THE EXAMINATION OF THE EFFECTS OF EXCHANGE VOLATILITY ON IMPORTS AND EXPORTS

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MASTER'S THESIS

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ÖZET

DÖVİZ KURU OYNAKLIĞININ İTHALAT VE İHRACAT ÜZERİNDE OLAN ETKİLERİNİN İNCELENMESİ

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Bu çalışma Türkiye'deki döviz kuru oynaklığı ile ithalat ve ihracat arasındaki ilişkiyi incelemeyi amaçlamaktadır. Çalışmada kullanılan nominal döviz kuru, toplam ithalat ve ihracat değişkenleri, ARDL Sınır testi yaklaşımı kullanılarak, 2000-2019 dönemi için aylık olarak incelenmiştir.

E-GARCH yöntemi kullanılarak bulunan döviz kuru oynaklığının, ampirik bulgulara göre asimetrik bir etkisi olduğu sonucuna varılmaktadır. Döviz kuru oynaklığının ithalat üzerinde olumsuz bir etkisi olurken, ihracat üzerinde olumlu bir etkisi vardır. Aynı zamanda ithalatın ihracat üzerinde olumlu bir etkisi olurken, ithalat için de durum aynı değildir.

Elde edilen sonuçlara göre, politika yapıcılar politika uygulamalarında makroekonomik bir değişken olan döviz kuru ile dış ticaret arasındaki ilişkiyi düşünebilirler.

Anahtar Sözcükler: Döviz Kuru Oynaklığı, İthalat, İhracat, E-GARCH Model, ARDL Sınır Testi

ABSTRACT

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In this study, the short-and long run effects of exchange rate volatility on imports and exports are examined by using ARDL Bounds testing approach. The study encompasses the export-import values of Turkey over the period of 2000 and 2019. In addition, the exchange rate volatility is analyzed through the employment of E-GARCH method.

Overall, the exchange rate volatility is investigated by using the E-GARCH method. The results of the study indicate that the exchange rate volatility has an asymmetric and negative effect on imports while it has boosting effect on exports. At the same time, while imports have a positive effect on exports, the same pattern is not the case for imports.

In terms of practical implications, the study provides fruitful insights for policy makers. In this regard, policy makers should consider the interrelations between exchange rate and foreign trade parameters in policy application.

Keywords: Exchange Rate Volatility, Import, Export, E-GARCH Model, ARDL Bounds Test

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STATEMENT OF COMPLIANCE WITH ETHICAL PRINCIPLES AND RULES

I hereby truthfully declare that this thesis is an original work prepared by me; that I have behaved in accordance with the scientific ethical principles and rules throughout the stages of preparation, data collection, analysis and presentation of my work; that I have cited the sources of all the data and information that could be obtained within the scope of this study, and included these sources in the references section; and that this study has been scanned for plagiarism with “scientific plagiarism detection program” used by Anadolu University, and that “it does not have any plagiarism” whatsoever. I also declare that, if a case contrary to my declaration is detected in my work at any time, I hereby express my consent to all the ethical and legal consequences that are involved.

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ABBREVEATIONS

ADF :Augmented Dickey-Fuller

AIC :Akaike Information Criterion

ARCH :Autoregressive Conditional Heteroskedasticity

ARDL :Autoregressive Distributed Lag

DCC :Dynamic Conditional Correlation

DEXPO :Difference of Total Export

DIMPO :Difference of Total Import

ECM :Error Correction Model

EGARCH :Exponential Autoregressive Conditional Heteroskedasticity

EXCHVOL :Exchange Rate Volatility

FDI :Foreign Direct Investment

GARCH :Generalized Autoregressive Conditional Heteroskedasticity

GDP :Gross Domestic Product

IID :Independent and Identically Distributed Random Variable

KPSS :Kwiatkowski, Phillips, Schmidt, and Shin Test

LS :Lee Strazich Test

PARCH :Power Autoregressive Conditional Heteroskedasticity

PP :Philips Peron's Test

SC :Schwarz information criterion

TGARCH :Threshold Generalized Autoregressive Conditional Heteroskedasticity

UECM :Unconstrained Error Correction Model

VAR :Vector Autoregressive Model

VECM :Vector Error Correction Model

ZA :Zivot Andrews Test

SYMBOLS

t : Time

H_0 : Null hypothesis

H_1 : Alternative hypothesis

$I(1)$: Integrated at order one

α_0 : Constant Variable

ε_t : Error Term

T : Number of Observations

χ^2 : Chi-square

INTRODUCTION

Exchange rates have been an important research topic that has attracted the attention of economists and financiers in every period. Exchange rates are one of the issues that need to be addressed, especially in economies open to foreign countries and developing countries.

