T.C
MARMARA ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
İKTİSAT (İNG.) ANA BİLİM DALI
İKTİSAT (İNG.) BİLİM DALI

A REGIONAL ANALYSIS OF THE EFFECTS OF EXCHANGE RATE VOLATILITY ON EXPORT AND IMPORT IN TURKEY

Yüksek Lisans Tezi

CANER ERDEM

İstanbul, 2019

T.C
MARMARA ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
İKTİSAT (İNG.) ANA BİLİM DALI
İKTİSAT (İNG.) BİLİM DALI

A REGIONAL ANALYSIS OF THE EFFECTS OF EXCHANGE RATE VOLATILITY ON EXPORT AND IMPORT IN TURKEY

Yüksek Lisans Tezi

CANER ERDEM

Doç. Dr. YASEMİN ÖZERKEK

İstanbul, 2019

T.C.
MARMARA ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ MÜDÜRLÜĞÜ

TEZ ONAY BELGESİ

İKTİSAT (İNGİLİZCE) Anabilim Dalı İKTİSAT (İNGİLİZCE) Bilim Dalı TEZLİ YÜKSEK LİSANS öğrencisi CANER ERDEM'nın A REGIONAL ANALYSIS OF THE EFFECTS OF EXCHANGE RATE VOLATILITY ON EXPORT AND IMPORT IN TURKEY adlı tez çalışması, Enstitümüz Yönetim Kurulunun 02.05.2019 tarih ve 2019-12/8 sayılı kararıyla oluşturulan jüri tarafından oy birliği / [redacted] ile Yüksek Lisans Tezi olarak kabul edilmiştir.

Tez Savunma Tarihi 29/05/2019

Öğretim Üyesi Adı Soyadı			İmzası
1.	Tez Danışmanı	Doç. Dr. YASEMİN ÖZERKEK	
2.	Jüri Üyesi	Dr. Öğr. Üyesi PINAR DENİZ	
3.	Jüri Üyesi	Dr. Öğr. Üyesi FATMA DİDİN SÖNMEZ	

GENEL BİLGİLER

Adı ve Soyadı	: Caner Erdem
Anabilim Dalı	: İngilizce İktisat
Programı	: İngilizce İktisat Yüksek Lisans
Tez Danışmanı	: Doç. Dr. Yasemin Özerkek
Tez Türü ve Tarihi	: Yüksek Lisans – Mayıs 2019
Anahtar Kelimeler	: Döviz Kuru Oynaklığı, İhracat, İthalat

ÖZ

TÜRKİYE'DE DÖVİZ KURU OYNAKLIĞININ İHRACAT VE İTHALAT ÜZERİNE ETKİLERİNİN BÖLGESEL BAZDA İNCELENMESİ

Döviz kuru oynaklığının uluslararası ticaretle olan ilişkisi 1973 yılında Bretton Woods Sisteminin çökmesinden beri ekonomistler için önemli bir soru olmuştur. Bu konuda yapılmış olan birçok çalışma olmasına rağmen, döviz kuru oynaklığının ihracat veya ithalata olan etkisi üzerinde fikir birliğine varılabilmiş değildir. Bu tezde 2004 ve 2014 yılları arasında reel efektif döviz kuru oynaklığının Türkiye'nin reel bölgesel ihracat ve reel bölgesel ithalat değerlerini nasıl etkilediğini incelemek amaçlanmıştır. Tüm analizler klasik ihracat talep denklemi ve klasik ithalat talep denklemine dayanarak yapılmıştır. Bu çalışmanın ana bulguları döviz kuru oynaklığının Türkiye'nin İBBS (İstatistiki Bölge Birimleri Sınıflandırması) Seviye-1 bölgelerinin ihracatları ve ithalatları üzerinde negatif ve önemli bir etkiye sahip olduğunu göstermiştir. Başka bir deyişle reel efektif döviz kuru oynaklığında bir artış olduğunda, bölgelerin ihracat ve ithalat seviyelerinde düşüş olmaktadır. Aynı şekilde göreceli fiyatlar da bölgelerin ihracat ve ithalat seviyeleri üzerinde negatif ve önemli bir etkiye sahiptir. Çalışmanın bir diğer bulgusu ise, reel bölgesel gelirde meydana gelen bir artışın bölgelerin ithalat seviyelerini, yabancı gelirde meydana gelen bir artışın ise bölgelerin ihracat seviyelerini artırdığıdır.

GENERAL INFORMATION

Name Surname	: Caner Erdem
Field	: Economics
Program	: Economics (English)
Supervisor	: Assoc. Prof. Yasemin Özerkek
Degree Awarded and Date	: MA – May 2019
Keywords	: Exchange Rate Volatility, Export, Import

ABSTRACT

A REGIONAL ANALYSIS OF THE EFFECTS OF EXCHANGE RATE VOLATILITY ON EXPORT AND IMPORT IN TURKEY

Exchange rate volatility and its relationship with international trade have been a significant question for economists since the decline of the Bretton Woods System in 1973. Despite many studies in the literature, there is no consensus about the effect of exchange rate volatility on export or import. This thesis aims at investigating the impact of real effective exchange rate volatility on both real regional import and real regional export of Turkey over the period 2004 to 2014. All analyses are performed depending on traditional export demand and classical import demand equations. Main findings of this research demonstrate that exchange rate volatility has a negative and significant effect on both export and import of the NUTS-1 Regions in Turkey. In other words, an increase in real effective exchange rate volatility decreases the export and import levels in regions. Likewise, relative prices have also negative and significant effect on both export and import levels of the regions. One of the other findings of the study is that an increase in real regional income leads to a rise in import activities and an increase in real foreign income leads to a rise in export activities of the regions.

PREFACE

Firstly, I would like to express my sincere appreciation and thanks to Assoc. Prof. Yasemin Özerkek for her support, guidance, and help throughout this challenging process. I also would like to thank Dr. Pınar Deniz for her contributions to my thesis. Furthermore, I also would like to thank Prof. Suut Doğruel and Prof. Fatma Doğruel for their inspirations, help, and guidance.

Secondly, I would like to thank my uncle Dr. Safa Demirbaş for his guidance, help, and support in every stage of my academic life.

Finally, I would like to thank my family for their support, help, and encouragement in every step of my life.

İstanbul 2019

Caner Erdem

TABLE OF CONTENTS

Page Num.

LIST OF TABLES

Page Num.

LIST OF FIGURES

Page Num.

LIST OF ABBREVIATIONS

ADF	: Augmented Dickey-Fuller
ARCH	: Autoregressive Conditional Heteroscedasticity
ARDL	: Autoregressive Distributed-lagged model
ARIMA	: Auto-Regressive Integrated Moving Average
CBRT	: Central Bank of the Republic of Turkey
EU	: European Union
G7	: Group of Seven
GARCH	: Generalized Autoregressive Conditional Heteroscedasticity
GDP	: Gross Domestic Product
IMF	: International Monetary Fund
NUTS	: Nomenclature of Territorial Units for Statistics
OECD	: Organisation for Economic Co-operation and Development
REERVOL	: Real Effective Exchange Rate Volatility
RP	: Relative Prices
SITC	: Standard International Trade Classification
TURKPATENT	: Turkish Patent and Trademark Office
TURKSTAT	: Turkish Statistical Institute
UK	: United Kingdom
US	: United States
USA	: United States of America
VAR	: Vector Autoregression

1. INTRODUCTON

Many advanced and emerging economies turned their monetary system into a floating exchange rate regime when the Bretton Woods System was collapsed in 1973. Since then, the uncertainty in the exchange rate and its relationship with international trade have been a significant question for economists.

Numerous studies are analyzing the impact of unexpected movements of exchange rate on export or import both empirically and theoretically but, there is no consensus about the effect of exchange rate movements on international trade. For example, Ethier (1973) states that if there is uncertainty concerning the future profit of the firms based on exchange rate volatility, firms will decrease their level of activities to minimize the risk of their actions. According to Baron (1976), firms have two options, selling their goods in local currency or foreign currency and each option has its own risk. If firms decide to sell their outputs in foreign currency, they will face a risk of decrease in their profit. However, if firms decide to sell their products in the local currency, they will face a risk of reduction in quantity. For these reasons, Baron states that exchange rate volatility might hurt trade depending on the risk behavior of the firms. Kenen and Rodrik (1986), Cushman (1986), Koray and Lastrapes (1989), Chowdhury (1993), Arize (1995) and Arize, Osang and Slottje (2000), are the other significant economists who have studies supporting this view. Despite the ideas about the adverse effect of exchange rate volatility on trade because of the risk-averse behavior of the firms, other studies show different results.

De Grauwe (1988) states that, if there is increasing risk, more risk-averse exporters will start to export more to protect themselves from less revenue. On the other hand, the less risk-averse exporters will begin to export less because of unattractive revenues. According to De Grauwe, the behavior of exporters is ambiguous under risk, and it is not directly possible to assert that if there are risk firms would be less willing to take a role in export activities. Sercu and Vanhulle (1992) indicate that there is a positive relationship between exchanges rate volatility, the value of the firms and trade. As previously mentioned, the effect of exchange rate volatility on trade is not apparent in literature, and different theoretical and empirical studies state not only different but also conflicting results. Relevant theoretical and empirical considerations are reviewed in the Literate Survey section comprehensively.

Many studies examine the effect of real exchange rate volatility on export or import or both of them for Turkey. According to Doğanlar (2002), the effect of exchange rate volatility on the Turkish export is negative. However, Kasman and Kasman (2005) state that the impact of exchange rate volatility on the export in Turkey is positive. However, these analyses examine this relationship at the aggregate level or sectoral level. The main difference of this study from others is the regional investigation of this relationship.

Turkey is divided into twelve regions according to Nomenclature of Territorial Units for Statistics (NUTS) level 1. The purpose of this research is to investigate the relationship between real exchange rate volatility and both real export and real import in these regions.

The primary motivation behind this thesis is the desire to understand the effect of exchange rate volatility on export and import of the regions in Turkey. The investigation of the relationship between exchange rate volatility with real export and real import has crucial importance to develop and implement more effective economic policies.

The thesis consists of six sections; Introduction, Literature Review, Data, Descriptive Statistics, Theoretical Considerations and Model Specification, and Conclusion. The main aim of the study, motivation and other important information presented in the first section. Significant researches that examine the effect of exchange rate volatility on international trade are summarized in the second section comprehensively. Information about existing variables, data sources, and calculation techniques are displayed in third section. The visual, informative illustrations and statistics about all variables are presented in the section 4. The models and econometric estimation techniques, theoretical background of the study and econometric estimation results are presented in Section 5. The assessment of the estimation results and other essential comments are given in Section 6.

2. LITERATURE REVIEW

Abrams (1980) considers the determinants of trade among countries by emphasizing the effects of exchange rate volatility. According to Abrams's study, one of the primary variables that might affect mutual trade is the income of the country. The other significant determinant of trade is distance. The third critical factor that might affect international trade is the membership of any trade organization. Furthermore, Abrams (1980) indicate that exchange rate volatility might be another factor that affects trade. Abrams creates a model and analyzes 19 countries from 1973 to 1976 to determine the impact of these variables on global trade. According to his research, the uncertainty in the exchange rate deteriorates trade (Abrams, 1980).

Akhtar and Hilton (1984) observe the relationship of exchange rate volatility with export and import in Germany and the United States over the period 1974 to 1981. Akhtar and Hilton state that there is no perfect way to compute the uncertainty in the exchange rate. For this reason, they use the volatility of the exchange rate as a proxy to represent uncertainties. What they have concluded is that the sign of the effect of exchange rate volatility on both import and export in Germany is negative and significant. Moreover, the effect of exchange rate volatility on the export in the United States is also negative and significant. On the other hand, exchange rate volatility has a weak effect on import in the United States (Akhtar and Hilton, 1984).

Kenen and Rodrik (1986) investigate the relationship between exchange rate volatility and trade for eleven advanced economies. Exchange rate volatility is calculated by three ways. The first measure of exchange rate volatility is computed by taking the standard deviation of the monthly percentage change in the real effective exchange rate. Second and third measures of exchange rate volatility are estimated by taking the standard deviation of the real effective exchange rate obtained from the logarithmic trend equation and first-order autoregressive equation respectively. One of the expectations of their research is to find a reduction in the real exchange rate volatility and its effect on trade when countries begin to gain knowledge in a flexible exchange rate regime. On the other hand, Kenen and Rodrik conclude that there is no decrease in the exchange rate volatility over time. Moreover, their study observes a negative and significant relationship between exchange rate volatility and import in four countries. Their research reveals that short-term real exchange rate volatility decreases the level of international trade (Kenen and Rodrik, 1986).

Cushman (1986) express that many studies use bilateral trade flow information to determine the effect of exchange rate uncertainty on trade. According to Cushman, these analyses may miss one critical point while making their estimates; the effect of the third country. Cushman asserts that one way to get rid of this problem is to use aggregate import or export data. However, the effect of uncertainty on bilateral trade is also important, and it is not possible to figure out the effect of uncertainty with an aggregate approach. Cushman uses aggregate and bilateral trade information without disregarding the effect of the third country, and he analyzes six trade partners of the United States. The outcome of his examination points out that, the risk of the third country has a role in international trade. Also, Cushman observes a negative impact of exchange rate volatility on trade, but he states that the effect of volatility on international trade is not as large as some of the previous studies show. These studies obtain a larger effect because of ignoring the effect of third country (Cushman, 1986).

Bailey, Tavlas and Ulan (1986) investigate the effect of exchange rate volatility on the export of 7 OECD countries namely Canada, United Kingdom France, Japan, United States, Italy and Germany over the years 1973 to 1984. One of the early results of their study finds real income as the main factor of real export in all the 7 OECD countries. Moreover, according to the conclusion of their research, the effect of exchange rate volatility on export is insignificant in each country (Bailey, Tavlas and Ulan, 1986).

De Grauwe (1988) states that the behavior of exporters is ambiguous under risk and it is not directly possible to say that if any risk exists firms will be less willing to take a role in export activities. The theoretical critique of De Grauwe is different from previous researches. De Grauwe (1988) considers that if there is increasing risk, more risk-averse exporters will begin to export more to defend themselves from less revenue. On the other hand, the less risk-averse exporters will start to export less because of unattractive revenues. According to De Grauwe, underlying reasoning behind these actions of exporters with different risk-aversion attitude can also be explained by substitution and income effect. If the substitution effect is more than the income effect, then exporters will start to export less when there is more exchange rate risk. The risk theory alone is not enough to conclude that volatility decreases trade. De Grauwe also examines the effect of the political economy on international trade, and he figures out that, if there are declines in output or employment there will be some damaged individuals that would like to defend their domestic market by protective legislation that will lead reductions in trade. Moreover, De Grauwe empirically investigate the impact of exchange rate volatility on the trade among ten developed countries. As a result of his study, exchange rate volatility is not the only factor that is enough to say there is a negative relationship between trade and exchange rate volatility. There might be different variables that have more meaning to explain negative relationship such as a decrease in growth rate of output. However, according to De Grauwe, it is not clear to determine whether to use the output growth rate as an independent variable (De Grauwe, 1988).

Cabellero and Corbo (1989) theoretically and empirically investigate the relationship between real exchange rate volatility and export for Colombia, Peru Chile, Philippines, Thailand, and Turkey. According to their research, uncertainty in exchange rate increases the expected export returns of the firms because of the convexity of firms' profit functions, and this may lead increases in export. However, risk aversion behavior of the firms tends to reduce the export level. They use ordinary least squares and instrumental variables techniques to decide the sign of the relationship between real exchange rate volatility and export. Real exchange rate volatility is estimated with standard deviation methods at the quarterly and yearly level in their study. Empirical results of their investigation demonstrate that there is an adverse relationship between export and real exchange rate volatility for all the six countries and 5 percent increase in real exchange rate volatility decreases export between 2 percent to 30 percent.

Koray and Lastrapes (1989) review the effect of real exchange rate volatility on the import in United States from United Kingdom, France, Germany, Canada, and Japan individually over the time 1959 to 1985 with VAR (Vector Autoregression) model. Moving standard deviations of the real exchange rate growth is used as an indicator of the real exchange rate volatility. Main variables in their study are the supply of money, industrial production index, consumer price index, nominal exchange rate and the returns of states bond. The outcomes of their research demonstrate that there is a weak and negative relationship between real exchange rate and import in the United States.

Klein (1990) analyzes the effects of exchange rate volatility in nine sectors of goods that are exported from the United States to the other seven developed countries. Klein observes a significant relationship between exchange rate volatility and export in six of the nine sectors. Firms tend to increase their export in five industries when there are more significant variations in exchange rate according to the conclusions of their research. However, Klein declares that exchange rate volatility might have a positive effect on the level of trade because of its' impact on the behavior of risk neutral firms, but his findings are not enough to explain risks neutral behavior of the firms sufficiently (Klein, 1990).

