of the Ordinary Least Squares method (OLS), we will test the cointegration relationship between the variables, and finally determine the Error Correction Model (ECM).

This process will be performed for both the cases in question. The first case under consideration is that of Turkey and the U.S.A.

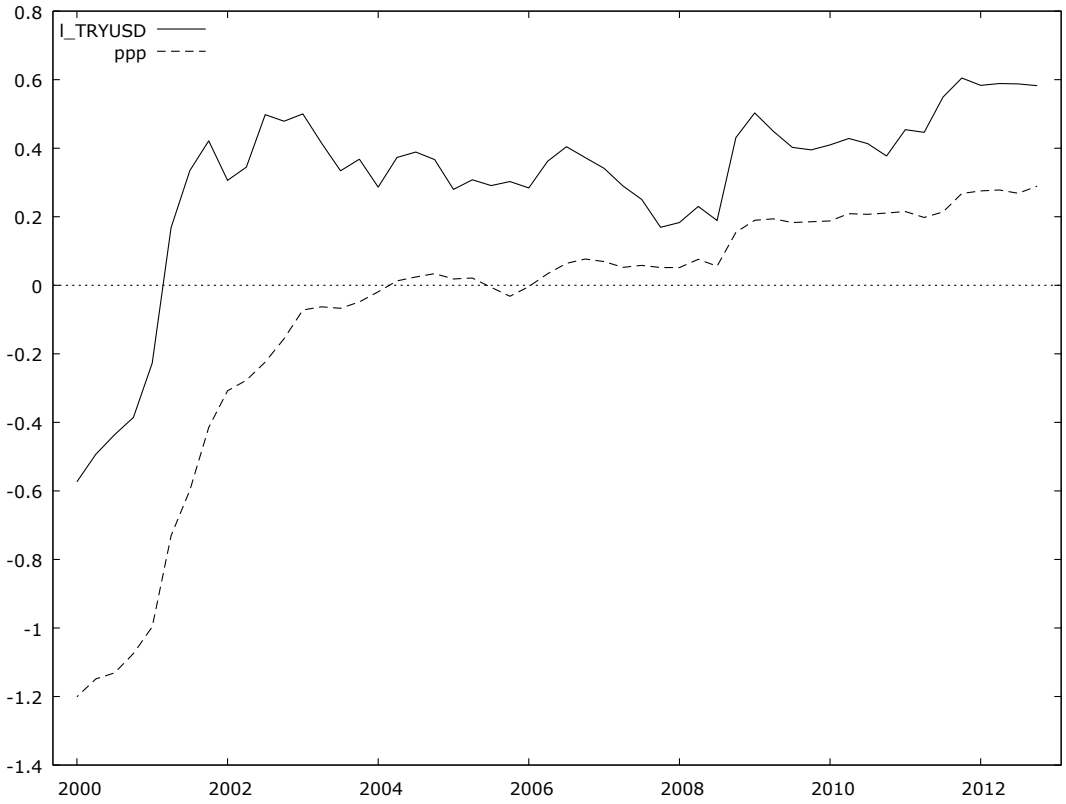
2.3 UNIT ROOT TESTS

Initially, we will estimate the natural logarithms of the nominal TRY/USD exchange rate l_TRYUSD and the PPP, which is the difference of the logarithms of the price levels of the two countries l_PUS and l_PTUR.

A time series is stationary if its mean and variance are constant over time and the value of covariance between two time periods depends only on the distance or gap between the two periods and not the actual time at which the covariance is computed.

The time series of the natural logarithms l_TRYUSD and PPP for the period 2000-2012 are illustrated in figure 1.

Figure 1. Natural logarithms of the nominal TRY/USD exchange rate and ppp



In order to examine the stationarity of the time series we perform an Augmented Dickey-Fuller unit root test (Dickey and Fuller 1979,1981). This is a test for a unit root in a time series sample. The Augmented Dickey-Fuller statistic use in the test is a negative number. The higher the negative number is, the stronger the rejection of the hypothesis of a unit root at some level of confidence. The results of the ADF test for the natural logarithms of the nominal TRY/USD exchange rate are given in Table 1.

Table 1. Augmented Dickey-Fuller unit root test for the natural logarithms of the nominal TRY/USD (l_TRYUSD)

Dickey-Fuller test for l_TRYUSD
sample size 43
unit-root null hypothesis: a = 1

with constant and trend
model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
1st-order autocorrelation coeff. for e: 0.117
estimated value of (a - 1): -0.192185
test statistic: tau_ct(1) = -1.97525
p-value 0.5979

The p-value of the test with constant and trend is high 0.5979>0.05. Therefore, the unit root hypothesis cannot be rejected and the time series of l_TRYUSD is non-stationary.

Then we perform the Augmented Dickey-Fuller test in the first difference of l_TRYUSD. In Table 2 we get the results of the test for d_l_TRYUSD.

Table 2. Augmented Dickey-Fuller unit root test for the first difference of l_TRYUSD.

Dickey-Fuller test for d_l_TRYUSD
sample size 42
unit-root null hypothesis: a = 1

with constant and trend
model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
1st-order autocorrelation coeff. for e: -0.039
estimated value of (a - 1): -0.973596
test statistic: tau_ct(1) = -6.10548
p-value 4.341e-005

In this case the p-value is (4.341e-005)<0.05. Hence the test illustrates that the time series of the first difference is stationary and there is no unit root. It is obvious that the l_TRYUSD variable is integrated of order one I(1).

We will follow the same procedure for the PPP variable. The results of the Augmented Dickey-Fuller test for the price level variable (PPP) are presented in Table 3.

Table 3. Augmented Dickey-Fuller unit root test for the price level ppp.

