The Impact of Exchange Rate Volatility on Exports in Turkey

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Abstract

This paper empirically investigates the impact of exchange rate volatility, export prices and weighed GDP of most of the trading partners of Turkey on aggregate exports for the period from 2003:2 to 2010:12. The primary focus is the impact of exchange rate volatility on exports from Turkey. To achieve this purpose, various approaches were employed previously. In line with the previous studies, the OLS regression method was employed. Appropriate tests to ensure the reliability of the analysis were undertaken. Time series data were used for the analysis. Cross correlation to determine the relationship between the pairs of variables was utilized. Our results indicated that there was a negative relationship between exports and volatility; however, this relationship was not significant at a level of 5%. Even though there were many studies exploring the impact of the volatility of the exchange rate on exports, there was no consensus for validation of the results among these various studies. This topic was chosen since there were few studies about Turkey's case, while in contrast, there have been innumerable studies made outside of Turkey.

Keywords: *Exchange Rate Volatility, OLS Regression, Turkey.*

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Introduction

The volatility and uncertainty of exchange rate movements after the breakdown of the Bretton-Woods agreement led policy makers and researchers to investigate the impact of exchange rate fluctuations on the volume of trade. In this context, foreign exchange rates have been highly volatile since the arrival of the flexible exchange rate system in the 1970's. Following this structural change, theoretical and empirical discussions were held by policy makers and researchers regarding the relationship between exchange rate volatility and international trade flows. Numerous studies examined whether exports were influenced by the volatility of the exchange rate. At the same time, the question as to whether it affects exports has not been explored, although there have been various other studies. A number of inquiries have examined this issue, most coming to a conclusion in favor of the existence of a negative as well as statistically significant relationship between exchange rate volatility and export flows. Although most models of trade argue that exchange rate volatility increases uncertainty and risk and therefore hinders trade flows, other studies present opposite suggestions. The previous empirical studies that examined the effect of exchange rate volatility reflected this conflict; as a result, no real consensus about the effects of exchange rate volatility on trade has emerged in the literature. The studies of Akhtar and Hilton (1984), Kenen and Rodrik (1986), Koray and Lastrapes (1989), Chowdhury (1993), and Arize et al. (2005), indicated that the exchange rate volatility reduced the volume of international trade. On the other hand, the studies of Brada and Mendez (1988), McKenzie and Brooks (1997), and Kasman and Kasman (2005) supported the thesis that exchange volatility had a positive effect on trade flows . Table 1 summarizes the literature regarding exchange rate volatility.

Table 1: Summary of the impact of exchange rate volatility on exports

Study	Data	Period	Method.	Impact of volatility
Akhtar and Hilton (1984)	Aggregate	74-81(quarterly)	OLS	Negative
Kenen and Rodrik (1986)	Aggregate	75-84 (quarterly)	OLS	Negative
Koray and Lastrapes (1989)	Bilateral	73-85 (monthly)	VAR	Negative
Chowdhury (1993)	Aggregate	73-90 (quarterly)	VAR	Negative
Arize et al. (2005)	Aggregate	73-04 (quarterly)	Cointegration, ECM	Negative
Brada and Mendez (1988)	Aggregate	73-77 (annually)	Cross Section	Positive
McKenzi and Brooks (1997)	Bilateral	73-92 (monthly)	OLS	Positive

Although there is comprehensive international empirical literature on the effects of exchange rate volatility on trade, there are only a few Turkish investigations on this issue. Ozbay (1999), Ozturk and Acaravcı (2002), Vergil (2002), Guloglu (2008) found in their empirical studies that Turkish exports are adversely affected by exchange rate volatility. On the other hand, Kasman and Kasman (2005) and Ozturk and Kalyoncu (2009) found a positive correlation between exports and exchange rate volatility.