Medhora (1990) examines the effects of exchange rate variability on trade for the West African Monetary Union composed of 6 countries namely Benin, Burkina, Faso, Cato d'Ivoire, Niger Senegal, and Togo. Standard deviation of the weekly, monthly and quarterly nominal exchange rate is used as a measure of uncertainty in exchange rates. According to the investigation of Medhora, exchange rate volatility does not affect the real import in the West African Monetary Union.

Asseery and Peel (1991) investigate Australia, Japan, West Germany, United States, and United Kingdom over the period 1972-1987 to observe the effect of exchange rate volatility on export. The outcome of their research claims that the impact of exchange rate volatility is positive for all countries in their research.

Pozo (1992) reviews the effect of exchange rate volatility on the export in the United Kingdom to the United States over the years 1900 to 1940. His research measures exchange rate volatility in two different ways. The first exchange rate volatility is computed with standard deviation method and the second is estimated with GARCH methodology. The main conclusion of his study state that the impact of exchange rate volatility on trade is negative.

Chowdhury (1993) examines the effect of exchange rate volatility on export in G7 countries over the time 1973 to 1990. Chowdhury performs his analyses based on traditional export demand equation. The main variables in his investigation are real export, relative prices, and real exchange rate volatility. The weighted mean of the ten most important trade partners' GDP for each country is used as an indicator of foreign economic activity. Chowdhury calculates exchange rate volatility with moving sample standard deviation method. Moreover, the division of home country export price to its most important trade partners' export prices is used as an indicator of relative price. According to the result of his research, the effect of exchange rate volatility on export is negative in all the G7 countries.

Caporale and Doroodian (1994) explore the relationship between the conditional variance of the real exchange rate and imports to Canada from the United States. They declare that there are several techniques to obtain the measure of movements in real exchange rates and they used GARCH model to observe exchange rate volatility. However, Medhora (1990) asserts that standard deviation is a more appropriate way to find exchange rate volatility. Caporale and Doroodian use real exchange rate values to observe exchange rate volatility, and they witness a negative relationship between exchange rate volatility and United States' import to Canada.

Arize (1994) employs Johansen cointegration test to determine the way of the long-term relationship between real effective exchange rate and trade balance in nine Asian nations over the period 1973 to 1991. Arize discovers a positive relationship for seven of these nine countries.

Arize and Ghosh (1994) analyze the export and exchange rate volatility association for the United States over the years 1973 to 1991. They use four different measures to calculate exchange rate volatility; standard deviation, ARCH (Autoregressive Conditional Heteroscedasticity) and two other ways. Their study empirically shows the negative relationship between export and exchange rate volatility.

Arize (1996) explores the impact of exchange rate volatility on trade in Denmark, Finland, Belgium, France, Greece, Netherlands, Spain, and Sweden over the period 1973 to 1992. Countries are separated into two groups according to their membership to the European Exchange Rate Mechanism (ERM). Arize performs his analyses depending on the export demand function. The findings of Arize indicate a negative relationship between the uncertainty of exchange rate and export demand in both short -term and long -term without being affected by ERM membership.

Arize (1997) investigates the relationship of real exchange rate volatility and real export for G7 countries over the period 1973-1992 with Johansen cointegration model and error correction model using quarterly data. Arize used general export demand equation generated by Gotur (1985). Real exchange rate volatility is computed by taking moving sample standard deviation of the real exchange rate over eight months in his research. Cointegration properties of the variables are tested by Dickey and Fuller tests that include time trends. According to the conclusions of Arize, the effect of exchange rate volatility on the level of export of G7 countries is negative.

McKenzie and Brooks (1997) examine the effect of exchange rate volatility on the import and export of Germany with the United States over the time 1973 to 1992. They use traditional export and import demand functions. The main variables in their research are; exports, imports, Domestic GDP, Foreign GDP, Exchange rate, relative prices, and exchange rate volatility. The expectation about the sign of the effects of exchange rate volatility and income on both import and export is positive in their study. The volatility in the exchange rate is supposed to decrease import and increase export according to McKenzie and Brooks. They use ARCH models to estimate exchange rate volatility. According to the outcome of their investigation, there is a positive relationship between exchange rate volatility and trade flow. Moreover, the effect of Germany's income on its export is negative, the effect of the United States' income on import from Germany is positive.

Arize and Shwiff (1998) explore real exchange rate volatility and real import relation over the years 1973 to 1995 in G7 countries. Their investigation is used traditional import demand function. The volatility of the real exchange rate is measured using the moving average standard deviation of the estimated exchange rate. The conclusion of their study discovers a negative association between real exchange rate volatility and real import for all G7 countries excluding Canada and Germany. (Arize and Shwiff, 1998). Arize (1998) also analyzes the relationship of real import and real exchange rate volatility for Finland, Denmark, Belgium, Greece, Netherlands, Spain, Sweden, and France over the time 1973 to 1995. The estimation methods are similar to the Arize and Shwiff. Their result states the meaningful and adverse effect of exchange rate volatility on import for all countries mentioned in their study except Greece and Sweden.

Arize (1998) reviews the effect of exchange rate volatility on the United States' import over the period 1973 to 1993 in a flexible exchange rate regime by general import demand function. The main variables in his investigation are real imports, exchange rate volatility, gross domestic product, and relative prices. Exchange rate volatility is observed with moving sample standard deviation method, and the ratio of import prices to export prices is used as an indicator of the relative prices. According to the outcome of his examination, there is a negative relationship between exchange rate volatility and import in both short and long-run.

McKenzie (1998) analyzes the effect of exchange rate volatility on both export and import in Australia over the time 1969 to 1995. He uses traditional export and import demand functions. The main variables of his research are export, import, real exchange rate volatility, and real exchange rate. The volatility of the real exchange rate is estimated with ARCH and GARCH models. One of the differences in McKenzie's study is the investigation of the impact of exchange rate volatility on export and import for both aggregate and sectoral levels. The effect of exchange rate volatility is negative on import and is positive on export at the aggregate level. However, according to McKenzie, the relationship of both export and import with exchange rate volatility is probably sensitive to the characteristics of the industries, and the impact of volatility varies in different sectors.

Fountas and Bredin (1998) study the effect of exchange rate volatility on Irish export to the United Kingdom over the period 1979-1993. They perform their analyses depending on traditional export demand function. Moving standard deviation of the real exchange rate growth is used as an indicator of exchange rate volatility. They does not find any effect of exchange rate volatility on Irish export in the long-run, and they observe a negative impact of exchange rate volatility on export in the short-term. However, foreign income and relative prices affect export especially in the long-run according to the conclusion of their investigation.

Arize, Osang, and Slottje (2000) review the relationship between real exchange rate volatility and real export over the time 1973 to 1996 in Tunisia, Thailand, Taiwan, Ecuador, Korea, Indonesia, Malawi, Malaysia, Mexico, Philippines, Mauritius, Morocco, and Sri Lanka. They perform their investigations depending on the export demand function. Real exchange rate volatility is estimated by taking the logarithm of the moving standard deviation of real exchange rates. The conclusion of their research reveals a negative relationship between exchange rate volatility and export for all the countries mentioned in their study for both the long-run and short-run.

Chou (2000) explores the relationship between real exchange rate volatility and real export in China over the period 1981 to 1996 at sectoral level according to Standard International Trade Classification (SITC). The sectors are in the four categories, foodstuffs and tobacco, industrial materials, mineral fuels, and manufactured goods. Exchange rate volatility is computed with the ARCH methodology. The mean of Chinas six most crucial trade partners' real GDP is calculated as a proxy of the foreign income. The impact of foreign income is expected to be positive, the impact of relative prices is supposed to be negative, and finally, there is no expectation about the effect of volatility on export in his research. The outcome of his research shows the adverse effect of exchange rate volatility in manufactured goods and mineral fuels sectors and at aggregate level.

Aristotelous (2001) observes the effect of exchange rate volatility and exchange rate regime on export from the United Kingdom to the United States over the years 1889 to 1999 with the gravity model. His study uses the long-term export equation for two trading countries. The main variables in his research are real export, real income, real income per capita, relative prices and real exchange rate volatility. Moving standard deviation of the percentage change in the real effective exchange rate is used as an indicator of real exchange rate volatility. According to the findings of his investigation, neither the real exchange rate volatility nor exchange rate regime affects the United Kingdom Export to the United States.

Sauer and Bohara (2001) investigate the relationship between exchange rate volatility and export for 91 countries over the period 1966-1993. They employ panel data approach in their research. Furthermore, three different estimation methods of volatility and three different export equations are used to determine the sign of the effect of exchange rate volatility on export. They perform their investigation based on long-run export demand function. They use real OECD GDP as a proxy for the foreign income and real exchange rate as a proxy for relative prices. The outcome of their study indicates that there is a meaningful and negative relationship between real exchange rate volatility and real export for less developed countries. However, real exchange rate volatility does not have any impact on the real export of the developed countries.

Aristotelous (2002) analyzes the effect of flexible exchange rate regime on United States export over the period 1959 to 1997 in Canada, Germany, Japan and the United Kingdom with Johansen cointegration method. Aristotelous performs his analysis based on augmented long-term export demand function with a dummy variable. Moving standard error of the real effective exchange rate growth is used as a measure of volatility. His research figures out that, there is an adverse effect of exchange rate volatility on export from the US to Germany and England in the short-term, and there is a positive effect of exchange rate volatility on export from the US to Germany and Japan in the long-run.

Doğanlar (2002) employs traditional export demand function to investigate the relationship between export and exchange rate volatility with Engle-Granger Cointegration test for five countries namely Turkey, Pakistan, South Korea, Indonesia, and Malaysia. The exchange rate volatility is computed as the moving standard deviation of the real exchange rate growth. The result of his investigation asserts that there is a negative relationship between exchange rate volatility and real export for all the five countries in his research.

Vergil (2002) analyzes the relationship between real exchange rate volatility and Turkish export with the United States, Germany, France, and Italy over the period 1990 to 2000. Traditional export demand function is employed by Vergil to make his analyses. According to the result of his research, there is an adverse effect of exchange rate volatility on Turkish export to France, United States and Germany in the long-run. Moreover, there is a negative impact of exchange rate volatility on Turkish export to Germany in the short-term.

Acaravcı and Öztürk (2002) explore the relationship between exchange rate volatility and export over the period 1989 to 2002 with Johansen cointegration test and error correction models in Turkey. They perform their analyses based on the general export demand function. The main variables of their investigation are real export, foreign income, relative prices, and exchange rate volatility. Real effective exchange rate volatility is estimated as the moving standard deviation of the real exchange rate growth. The result of their research asserts that there is a negative relationship between exchange rate volatility and export in Turkey.

Bredin, Fountas, and Murphy (2003) investigate the effect of real exchange rate volatility on Ireland’s export to EU over the period 1978 to 1998 at both sectoral and aggregate level. European Union is one of the key trading partners of Ireland. Therefore, it is rational to analyze the effect of uncertainty in exchange rate on the Ireland’s export to European Union. The empirical analysis of their research is based on traditional export demand equation. The weighted mean of the five crucial European Union export partners' GDP is used as a proxy of the foreign income. The weights are computed by dividing the export and import of each of the five countries to Ireland’s aggregate export and import. The moving standard error of the growth rate of the real effective exchange rate is used as an indicator of the exchange rate volatility. They conclude that there is a positive relationship between exchange rate volatility and export in the long-run at aggregate level and SITC 0-4, SITC 5-8 sectoral levels. However, there is no effect of the exchange rate volatility on export in the short-run at both aggregate and SITC 0-4, SITC 5-8 levels in the short-run.

Arize, Malindretos, and Kasibhatla (2003) empirically investigate the real exchange rate volatility and export relation for less developed countries, Burkina, Faso, Colombia, Jordan, Korea, Venezuela, Pakistan, South Africa, Costa Rika, and Kenya over the period 1973-1998. Analysis of their research is conducted based on conventional long-run-export demand function. Moving standard deviation of the real exchange rate growth is used as an indicator of the exchange rate volatility. Real export is calculated with dividing nominal export to export unit value index. The weighted average of 16 countries' real GDP is taken as a proxy of foreign economic activity. Their research employs Augmented Dickey and Fuller (ADF) test and Johansen cointegration test. They conclude that there is an adverse effect of exchange rate volatility on export for most of the countries in their study.

Saatçioğlu and Karaca (2004) study the relationship between exchange rate volatility and export over the period 1981 to 2000 in Turkey with error correction technique and Johansen cointegration models. The main variables of their investigation are real export, real foreign income, relative prices, real effective exchange rate, and real effective exchange rate volatility. The real GDP of G7 countries is taken as an indicator of real foreign income. The moving standard deviation of the real exchange rate growth is used as an indicator of real exchange rate volatility. The ratio of Turkey export prices to world export prices is calculated as an indicator of relative prices. According to the conclusion of their study, real income and real effective exchange rate have a positive effect on Turkish export. However, the real exchange rate volatility hurts Turkish export in both long-run and short-run.

De Vita and Abbott (2004) analyze the effect of real exchange rate volatility on the export of USA to Germany, Canada, Mexico, Japan, and the United Kingdom over the period 1987 to 2001 with ARDL (Autoregressive distributed lag) framework. They make their estimations based on long-run export demand functions. Their main variables are real export, relative prices, foreign income, and real exchange rate volatility. Moving standard deviation of the real exchange rate is used as an indicator of exchange rate volatility. According to their research, there is cointegration relation of export volume, relative prices, foreign income, and exchange rate volatility. Moreover, they discover a significant relationship between reel exchange rate volatility and export in most of the countries and they assert that the sign of this relationship varies according to countries.

Cheong (2004) investigate the effect of exchange rate volatility on the UK's import over the period 1974 to 2000 using monthly data. Cheong uses traditional import demand equation to perform his investigation. The main variables of his research are the real import, income of the UK, relative prices, and exchange rate volatility. The expectation about the effect of income on import is positive while the expectation about the impact of relative prices is negative in his study. Moreover, there is no expectation about the effect of exchange rate volatility on the UK's import. The volatility of the exchange rate is calculated with the GARCH model. According to the result of his examination, the only variable that affects import in the short-run is income. However, the impact of exchange rate volatility and relative prices is negative and the effect of income on import is positive in the long- run.

Vita and Abbott (2004) investigate the relationship between exchange rate volatility and UK's export to European Union countries over the period 1993 to 2001 at both aggregate and sectoral levels. They use the ARDL bound test approach to observe the cointegration properties of the variables. The main variables of their research are; export, export price index, foreign income, and exchange rate volatility. Industrial production index is used as a proxy of foreign economic activity. Three different measures of exchange rate uncertainty are used in their examination. The first measure of exchange rate uncertainty is estimated as the moving sample standard deviation of the nominal exchange rate growth. The second and third measure of exchange rate uncertainty is obtained with GARCH method from nominal and real exchange rate respectively. According to the conclusion of their investigation, there is no effect of exchange rate volatility on export in the short-run at both aggregate and sectoral levels. However, the impact of exchange rate volatility on export in the long-run is negative at both aggregate and sectoral levels.

Kasman and Kasman (2005) employ traditional long-run export demand function to examine the effect of exchange rate volatility on the export in Turkey over the period 1982 to 2001. Three measures of exchange rate volatility are calculated with taking the moving standard deviation of the real exchange rate growth and two different nominal exchange rate growths. Real export, real foreign income, and relative prices are the other important variables in their research. The effect of exchange rate volatility on export is significant and positive in both long-run and short-run according to the outcome of their investigation.

Choudhry (2005) explores the relationship between exchange rate volatility and United States' export to Japan and Canada over the years 1974 to 1998 with the Johansen cointegration method and constrained error correction models. Choudhry use standard export demand function to perform his investigation. Industrial production index is used as a proxy of real income. The expected effect of the real income of Japan and Canada is positive on United States export. The predicted effect of relative prices on export is negative, and there is no expectation on the impact of exchange rate volatility on the export in their research. The volatility of the exchange rate is obtained with GARCH method using both nominal and real exchange rates. According to the findings of their analysis, there is a negative relationship between United States' export and exchange rate volatilities.

Hwang and Lee (2005) analyze the effect of exchange rate volatility on both import and export in the United Kingdom over the period 1990 to 2000. The main variables of their study are real exchange rate, export, import, Industrial production index and exchange rate volatility. Exchange rate volatility is obtained with GARCH methodology. According to the conclusion of their research, the effect of exchange rate volatility on import is positive. On the other hand, the impact of exchange rate volatility on export is negative.

Tunçsiper and Öksüzler (2006) investigate the effect of uncertainty in the exchange rate on export at both aggregate and sectoral levels for Turkey. They perform their analysis based on traditional export demand function. The main variables of their research are real export, real foreign income, real exchange rate, and real exchange rate volatility. Exchange rate volatility is calculated with the ARIMA model. The main sectors in their examination are agriculture, energy, raw materials, and manufacturing. The time period is from 1980 to 2001 for aggregate export and 1980 to 1996 for sectoral export. According to the conclusion of their research, the effect of real foreign income is positive for aggregate export, agriculture sector, and the manufacturing sector. The impact of exchange rate volatility is negative for aggregate export, agriculture sector, and the manufacturing sector. One of the other important conclusion of their investigation state that, if Turkey goes into the European Union, then the effect of exchange rate volatility on trade will decrease.