Dickey-Fuller test for ppp
sample size 51
unit-root null hypothesis: a = 1

with constant and trend
model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
1st-order autocorrelation coeff. for e: 0.390
estimated value of (a - 1): -0.0833276
test statistic: tau_ct(1) = -3.05162
p-value 0.1289

The p-value of the test with constant and trend is high 0.1289>0.05. Thus, the unit root hypothesis cannot be rejected and the time series of PPP is non-stationary.

Then we perform an Augmented Dickey-Fuller test in the first difference of PPP. In Table 4 we get the results of the test for d_PPP. In this case the p-value is 0.01154<0.05. We accept the hypothesis that there is a unit root and the time series of d_PPP is stationary. Therefore the PPP variable is integrated of order one I(1).

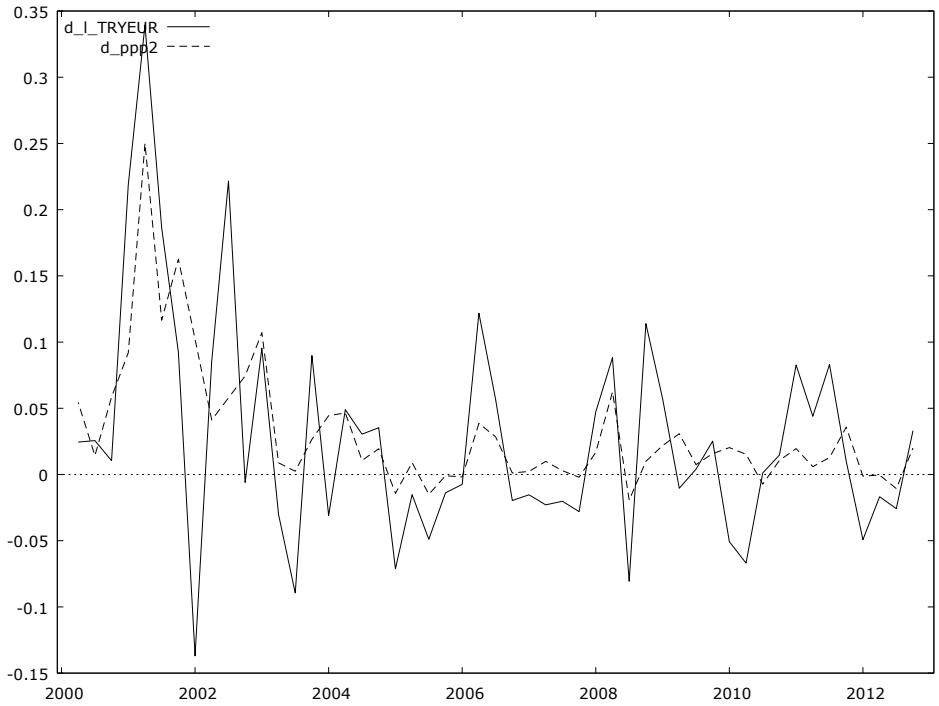
Table 4. Augmented Dickey-Fuller unit root test for the first difference of the price level d_ppp

Dickey-Fuller test for d_ppp
sample size 50
unit-root null hypothesis: a = 1

with constant and trend
model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
1st-order autocorrelation coeff. for e: -0.071
estimated value of (a - 1): -0.530798
test statistic: tau_ct(1) = -4.09868
p-value 0.01154

The time series of the first differences of the natural logarithms of the exchange rate d_l_TRYUSD and price level d_ppp for the period 2000-2012 are presented in figure 2.

Figure 2.First differences of the natural logarithms of the nominal TRY/USD exchange rate d_l_TRYUSD and price level d_ ppp



2.4 COINTEGRATION ANALYSIS

To this point our research suggests that we have two variables l_TRYUSD and PPP, which are non-stationary in their levels while their first differences are stationary. That is, these variables are both first-order integrated I(1) and their first differences are integrated of order zero I(0). There is the possibility of these variables being cointegrated if there is a stationary linear combination of them. Generally, if two or more series are individually integrated (in the time series sense) but some linear combination of them has a lower order of integration, then the series are considered to be cointegrated. Thus, if the relationship between the two variables is given by the following equation,

$$e_t=\alpha+\beta p_t+u_t \qquad (5)$$

then their linear combination will be:

$$u_t=e_t-(\alpha+\beta p_t) \quad (6)$$

This linear combination is the time series of the residuals. If the residuals are zero order integrated then the l_TRYUSD and PPP variables are cointegrated.

According to the Purchasing Power Parity (PPP) theory, factors a and b should be a=0 and b=1. With an Ordinary Least Square Model (OLS) we will determine the first relationship and then we will examine the stationarity of the residuals. In Table 5 we get the results of the OLS model.

Table 5.Cointegration between l_TRYUSD and PPP

OLS, using observations 2002:1-2012:4 (T = 44)

Dependent variable: l_TRUYSD

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.363745	0.0170567	21.3257	<0.00001	***
ppp	0.35421	0.105697	3.3512	0.00171	***

Mean dependent var	0.389108	S.D. dependent var	0.112811
Sum squared resid	0.431780	S.E. of regression	0.101393
R-squared	0.210976	Adjusted R-squared	0.192190
F(1, 42)	11.23034	P-value(F)	0.001711
Log-likelihood	39.29532	Akaike criterion	-74.59063
Schwarz criterion	-71.02226	Hannan-Quinn	-73.26731
rho	0.833735	Durbin-Watson	0.347324

The p-value for both constant and PPP are<0.05. Therefore both coefficients a and b are statistically significant and because of *** we consider them very satisfactory.

The relationship derived from the results of the OLS model is:

$$L\_TRYUSD=0.363745+0.34521PPP+u_t \quad (7)$$

where the value of Adjusted R-square is 19.2%. The above equation explains the 19.2% of the exchange rate while the rest is explained by its residuals. From the OLS model we calculate the residuals uhat1 and we perform an Augmented Dickey-Fuller test. The results of this test are presented in Table 6.