Table 2: Summary of the impact of exchange rate volatility on Turkish exports

Study	Data	Period	Method.	Impact of volatility
Ozbay (1999)	Aggregate	88-97(quarterly)	Cointegration	Negative
Ozturk and Acaravcı (2002)	Aggregate	89-02 (monthly)	Cointegration	Negative
Vergil (2002)	Bilateral	90-00 (monthly)	Cointegration	Negative
Guloglu (2008)	Aggregate	82-06 (monthly)	MS-ARCH	Negative
Kasman and Kasman (2005)	Aggregate	82-01 (quarterly)	Cointegration	Positive
Ozturk and Kalyoncu (2009)	Aggregate	82-05 (quarterly)	Cross Section	Positive

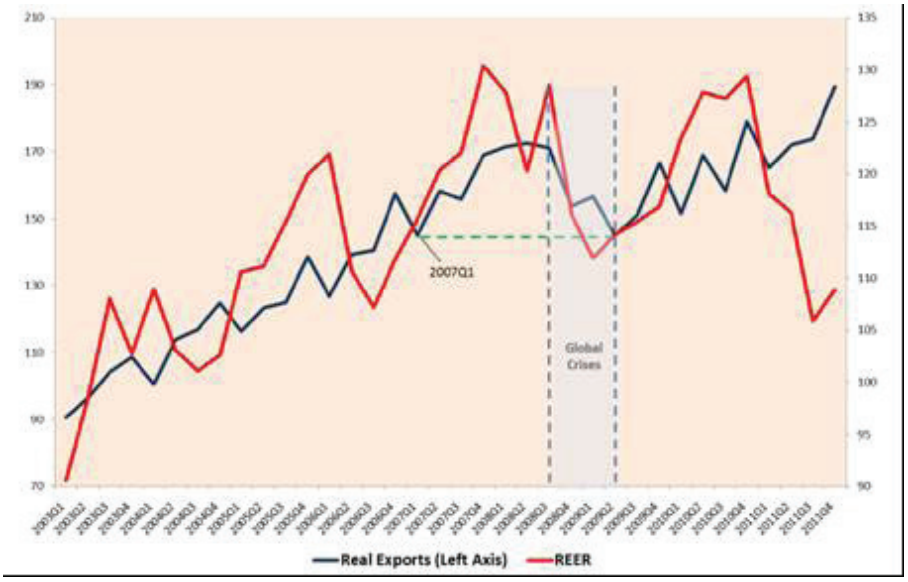
In this paper we will empirically investigate the impact of exchange rate volatility on the export function of Turkey with it's major trading partners. A country's exchange rate is an important determinant of export growth and it's progress through time. In addition, it serves as a measure of international competitiveness and is therefore a useful indicator of economic performance. Increasing exchange rate volatility, which is a major source of exchange rates risk, has significant implications on the volume of trade flows. High fluctuations in exchange rates create uncertainty about the profits to be made, and thus reduce the gains of international trade, hampering the volume of trade. Also, the degree of risk aversion exerts a key influence in determining the effect of exchange rate uncertainty on exports.

As summarized in Table 2, previous studies examining this structure focused on a single regression type of model, such as OLS, GARCH/MGACRCH, and VAR. In our study, similarly, we employed OLS regression in order to analyze the impact of exchange rate volatility on exports from Turkey.

Liberal economic policies were implemented after the 1980's in Turkey, but the exchange rate policy was not fully liberalized. Various adjustable exchange rate policies were implemented between 1980 and 2001 (Crawling Peg Exchange Rate Regime (1980 to 1989), flexible Exchange Rate Regime (1989 to 1993), Crawling Band Regime (1994 to 1996), and the Currency-Peg Regime in 2000). After the economic crisis in February, 2001 and adoption of new regulations to ensure efficiency

in the foreign exchange market and trade, Turkey adopted a floating exchange rate system. Since then, as the exchange rate was liberalized, it began to fluctuate and the volatility of the Turkish Lira against the major trading partners' currencies has increased significantly in trade flows.

The remainder of the paper is organized as follows : Section 2 presents the measurement of the Exchange rate volatility; Section 3 describes data sources and sample selections; Section 4 discusses the methodology and empirical results; and the conclusions are drawn in the last section.



Source: Exchange Rates – Trade: Turkey Case, World Trade Organization, Seminar on Exchange Rates and Trade, March 2012.