Today, countries apply different exchange rate regimes according to their own circumstances and can change the regime they have applied in a planned or unplanned manner according to the market situation. Changes in exchange rate policy affect foreign investment and international trade, but also play an important role in the real and financial sector for the country. The collapse of the Bretton-Woods (1973) system has led to the transition of many of the world's major trading countries to a fluctuating exchange rate (Senedza, 2017) and the beginning of a new era for the global economy. In this context, the volatility concept that emerges with the fluctuation of the exchange rate affects both foreign trade and domestic markets.

Exchange rate volatility can be expressed as a measure of how much the exchange rates deviate from the expected value. Sudden changes in the economy, such as government change, a pandemic situation or crisis periods, increase volatility. Increasing exchange rate volatility increases the exchange rate risk in foreign exchange markets, which may have misleading or negative effects on the future decision-making process. In this context, the effects, and consequences of the volatility of the exchange rate should be modeled well in order to avoid a risk that the exchange rate volatility may cause.

Since 1973 including Turkey, many countries have started their transition from a fixed exchange rate regime to a floating exchange rate regime. However, there is a concern over the floating exchange rate system due to the high volatility and uncertainty of exchange rate movements and the impact of this volatility on international trade balance. The traditional argument is that increased uncertainty in exchange rate high volatility can affect international trade, but empirically and theoretically there is no real consensus about the effects of exchange risk on trade volume (Kasman, 2005). Laissez faire economists have adopted this transition, although they are not welcomed by those who claim that the transition to a free-floating exchange rate would have a negative impact on world trade. They think that exporters away from risk will decrease production when they encounter an increase in the exchange rate volatility caused by the transition

to floating exchange rates. In this regard, the risk associated with unexpected movements in the exchange rate can be expressed as exchange rate volatility. (McKenzie, 1999). Moreover, the process of changing from the fixed exchange rate system of Turkey to the floating exchange rate system has taken time from 1973 to 2001. Between 1980 to 1989, a constant exchange rate system with frequent devaluations has been implemented, and the following decade, a controlled free exchange rate system has been implemented. Although the export-based growth model has been implemented between 1980 to 2001, it has started to be used in real terms as of 2001.

Both theoretical and empirical studies have not given conclusive conclusions about the relation between trade terms and exchange rate volatility. Although most trade models claim that exchange rate volatility increases uncertainty and risk, and hence hinders trade flows, some other studies show otherwise. Also, while all studies proceed under the assumption of symmetry, that is, there is no difference between the risk effects of the exchange rate depreciation and appreciation, some theoretical and empirical models try to isolate the quantitatively important effects of exchange rate risk on exports. (Fang, 2009). In the analysis of Tse and Tsui (1997) a depreciation shock produces a greater effect on future volatility in exchange rates than an appreciation shock of the same magnitude has been found. In foreign exchange market crises, asymmetrical volatility, that is, a significant depreciation in the exchange rate, becomes more pronounced if it is associated with a significant rise in market volatility. When risk-averse exporters facing varying degrees of foreign exchange market volatility, they act differently. Therefore, different risk effects can occur under exchange rate appreciation and depreciation conditions (Fang, 2009*).* In this study, the effects on imports and exports of exchange rate volatility in Turkey, will be examined empirically. The study consists of three parts. In the first section, the definition and scope of the exchange rate, exchange rate systems, the definition, causes and effects of the exchange rate volatility are examined theoretically.

In the second part of the study, after giving theoretical information about the modeling of exchange rate volatility, recently used and popular volatility models are mentioned. In addition, ARDL Bounds Test approach, which is one of the time series analysis methods and some basic unit root and structural break tests underlying econometric analysis are mentioned.