Table 6. Augmented Dickey-Fuller test for the residuals uhat1

Dickey-Fuller test for uhat1
sample size 43
unit-root null hypothesis: a = 1

test without constant
model: (1-L)y = (a-1)*y(-1) + e
1st-order autocorrelation coeff. for e: 0.098
estimated value of (a - 1): -0.166265
test statistic: tau_nc(1) = -1.87313
p-value 0.05883

The p-value of the test without constant is marginal (0.5883>0.05) for 5% but we can accept this value for 10%. Thus, we accept the residuals as a stationary time series.

Since the two variables are integrated of order one I(1) and their linear combination (i.e. the residuals) are integrated of zero order I(0),then we conclude that there is cointegration between the exchange rate and the price level.

In this case we can say that there is a long term relationship between the variables. While in the long run the variables co-fluctuate, they may substantially diverge from that equilibrium relationship in the short run.

2.5 ERROR CORRECTION MODEL

The short-run relationship between the exchange rate and the price level can be expressed by an Error Correction Model (ECM). With this model we can examine if there is a disequilibrium in the short run and combine the short-run with the long-run relationship. The Error Correction Model (ECM) estimates the speed at which the dependent variable (exchange rate) returns to equilibrium after a change in the independent variable (price level). An ECM is a dynamic system of the following form:

$$\Delta e_t = \gamma + \delta \Delta p_t - J u_{t-1} \quad \textbf{(8)}$$

With the use of the Ordinary Least Square Model (OLS) we will determine this relationship. In Table 7 we get the results of the OLS model with one lag.

Table 7. Error Correction Model

OLS, using observations 2002:2-2012:4 (T = 43)

Dependent variable: d_l_TRYUSD

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-0.0170702	0.00807485	-2.1140	0.04080	**
d_ppp	1.64576	0.268484	6.1298	<0.00001	***
uhat1_1	-0.239064	0.0739853	-3.2312	0.00247	***

Mean dependent var	0.006428	S.D. dependent var	0.065262
Sum squared resid	0.087650	S.E. of regression	0.046811
R-squared	0.510020	Adjusted R-squared	0.485521
F(2, 40)	20.81801	P-value(F)	6.36e-07
Log-likelihood	72.19124	Akaike criterion	-138.3825
Schwarz criterion	-133.0989	Hannan-Quinn	-136.4340
rho	0.152105	Durbin-Watson	1.691848

The p-values for all variables are<0.05. Therefore all coefficients are statistically significant and because of *** we consider that two of them are very satisfactory. The equation that we derived from the OLS model is:

d_l_TRYUSD=-0.0170702+1.64576d_PPP+-0.239064uhat1_1 **(9)**

The coefficient of uhat1_1 depicts how the real price of the exchange rate achieves the equilibrium. In particular we observe that every quarter there is a convergence of 23%. While according to the Adjusted R-square we find that this model explains 48,55% of the reality. Then with the use of F-statistic we will determine whether the d_PPP variable is one/1.

Table 8. F-statistic for the first difference of ppp (d_ppp)

Restriction:
b[d_ppp] = 1

Test statistic: F(1, 40) = 5.78502, with p-value = 0.0208804

Restricted estimates:

	coefficient	std. error	t-ratio	p-value
const	-0.00800485	0.00754647	-1.061	0.2950
d_ppp	1.00000	0.000000	NA	NA
uhat1_1	-0.202518	0.0765169	-2.647	0.0115 **

Standard error of the regression = 0.0494669

In figure 3 we see the actual and fitted values of the first difference of the natural logarithm of the exchange rate and in figure 4 the residuals.