Figure 1: Exports vs. Real Effective Exchange Rate

Measuring Exchange Rate Volatility

For the empirical part of this study, we constructed a simple export demand function including a proxy for a measure of exchange rate uncertainty . The long run export demand function can be written as (McKenzie 1998, Chowdhury 1993):

$$\ln X = \alpha_0 + \alpha_1 \ln Y^* + \alpha_2 \ln EPI + \alpha_3 \ln V + \upsilon \quad \text{(Eq.1)}$$

where X is real exports, Y* is a measure of real foreign activity, EPI denotes the export price index, and V is the exchange rate volatility. According to the function above, it is expected that $\alpha_1 > 0$, $\alpha_2 < 0$ and $\alpha_3 < 0$ or > 0 as indicated previously.

While there is no specific calculation of exchange rate volatility, various statisti-

cal measures of exchange rate volatility have been calculated in the literature. In our empirical study, the exchange rate volatility variable is constructed by the moving sample standard deviation of the growth of the real exchange rate

$$V_t = \left[\left(\frac{1}{m}\right)\sum_{i=1}^{m}(logQ_{t+i-1} - logQ_{t+i-2})^2\right]^{\frac{1}{2}} \quad \text{(Eq. 2)}$$

where m = 12 is the order of the moving average (Chowdhury 1993). McKenzie (1999) summarized the measures used to generate the exchange rate volatility; according to his study, the most widely used exchange rate volatility is the moving average of the standard deviation of exchange rate. The relevant exchange rate measures changes according to the sample period, no matter whether the exchange rate is real or nominal, what explanatory variables should be included and what estimation technique is to be employed. In the literature Kenan and Rodrik (1986), Koray and Lastrapes (1989) also used this measure in their empirical study.

Data and Sample Selection

Turkey's aggregate export was examined for the period of 2003:2 to 2010:12. The data set consisted of monthly observations for the interest variables used in the analysis. We obtained the monthly real effective exchange rate data from the Central Bank of Turkey. Data for the exports, the export price index and the consumer price index of Turkey were obtained from the Turkish Statistical Institute (TurkStat), and the consumer price index of the USA was obtained from the US Bureau of Labor Statistics.

Economic theory suggests that income in trading countries is a major determinant of a nation's exports. Where the GDP is one of the main variables of the equation, Y* that shows the foreign activity of Turkey is calculated as the weighted average GDP of the major Turkish trading partners. The GDP levels of Turkey's major trading partners (Germany, United Kingdom, Italy, United States, France, Spain, Netherlands, Belgium, and Greece) were taken and multiplied by their trade volume in relation to Turkey. We used the OECD Industrial Production Index to obtain the monthly details for this data.

In order to measure competitiveness, the relative variable export prices were obtained from TurkStat in order to analyze the real effects.

To calculate the volatility variable, real exchange rates were taken from TurkStat and calculated as the moving sample standard deviation of growth for the real exchange rate for each month for the specified period.

Results and Methodology

In this section, descriptive statistics, cross correlations, the unit root test, the Chow test, regression results and their main assumptions are provided. The descriptive statistics are shown in Table 3. According to these statistics, the average rate of exchange was 115, while LnExport was 22.70, LnY was 11.80 and Volatility was 0.038.

Table 3: Descriptive statistics results

Variable	Obs	Mean	Std. Dev.	Min	Max
Real Exchange Rate	95	115.0265	9.9063	91.1900	131.8500
LnExport	95	22.6968	0.3388	21.7960	23.2722
LnY*	95	11.8036	0.0666	11.6692	11.9025
Volatility	94	0.0376	0.0117	0.0196	0.0598

In order to investigate the relationship between two time series, cross correlation among the LnExport and the independent variables were employed and are shown below (Figure 2, 3, and 4). According to figure 2, at lag 0 there was a positive correlation between LnExport and LnY, which means that while an increase in LnY caused an increase in LnExport, it decreased slowly by the 12th lag. Similarly, there was a positive significant impact of LnEPI on LnExport. This relationship was at it's highest at lag 0 and slowly decreased until lag 13 (Figure 3). However, there seemed to be a very weak correlation between volatility and LnExport (Figure 4) .