Baak, Mahmood, and Vixathep (2007) examine the relationship between exchange rate volatility and export from Hong Kong, South Korea Singapore and Thailand to the United States and Japan over the period 1981 to 2004 with Johansen cointegration test and error correction models. The main variables of their study are real bilateral exchange rate, volatility of real bilateral exchange rate, foreign income, and real export. Exchange rate volatility is calculated with the standard deviation method. The result of their research demonstrates that the effect of foreign income is positive on export. Moreover, the impact of exchange rate volatility on the export of South Korea, Singapore, and Thailand to both the United States and Japan is negative in the long-run. However, the effect of exchange rate volatility on Hong Kong’s export to Japan is insignificant, and it is positive for Hong Kong's export to the United States in the long-run. There is a negative relationship between export from Hong Kong to Japan, and export from Hong Kong, and South Korea to the United States in the short-run.

Grier and Smallwood (2007) study the effect of exchange rate volatility and foreign income on export in Argentina, Brazil, Canada, Australia, Denmark, United States, United Kingdom, Turkey, Thailand, Switzerland, India, Japan, Mexico, Norway, Peru, South Africa, South Korea and Sweden over the years 1973 to 2003. Exchange rate volatility is calculated with the GARCH model. The main variables of their investigation are foreign real income, real effective exchange rate, and real effective exchange rate volatility. According to the conclusion of their research, the effect of exchange rate volatility on export is positive for Japan and Sweden, and it is negative for Argentina, Brazil, Denmark, Mexico, South Africa, and India. There is no effect of the exchange rate volatility on trade for the remaining eight countries. According to Grier and Smallwood, it is critical to realize that exchange rate volatility usually hurts emerging economies while it usually has no impact on advanced economies.

Bahmani-Oskooee and Mitra (2007) review the effect of exchange rate volatility on import and export from the United States to India over the period 1962 to 2004 at the commodity level. The main variables of their research are import, United States' income, real exchange rate, exchange rate volatility, export and the level of economic activity in India. They employ bound testing approach and error correction models to perform their analysis. According to the outcomes of their examination, there are both negative and positive effects of exchange rate volatility on export and import of the United States in the short-run. However, the effect of exchange rate volatility is significant only for a few industries in the long-run.

Arize, Osang, and Slottje (2008) observe the effects of real exchange rate volatility on export in both short-run and long-run in Chile, Brazil, Bolivia, Colombia, Venezuela, Peru, Costa Rica, The Dominican Republic, Honduras, and Ecuador. They use traditional export demand function to perform their estimations. Real world income is used as a proxy for foreign economic activity. Exchange rate volatility is estimated with the ARCH methodology. The findings of their research reveal the negative relationship between real exchange rate volatility and real export in all the eight Latin American countries in the both short-run and long-run.

Choudhry (2008) explores the relationship between exchange rate volatility and real import from the United Kingdom to Canada, New Zealand and Japan over the period 1980 to 2003 with Johansen cointegration and constrained error correction models. He employs traditional import demand function. The primary variables in his investigation are the real import, the real income of the United Kingdom, relative prices and exchange rate volatility. The expectation about the effect of real income on import is positive while the expectation on the impact of relative prices is negative in his research. Moreover, there is no expectation about the effect of exchange rate volatility on import. The exchange rate volatility is estimated with GARCH procedure with both nominal and real exchange rate. According to the conclusions of their examination, the relationship between real income and real import from the United Kingdom to Canada and Japan is positive.

Köse, Ay, and Topallı (2008) analyze the effect of exchange rate volatility on the export of Turkey over the period 1995-2008 with error correction and Johansen cointegration tests. They use traditional long-run export demand function. Real export, real foreign income, relative prices, and real exchange rate volatility are the main variables in their research. Nominal export is converted into real export by division with the consumer price index. Industrial production indices of 15 European Union countries are used as an indicator of real foreign income. The ratio of export unit value index to import unit value index is calculated as a proxy of relative prices. The real exchange rate volatility is measured with three different ways, standard deviation of first difference logarithm of the real exchange rate, moving standard deviation of the real exchange rate growth and generalized autoregressive conditional heteroscedasticity (GARCH) method. According to the conclusion of their investigation, relative prices and real exchange rate volatility have a negative effect on export while real foreign income has a positive impact. Moreover, they discover that simple standard deviation method is a more appropriate way to explain real exchange rate volatility in their investigation.

Byrne, Darby, and MacDonald (2008) analyze the effect of exchange rate volatility on United States' export and import with Germany, United Kingdom, Italy, France, Spain, and the Netherlands at sectoral level with panel data estimation techniques. According to their investigation, there may be differences in the effect of exchange rate volatility in different sectors. Standard deviation of monthly exchange rate movements is calculated as exchange rate volatility. According to the conclusion of their analysis, the effect of exchange rate volatility is negative for both export and import at the panel level where all industries are together. However, the impact of exchange rate volatility on export is more significant than import.

Hayakawa and Kimura (2009) observe the effect of exchange rate volatility on international trade for East Asia over the period 1992 to 2005. They make their analyses based on the gravity model. The main variables of their research are real export, real income, distance, and exchange rate volatility. The outcome of their examination states that the effect of real income of importers and exporters and the effect of short distance is positive on international trade. However, the impact of exchange rate volatility on both trade of final goods and capital goods is negative. Moreover, the impact of exchange rate volatility is less than the effect of distance and more than the effects of tariffs on the trade in East Asia.

Tarı and Yıldırım (2009) analyze the relationship between export and exchange rate volatility in Turkey over the period 1989 to 2007. Real export is obtained by dividing nominal export to export price index. The total income of G7 countries is taken as a proxy for foreign income. The ratio of Turkish export price index to the world export price index is taken as relative prices. The other variables are the real exchange rate and real exchange rate volatility in their research. Moving standard deviation of real exchange rate growth is used as an indicator of exchange rate volatility. According to the conclusion of their research, the effect of real exchange rate volatility on Turkish export is negative in the long-run. On the other hand, there is no effect of exchange rate volatility on Turkish export in the short-term.

Öztürk and Kalyoncu (2009) use traditional export demand model to investigate the relationship between real exchange rate volatility and export in South Korea, Poland, Pakistan, Hungary, Turkey, and South Africa over the period 1980 to 2005 with Engle-Granger cointegration method. Main variables of their research are real export, foreign income, relative prices, real effective exchange rate, and real effective exchange rate volatility. The division of nominal export values to export price index is used as an indicator of real export. The ratio of host country export prices to developed countries export prices is used as a proxy of relative prices. The moving standard deviation of the real effective exchange rate growth is used as an indicator of real exchange rate volatility. According to the outcomes of their investigation, the effect of exchange rate volatility is negative for Pakistan, South Korea, South Africa, and Poland. On the other hand, the effect of exchange rate volatility is positive for Turkey and Hungary. However, exchange rate volatility has a significant effect only for Poland, Hungary, Pakistan, and South Africa in the short-run.

Baum and Caglayan (2010) state that the result of the studies that investigate the effect of exchange rate volatility on trade is sensitive to model and period that are used in the research, and it is also sensitive to the countries and calculation method of the exchange rate volatility. Baum and Caglayan (2010) study the effect of exchange rate volatility on trade and variation of trade in Canada, United States, United Kingdom, Japan, Italy, France, Switzerland, Sweden, Germany, Finland, Netherlands, Norway, and Spain over the period 1980 to 1998. The volatility of the exchange rate is calculated with the bivariate GARCH technique. According to the conclusion of their research, the effect of exchange rate volatility on trade is unambiguous. They find both negative and positive relation of exchange rate volatility and trade for only a small number of the models they constructed. The other meaningful outcome of their investigation asserts that the impact of exchange rate volatility on the variation of trade flow is positive and significant in most of the models they constructed.

Sarı (2010) investigates the effect of exchange rate volatility on Turkish import over the period 1982 to 2006. The result of his study states that there is a negative relationship between exchange rate volatility and import in Turkey.

Caglayan and Di (2010) explores the effect of real exchange rate volatility, real income variability and its interaction with exchange rate on the export and import from United States to Japan, Brazil, China, Germany, Malaysia, United Kingdom, Singapore, France, South Korea, Italy, Canada, Netherlands and Ireland at sectoral level. They use Merton (1980) methodology to calculate real exchange rate volatility. According to the outcome of their investigation, the effect of exchange rate volatility is insignificant in most of the cases at the sectoral level.

Corig and Pugh (2010) examine 58 studies that investigate the relationship between exchange rate volatility and trade with meta-regression analysis. The main aim of their research is help to explain the different and conflicting results of the studies. According to the result of their examination, the average effect of exchange rate volatility on trade is negative. On the other hand, they state that their conclusion is not enough to establish a precise idea concerning the effect of exchange rate volatility on trade.

Bahmani-Oskooee and Harvey (2011) investigate the effect of exchange rate volatility on United States' export and import with Malaysia over the period 1971 to 2006 at both aggregate and sectoral levels. According to their study, the effect of exchange rate volatility on aggregate export is insignificant in both short-run and long-run. On the other hand, there is a significant effect of exchange rate volatility on export in 66 of 101 industries in the short-run. Moreover, there is a considerable effect of exchange rate volatility on export for only 38 sectors in the long-term. The sign of the impact is positive for 29 industries while it is negative for the rest of the nine sectors. It is interesting for Bahmani-Oskooee and Harvey that, exchange rate volatility does not affect the industry that has 50 percent of market share in the short-run. In the case of import there is not any effect of exchange rate volatility on the aggregate import of the United States to Malaysia in both long-term and short-run. However, the exchange rate volatility has a significant impact on import from the United States to Malaysia in 11 of 17 industries in the long-run. There is a considerable effect of exchange rate volatility in 10 of 17 sectors in the long-term. The sign of this effect is negative for 7 out of 10 industries according to their research.

Erdal, Erdal, and Esengün (2012) study the effect of exchange rate volatility on export and import in Turkish agricultural sector at aggregate level over the period 1995 to 2007 using monthly data. Real exchange rate volatility is calculated with GARCH methodology. The main findings of their research state that, the effect of exchange rate volatility on agricultural export is positive while the impact of exchange rate volatility on agricultural import is negative.

Bahmani-Oskooee, Bolhassani, and Hegerty (2012) analyze the effect of exchange rate volatility on both export and import of Canada with Mexico over the period 1973 to 2006. Exchange rate volatility is calculated as the standard deviation of monthly real exchange rate. According to the outcome of their examination, only 36 of 45 Canadian export industries are affected by the volatility in the exchange rate in the short-run. However, only 9 of 36 Canadian export industries are affected by exchange rate volatility in the long-term. The sign of the effect is negative for 5 of 9 Canadian export industries while it is positive for the rest four industries in the long-run. In the case of Canadian import, there is a significant effect of exchange rate volatility in 32 of 43 importing sectors in the short-term. However, there is a considerable effect of exchange rate volatility for only 17 Canadian import industries in the long-run. The impact of exchange rate volatility is negative for 9 of 17 sectors while it is positive for other 8 Canadian importing industries. One of the other results of their study is that the effect of exchange rate volatility is stronger for Mexican export than Canadian export.

Bahmani-Oskooee, Harvey and Hegerty (2012), Bahmani-Oskooee and Satawatananon (2012), Bahmani-Oskooee, Hegerty, and Zhang (2014), Bahmani-Oskooee and Wang (2007), Bahmani-Oskooee, Hegerty, and Xu (2012) study the effect of exchange rate volatility on trade between different countries at industrial levels. According to these examinations, the sectoral investigation of the relationship between exchange rate volatility and trade flows is essential and has different results than aggregate level investigation. The effect of exchange rate volatility on export and import are reviewed for the trade flows of following countries, the United States and Korea, United States and Thailand, Korea and World, European Union and Egypt, United States and Indonesia, United States and China and Japan and Chine respectively. The outcome of the studies is different or similar to each other. The main finding of these investigations asserts that the effect of exchange rate volatility can be positive, negative or insignificant depending on the industry, country or other characteristic features.

Doğru and Uysal (2013) examine the effect of exchange rate volatility on export over the period 2002 to 2010 with the ARDL bound testing approach for the Euro Area. They use traditional export demand equation in their analyses. The main variables of their research are real export, real effective exchange rate, real effective exchange rate volatility, and world industrial production index. Exchange rate volatility is estimated with the two different methods; standard deviation method and GARCH method. According to conclusion of their research the effect of exchange volatility on export in Euro Area is negative in the short-run and positive in the long-term.

Kılıç (2013) studies the effect of real effective exchange rate volatility on both export and import in Turkey at sectoral basis over the period 2005 to 2012 with panel data approach. Kılıç employs traditional export and import demand functions to perform her analysis. According to the conclusion of her investigation, the sign of the effect of exchange rate volatility on export is positive, and its impact on import is insignificant at sectoral level.

Çelik (2018) observes the relationship between the volatility in the exchange rate and Turkish export over the period 1995 to 2017. According to her research, the effect of exchange rate volatility on export is negative in the both short-run and long-run.

3. DATA

The variables in this research are; real export, real import, relative prices, real effective exchange rate volatility, real regional GDP, real OECD GDP, and the number of patent applications. The information about these variables are summarized in this section. Moreover, the period of the study is from 2004 to 2014 because of data unavailability.

3.1 Real Export

Nominal export values of each city in Turkey and the export unit value index are obtained from TURKSTAT web-site. First, nominal export values of each city are divided by the export unit value index to compute real export values for each city. Then, the cities are grouped into twelve regions according to Nomenclature of Territorial Units for Statistics (NUTS) classification at level 1. Finally, the export values of each city in same NUTS-1 region are summed up to determine local real export values at NUTS Level 1.

3.2 Real Import

Similarly, nominal import values of each city in Turkey and import unit value index obtained from TURKSTAT web-site. First, nominal import values of each city are divided by import unit value index to compute real import value for each city. Then, cities are grouped into twelve regions according to Nomenclature of Territorial Units for Statistics (NUTS) classification at level 1. Finally, import values of each city in same NUTS-1 region are summed up to determine regional import values at NUTS Level 1.

3.3 Relative Prices

The division of the export unit value index to import unit value index is described as terms of trade index. A unit of export is of higher value compared to import if there is an increase in terms of trade index. Moreover, a unit of import is of higher value compared to export if there is a decrease in this index. Terms of trade index is used as a proxy of relative prices in this research. Furthermore, terms of trade index and similar indicators of relative prices are used by many economists such as Arize (1997), Doğanlar (2002), Acaravcı and Öztürk (2002), Arize, Osang and Slottje (2008), Köse, Ay and Topallı (2008), Yılmaz and Saygılı (2010).

3.4 Real Effective Exchange Rate Volatility

Real effective exchange rate volatility is used as an indicator of exchange rate uncertainty in this study. Real effective exchange rates are obtained from CBRT web-site. Real effective exchange rate volatility is computed by taking moving standard deviation of the real effective exchange rate growth with the following formula;

$$V_t = [(1/m)\ \sum_{i=1}^{m}(lnrer_t - lnrer_{t-1})^2\ ]^{1/2}$$

Where V is real effective exchange rate volatility, rer is real effective exchange rate, t is time, and m is the order of moving average. This calculation method is easy and effective way to calculate volatility and used by many economists such as Kenen and Rodrik (1986), Koray and Lastrapes (1989), Arize (1998), Chowdhury (1993) Bredin, Fountas and Murphy (2003).

3.5 Regional Real GDP

Nominal GDP per capita and the population of each city in Turkey are obtained from TURKSTAT. First, the nominal GDP of each city is calculated by multiplying the GDP per capita of each city with its population. Second, the cities are grouped into twenty-six regions according to Nomenclature of Territorial Units for Statistics (NUTS) classification at level 2. Third, nominal GDP of each city in the same NUTS-2 region is summed up to obtain regional nominal GDP at NUTS Level 2. Fourth, NUTS-2 regional nominal GDP values are divided by the regional consumer price index, which is especially calculated for NUTS-2 regions, to obtain real GDP of the twenty-six regions. It is clear from Table 3 and Table 4 that, NUTS-2 regions are just smaller parts of NUTS-1 regions. Therefore, it is possible to obtain the real GDP of NUTS-1 regions by summing up NUTS-2 regions' real GDP in the same NUTS-1 area. For example, West Anatolia is NUTS-1 region. It is composed of two NUTS-2 regions. One of the NUTS-2 regions that is part of West Anatolia is Ankara and the second NUTS-2 region that is part of West Anatolia is the combination of Konya and Karaman Provinces.

Therefore, it is possible to obtain real GDP of West Anatolia by summing up real GDP of these two NUTS-2 Regions.

3.6 Total Real GDP of OECD Countries

Nominal GDP and consumer price index of OECD countries are obtained from the OECD database. Real OECD GDP is calculated by dividing the nominal OECD GDP to OECD consumer price index. The export of Turkey to OECD countries over the period 2004 to 2014 accounts for more than 50 percent of the total export in Turkey on average. Therefore, total real GDP of OECD countries is selected as a proxy for foreign income. Real GDP of OECD countries are also used by Sauer and Bohara (2001) and Asseery and Peel (1991) as a proxy for foreign economic activity.