Figure 3. Actual and fitted d_l_TRYUSD

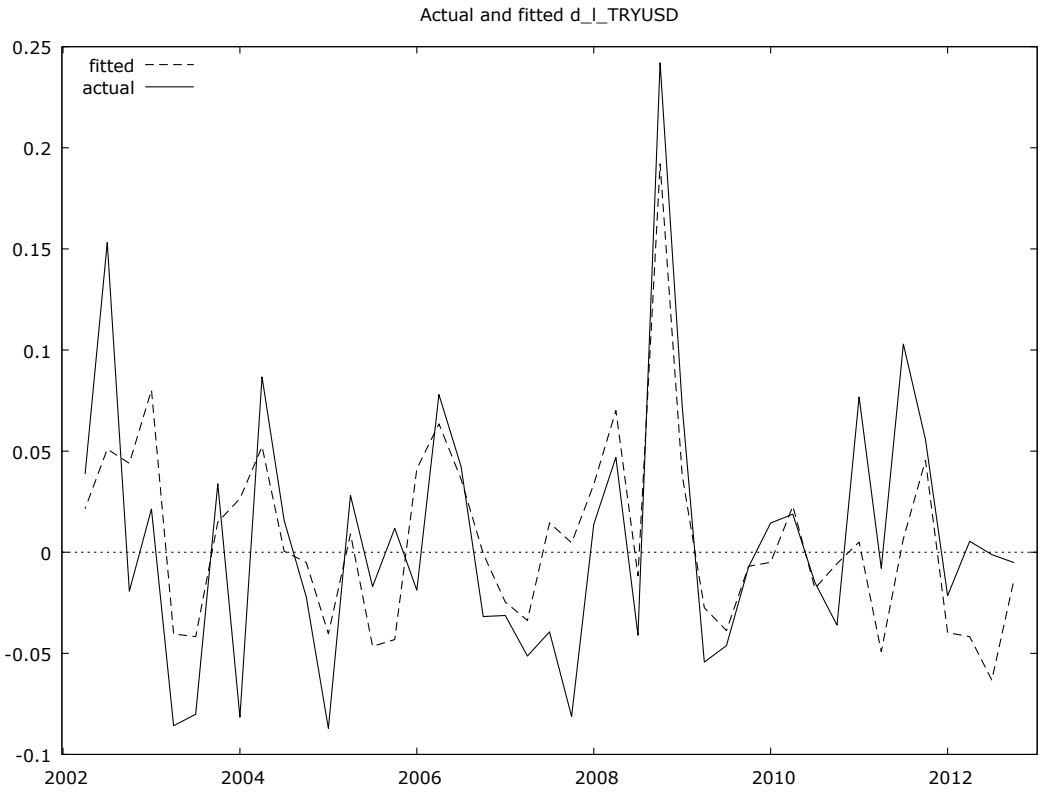
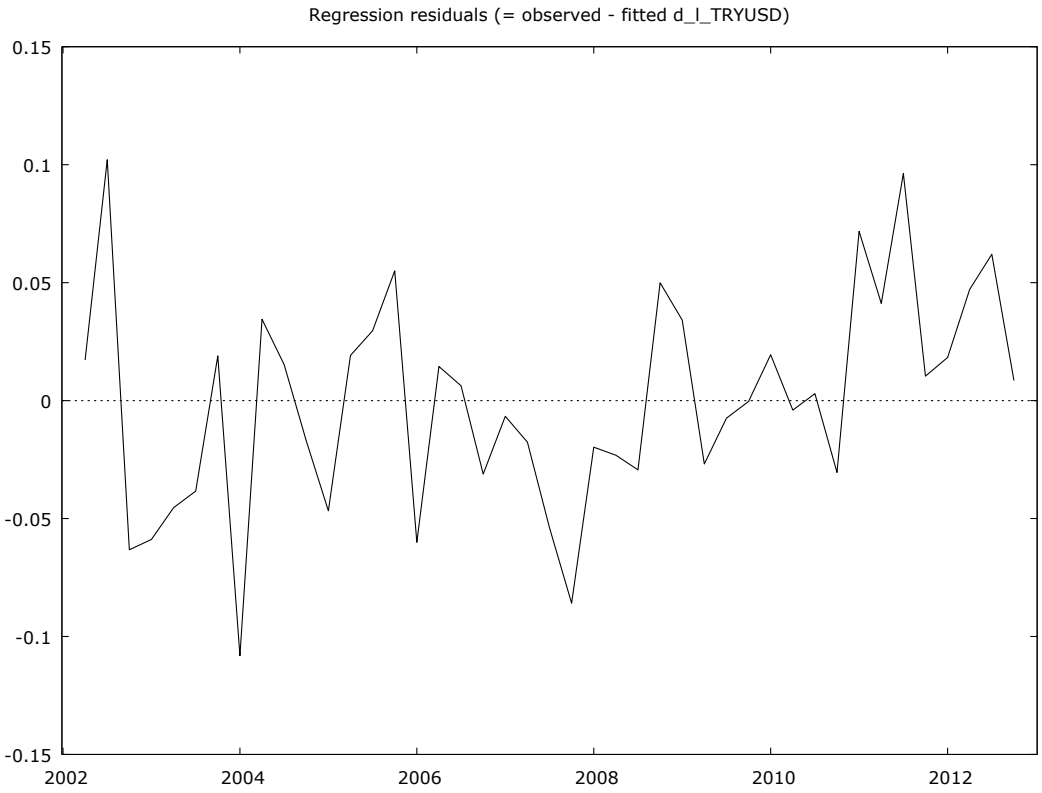


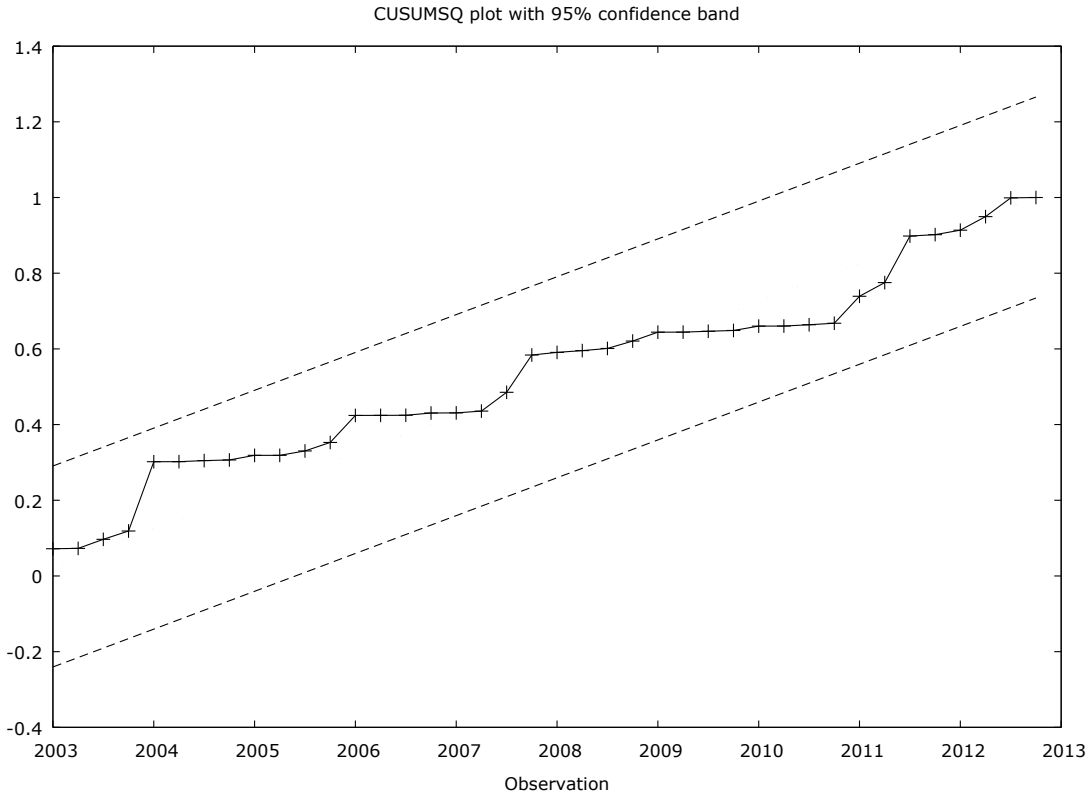
Figure 4. Residuals of the ECM



2.6 STABILITY TEST

An important stability test is the CUSUMSQ test. This test is derived from the residuals of the recursive estimation. The CUSUMSQ test is based on a normalized version of the cumulative sums of squared residuals. The scaling is such that under the null hypothesis of parameter stability, the CUSUMSQ statistic will start at zero and end the sample with a value of 1. A set of +_2 standard error bands is usually plotted around zero (95% confidence band) and any statistic lying outside these is taken as evidence of parameter stability.