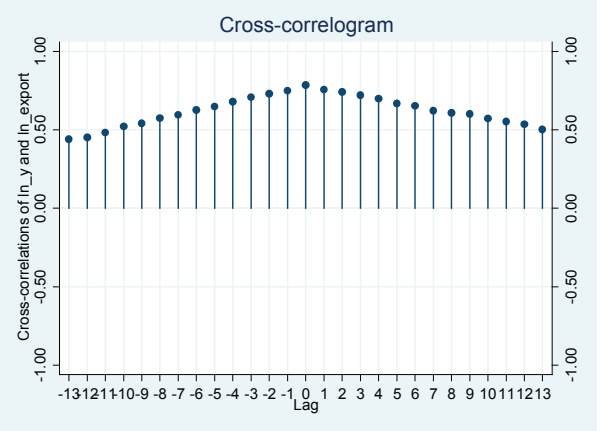


Figure 2: Cross correlation between LnExport and LnY

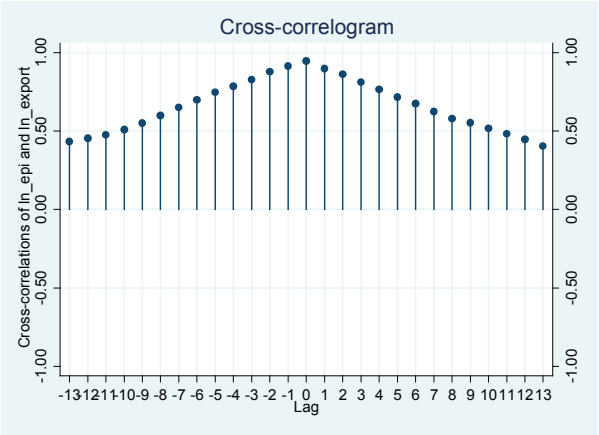


Figure 3: Cross correlation between LnExport and LnEPI

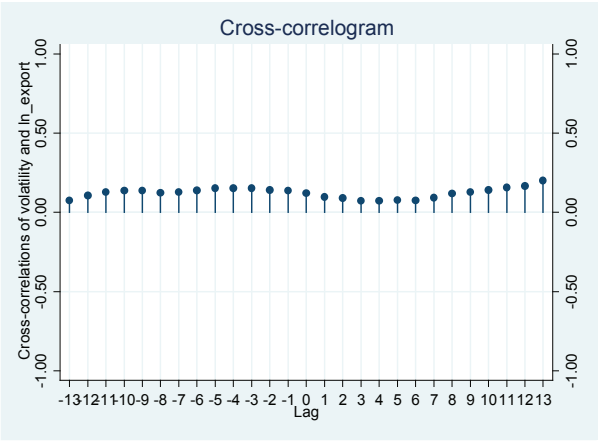


Figure 4: Cross correlation between LnExport and LnEPI

The unit root test was used in case there was more than one trend in the series. In order to test stationarity, there are various tests such as the Dickey-Fuller (DF) , Augmented Dickey-Fuller (ADF) , and the Phillips-Perron (PP). ADF is the most commonly used test, therefore it was employed for each variable (Table 4). ADF tests whether a variable has a unit root; the null hypothesis was that the variable contained a unit root, and the alternative was that the variable was generated by a stationary process. For ADF, the optimum number of lags to be selected was determined by using the Akaike's Information Criterion (AIC). According to the results of AIC, the number of lags varied between 3 or 4 in the ADF test.

According to the unit ratio test results, the LnExport dependent variable did not have a unit root in both tests. Since our time series data had an upward trend, this trend option was considered in calculating the tests. It is of interest that the ADF results were significant in all of the variables at the 0.05 significant level while the independent variables were not significant using the PP unit test. According to these tests, LnExport did not have a stochastic trend.

Table 4 : PP and ADF unit root test results.

Variables	**ADF**
LnExport (Intercept and trend)	-5.653*** (0.0001)
LnExport (Intercept only)	-5.581*** (0.0001)
LnY (Intercept and trend)	-4.347** (0.0027)
LnY (Intercept only)	-4.268** (0.0005)
LnEPI (Intercept and trend)	-3.853** (0.0141)
LnEPI (Intercept only)	-3.754** (0.0034)
Volatility (Intercept and trend)	-3.82**5 (0.0153)
Volatility (Intercept only)	-3.77**5 (0.0032)

ADF statistics are given with their MacKinnon approximate p-value in brackets.