3.7 Number of Patent Application

The number of patent applications from each city in Turkey are obtained from Turk Patent and Trademark Office. First, cities are grouped into twelve regions according to Nomenclature of Territorial Units for Statistics (NUTS) classification at level 1. Then, the number of applications of each city in the same region are summed up to obtain total applications at the regional level.

4. DESCRIPTIVE STATISTICS

The visual, informative illustrations and statistics about the variables of this research are presented in this section of the study.

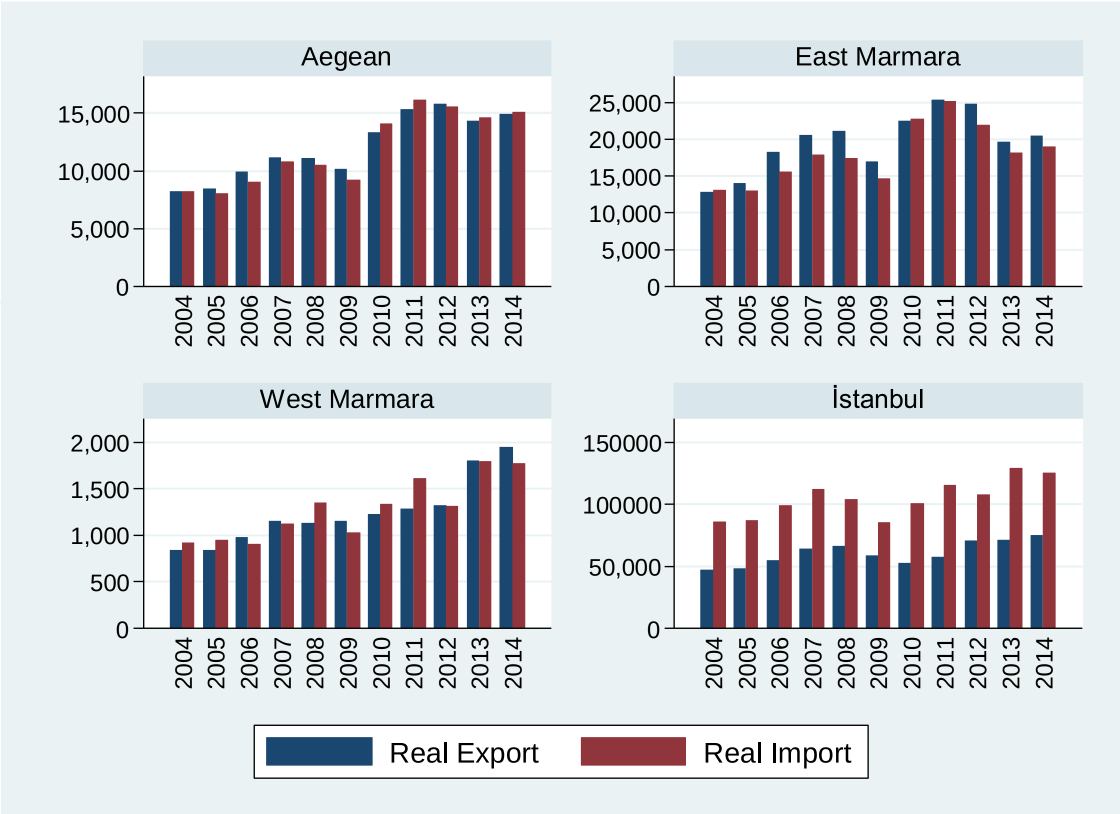

Figure 1 Real Export and Real Import Values (Million USD) in Aegean, East Marmara, West Marmara and Istanbul Regions of Turkey (2004-2014)
Source: TURKSTAT (2018)

Figure 1 demonstrates real export and real import values in Aegean, East Marmara, West Marmara and Istanbul Regions of Turkey over the years 2004 to 2014. According to bar charts, import is always greater than export in Istanbul Region. Export is often higher than import in Aegean Region. Export and import values are close to each other in West Marmara Region. Finally, export is often higher than import in East Marmara Region.

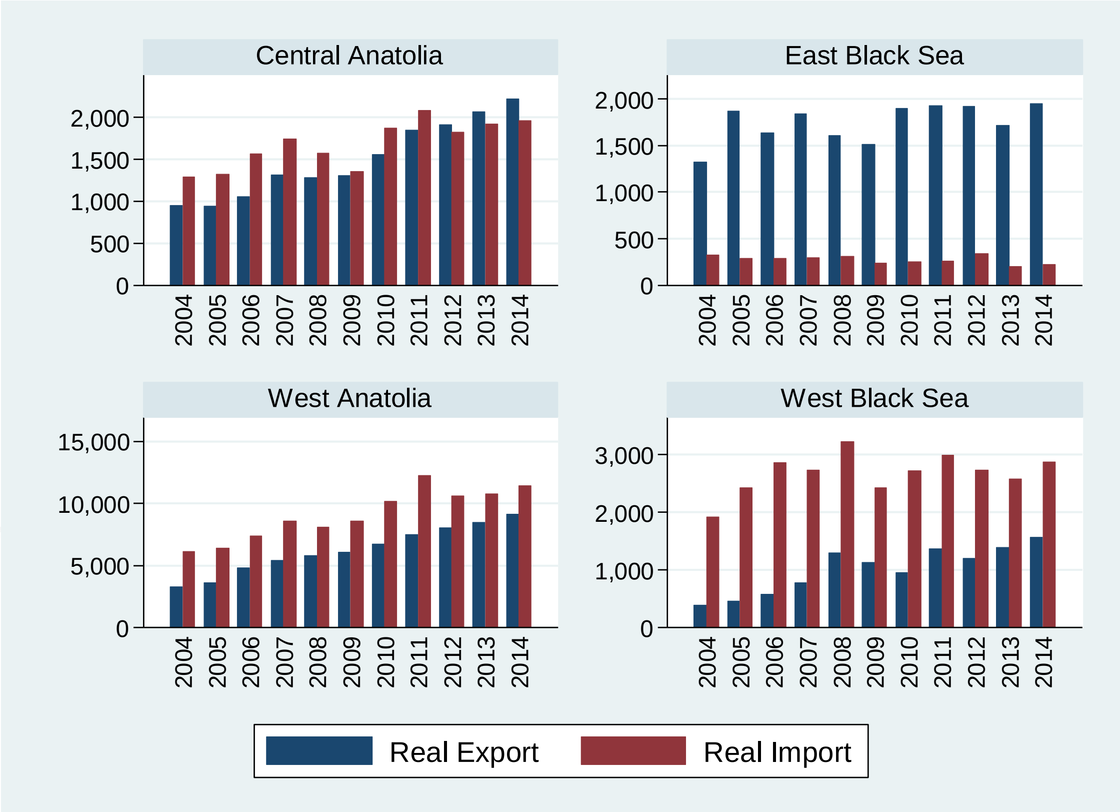

Figure 2 Real Export and Real Import Values (Million USD) in Central Anatolia, East Black Sea, West Anatolia and West Black Sea Regions of Turkey (2004-2014)
Source: TURKSTAT (2018)

Figure 2 illustrates the real export and real import values in Central Anatolia, East Black Sea, West Anatolia, and West Black Sea Regions of Turkey over the period 2004 to 2014. It is clear from bar charts that, export values are always higher than import values in the East Black Sea Region. Also, there are both decreases and increases in export and import levels of East Black Sea Region throughout the study. On the other hand, import in West Anatolia and West Black Sea regions is always greater than their exports. Despite the decreases in export and import levels of West Black Sea and West Anatolia Regions in some years, both export and import values are increasing over time. In Central Anatolia Region, import is greater than export from 2004 to 2011. However; export is higher than import from 2012 to 2014, and both export and import values are increasing over time. It is also clear from bar charts that, the export and import volume of West Anatolia Region is more significant than Central East Anatolia, East Black Sea, and West Black Sea Regions.

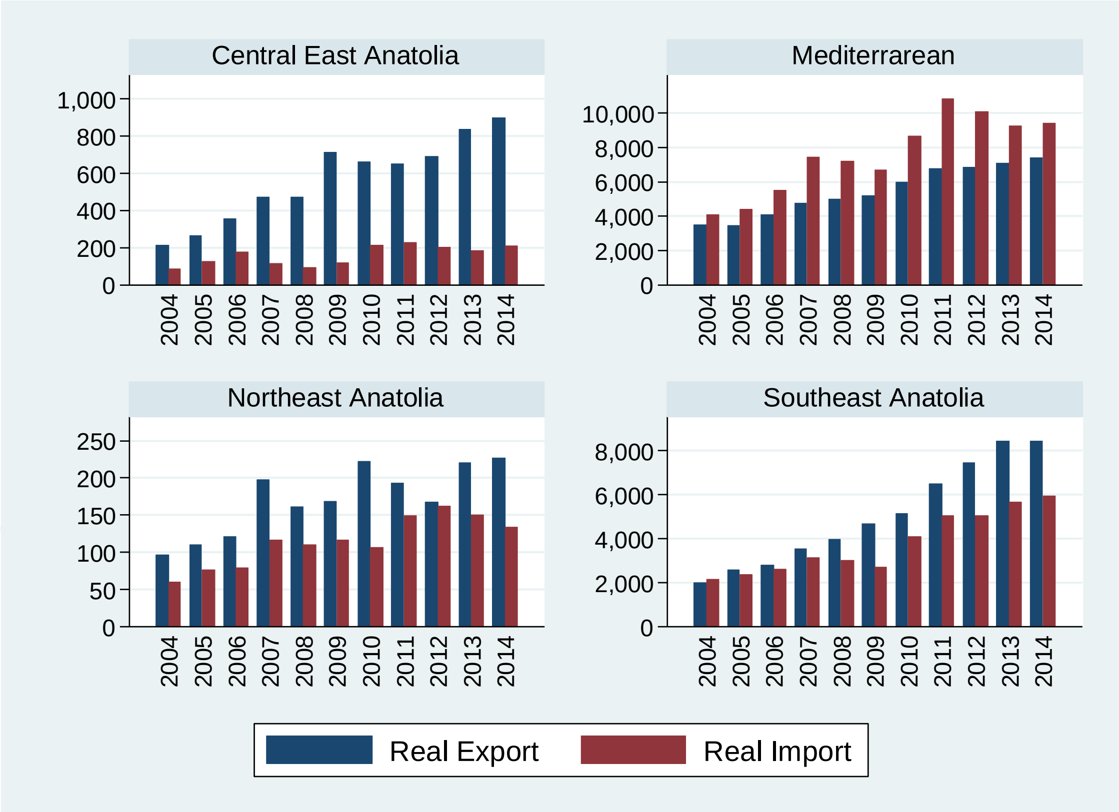

Figure 3 Real Export and Real Import Values (Million USD) in Central East Anatolia, Mediterranean, Northeast Anatolia and Southeast Anatolia Regions of Turkey (2004-2014)
Source: TURKSTAT (2018)

According to Figure 3, real export in Central East Anatolia, Northeast Anatolia, and Southeast Anatolia is higher than their import in almost all years throughout the study. On the other hand, the real export is less than real import in the Mediterranean region in all years over the period 2004 to 2014.

Table 1
Summary Statistics of the Variables (2004-2014)

VARIABLES	Obs.	Mean	St. Dev.	Min.	Max.
Real Export (Million USD)	132	9,601	16,657	96.79	75,101
Real Import (Million USD)	132	13,438	28,453	60.65	128,823
Real Regional GDP (Million USD)	132	35,545	32,661	5,602	147,582
Real OECD GDP (Billion USD)	132	43,587	2,010	39,672	46,846
Patent Application	132	233.1	387.9	0	2,108
REER	132	0.0271	0.00929	0.0156	0.0455
Terms of Trade Index (Relative Prices)	132	103.1	3.768	97.53	110.6

Source: TURKSTAT; OECD Database; Central Bank of the Republic of Turkey; Turkish Patent and Trademark Office (2018)

Table 1 demonstrates the information about the summary statistics of the existing variables in the study.

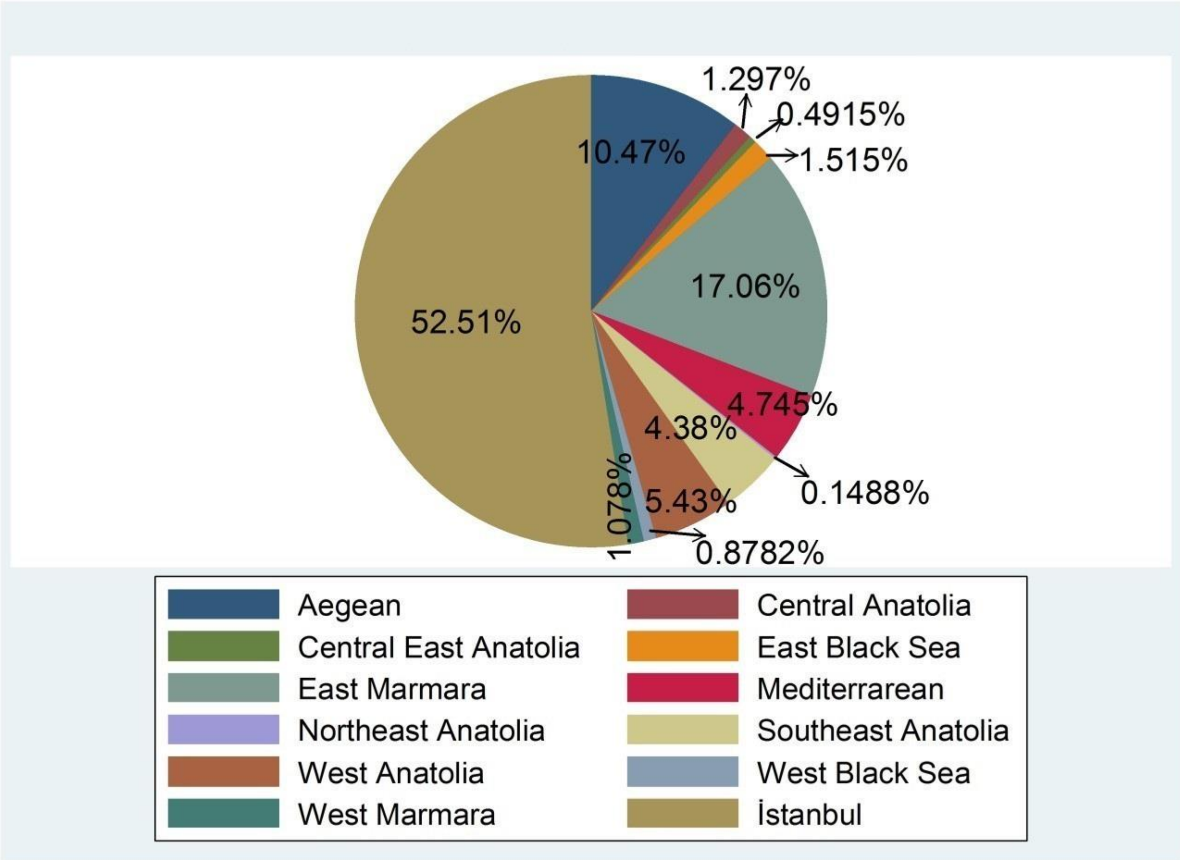

Figure 4 Share of Real Export by Regions in Turkey
Source: TURKSTAT (2018)

The pie chart is created by taking the average of real export values in the regions over the time 2004 to 2014. It demonstrates percentage share of real export among the twelve regions in Turkey namely Aegean, Central East Anatolia, East Marmara, Northeast Anatolia, West Anatolia, West Marmara, Central Anatolia, East Black Sea, Mediterranean, Southeast Anatolia, West Black Sea, and Istanbul. According to the pie chart, the most significant share of export activities belongs to Istanbul Region of Turkey. Istanbul Region accounts for more than 50 percent of export activities. The region that has the second most notable share of export activities is East Marmara. More than 15 percent of export activities occur in East Marmara Region. Aegean Region is the third region that has the most critical share in export activities of Turkey. More than 10 percent of export activities take place in this region.

In summary, it is clear from the pie chart that Istanbul, East Marmara, and Aegean Regions account for more than 80 percent of export activities in Turkey.