Figure 5



The residuals are well within the confidence bands, which constitutes sufficient evidence for parameter stability.

3 MODELING THE TRY/USD EXCHANGE RATE

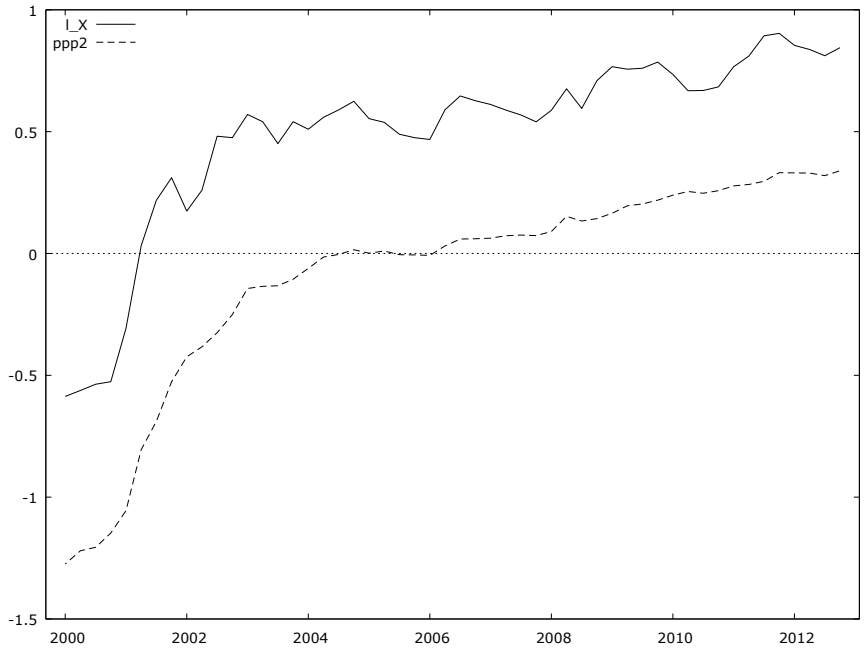
3.1 DATA AND METHODOLOGY

In the previous chapter we have examined the relationship between the exchange rate and the price level of Turkey and USA. In this chapter we will follow the same procedure for Turkey and the Eurozone. The first step in our study is to calculate the nominal logarithms of the nominal TRY/EUR exchange rate l_TRYEUR and the PPP2, which is the difference between the logarithms of the price levels of Turkey l_PTUR and the Eurozone l_PEZ.

3.2 UNIT ROOT TESTS

In order to determine whether there is a long-run relationship between the exchange rate and the price level, we have to investigate if these variables are cointegrated. The time series of the natural logarithms l_TRYEUR and PPP2 for the period 2000-2012 are presented in figure 6.

Figure 6. Natural logarithms of the nominal TRY/EUR exchange rate and ppp2.



We examine whether the time series of the variables l_TRYEUR and PPP2 are stationary. We perform an Augmented Dickey-Fuller test for the variables. The results of the test for the natural logarithms of the nominal TRY/EUR exchange rate are illustrated in Table 9.

Table 9. Augmented Dickey-Fuller unit root test for the natural logarithms of the nominal TRY/EUR(l_TRYEUR)

Dickey-Fuller test for l_TRYEUR
sample size 51
unit-root null hypothesis: a = 1

with constant and trend
model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
1st-order autocorrelation coeff. for e: 0.203
estimated value of (a - 1): -0.134181
test statistic: tau_ct(1) = -2.70541
p-value 0.2389

The p-value of the test with constant and trend is high: 0.2389>0.05. Thus, the unit root hypothesis cannot be rejected and the time series of l_TRYEUR is non-stationary.

Then we perform an Augmented Dickey-Fuller test in the first difference of l_TRYEUR. Table 10 presents the results of the test for d_l_TRYEUR.

Table 10. *Augmented Dickey-Fuller unit root test for the first difference of l_TRYEUR.*

Dickey-Fuller test for d_l_TRYEUR
sample size 50
unit-root null hypothesis: a = 1

with constant and trend
model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
1st-order autocorrelation coeff. for e: 0.029
estimated value of (a - 1): -0.765636
test statistic: tau_ct(1) = -5.39796
p-value 0.0001

In this case the p-value is 0.0001<0.05. Hence, the test suggests that the time series of the first difference of the logarithm of exchange rate d_l_TRYEUR is stationary, and there is no unit root. Thus we conclude that the l_TRYUSD variable is integrated of order one I(1).

We will follow the same procedure for the PPP2 variable. The results of the Augmented Dickey-Fuller test for the price level variable (PPP) are presented in Table 11.

Table 11. Augmented Dickey-Fuller unit root test for the price level ppp2.

. Dickey-Fuller test for ppp2
sample size 51
unit-root null hypothesis: a = 1

with constant and trend
model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
1st-order autocorrelation coeff. for e: 0.358
estimated value of (a - 1): -0.0740984
test statistic: tau_ct(1) = -3.01527
p-value 0.1382

The time series of the price level is a non-stationary series because of the p-value 0.1382>0.05. Accordingly, the unit root hypothesis cannot be rejected. Thus, we will examine the stationarity of the first difference of the variable, d_PPP2. In Table 12 we get the results of the Augmented Dickey-Fuller test for d_PPP2.