In order to test serial correlations, Breush-Godfrey LM and Durbin-Watson are the most commonly used tests. The null hypothesis was that there was no serial correlation for both tests. In the LM test, up to 4 lags of options were added. According to the test results, both tests strongly accepted the null that there were no first-order serial correlations. As a result, there is no serial correlation issue in the study data.

The Chow test allows us to discover whether a particular date causes a break in the regression coefficients. It is most commonly used to detect the presence of a structural break and is often used to determine whether independent variables have different impacts on different subgroups of the population. In this study, we employed structural change regressions and the Chow test (Table 6) designed by Shehata (2011); the null hypothesis was that there was no structural change. This methodology provided the Chow test results as well as the regression , with three types within it. According to the results, there was no structural change in each of the

types provided.

Table 5 explains the regression results in which LnExport was the dependent variable while LnY, LnEPI and Volatility were the independent variables. As well as OLS, we have provided regressions by Cochrane-Orcutt, Prais-Winsten and Newey to demonstrate the robustness of the results. Other than OLS, these regressions are necessary for autocorrelation in the event of error. Even though our model had not demonstrated a serial correlation, we have provided these estimates to support the robustness of the OLS regression results.

According to the OLS results, the weighted average of GDP (LnY) for trading partners had a significant positive impact on exports at the 1% significance level which indicated that a higher income level for the trading partners of Turkey will increase Turkey's exports to the indicated countries. Our investigations indicated that there was a positive significant relationship between export prices and exports from Turkey. These results did not match the results found in the literature. Using the Chow test analysis (Table 6) in order to check the OLS results for the export price index over exports, we tried to determine the same relationship both before and after 2008, when there was a serious worldwide financial crisis. However, the positive relationship between these variables did not change. Volatility had a negative impact on exports, but it was not significant. This explained the ambiguity of the results in the literature. According to the Ramsey reset test[4], our model indicated no omitted variables. Therefore, the current explanatory variables are sufficient.

4 Ramsey Reset F-statistics (3,87): 1.50; p-value: 0.22, H0: Model has no omitted variables.

Table 5: The OLS regression results

Variables				
Dependent Variables: LnExport	***Regular OLS***	***Cochrane-Orcutt regression***	***Prais-Winsten regression***	***Newey-West standard Error***
LnY	0.99*** (4.50)	1.002*** (4.64)	0.995*** (4.64)	0.993*** (5.03)
LnEPI	1.78*** (18.22)	1.782*** (18.64)	1.778*** (18.75)	1.778*** (19.89)
Volatility	-0.22 (-0.25)	-0.192 (-0.23)	-0.218 (-0.26)	-0.215 (-0.34)
Constant	2.31 (1.01)	2.176 (0.97)	2.277 (1.02)	2.308 (1.13)
R2	0.91	0.9165	0.9286	-
F-Statistics	321.98 ***	325.45***	389.98***	424.61***
Observations	95	95	95	95
Durbin Watson	2.0281	1.974203	1.972195	N/A
Breusch-Godfrey LM test ***Lags/ Chi-Squre (df)/ p-value***	1/0.085(1)/0.7709 2/0.902(2)/0.6369 3/1.281(3)/0.7336 4/6.732(4)/0.1507	N/A	N/A	N/A
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity ***Chi-Squre (df)/ p-value***	0.71(1)/0.40			

T-statistics are given in parentheses. *significant at 10 per cent level, **significant at 5 per cent level, ***significant at 1 per cent level;

Table 6: Chow test results

Variables	***Chow test- Type 1***	***Chow test- Type 2***	***Chow test- Type 3***
Dependent Variables: LnExport			
LnY	0.985*** (4.41)	0.630* (1.64)	0.877** (2.09)
LnEPI	1.761*** (15.46)	1.975*** (8.99)	1.865*** (8.03)
Volatility	-0.242 (-0.28)	-0.232 (-0.20)	-0.269 (-0.23)
Constant	2.479 (0.299)	5.632 (1.54)	3.250 (0.81)
D	0.008 (0.29)	-	13.055 (1.39)
D*LnY	-	0.160 (1.15)	-0.885 (-1.16)
D*LnEPI	-	-0.376 (-1.14)	-0.499 (-1.47)
D*Volatility	-	-0.571 (-0.30)	-1.707 (-0.84)
R2	0.9148	0.9161	0.9179
F-Statistics	239.05***	158.34***	137.45***
Observations	94	94	94
Structural Change Test (Chow test statistics)	0.0831 (p-value: 0.7738)	0.4630 (p-value: 0.7089)	0.8333 (p-values: 0.5077)