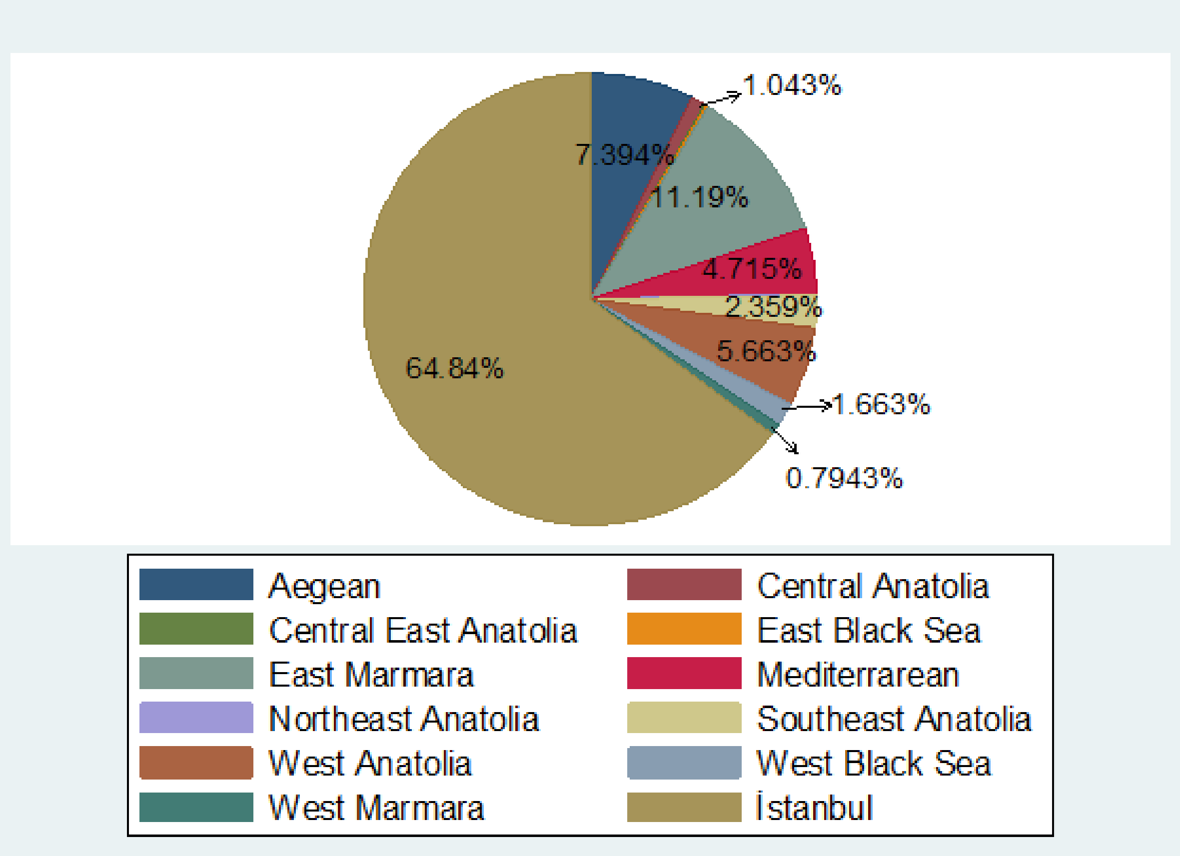

Figure 5 Share of Real Import by Regions in Turkey
Source: TURKSTAT (2018)

The pie chart is created by taking the average of real import values in the regions over the time 2004 to 2014. It demonstrates percentage share of real import among the twelve regions in Turkey namely Aegean, Central East Anatolia, East Marmara, Northeast Anatolia, West Anatolia, West Marmara, Central Anatolia, East Black Sea, Mediterranean, Southeast Anatolia, West Black Sea, and Istanbul. According to the pie chart, the most significant share of import activities belongs to Istanbul Region. Istanbul Region accounts for more than 60 percent of import activities in Turkey. The region that has the second most crucial share of import activities is East Marmara. More than 10 percent of import activities occur in East Marmara Region. Aegean Region is the third region that has the most critical share in import activities. More than 7 percent of import activities take place in this region.

In summary, it is clear from the pie chart that Istanbul, East Marmara, and Aegean Regions account for more than 80 percent of export activities in Turkey.

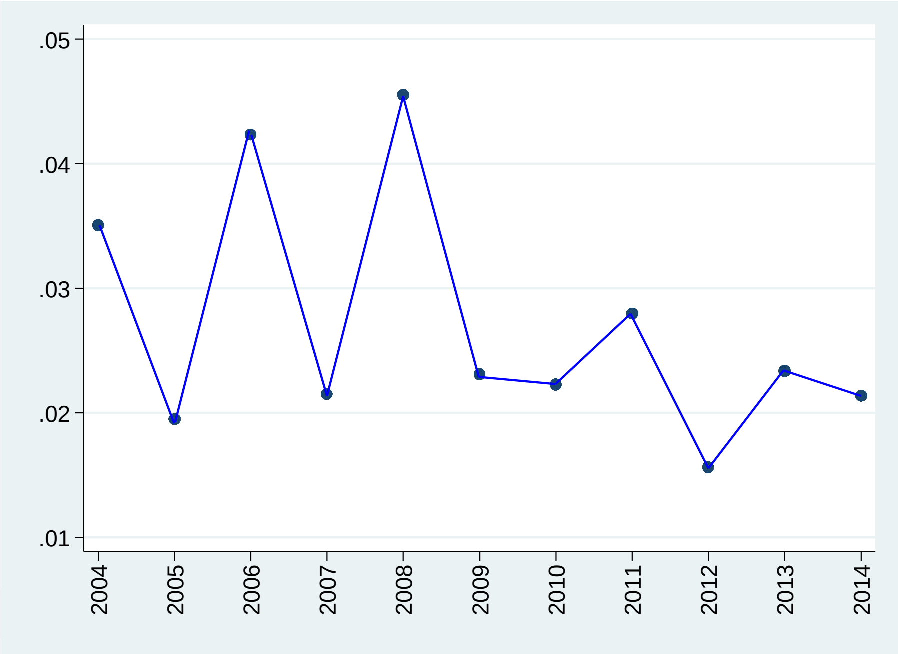

Figure 6 Real Effective Exchange Rate Volatility
Source: Central Bank of the Republic of Turkey (2018)

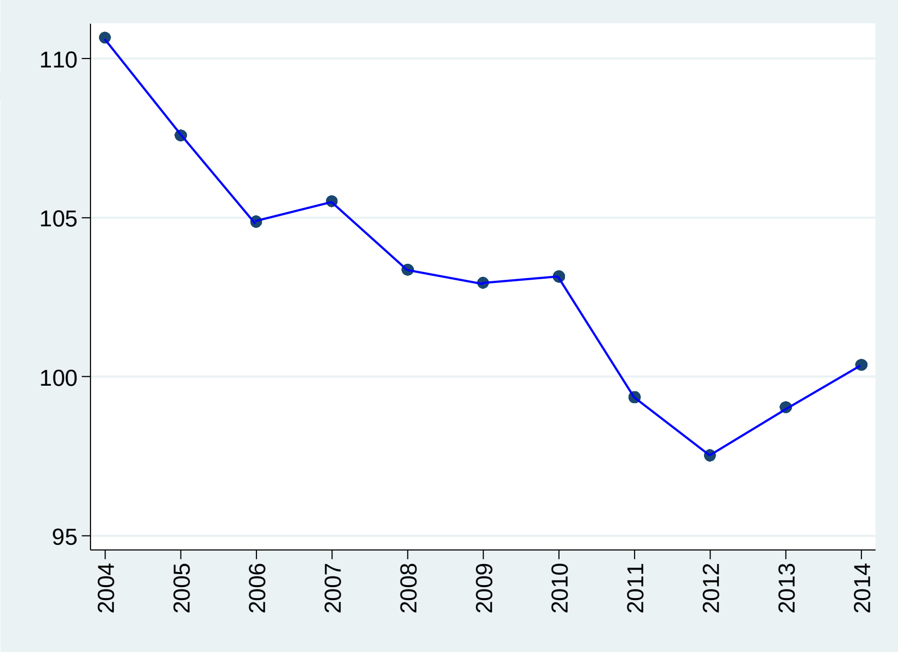

Figure 7 Terms of Trade Index over the time 2004 to 2014.
Source: TURKSTAT (2018)

Figure 6 and Figure 7 demonstrate the movements of real effective exchange rate volatility and terms of trade index over the period 2004 to 2014.

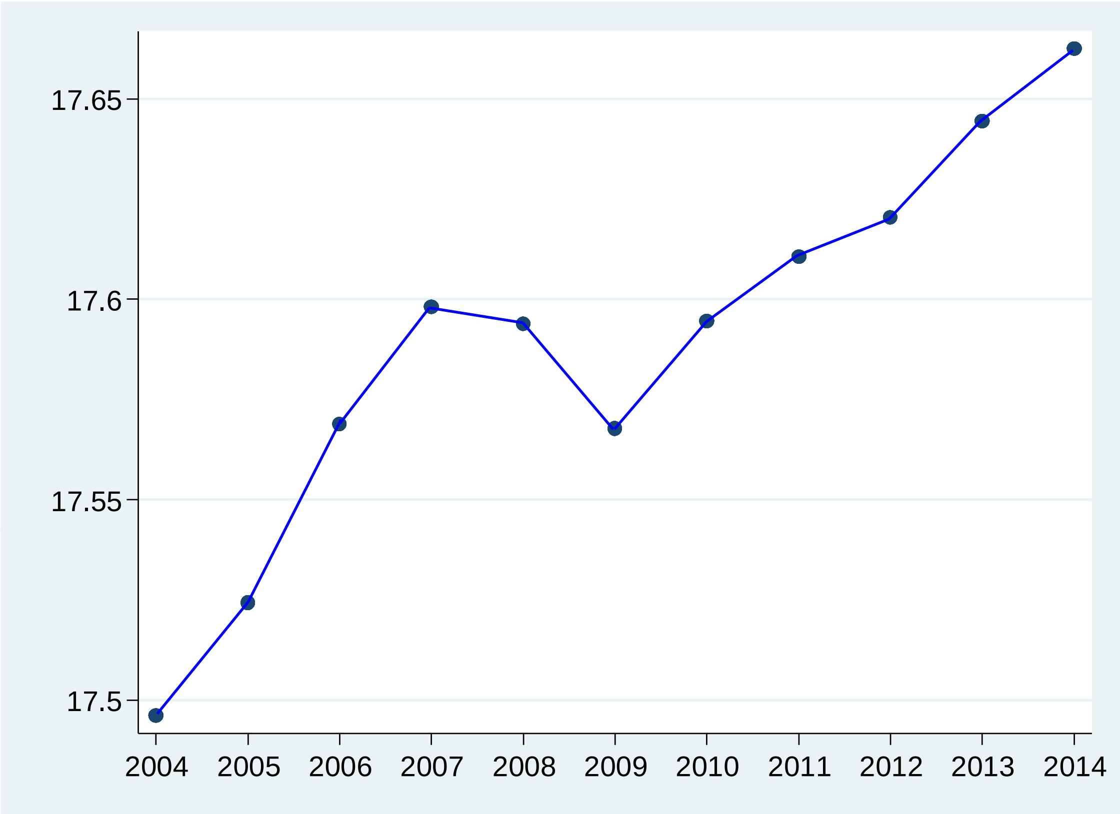

Figure 8 Total Real GDP of OECD (Natural Logarithm) over the period 2004 to 2014.
Source: OECD Database (2018)

Figure 8 demonstrates the movements of total real GDP of OECD countries over the period 2004 to 2014. According to the graph, the real OECD GDP is steadily increasing from 2004 to 2007. Then, there is a dramatic decrease in real GDP of OECD countries in the years 2008 and 2009. Total real GDP of OECD countries continue to increase from the year 2009 to 2014.

In sum, the graph reveals that total real GDP of OECD countries is steadily increasing over the years 2004 to 2014 except for the years 2008 and 2009.

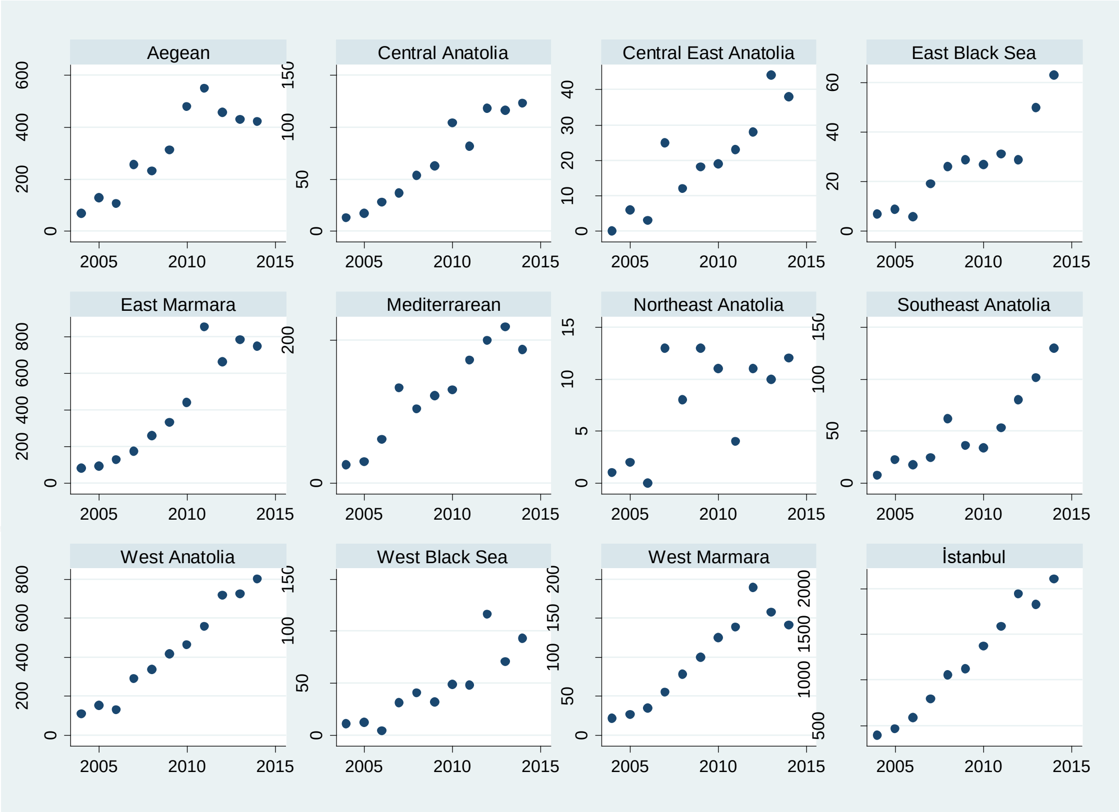

Figure 9 The number of Patent Applications by Regions over the time 2004 to 2014.
Source: Turkish Patent and Trademark Office (2018)

Figure 9 demonstrates the number of patent applications of the twelve regions in Turkey over the period 2004 to 2014.

According to scatter diagrams, the number of patent requests is increasing in almost every region in Turkey. Northeast Anatolia, Central East Anatolia, and East Black Sea Regions are the three regions that have less patent applications than the other nine regions. On the other hand, Istanbul Region has the most notable number of patent applications among all the twelve regions in each year of the period of the study. Despite the increasing tendency of the number of patent demands over the years, it is apparent that patent requests in the Northeast Anatolia Region have an irregular distribution. West Anatolia, Aegean, and East Marmara are three regions that have the maximum number of patent applications among all regions in Turkey after Istanbul Region. Furthermore, the number of patent requests by Central Anatolia, Mediterranean, West Black Sea, Southeast Anatolia, and West Marmara Regions is on the average levels compared to all regions.

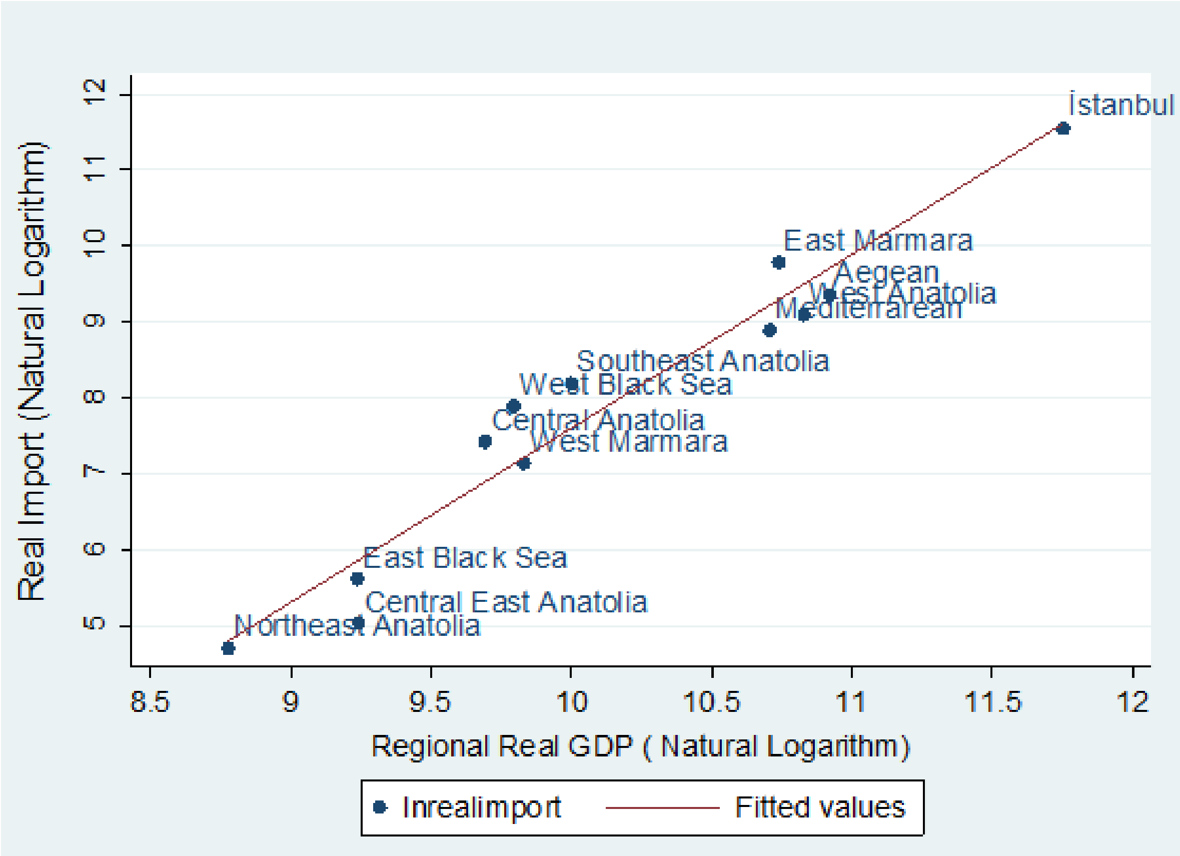

Figure 10 Real Imports vs. Regional Real GDP of 12 Regions in Turkey
Source: TURKSTAT (2018)

Figure 10 is created using the average value of real import and real regional GDP values of the 12 regions in Turkey over the period 2004 to 2014. Scatter diagrams demonstrate the movements of real import and regional real GDP of each region in the research. According to the graph, real import and regional real GDP tend to move in the same way in each region of Turkey.