In the third part of the study on the effects of exchange rate volatility of imports and exports on Turkey, monthly nominal exchange rate, total imports, and total exports

data for the period from January 2000 to December 2019 were used to apply econometric analysis. Also, in this section, studies from the related literature on the subject were presented. While analyzing the effect of exchange rate volatility on foreign trade, firstly exchange rate volatility has been obtained by using an ARCH model type, EGARCH model, and it has been proved to have an ARCH effect. After the volatility has been obtained, its effect on total import and export has been analyzed using the ARDL boundary test method. The results obtained are evaluated in the last section which is conclusion.

1. CONCEPT OF EXCHANGE RATE

In the first part of the study, the definition of exchange rate, exchange rate systems, exchange rate volatility, effects of exchange rate volatility and results will be discussed.

1.1. Definition and Scope of Exchange Rate

Each country provides trade in its own national economy with its own national currency, while this is not possible in foreign trade. For this reason, the common currency used by the importer and exporter is called foreign currency in order to carry out and maintain foreign trade.

The exchange rate means the value of the currency of one country in the currency of another country. In other words, the exchange rate is the rate of change between the two national currencies. Moreover, the exchange rate is the price expressed in terms of each other of the two national currencies (Öztürk, 2011). This price is related to the markets of goods and services and any change in the exchange rate will affect these markets as a priority and then the markets to which these markets are related. For this reason, any change in the exchange rate should be considered as it can affect international economic relations and activities (Karluk, 1998).

Foreign currencies obtained in any way and supplied to the foreign exchange market to be converted into national currency is the constitute of the foreign exchange supply of that country. Foreign currency supply is mainly related to the exports of a country. There is an overall positive relationship between the exchange rate and the foreign exchange supply. The decrease in the price of an exported good in foreign currency occurs with the increase in the exchange rate and that indicates the national currency has depreciated.

Foreign exchange demand is the total amount of foreign currency requested to pay to foreign countries. The relationship between the exchange rate and the demand for foreign exchange is negative. As the exchange rate rises, the price of imported goods in national currency rises, which means that both foreign goods and foreign exchange demand decreases.

In case the foreign exchange supply and demand are equal and there are no artificial obstacles such as government intervention on the foreign exchange market, market equilibrium is provided. The equilibrium exchange rate is ensuring the equality of foreign

exchange of supply and demand, and the amount at which it occurs is called the equilibrium currency volume.

The concept of exchange rate is expressed in two different ways as indirect and direct quotations. The direct quotation is the definition of the exchange rate as the amount of national currency per foreign currency. Expressing the exchange rate in the form of the amount of foreign currency, which is a unit of national currency, is indirect quotations (Seyidoğlu, 2015).

In the other section, exchange rate systems will be discussed.

1.2. Types of Exchange Rate

The basic definitions of the exchange rate will be described in this section as subtitles. Nominal and real, foreign exchange buying and selling, direct and cross exchange rate will be expressed in 3 sub-titles.

1.2.1. Nominal and reel exchange rate

The nominal exchange rate is the amount of national currency that must be paid to receive one unit of foreign currency. Moreover, it can also be expressed as the value of one unit of national currency in foreign currencies or rate of the price of the currency of two countries (Özkan, 2003).

It can be formulated as following;

$$e;\ \frac{1}{FE_f} = FE_d{}^1 \qquad \textbf{(1.1)}$$

According to this equation, the appreciation of the domestic currency means an increase in the value of the domestic currency compared to the value of the foreign currency, and same rule is valid for opposite situation (Özkan, 2003).

In the calculating of the nominal exchange rate, the increase in the prices of the country, in other words, inflation rates are not considered. This means that the nominal exchange rate has a lower value than the real exchange rate and an external value above the real value of the national currency. In this regard, the export goods and services of the country may decrease, as domestic goods and services may be more expensive for

[1] $e: Nominal\ Exchange\ Rate\ , FE_f: Foreign\ Exchange\ of\ Foreign\ Currency,$
$FE_d: Foreign\ Exchange\ of\ National\ Currency$

foreigners. As a result, there may be an increase in the country's imports and a decrease in its exports (Akyıldız, 2017).