Chow test types: Type 1:Y=X+D, Type 2:Y = X + DX, Type 3: Y = X + D + DX, D represents the dummy variable (0,1 which takes 0 in the first period, and 1 in the second period.
DX represents the cross product of each times in D. The first period was selected until 2008. According to the

line graphic (Figure 4) there seems to be a change in the trend line. Therefore, we tried to test it using the Chow test. The t-statistics are given in parenthesis. *significant at 10 per cent level, **significant at 5 per cent level, ***significant at 1 per cent level; "D" represents the dummy variable

The scatter plots with trend line, as well as the line graph of LnExport versus the years are shown in figures 4 and 5. The dependent variable "LnExport" shows a steady trend, even though there is a sharp decrease around 2008.

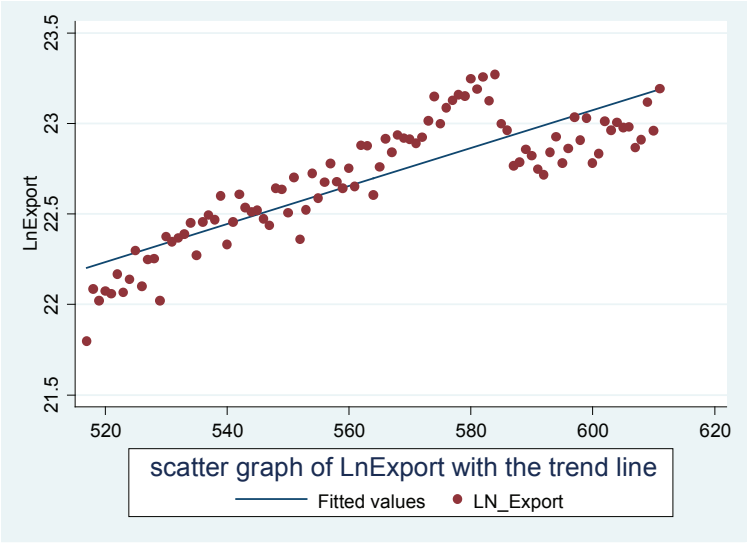


Figure 5: Scatter graph of LnExport

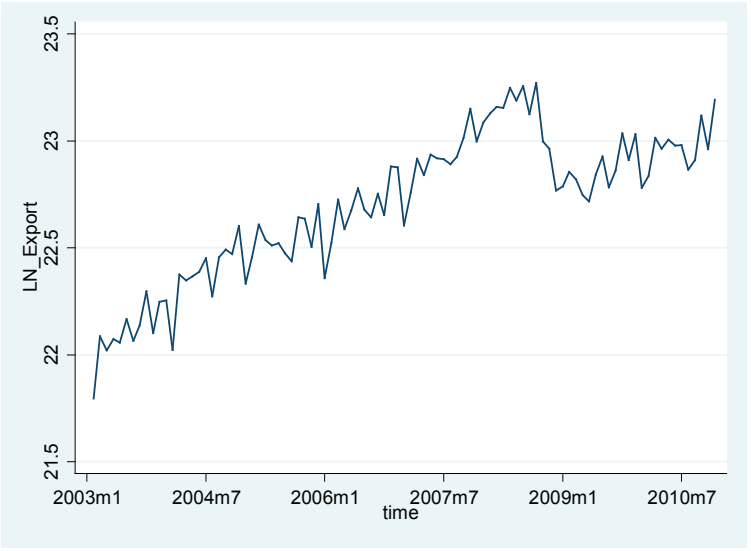


Figure 6: Line graph of LnExport versus the year

In order to determine how well the model demonstrated it's predictions, we have shown the linearity of the model and the behavior of the residuals. Figure 5 shows the ability of the model prediction. It is customary to expect a 45 degree pattern in the data. The Y-axis is the observed data (LnExport) and the X-axis is the predicted data. According to the scatter graph, our model seems to predict LnExport reasonably well. Another important assumption is that the variance in the residuals had to be homoskedastic, or constant.