5. THEORETICAL CONSIDERATIONS AND MODEL SPECIFICATION

5.1 Theoretical Considerations

Expectations about the future exchange rate affect the behavior of the firms. If there is a doubt about the future profit of the firms based on exchange rate uncertainty, firms will decrease their level of activities to minimize the risk of their actions. However, if firms have information about their future profit without knowing the future exchange rate, there will be no reduction in the level of their activities. Moreover, it is more probable that, if there is uncertainty in the exchange rate, firms will not be able to have accurate information about their future profit. Therefore, they will reduce their activities, and the level of trade will decrease (Ethier, 1973).

Floating exchange rate regime will create uncertainty both in international trade and investment because it would not be possible for the ones who are dealing with international transactions to calculate the domestic value of their actions (Clark, 1973). Clark (1973) focuses on the effects of exchange rate volatility on the level of export. Clark’s analyses are depending on the assumption that firms take their actions according to their long-term profit. It is more challenging to obtain a clear picture of long-term profit while there is uncertainty in the exchange rate and this tends to diminish the trade if the firms are risk-averse.

According to Clark (1973), exporters will not able to sufficiently protect themselves from exchange rate risks because of two reasons. Firstly, the forward exchange market may be insufficient and less developed to allow exporters to defend themselves from the uncertainties. If the duration of the contract is shorter than firms' desire to shield themselves from the variations in the exchange rate, then exporters will face risk unless other hedging opportunities are possible. The second reason is that the foreign price of a commodity would be unclear. In this circumstance, exporters will not be able to determine their revenue from transactions.

Clark (1973) improves two theoretical models for two separate market conditions. The effect of variability in exchange rate on export for less developed forward market conditions is investigated in his first model. In his second model, the effect of exchange rate volatility on the export of a country is observed in the perfect forward markets conditions with an unclear foreign price.

In the first model, there are several assumptions. Considering all assumptions, there is a steady income from export, but the amount of domestic currency of this revenue is not clear for exporter after 90 days. This situation generates risk for the exporters. It is possible to assert that if the firms are risk-averse, then the uncertainty in the exchange rate will create a decline in global trade. According to Clark, the assumption of selling all the goods to abroad is unrealistic. However, Clark states that, even if exporters have chances to sell both in the domestic and international market, the result reached in his research will not change. Moreover, the conclusions of Clark are still the same if the assumption that states all inputs are domestic is released.

In the second part of his theoretical research, Clark studies the same relationship with perfect forward market conditions and variable foreign price. The perfect forward market enables exporters to use any of the maturity dates. The second part of his study has the same conclusions with the first part. There is an adverse effect of exchange rate volatility on the volume of trade. One of the crucial conclusions of the second part is that the adverse effect of exchange rate volatility can be balanced with the changes in prices of traded goods (Clark 1973).

The finding of Clark (1973) is clear in asserting that there is an adverse effect of exchange rate volatility on trade. On the other hand, these outcomes depend on various assumptions. Firstly, advanced economies have developed forward exchange market, and this allows hedging transactions. Therefore, irregular movements in the exchange rate decline. However, most of the emerging economies do not have a perfect forward market. Also, export and import decisions need more than one transaction over time, and this creates a risk even for advanced economies. However, there are other ways rather than forward exchange market to diminish the risk that stems from uncertainty in the exchange rate (Clark et al., 2004).

Baron (1976) explains the effects of exchange rate volatility on trade using invoicing decision of the firms. According to Baron's research, the action by the exporter firms depends on its behavior against uncertainty. Moreover, firms have two options, selling their goods in local currency or foreign currency and each option has its own risk. On one hand, if a firm decides to sell its outputs in foreign currency, it will face a risk of a decrease in its profit in the case of exchange rate volatility. On the other hand, if a firm decides to sell its output in the local currency, the firm will face a risk of reduction in quantity. Both risks will affect the trading behavior of the firms. Therefore, the exchange rate volatility might harm trade depending on the risk behavior of the firms (Baron, 1976).

Hooper and Kohlhagen (1978) develop a model to investigate the association between exchange rate uncertainty and global trade. In their model, they assume that there is no factor other than the exchange rate risk that affects international trade. For this reason, the result of their study may overstate the effect of exchange rate volatility. They employ individual firms' import demand and export supply functions to obtain aggregate demand and supply in the economy. According to their examination, both importers and exporters aim to maximize their utility. The unexpected, fast and permanent movements in exchange rates create risk for the firms because there will be differences in the exchange rate between the time of agreement and time of the payment. Therefore, firms cannot plan their utility maximization point with this uncertainty in the exchange rate. The expected negative relationship between the exchange rate volatility and international trade depends on the risk behavior of the firms. If the firms are risk-averse, exchange rate volatility will cause an increase in the cost of unit production and reduction in foreign trade (Hooper and Kohlhagen, 1978).

According to Clark et al. (2004), one of the critical reasons behind the opinion that there is a negative relationship between exchange rate volatility and trade is the assumption that firms are unable to change their inputs to optimize their production according to the exchange rate. If we assume that, firms can change their inputs to optimize their production according to movements in the exchange rate, then it will be possible to state that firms may make more profit with an increase in exchange rate volatility. There are two main reasons for the volatility in the exchange rate to have a positive effect on trade in this case. Firstly, if we assume that firms can change their inputs according to different prices, then their expectation about profit will be in a positive direction with high exchange rate volatility. For this reason, they can sell more goods when the prices are high, and they can sell fewer goods when the prices are low. Secondly, firms may increase their export level according to their risk attitude. If the risk-aversion level of the firm is high, then the firm may decrease their export because of high variability in predicted profit. However, if the firm is less risk-averse, then it will increase its production level despite high variability in expected profit. (Clark et al., 2004) Finally, Clark asserts that this relationship observed by Canzoneri et al. (1984), De Grauwe (1992), and Gros (1987).

Despite the ideas about the adverse effect of exchange rate volatility on trade because of the risk-averse behavior of the firms, other researches show different results. De Grauwe (1988) constructs a simple model to investigate the effects of exchange rate volatility on foreign trade. He states that the effect of exchange rate volatility on the supply of export is unclear even in his simple model. If there are increases in exchange rate volatility, and if the producer is risk-averse the export of the individual producer increases because of the increases in the marginal utility of income from export according to his theoretical analysis. Furthermore, if there are increases in exchange rate volatility and if the producer is not risk-averse, the export decline because of the diminishing marginal utility of income from export. According to De Grauwe, the economic reasoning behind these conclusions is simple. If the producer is very risk-averse, they will not be willing to face a dramatic decrease in their revenues, and they will start to export more to prevent this.

On the other hand, the less risk-averse producers will not find export as attractive as the past, and they will begin to export less. The underlying reasoning behind these actions of exporters with different risk-aversion attitude can also be explained by substitution and income effect. If the substitution effect is more than the income effect, then exporters will begin to export less when there is more exchange rate risk. However, if the income effect is more than the substitution effect than exporter will start to export more.

Brada and Mendez (1988) explain that there are two main reasons behind the idea of a negative relationship between exchange rate volatility and trade. The first reason is the risk-averse behavior of firms. It means that, if there are risk firms may decrease their export activities. The second reason is that governments may take part in the trade process of their countries to defend their economies from unforeseen risk due to exchange rate fluctuations. Their research aims to compare the effects of flexible exchange rates and fixed exchange rates on trade volume. They conclude that there is a negative relationship between exchange rate uncertainty and trade.

According to Dixit (1989), the decision of investment is taken in a risky environment. For example, the entry and the exit of companies in the external market will face risk because of the fluctuations in the exchange rate. Dixit states that one of the critical characteristics of the entry and exit decisions of the firms in an environment with uncertainty is hysteresis. In his hysteresis model, Dixit points out that firms are facing with sunk cost when they are taking entry or exit decision to the market, and sunk cost for exit or entry to the market can influence foreign trade. The sunk cost creates hysteresis for the firms. Firms are tending to wait longer to go out or to enter the market when the exchange rate is more volatile. Trade can be affected by the entry and exit decisions of the firms. On the other hand, the direction of this effect on trade is unclear.

Froot and Klemperer (1989) state that exporters charge different prices to different markets and their pricing strategies are affected by unexpected movements in exchange rates. According to their investigation, the sudden movements in the exchange rate can affect the price and quantity of the traded goods positively or negatively.

Franke (1991) indicates that there is a misbelief about the negative impact of exchange rate volatility on export because of the risk-averse behavior of the firms. However, Franke says that export is an option for firms and firms decide to take a role in export activities if they think they will obtain a benefit. According to Franke if the expected revenue of trade is more than the entry or exit cost to the market, exchange rate volatility can positively affect export.

Sercu and Vanhulle (1992) theoretically investigate the relationship between exchange rate volatility, trade and the value of the firms. They assert that there is a positive relationship between the value of exporter firms and exchange rate volatility.

On the other hand, the effect of exchange rate volatility on trade is unclear in their research.

Viaene and Vries (1992) theoretically examine the exchange rate volatility and international trade with the existence of the mature forward market and without the existence of the developed forward market. Their investigation states that the effect of volatility on exporters and importers are different because they are on the different side of the forward market. Moreover, net currency situation of the firms is one of the key factors to decide the sign of the effect of exchange rate volatility on trade. According to their research, the imports and exports decrease as exchange rate volatility increases if there is not well developed forward market. However, they state that if there is developed forward market, one trader will benefit and the other trader will lose from trade according to their net currency position.

Dellas and Zilberfarb (1993) state that, one of the critical reasons behind the studies that indicate a negative relationship between exchange rate volatility and trade is the assumption that the operation in forwarding exchange market to eliminate exchange rate risk is not possible or limited. According to Dellas and Zilberfarb, trade contracts are not in hedge status in this situation, and therefore they are risky, so increases in exchange rate volatility affect the trade. On the other hand, the direction of this effect is not clear and is related to the risk aversion parameter of the model.

Broll and Eckwert (1999) theoretically examine the effect of exchange rate volatility on international trade. According to their study, if there are suitable conditions in the market for the firms to see export as an option, then exchange rate volatility will increase the value of export and therefore firms will be more willing to increase their production. The effect of exchange rate uncertainty on trade depends on the risk-averse behavior of the firms; if we assume that the firms are risk-averse, then an increase in uncertainty will decrease the firms’ marginal utility hence their production. On the other hand, high volatility in the exchange rate makes trade more profitable and increases the production of the firms. The outcome of their investigation states that the net effect of the exchange rate volatility on trade depends on the risk-averse behavior of the firms (Broll and Eckwert, 1999).

It is important to note that, the other elements that may affect exchange rate movements and trade are needed to take into consideration to investigate the role of exchange rate volatility on trade. Therefore, to take a more comprehensive conclusion about the influence of exchange rate volatility on trade, important macroeconomic variables should be examined (Clark et al., 2004). Bacchetta and Van Wincoop (2000) investigate the relationship between exchange rate volatility and trade by analyzing key macroeconomics variables under the general equilibrium model. According to their investigation, there are two countries and the reasons for the uncertainty are fiscal, financial and technological shocks. Moreover, they examine the effect of these shocks on trade and welfare in both fixed and flexible exchange rate regime. The result of their examination asserts that fixed or flexible exchange rate regime has no power to affect the level of trade. Also, their conclusions declare that there is no relationship between the level of trade and exchange rate volatility because other macroeconomic variables offset the effect of exchange rate volatility. For example, if there is monetary expansion in one country, then both value of its' currency and import will decline. However, the demand will increase, and the effect of exchange rate volatility is going to offset by these movements in demand partly or entirely.

Sercu and Uphal (2003) investigate the effect of exchange rate volatility on trade by constructing a model in imperfect goods market conditions. They perform their analyses under a general endowment economy framework. According to their research, the reasons that cause an increase in the volatility of the exchange rate is significant to determine the direction of the effect of exchange rate volatility on international trade. Moreover, if the reason behind the increase in volatility is the duration of the endowment, the effect of exchange rate volatility on trade will be positive. However, if the reason for increases in exchange rate volatility is the goods market, then the effect of exchange rate volatility on trade will be negative.

There is no theoretical consensus about the effect of exchange rate volatility on trade. According to Arize (1997), the effect of exchange rate volatility on trade needs empirical investigation rather than theoretical ones.

5.2 Traditional Export Demand and Import Demand Equations

Traditional long-run export demand function has been used by several economists in many studies to investigate the relationship between exchange rate volatility and export such as Chowdhury (1993), Arize (1995), and Asseery and Peel (1991). Conventional long-run export demand equation is as follows;

$$\ln X_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln RP_t + \beta_3 V_t \qquad (5.1)$$

where X is export, Y is foreign economic activity, *RP* is relative prices, and V is exchange rate volatility. Many studies in the literature are performed their analysis depending on this equation. However, the calculation techniques of the variables and their indicators show differences. Both nominal and real export values are used in previous researches. Industrial production index in different countries is used by Arize (1997) to calculate the world industrial production index as a proxy of foreign economic activity. However, real GDP of OECD is used by Sauer and Bohara (2001) as a proxy for foreign economic activity. The ratio of country A's export price to its trading partner's export price is used by Aristotelous (2002) and Chowdhury (1993) as a proxy of relative prices. On the other hand, real effective exchange rate is used by Sauer and Bohara (2001) as an indicator of relative prices. Weighted average of income of the most crucial trading partners of the country which is under observation is calculated by Chowdhury (1993) to use as a proxy for foreign economic activity.

Traditional long-run import demand equation used by Arize (1998), Arize and Shwiff (1998) is as follows:

$$\ln M_t = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln RP_t + \alpha_3 V_t \qquad (5.2)$$

where *M* is import, *Y* is domestic income, *RP* is relative prices and *V* is exchange rate volatility.

5.3 Model Specification

The analyses are conducted based on long-run export demand and import demand functions. On the other hand, the number of patent applications is added as a control variable to long-run export demand function to observe if there is any changing in the results.

$$\ln X_{it} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln RP_{it} + \beta_3 V_{it} + \beta_4 P_{it} + \varepsilon_{it} \qquad (5.3)$$

where *X* is real export, *Y* is total real GDP of OECD nations, total real GDP of OECD countries is used as a proxy for foreign economic activity, *RP* is relative prices, *P* is the number of patent applications and ε_t is disturbance term.

The expectation about the effect of foreign economic activity on export is positive according to standard demand theory. It means that if there are increases in foreign economic activities, then their demand for export will also increase. Therefore, the expected sign of β_1 is positive. However, the expected impact of relative prices on export is negative. Because, if there is an increase in export prices of a country, the demand for its export will decrease. For this reason, the expected sign of β_2 is negative (Arize, 1997; Arize, Malindretos and Kasibhatla, 2003; Aristotelous, 2002; Kasman and Kasman, 2005; Arize, Osang and Slottje, 2008).

The effect of exchange rate volatility on export is not apparent in the literature. Significant considerations about the effect of exchange rate volatility on export are summarized in the theoretical background section of this research. Therefore, the effect of exchange rate volatility on export might be positive, negative or insignificant.

The model is as follows:

$$\ln M_{it} = \alpha_0 + \alpha_1 \ln Y_{it} + \alpha_2 \ln RP_{it} + \alpha_3 V_{it} + \varepsilon_{it} \qquad (5.4)$$

where *M* is real import, *Y* is real domestic income, *RP* is relative prices, *V* is real effective exchange rate volatility and ε_{it} disturbance term. Model 5.4 is almost same with Arize (1998), Choudhry (2008), Arize and Shwiff (1998).