Table 12. Augmented Dickey-Fuller unit root test for the first difference of the price level d_ppp2

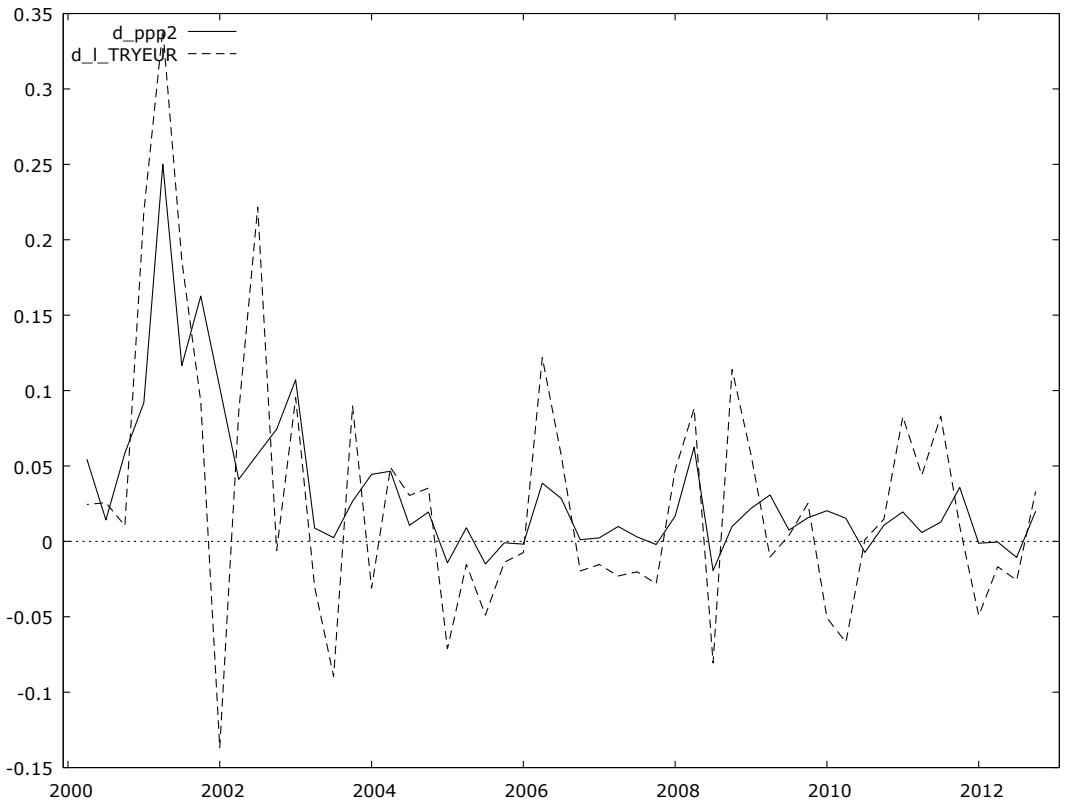
Dickey-Fuller test for d_ppp2
sample size 50
unit-root null hypothesis: a = 1

with constant and trend
model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
1st-order autocorrelation coeff. for e: -0.068
estimated value of (a - 1): -0.557115
test statistic: tau_ct(1) = -4.23857
p-value 0.007934

In this case the p_value is low 0.007934<0.05. Thus, we accept the alternative hypothesis that there is a unit root. Therefore the time series of the first difference d_PPP2 is a stationary series and the price level PPP2 is first order integrated I(1).

The time series of the first differences of the natural logarithms of the exchange rate d_l_TRYEUR and price level d_PPP2 for the period 2000-2012 are presented in figure 7.

Figure 7.First differences of the natural logarithms of the nominal TRY/USD exchange rate d_l_TRYUSD and price level d_ ppp



In this case we have two variables, the nominal logarithm of the exchange rate l_TRYEUR and the price level PPP2 that are non-stationary in their level while their first differences are stationary. Therefore we have two variables first order integrated I(1) and their first differences are zero order integrated I(0). Given that the presuppositions are fulfilled. We will examine if these variables have a long- run relationship by adopting a cointegration regression.

3.3 COINTEGRATION ANALYSIS

With an Ordinary Least Squares Model (OLS) we will examine the relationship between the l_TRYEUR and PPP2 variables. Then we will calculate the residuals of this relationship and by performing an Augmented Dickey-Fuller test we will determine if the time series of the residuals is stationary. As we know, the residuals is a linear combination of the two variables and if this combination is stationary, then the variables are cointegrated. In Table 13 we get the results of the OLS model.

Table 13. Cointegration between l_TRYEUR and ppp2

OLS, using observations 2000:1-2012:4 (T = 52)

Dependent variable: l_TRYEUR

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.567352	0.0115199	49.2496	<0.00001	***
ppp2	0.833269	0.0259392	32.1240	<0.00001	***

Mean dependent var	0.492811	S.D. dependent var	0.374780
Sum squared resid	0.331043	S.E. of regression	0.081369
R-squared	0.953787	Adjusted R-squared	0.952863
F(1, 50)	1031.951	P-value(F)	4.78e-35
Log-likelihood	57.69069	Akaike criterion	-111.3814
Schwarz criterion	-107.4789	Hannan-Quinn	-109.8853
rho	0.654937	Durbin-Watson	0.664514

The p-values for both constant and PPP2 are<0.05. Therefore both coefficients a and b are statistically significant and because of *** we consider them very satisfactory.

The relationship derived from the results of the OLS model is:

$$l\_TRYEUR = 0.567352 + 0.833269 PPP2 + u_t \quad \textbf{(10)}$$

We can observe that the value of Adjusted r-squared is very high 95.2%. From this equation we calculate the residuals. In Table 14 we get the results of the Augmented Dickey-Fuller test of the residuals.