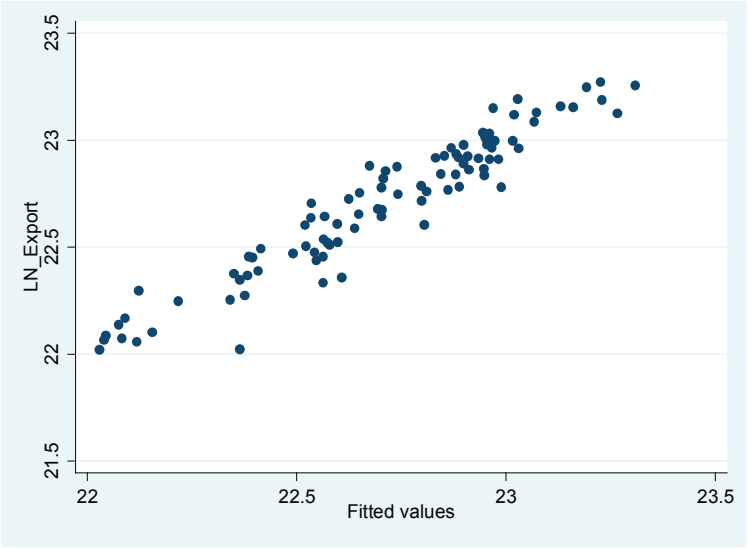


Figure 7: Predictive ability of the model

Figure 6 shows the homoskedastic test results; customarily we should not be able to observe a pattern at all. Our results indicated that there is no issue of homoskedasticity. In addition to the graphical representation of the homoskedasticity test, we have provided a non-graphical way to detect heteroskedasticiy using the Breusch-Pagan test (Table 5). The null hypothesis was that residuals are homoskedastic; we failed to reject the null at 95% and concluded that the residuals are homogeneous.

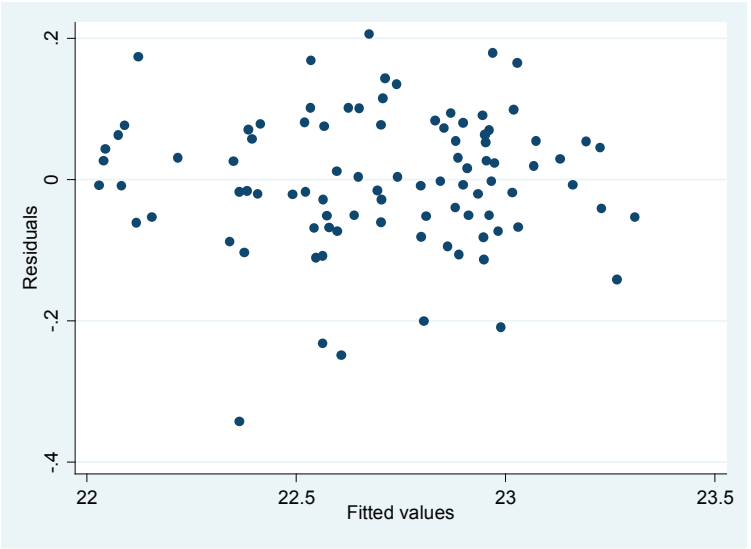


Figure 8: Testing for homoskedasticity

Conclusion

This study attempted to demonstrate the impact of exchange rate volatility as well as export prices with the weighted average income of Turkey's trading partners. The exchange rate is an important determinant of export growth and its progress through time, while it serves as a measure of international competitiveness and is therefore a useful indicator of economic performance. High fluctuations in exchange rates create uncertainty about the profits to be made, thus reducing the gains of international trade and hampering the volume of trade. According to this theoretical approach, we investigated the same relationship for Turkey. Even though we could not find a significant impact of volatility on exports, our findings indicated that there is no single result depicting the relationship between these variables within Turkey or even in the world. The expected coefficient signs of the income of the various trading partners as well as volatility were confirmed by the literature, while the expected export price index was not supported in this study. The OLS regression technique was employed. Various other models such as VAR, GARCH and MGARCH might be used in future studies.