The model 5.5 is created by adding the number of patent applications to Model 5.4 as a control variable to observe if there is any changing in the results.

$$\ln M_{it} = \alpha_0 + \alpha_1 \ln Y_{it} + \alpha_2 \ln RP_{it} + \alpha_3 V_{it} + \alpha_4 P_{it} + \varepsilon_{it} \qquad (5.5)$$

where *M* is real import, *Y* is real domestic income, *RP* is relative prices, *V* is real effective exchange rate volatility P is the number of patent applications and ε_{it} disturbance term.

The impact of real regional income on import is expected to be positive according to standard demand theory for two reasons. Firstly, the consumption is going to increase with an increase in real regional income. Furthermore, if the distribution of income stays same then the demand for imported goods increase. Secondly, investment is going to increase with an increase in real income and the demand for imported goods is going to increase as well. On the other hand, if the domestic production of the imported goods' increases is more than the increases in demand to these products or if the imported goods are not normal goods then the effect of real income on import might be negative. Furthermore, the expected effect of relative prices on import is negative because if there is an increase in the price of imported goods, then consumers tend to change their preferences to domestic ones (Arize, Ndubizu, 1992; Arize, 1995, 1998; Arize, Shwiff, 1998). Therefore, the expected sign of α_1 is positive and the expected sign of α_2 is negative.

The effect of exchange rate volatility on import is not apparent in the literature. Significant considerations regarding the effect of exchange rate volatility on import are summarized in the theoretical considerations section. For these reasons, the effect of exchange rate volatility on import might be positive, negative or insignificant.

5.4 Empirical Analysis

5.4.1 Panel Data Analysis: Fixed Effect

Panel data analysis is appropriate to include cross-sections such as regions, provinces or countries and time series at the same time (Asteriou and Hall, 2007). There are twelve cross-sections that are NUTS-1 regions of Turkey in this research. Moreover, the period of the investigation is 2004 to 2014. Therefore, panel data analysis is proper to use in this examination.

One of the significant features of the panel data fixed effect method is that it provides opportunity to work with group-specific constants. It means that it is possible to make analyses when some groups or individuals have specific characteristics. In other words, the panel data fixed effect method enables controlling the effects of characteristic features that do not vary over time (Asteriou and Hall, 2007). Fixed effect method is helpful to stay away from biased result because of individual differences among cross sections (Terras-Reyna, 2007).

Since there are characteristic differences (such as geographical, environmental) among regions in Turkey, it is reasonable to use panel data fixed effect method in this study. Moreover, there is a specific test, Hausman Test, to determine whether to use the fixed effect procedure or Random effect method in the analyses. According to Hausman test results, it is still more sensible to use panel data fixed effect methodology in this research.

5.5 Result

Table 2
Result of Panel Data Analysis Fixed Effect Method for Model 5.1, Model 5.3 and Model 5.4.

VARIABLES	(5.1) Real Export	(5.3) Real Export	(5.4) Real Import	(5.5) Real Import
REERVOL	-2.236*	-2.768**	-1.853*	-1,875*
	(1.180)	(1.087)	(0.847)	(0.952)
Terms of Trade Index (Relative Price)	-2.691***	-3.161***	-4.753***	-4,790***
	(0.822)	(0.963)	(0.796)	(1.047)
OECD Real GDP	3.691***	3.911***		
	(0.484)	(0.512)		
Constant	-44.39***	-46.02***	26.33***	26.52***
	(9.656)	(9.827)	(4.347)	(5.622)
Patent		-0.000243**		-1.23e-05
		(0.000109)		(0.000124)
Regional Real GDP			0.359**	0.358***
			(0.131)	(0.137)
Observations	132	132	132	132
Number of id	12	12	12	12
R-squared	0.737	0.754	0.551	0.551

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2 demonstrates the result of the panel data fixed effect estimation method for models 5.1, 5.3, 5.4 and 5.5 respectively.

According to Table 2, the effect of real exchange rate volatility and relative prices on real export is significant and negative at %10 and %1 significance level respectively. Moreover, the impact of total real GDP of OECD countries on real export is significant and positive at %1 significance level. In other words, an increase in exchange rate volatility or an increase in terms of trade index declines export activities of the NUTS-1 regions of Turkey. Furthermore, an increase in the total real GDP of OECD countries increases the export level of the regions.

Moreover, the number of patent application is added as a control variable to Model 5.1 to test the effect of real exchange rate volatility on real export one more time. The result of panel data fixed effect analysis for model 5.3 is displayed in Table 2. According to Table 2, real exchange rate volatility still has an adverse and significant effect on real export at %5 significance level. Furthermore, the sign of the effect of total real GDP of OECD nations and the sign of the effect of relative prices is the same as model 5.1. The effect of the patent application is negative and significant at %5 significance level. In other words, an increase in exchange rate volatility or an increase in terms of trade index still decreases the export activities of NUTS-1 regions of Turkey. However, an increase in real GDP of OECD countries increases the export level of the regions.

According to Table 2, the effect of regional real GDP on real import is positive and significant at %5 significance level. It means that there is a positive relationship between regional real GDP and real import. Moreover, the effect of relative prices and real exchange rate volatility on real import is negative and significant. In other words, if there are increases in real exchange rate volatility or relative prices, import activities of regions decreases.

Furthermore, the number of patent application is added as a control variable to Model 5.4 to test the effect of real exchange rate volatility on real import one more time. The result of panel data fixed effect analysis for model 5.5 is displayed in Table 2. According to Table 2, real exchange rate volatility still has an adverse and significant effect on real import. Furthermore, the sign of the effect of regional real GDP and the sign of the effect of relative prices is the same as model 5.4. The effect of the patent application is insignificant. In other words, an increase in exchange rate volatility or an increase in terms of trade index still decreases the import activities of NUTS-1 regions of Turkey. However, an increase in regional real GDP increases the import level of the regions.

6. CONCLUSION

Exchange rate volatility is in the interest of economists, policy makers, investors, entrepreneurs, employers, and others since the decline of the Bretton Woods System in 1973. Despite many studies in the literature, there is no consensus about the effect of exchange rate volatility on trade.

Changing that occurred in the exchange rate is one of the most critical issues in the agenda of Turkey these days. However, the effect of fluctuations in the exchange rate is not a significant issue only for today and only for Turkey, the effect of variations in the exchange rate is an international issue that takes attention by many countries since the collapse of Bretton Woods System. It seems that it will continue to take attention in future as well.

This thesis investigates the effect of real effective exchange rate volatility on both real regional import and real regional export in Turkey over the period 2004 to 2014. All analyses are performed depending on traditional export demand and traditional import demand equations. The regions in this research are NUTS-1 regions of Turkey; Istanbul, West Marmara, Aegean, East Marmara, West Anatolia, Mediterranean, Central Anatolia, West Black Sea, East Black Sea, Northeast Anatolia, Central East Anatolia, and Southeast Anatolia.

As stated in section 5.3, foreign income is expected to affect real export positively. However, the expected effect of relative prices on real export is negative. The expected impact of real effective exchange rate volatility on real export might be positive, negative or insignificant. The total real income of OECD countries is taken as a proxy of foreign income in this research. Because Turkish export to OECD countries accounts for more than 50 percent of the total export in Turkey over the period 2004 to 2014 on average. Terms of trade index is selected as a proxy to relative prices. According to the results in table 2, real exchange rate volatility has a negative and significant impact on export at the regional level. The effects of other variables are the same as the expectation of this investigation. There is a positive relationship between the total real income of OECD countries and real regional export. However, the effect of relative prices on export is negative on regional basis.

The second model of this investigation is created by adding the number of patent applications as a control variable to the first model of the research to observe if there is a change in the effect of real effective exchange rate volatility on real export of regions. According to the outcomes in Table 2, the effect of real exchange rate volatility on real regional export is still negative and significant. In other words, an increase in real exchange rate volatility is decreasing the real export of regions in Turkey. It is important to note that, after the addition of the number of patent applications as a control variable to the first model of the investigation, the effect of real exchange rate volatility is still the same. Moreover, the effect of relative prices and foreign income on real export is also the same as the result of the first model and with the expectation of this research. Effect of the number of patent applications by regions is significant and negative on real export at the regional level.

According to the outcomes of this analysis, the effect of real exchange rate volatility on real regional import is negative and significant. Moreover, the effect of real regional income on real regional import is positive and significant while the effect of relative prices is negative and significant. In other words, an increase in real exchange rate volatility and relative prices decreases and an increase in local real income increases the real import of the regions in Turkey.

The last model of this research is created by adding the number of patent applications as a control variable to the third model of the study to observe if there is a change in the effect of real effective exchange rate volatility on real import of regions. According to the outcomes in Table 2, the effect of real exchange rate volatility on real regional import is still negative and significant. In other words, an increase in real exchange rate volatility is decreasing the real import of regions in Turkey. It is important to note that, after the addition of the number of patent applications as a control variable to the third model of the investigation, the effect of real exchange rate volatility is still the same. Moreover, the effect of relative prices and regional real income on real import is also the same as the result of the third model and with the expectation of this research. Effect of the number of patent applications by regions is insignificant on real import at the regional level.

The primary purpose of this thesis is to investigate the relation of real exchange rate volatility on both real import and real export of the NUTS-1 regions in Turkey over the period 2004 to 2014. The estimation results show that real exchange rate volatility has a negative and significant effect on real export and real import level of the regions in Turkey. In other words, an increase in real exchange rate volatility decreases the real import and real export activities of the regions.

The fluctuations in the exchange rate is an inevitable and reasonable consequence of the flexible exchange rate regime. The outcomes of this research demonstrate that real effective exchange rate volatility has a dampening effect on both export and import activities of the NUTS-1 regions in Turkey. The investigation of the possible effects of exchange rate volatility on real export and real import of the regions in Turkey has a critical role in implementing and improving more effective economic policies. The economic policies aiming to decrease the exchange rate volatility are necessary for the stable export and import activities in the regions. In other words, economic policies that aim to provide stability in the exchange rate will also provide stability in export and import activities of the regions in Turkey.

REFERENCES

Abrams, R. K. (1980). International Trade Flows under Flexible Exchange Rates. *Economic Review, Federal Reserve Bank of Kansas City* 65, 3-10.

Acaravcı, A. and Öztürk, I. (2002). Döviz Kurundaki Değişkenliğin Türkiye İhracatı Üzerine Etkisi: Ampirik Bir Çalışma.*Review of Social,Economic &Business Studies.* 2, 197-206.

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

Aristotelous, K. (2001). Exchange-Rate Volatility, Exchange-Rate Regime, and Trade Volume: Evidence from the UK–US Export Function (1889–1999). *Economics Letters.* 72, 87-94.

Aristotelous, K. (2002). The Impact of the Post-1972 Floating Exchange-Rate Regime on US Exports. *Applied Economics.* 34.13, 1627-1632.

Arize, A. (1987). The Supply and Demand for Imports and Exports in a Simultaneous Model. *Applied Economics.*19.9, 1233-1247.

Arize, A. (1995). The Effects of Exchange-Rate Volatility on U.S. Exports: An Empirical Investigation, *Southern Economic Journal* 62.1, 33-43.

Arize, A. C. (1995) The Effects of Exchange Rate Volatility on U.S Export: An Empirical Investigation. *Southern Economic Journal.* 62.1, 34-43.

Arize, A. C. and Ghosh, D.K. (1994) Exchange Rate Uncertainty and Recent U.S. Export Demand Instability. *The International Trade Journal.* 8.3, 347-365.

Arize, A. C. and Ndubizu, G. (1992). Cointegration, Error Correction Representation and the Import Demand Function with Implications in International Finance and Accounting Research. *Review of Quantitative Finance and Accounting.* 2, 259-376.

Arize, A.C. (1994). Cointegration Test of a Long- Run Relation Between the Real Effective Exchange Rate and the Trade Balance. *International Economic Journal.* 8.3, 1-9.

Arize, A.C. (1996). Real Exchange Rate Volatility and Trade Flows: The Experience of Eight European Economies. *International Review of Economics and Finance.*5.2, 187-205.

Arize, A.C. (1997). Foreign Trade and Exchange-Rate Risk in the G-7 Countries: Cointegration and Error-Correction Models. *Review of Financial Economics,* 6.3, 95-112.

Arize, A.C. (1998), The Effects of Exchange Rate Volatility on U.S. Imports: An Empirical Investigation. *International Economic Journal.* 12.3, 34-40.

Arize, A.C. (1998). The Long-run Relationship between Import Flows and Real Exchange Rate Volatility: The Experience of Eight European Economies. *International Review of Economics and Finance.* 7.4,417-435.

Arize, A.C. and Shwiff, S.S. (1998). Does Exchange-Rate Volatility Affect Import Flows in G-7 Countries? Evidence from Cointegration Models. *Applied Economics.* 30.10,1269-1276.

Arize, A.C., J. Malindretos and K.M. Kasibhatla (2003). Does Exchange- Rate Volatility Depress Export Flows: The Case of LDCs', *International Advances in Economics Research*, Vol. 9.1, 7–19.

Arize, C. A., Osang, T., and Slottje, J. D. (2000). Exchange-Rate Volatility and Foreign Trade: Evidence from Thirteen LDC's. *Journal of Business & Economic Statistics.* 18.1, 10-17.

Arize, C. A., Osang, T., and Slottje, J. D. (2008). Exchange Rate Volatility in Latin Amerika and its Impact on Foreign Trade. *International Review of Economics and Finance*. 17, 33-44.

Asseery, A. and Peel, A.D. (1991). The Effects of Exchange rate volatility on exports'. *Economic Letters.* 37, 173-177.

Asteriou, D., Hall, and S.G. (2007) Applied Econometrics: A Model *Approach New York: Palgrave Macmillan*.

Baak, J.S., Al-Mahmood, M.A., and Vixathep, S. (2007) Exchange Rate Volatility and Exports from East Asian Countries to Japan and the USA. *Applied Economics.* 39.8, 947-959.

Bacchetta, P. and Van Wincoop, E. (2000) Does Exchange Rate Stability Increase Trade and Welfare? *American Economic Review*, 90.5,1093-1109.

Bahmani-Oskooee, M. and Harvey, H. (2011). Exchange-Rate Volatility and Industry Trade Between the U.S. and Malaysia. *Research in International Business and Finance.* 25, 127-155.

Bahmani-Oskooee, M. and Mitra, R. Exchange Rate Risk and Commodity Trade Between the U.S. and India. *Open Economies Review.* 19. 71-80.

Bahmani-Oskooee, M. and Satawatananon, K. (2012). The impact of Exchange Rate Volatility on Commodity Trade between the US and Thaliand. *International Review of Applied Economics.* 26.4, 515-532.

Bahmani-Oskooee, M. and Wang, Y. (2007) The Impact of Exchange Rate Volatility on Commoditv Trade between the U.S. and China. *Economic Issues.* 12, 31-52.

Bahmani-Oskooee, M., Bolhassani, M., and Hegerty, S. (2012). Exchange Rate Volatility and Industry Trade between Canada and Mexico. *The Journal of International Trade & Economic Development.* 21.3, 389-408.

Bahmani-Oskooee, M., Harvey, H., and Hegerty, W.S. (2012). Exchange Rate Volatility and Industry Trade Between the U.S and Korea. *Journal of Economic Development.* 37.1, 1-27.

Bahmani-Oskooee, M., Hegerty S.W., and Hosny, A. (2015). Excahnge Rate Volatility and Commodity Trade between the E.U and Egtpy: Evidence from 59 Industries. *Empirica.* 42.1, 109-129.

Bahmani-Oskooee, M., Hegerty, S. W., and Xu, J. (2012). Exchange-Rate Volatility and Industry Trade Between Japan and China. *Global Economy Journal.* 12.3, 1-19.

Bahmani-Oskooee, M., Hegerty S.W., and Harvey, H. (2015). Exchange-Rate Volatility and Commodity Trade between the USA and Indonesia. *New Zealand Economic Papers.* 49.1, 78-102.

Bahmani-Oskooee, M., Hegerty, S.W., and Zhang, R. (2014). The Effects of Exchange-Rate Volatility on Korean Trade Flows: Industry-Level Estimates. *Economic Papers.* 33.1, 76-94.

Bailey, M. J., Tavlas, G. S., and Ulan, M. (1986). Exchange- Rate Variability and Trade Performance: Evidence for the Big Seven Industrial Countries, *Weltwirtschaftliches Archiv.* 122.3, 466-477.

BARON, D. (1976). Fluctuating Exchange Rates and the Pricing of Exports. *Economic Inquiry*. 14, 425-38.

Baum, C. F. and Caglayan, M. (2010). On the Sensitivity of the Volume and Volatility of Bilateral Trade Flows to Exchange Rate Uncertainty. *Journal of International Money and Finance.* 29, 79-93.

Brada, C. J. and Mendez, A. J. (1988). Exchange Rate Risk, Exchange Rate Regime and the Volume of International Trade. *Kyklos*. 41.2, 263-280.