Table 14 Augmented Dickey-Fuller test for the residual sresid2

Dickey-Fuller test for resid2
sample size 51
unit-root null hypothesis: a = 1

test without constant
model: (1-L)y = (a-1)*y(-1) + e
1st-order autocorrelation coeff. for e: 0.185
estimated value of (a - 1): -0.345063
test statistic: tau_nc(1) = -3.30356
p-value 0.001402

The p-value of the test without constant for the residuals is 0.001402<0.05, thus concluding that the time series of the residuals of the model is a stationary series. According to our research, the logarithm of the exchange rate l_TRYEUR and the price level PPP2 are cointegrated because both variables are first order integrated I(1) and their linear combination is zero order integrated I(0). In other words, there is a long-run relationship between the two variables.

In Table 15 we examine with an F statistic if the price level PPP2 is one. The results of the test clearly indicate that the price level is not 1.

Table 15. F-statistic for the price level ppp2

Restriction:

b[ppp2] = 1

Test statistic: F(1, 50) = 41.3161, with p-value = 4.71483e-008

Restricted estimates:

	coefficient	std. error	t-ratio	p-value
const	0.582267	0.0150989	38.56	2.13e-039 ***
ppp2	1.00000	0.000000	NA	NA

Standard error of the regression = 0.108879

3.4 ERROR CORRECTION MODEL

We will investigate the short-run relationship between the two variables by means of an error correction model. With this model we can examine whether there is a disequilibrium in the short run and combine the short run with the long run. We will apply an Ordinary Least Square Model. In Table 16 we get the results of the OLS model with one lag.

Table 16. Error Correction Model

OLS, using observations 2000:2-2012:4 (T = 51)
Dependent variable: d_l_TRYEUR

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-0.0175365	0.00934933	-1.8757	0.06679	*
d_ppp2	1.44268	0.170775	8.4478	<0.00001	***
resid2_1	-0.474974	0.101484	-4.6803	0.00002	***

Mean dependent var	0.028065	S.D. dependent var	0.085308
Sum squared resid	0.142589	S.E. of regression	0.054503
R-squared	0.608137	Adjusted R-squared	0.591809
F(2, 48)	37.24590	P-value(F)	1.72e-10
Log-likelihood	77.56435	Akaike criterion	-149.1287
Schwarz criterion	-143.3332	Hannan-Quinn	-146.9141
rho	0.080123	Durbin-Watson	1.793859

The p-values of all coefficients are<0.05. Therefore all coefficients are statistically significant and because of ***we consider two of them to be very satisfactory. The equation that we derived from the OLS model assumes this form:

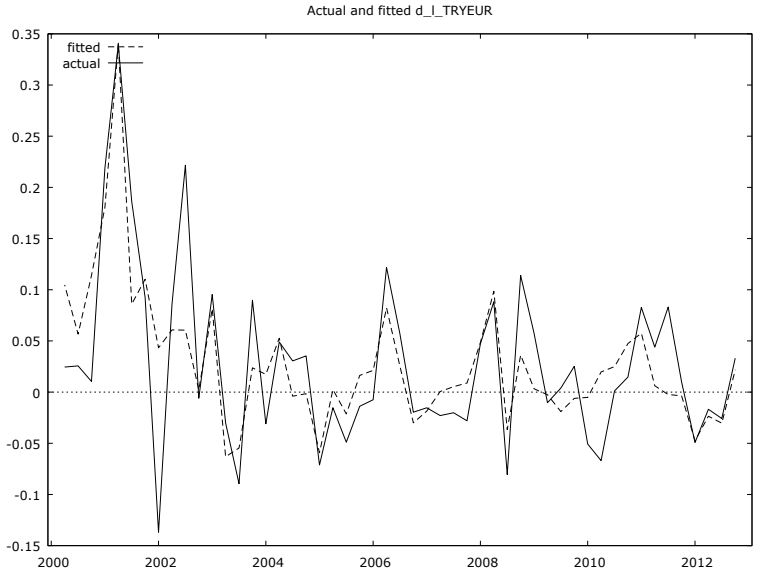
d_l_TRYEUR=-0.0175365+1.44268d_PPP2-0.474974resid2_1 **(11)**

The coefficient of resid2_1 depicts how the real price of the exchange rate achieves the equilibrium. In particular we observe that every term there is a convergence of

47.49%. While according to the Adjusted R-square we find that this model explains 59.18% of the reality.

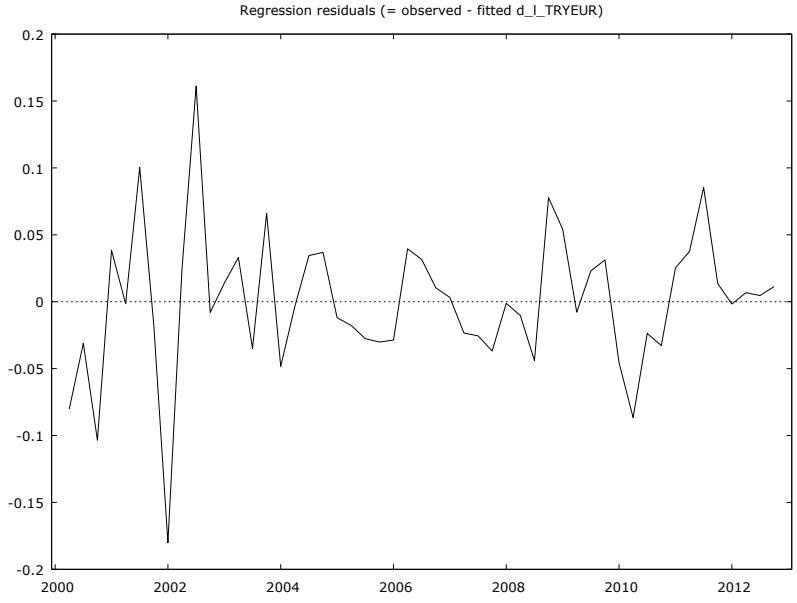
In figure 8 we see the actual and fitted values of the first difference of the natural logarithm of the exchange rate.