References

Akhtar, M.A. and R. Spence Hilton. 1984. ''Effects of Exchange Rate Uncertainty on German and U.S. Trade'', *Federal Reserve Bank of New York Quarterly Review*, 9(1): 7-15.

Arize, C. A., T. Osang and J. D. Slottje. 2005. ''Exchange-Rate Volatility in Latin America and its Impact on Foreign Trade'', September. Available at: http://faculty.smu.edu/tosang/pdf/latin.pdf

Brada, Josef C. and José A. Méndez. 1988. ''Exchange Rate Risk,. Exchange Rate Regime and the Volume of International Trade'',. *KYKLOS*, 41: 263-80.

Chowdhury, A. R. 1993. ''Does Exchange Rate Volatility Depress Trade Flows? Evidence from Error-Correction Models'', *Review of Economics and Statistics*, 75: 700-706.

Güloğlu, B. 2008. ''Exports and Volatility of Exchange Rate Under Alternative Exchange Rate Regimes:The Case of Turkey'' Proc. The International Conference on Policy Modeling, EcoMod, Berlin.

Ivanov, V. and Kilian L. 2001. ''A Practitioner's Guide to Lag-Order Selection for Vector Autoregressions'' CEPR Discussion Paper no. 2685. London, Centre for Economic Policy Research. http://www.cepr.org/pubs/dps/DP2685.asp.

Kasman, A. and S. Kasman. 2005. ''Exchange Rate Uncertainty in Turkey and its Impact on Export Volume'', *METU Studies in Development*, 32 (June), 2005, 41-58.

Kenen, P.B. and D. Rodrik. 1986. ''Measuring and Analyzing the Effects of Short-term Volatility in Real Exchange Rates'', *Review of Economics and Statistics* 68: 311-15.

Koray, F. and W. D. Lastrapes. 1989. ''Real Exchange Rate Volatility and US Bilateral Trade: a VAR Approach'', *Review of Economics and Statistics,* 71: 708-12.

McKenzie, Michael D. 1998. ''The Impact of Exchange Rate Volatility on Australian Trade Flows'', *Journal of International Financial Markets, Institutions & Money* 8: 21-38.

McKenzie, Michael D. 1999. ''Impact of Exchange Rate Volatility on International Trade Flows'', *Journal of Economic Surveys* 13: 71-106.

McKenzie, Michael D. and R. Brooks. 1997. ''The Impact of Exchange Rate Volatility on German - US Trade Flows,'' *Journal of International Financial Markets, Institutions and Money*, 7, pp. 73-87.

Nazlıoglu, S. 2012. ''Exchange rate volatility and Turkish industry-level ex-

port: Panel cointegration analysis'', *The Journal of International Trade & Economic Development*, 2012, 1-20, iFirst Article.

Ozbay, P. 1999. ''The Effect of Exchange Rate Uncertainty on Exports: A Case Study for Turkey'', *Central Bank of the Republic of Turkey Research,* Department Working Papers.

Ozturk, I. and H. Kalyoncu. 2009. ''Exchange Rate Volatility and Trade: An Empirical Investigation form Cross-country Comparison'', *African Development Review*, 21, 499-513.

Ozturk, I. and A. Acaravcı. 2002. ''The effects of exchange rate volatility on the Turkish export: an empirical investigation'' *Review of Social, Economic and Business Studies* , Vol. 2, No. Fall, pp. 197-206.

Shehata, Emad Abd Elmessih. 2011.CHOWREG: ''Stata Module to Estimate Structural Change Regressions and Compute Chow Test''

Vergil, H. 2002. ''Exchange Rate Volatility in Turkey and Its Effect on Trade Flows'', *Journal of Economic and Social Research*, 4 (1), 83-99.

WTO (2012) Exchange Rates – Trade: Turkey Case, Seminar on Exchange Rates and Trade, March 2012. http://www.wto.org/english/news_e/news12_e/s2_kizilarslan_turkey_e.pdf