Bredin, D., Fountas, S., and Murphy, E. (2003). An Empirical Analysis of Short-run and Long- run Irish Export Functions: Does Exchange Rate Volatility matter. *International Review of Applied Economics.* 17.2,193-208.

Broll, U. and Eckwert, B. (1999). Exchange Rate Volatility and International Trade. *Southern Economic Journal*, 66.1, 178-185.

Byrne, P. J., Darby, J., and MacDonald, R. (2008). US Trade and Exchange Rate Volatility: A Real Sectoral Bilateral Analysis. *Journal of Macroeconomics.* 30, 238-259.

Caballero, R. J. and Corbo, V. (1989). The Effect of Real Exchange Rate Uncertainty on Exports: Empirical Evidence. *The World Bank Economic Review*. 3.2, 263-278.

Caglayan, M. and Di, J. (2010). Does Real Exchange Rate Volatility Affect Sectoral Trade Flows? *Southern Economic Journal.* 77.12, 313-335.

Canzoneri, M, B., Clark, P, B., Thomas, C, G., and Michael, P, L. (1984). The Effect of Exchange Rate Variability on Output and Employment, *International Finance Discussion Papers*, 240.

Çelik, R. (2018). Döviz Kuru Volatilitesinin İhracat Üzerine Etkisi: Türkiye Örneği (1995-2017). *Istanbul Journal of Economics.* 68, 181-220.

Cheong, C. (2004). Does the Risk of Exchange Rate Fluctuation Really Affect International Trade Flows between Countries? *Economics Bulletin.* 6.4, 1-8.

Chou, W. L. (2000). Exchange Rate Variability and China's Exports. *Journal of Comparative Economics.* 28, 61-79.

Choudhry, T. (2008). Exchange Rate Volatility and United Kingdom Trade: Evidence from Canada, Japan and New Zealand. *Empirical Economics.* 35. 607-619.

Choudhry, T. (2005) Exchange rate volatility and the United States Exports: Evidence from Canada and Japan. *Journal of the Japanese and International Economies.* 19, 51-77.

Chowdhury, R. A. (1993). Does Exchange Rate Volatility Depress Trade Flows? Evidence from Error- Correction Models. The Review of Economics and Statistics, 75.4, 700-706.

Clark P. B. (1973). Uncertainty, Exchange Risk, and the Level of International Trade. *Westren Economic Journal.* 11, 302-313.

Clark, P., Tamirisa, N., Wei, J.S., Sadikov, A., and Zeng, L. (2004). Exchange Rate Volatility and Trade Flows - Some New Evidence. *International Monetary Fund.*

Coporale, T. and Doroodian, K. (1994). Exchange Rate Variability and the Flow of International Trade. *Economic Letters.* 46, 49-54.

Coric, B. and Pugh, G. (2010). The Effects of Exchange Rate Variability on International Trade: A Meta-Regression Analysis. *Applied Economics.* 42.20, 2631-2644.

Cushman, D. O. (1983) The Effects of Real Exchange Rate Risk on International Trade. *Journal of International Economics.* 15, 45-63.

Cushman, O. D. (1986). Has Exchange Rate Risk Depressed International Trade? The Impact of Third Country Exchange Risk. *Journal of International Money and Finance.* 5, 361-379.

De Grauwe, P. (1988). Exchange Rate Variability and the Slowdown in Growth of International Trade, *IMF Staff Papers*. 35.1, 63-84.

De Grauwe, P. (1992) Economics of Monetary Integration. *Oxford: Oxford University Press*.

De Vita, G. and Abbott, A. (2004). Real Exchange Rate Volatility and US Exports: An ARDL Bounds Testing Approach. *Economic Issues* 9, 69–78.

De Vita, G. and Abbott, A. (2004). The Impact of Exchange Rate Volatility on UK Exports to EU Countries. *Scottish Journal of Political Economy.* 51.1, 62-81.

Dellas, H. and Zilberfarb, B. Z. (1993). Real Exchange Rate Volatility and International Trade: A Reexamination of the Theory. *Southern Economic Journal.* 59.4, 641-647.

Dixit, A. (1989). Entry and Exit Decisions under Uncertainty. *Journal of Political Economy* 97.3, 620–638.

Doğanlar, M. (2002). Estimating the Impact of Exchange Rate Volatility on Exports: Evidence from Asian countries. *Applied Economics Letters.* 9.13, 859-863.

Doğru, B. and Uysal, M. (2013). Efektif Euro Kurundaki Belirsizliğin Euro Bölgesi İhracatına Etkisi. *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi.* 27.3, 245-262.

Erdal, G., Erdal, H., and Esengün, K. (2012). The Effects of Exchange Rate Volatility on Trade: Evidence from Turkish Agricultural Trade. *Applied Economics Letters.* 19.3, 297-303.

Ethier, W. (1973). International Trade and the Forward Exchange Market. *The American Economic Review.* 63.3, 494-503.

Eurostat. (2011) Regions in the European Union. Luxembourg. Publications Office of the European Union.

Fountas, S. and Bredin, D. (1998). Exchange Rate Volatility and Exports: the Case of Ireland. *Applied Economic Letters.* 5.5, 301-304.

Franke, G. (1991). Exchange rate volatility and International Trading Strategy. *Journal of International Money and Finance.* 10, 292-307.

Froot, A. K. and Klemperer, D.P. (1989). Exchange Rate Pass-Through When Market Share Matters. 79.4, 637-654.

Giovannini, A (1988). Exchange Rates and Traded Goods Prices. *Journal of International Economics* 24, 45-68.

Grier, B. K. and Smallwood, A.D. (2007). Uncertainty and Export Performance: Evidence from 18 Countries. *Journal of Money, Credit and Banking.* 39.4, 965-979.

Gros, D. (1987), "Exchange Rate Variability and Foreign Trade in the Presence of Adjustment Costs," *Département des sciences économiques, Université Catholique de Louvain* Working Paper No. 8704.

Hayakawa, K. and Kimura, F. (2009). The Effect of Exchange Rate Volatility on International Trade in East Asia. *Journal of the Japanese and International Economics.* 23, 395-406.

Hooper, P. and Kohlhagen, W. S. (1978). The effect of Exchange Rate Uncertainty on the Prices and Volume of International Trade. 8, 483-511.

Hwang, H. and Lee, J. (2005). Exchange Rate Volatility and Trade Flows of the U.K. in 1990s. *International Area Review.* 8.1,173-182.

Kasman, A. and Kasman, S. (2005). Exchange rate uncertainty in Turkey and its impact on export volume. *METU Studies in Development*. 32, 41-58.

Kayalak, S. and Kiper, T. (2006). İstatistiki Bölge Birimleri Nomenklatörü'ne (NUTS) göre Türkiye'de Bölgesel Farklılıklar. *IV. Ulusal Coğrafya Sempozyumu (pp. 45–54)*. Ankara: Ankara Üniversitesi Türkiye Coğrafyası Araştırma ve Uygulama Merkezi.

Kenen, P. B. and Rodrik, D. (1986). Measuring and Analyzing the Effects of Short-Term Volatility in Real Exchange Rates. *The Review of Economics and Statistics* 68.2, 311-315.

Kılıç, E. (2013). Döviz Kuru ve Sektörel Reel Döviz Kuru Volatilitesinin Dış Ticatet Hacmi Üzerine Etkileri. Doktora Tezi, Anadolu Üniversitesi.

Klein, W.M. (1990). Sectoral Effects of Exchange Rate Volatility on United States Exports. *Journnl of International Money and Finance (1990).* 9, 299-308.

Koray, F. and Lastrapes, D. W. (1989). Real Exchange Rate Volatility and U.S. Bilateral Trade: A Var Approach. *The Review of Economics and Statistics.* 71.4, 708-712.

Köse, N., Ay, A. and Topallı, N. (2008). Döviz Kuru Oynaklığının İhracata Etkisi: Türkiye Örneği (1995-2008). *Gazi Üniversitesi İ.İ.B.F Dergisi*, 10.2, 25-45.

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

McKenzie, D.M. (1998). The Impact of Exchange Rate Volatility on Australian Trade Flows. *Journal of International Financial Markets, Institutions and Money.* 8, 21-38.

McKenzie, D.M. (1999). The Impact of Exchange Rate Volatility on International Trade Flows. *Journal of Economic Surveys.* 13.1, 71-106.

Medhora, R. (1990). The Effect of Exchange Rate Variability on Trade: The Case of the West African Monetary Union's Imports. *World Development.* 18, 313-324.

OECD,Consumer Price Indices https://stats.oecd.org/Index.aspx?DataSetCode=PRICES_CPI# (12 July 2018).

OECD. Data, Gross Domestic Product https://data.oecd.org/GDP/gross-domestic-product-GDP.htm (16 December 2018).

Ozturk, I. and Acaravci, A. (2002). The Effects of Exchange Rate Volatility on the Turkish export: an Empirical Investigation. *Review of Social, Economic and Business Studies.* 2, 197-206.

Ozturk, I. and Kalyoncu, H. (2009) Exchange Rate Volatility and Trade: An Empirical Investigation from Cross-country Comparison. *African Development Review.* 21.3, 499-513.

Pozo, S. (1992). Conditional Exchange-Rate Volatility and the Volume of International Trade: Evidence from the Early 1900s. *The Review of Economics and Statistics.* 74.2, 325-329.

Saatcioglu, C. and Karaca, O. (2004) Döviz Kuru Belirsizliginin İhracata Etkisi. *Dogus Universitesi Dergisi*. 5.2, 183-195.

Sarı, A. (2010). Döviz Kuru Oynaklığının İthalata Etkileri: Türkiye Örneği. *Ekonometri ve İstatistik.* 11, 31-44.

Sauer, C. and Bohara, A.K. (2001). Exchange Rate Volatility and Exports: Regional Differences between Developing and Industrialized Countries. *Review of International* Economics. 9.1,133-152.

Saygılı, H. Yılmaz, G., and Saygılı, G. (2010). Türkiye İçin Yeni Reel Efektif Döviz Kuru Endeksleri. CBRT. ÇALIŞMA TEBLİĞ NO:10/12.

Sercu, P. and Uphal, R. (2003). Exchange Rate Volatility and International Trade: A General-Equilibrium Analysis. *European Economic Review.* 47,429-441.

Sercu, P. and Vanhulle, C. (1992). Exchange Rate Volatility, International Trade and the Value of Exporting Firms. *Journal of Banking and Finance.* 16, 155-182.

Tarı, R. and Yıldırım, Ç. D. (2009). Döviz Kuru Belirsizliğinin İhracata Etkisi: Türkiye İçin Bir Uygulama. *Yönetim ve Ekonomi.* 16.2, 95-105.

CBRT, Consumer Price Index and Indices by Regions https://evds2.CBRT.gov.tr/index.php?/evds/serieMarket (16 December 2018).

CBRT, Data PPI Based Real Effective Exchange Rate https://www.CBRT.gov.tr/wps/wcm/connect/EN/CBRT+EN/Main+Menu/Statistics/Exchange+Rates/Real+Effective+Exchange+Rates+Deneme/Data+-+November+2018/ (16 December 2018).

CBRT, Data, CPI Based Real Effective Exchange Rate https://www.CBRT.gov.tr/wps/wcm/connect/EN/CBRT+EN/Main+Menu/Statistics/Exchange+Rates/Real+Effective+Exchange+Rates+Deneme/Data+-+November+2018/ (16 December 2018).

CBRT, Domestic Producer Prices Index https://evds2.CBRT.gov.tr/index.php?/evds/serieMarket (23 December 2018).

Torres-Reyna, O. Panel Data Analysis Fixed and Random Effects using Stata (v. 4.2). 2007. Princeton University. https://www.princeton.edu/~otorres/Panel101.pdf (12 September 2018).

TURKSTAT, Foreign Trade Indeces http://www.TURKSTAT.gov.tr/PreTablo.do?alt_id=1054 (16 December 2018).

TURKSTAT, Regional Statistics https://biruni.TURKSTAT.gov.tr/bolgeselistatistik/degiskenlerUzerindenSorgula.do (23 December 2018).

TURKSTAT. (2014). *Income and Living Conditions Survey Micro Data Set (Cross Sectional).* http://www.TURKSTAT.gov.tr/MicroVeri/GYKA_2014/english/meta-data/classification/index.html (12 September 2018).

TURKSTAT. Foreign Trade Indices, Unit Value Indices by Year and Month by Standard International Trade Classification http://www.turkstat.gov.tr/PreTablo.do?alt_id=1054 (16 December 2018).

TURKSTAT. Foreign Trade Statistics, Export by Provinces http://www.turkstat.gov.tr/PreTablo.do?alt_id=1046 (16 December 2018).

TURKSTAT. Foreign Trade Statistics, Import by Provinces http://www.turkstat.gov.tr/PreTablo.do?alt_id=1046 (16 December 2018).

TURKSTAT. Main Statistics, Population and Demography, Population of Provinces by Years http://www.turkstat.gov.tr/UstMenu.do?metod=temelist (16 December 2018).

TURKSTAT. *The Data: Coverage, Periodicity and Timeliness* http://www.TURKSTAT.gov.tr/PreTablo.do?alt_id=1054 (21 November 2018).

Tuncsiper, B. and Oksuzler, O. (2006). Döviz Kuru Riski Türkiye'nin İhracatını azaltır mı? Hata Doğrulama Yöntemi ile Bir Ampirik Değerlendirme. *ZKU Sosyal Bilimler Dergisi.* 2.3, 1-13.

TURKPATENT, Distribution of Patent Applications With Respect To Cities http://www.turkpatent.gov.tr/TURKPATENT/statistics/ (16 December 2018).

Vergil, H. (2002). Exchange Rate Volatility in Turkey and Its Effect on Trade Flows. *Journal of Economic and Social Research.* 4.1, 83-99.

Viaene, J.M and de Vries, C.G. (1992). International Trade and Exchange Rate Volatility. *European Economic Review.* 36, 1311-1321.

APPENDIX

Table 3
Regions in Turkey according to NUTS-1, 2 Classification

NUTS-1	**NUTS-2**
İstanbul	İstanbul
West Marmara	Tekirdağ, Edirne, Kırklareli
	Balıkesir, Çanakkale
Aegean	İzmir
	Aydın, Denizli, Muğla
	Manisa, Afyonkarahisar, Kütahya, Uşak
East Marmara	Bursa, Eskişehir, Bilecik
	Kocaeli, Sakarya, Düzce, Bolu, Yalova
West Anatolia	Ankara
	Konya, Karaman
Mediterranean	Antalya, Isparta, Burdur
	Adana, Mersin
	Hatay, Kahramanmaraş, Osmaniye

Source: TURKSTAT

Table 4
Regions in Turkey according to NUTS-1, 2 Classification.

NUTS-1	NUTS-2
Central Anatolia	Kırıkkale, Aksaray, Nigde, Nevşehir ,Kırşehir
	Kayseri, Sivas, Yozgat
West Black Sea	Zonguldak, Karabük, Bartın
	Kastamonu, Çankırı, Sinop
	Samsun, Tokat, Çorum, Amasya
East Black Sea	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane
Northeast Anatolia	Erzurum, Erzincan, Bayburt
	Ağrı, Kars, Iğdır, Ardahan
Central East Anatolia	Malatya, Elazığ, Bingöl, Tunceli,
	Van, Muş, Bitlis, Hakkari
Southeast Anatolia	Gaziantep, Adıyaman, Kilis
	Şanlıurfa, Diyarbakır
	Mardin, Batman, Şırnak, Siirt

Source: TURKSTAT

Table 5
Result of Hausman Test for Model 5.3

	Coefficients (b) Fixed	 (B) random	 (b-B) Difference	 sqrt(diag(V_b-V_B) S.E
OECD Real GDP	3,91	3,87	0,031	0,007
Patent	-0,0002	-0,0002	-0,00003	8,39e-06
Terms of Trade Index	-3,16	-3,093	-0,067	0,016
Real Effective Exchange Rate Volatility	-2,76	-2,69	-0,076	0,018
	b=consistent under H_0 and H_a ; obtained from xtreg B=inconsistent under H_a, efficient under H_0; obtained from xtreg Test: H_0: difference in coefficients not systematic Chi2(2) =(b-B) ‘ [(V_b-V_B)^(-1)] (b-B) = 17,45 Prob>chi2= 0,0002 (V_b-V_B is not positive definite)			

Table 6
Result of Hausman Test for Model 5.4

	Coefficients (b) Fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B) S.E
Real Effective Exchange Rate Volatility	-1,85	-4,71	2,86	
Terms of Trade Index	-4,75	-4,31	-0,43	
Regional Real GDP	0,35	1,36	-1,00	0,101
	b=consistent under H_0 and H_a ; obtained from xtreg B=inconsistent under H_a, efficient under H_0; obtained from xtreg Test: H_0: difference in coefficients not systematic Chi2(3) =(b-B) ‘ [(V_b-V_B)^(-1)] (b-B) = 96,54 Prob>chi2= 0,0000 (V_b-V_B is not positive definite)			