Figure 8. Actual and fitted_l_TRYEUR



In figure 9 we can see the residuals of the Error Correction Model.

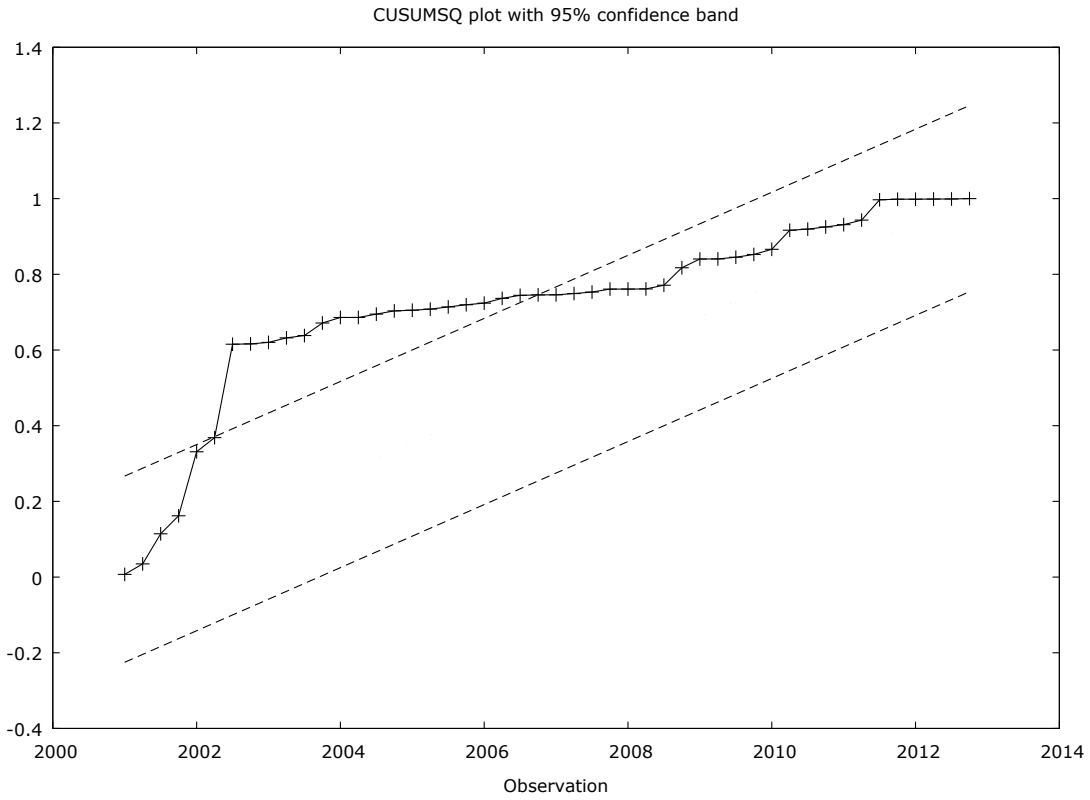
Figure 9.Residuals if the ECM



3.5 STABILITY TEST

We will perform a CUSUMSQ stability test in the residuals of the Error Correction Model. In figure 10 we can see the results of the test. It is obvious that for a long period the residuals are out of the confidence bands.

Figure 10.



4 CONCLUSIONS

The present thesis examines the validity of Purchasing Power Parity (PPP) theory during the period 2000-2012 for the Turkish lira exchange rates with US Dollar TRY/USD and Euro TRY/EUR. We use quarterly data for the period 2000:1-2012:4 for the price levels for both countries and the exchange rates between the two currencies. In our study, we identify a co-integration relationship, which suggests a long-run relationship between the two variables and an error correction model for the short-run period.

According to the economic theory, the constant and the coefficient of PPP in the cointegration relation have to be zero and one because the exchange rate and PPP have a proportional relationship. As we can see in the first cointegration relation for the Turkish lira and US Dollar, there is a discrepancy between the theory and the empirical estimations. However, this difference is not a sufficient reason to reject the theory. The coefficient of PPP in the cointegration relation is the elasticity of the exchange rate as for the price level. Hence, a 1% increase in the PPP causes an appreciation of 0.345% of the exchange rate with a standard error of 0.10.

With the error correction model, we examine the speed of adjustment of the exchange rates to the equilibrium in the short-run period. In the error correction relation , we can see that the deviations of the exchange rate from the equation will be corrected by about 23.9% within a quarter.

The CUSUMSQ test, a stability test, confirms the stability of parameters in our model.

Following the same procedure, we test the validity of the PPP theory for the exchange rates of the Turkish Lira and Euro. We use quarterly data for the same period, 2000:1-2012:4, for both exchange rates and price levels.

The cointegration analysis for the TRYEUR exchange rate and the difference of their price levels (PPP) has indicated that exists a discrepancy between the theory and the empirical estimations, but as in the previous case this difference is not sufficient reason to reject the theory. Thus, we can say that both exchange rate and PPP are moving together over time.

The elasticity of the exchange rate to the price level suggests that a 1% increase in the PPP causes an appreciation of 0.833% of the exchange rate with a standard error of 0.025.

In the error correction model we can see that the deviations of the exchange rate from the equation will be corrected about 47.4% within a quarter.

In conclusion, our analysis showed that in both cases there is a strong relation between the exchange rate and PPP. These results provide us with more evidence on the validity of the PPP theory suggested by the economic theory. Our study using recent data has provided results compatible with the relevant economic literature.

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