Real exchange rate is the exchange rate between the countries calculated by considering the inflation or the price increases. It is formulated as follows;

$$R = \frac{e.P_f}{P_d}\,^{2} \qquad \textbf{(1.2)}$$

The increase in the real exchange rate means that the prices of domestic goods and services decrease, and the prices of foreign goods increase. This indicates that the export of domestic goods (X) will increase while the amount of import (M) foreign goods will decrease. As a result, an increase in net exports (X-M) and a positive effect in current transactions can be mentioned. There is another situation in which imports will increase and exports will decrease as the real exchange rate decreases. This will have a negative impact on current transactions.

The real exchange rate plays an important role in determining the competitiveness of foreign trade countries, as an increase or decrease in the real exchange rate has an effect on the prices of export goods. Also, there are two situations such as national currency gaining value (appreciation) or losing value (depreciation) against foreign currency. Therefore, it is necessary to calculate the effective exchange rate in order to find the external value of the national currency. The effective exchange is equal to the weighted average of the national currency's exchange rates, which are the major trading partners. However, since the effective exchange rates to be calculated in this case will reflect the nominal exchange rate and the national currency. Effective exchange rates must directly reflect the purchasing power, so it must be converted into a real effective exchange rate. Moreover, the real effective exchange rate index is required because a country is likely to be found in trade with more than one country. The real effective exchange rate (REER) is calculated for Turkey as follows.

$$REER = \prod_{i=1}^{N} \left[\frac{P_{TUR}}{P_i * e_{i,TUR}}\right]^{w_i}\,^{3} \qquad \textbf{(1.3)}$$

---

[2] $R: Real\ Exchange\ Rate, P_d: Price\ od\ Domestic\ Goods\ and\ Services$
$P_f: Price\ of\ Foreign\ Goods\ and\ Services$

[3] $N: Number\ of\ Country, P_{TUR}: Price\ Index\ of\ Turkey, P_i: Price\ Index\ of\ Country\ i$
$w_i\ is\ the\ country\ i's\ weight\ in\ Turkey's\ REER\ Index,$
$e_{i,TUR}: Nominal\ Exchange\ Rate\ of Country\ i\ in\ terms\ of\ \ Turkey$

An increase in REER indicates the real appreciation of TL, representing an increase in the value of Turkish products in terms of foreign products (Eğilmez, 2012).

1.2.2. Buying and selling exchange rate

Banks and every institution which are trading foreign currency declare two different exchange rates, namely foreign exchange buying and selling. The buying foreign exchange rate is different from the selling foreign exchange rate, also it is lower than the selling foreign exchange rate.

The currency margin consists of the sum of the costs and profits incurred by brokerage firms performing transactions in the foreign exchange market. The main factors that determine the amount of the currency margin are; the size of the foreign exchange transactions being small or high, the amount of transactions in the foreign exchange market being low or high, the stability or instability of the foreign exchange market, the expectations of foreign exchange agents, the wider margin at the effective exchange rates compared to the foreign currency and the situation of all financial institutions are not the same (Seyidoğlu, 2007). Currency margin percentage is calculated to compare foreign currency currencies in terms of exchange margin, to compare the returns of investment instruments and to obtain more reliable results. It is calculated as following.

$$PEM = \frac{EB-ES}{ES} * 100 \quad \textbf{(1.4)}$$

where, *PEM* refers percentage of exchange margin, *EB* means buying exchange rate and *ES* indicates selling exchange rate.

If the currency margin is high, it is an indication that the transaction volume in the foreign exchange market is small, there is instability in the foreign exchange market or fluctuations may occur in the future foreign exchange markets. If the currency margin is low, it means the expectation that the markets have a stable structure, the transaction volume in the foreign exchange markets is large, or that there will be no fluctuations in the future foreign exchange markets (Çelik, 2008).

1.2.3. Direct and cross rate

The direct exchange rate is the expression of two national currencies directly in terms of each other. According to the direct exchange system, each of the national currency has a value corresponding to the foreign currency. For example, 1 US dollar is 6.90 TL while 1 Euro is 7.50 TL. Foreign trade countries around the world usually buy

or sell in the common currency, which is the dollar, in order to minimize confusion in foreign exchange markets and simplify market transactions. The value of the two national currencies against each other is expressed as a cross exchange rate. For example, 1 US dollar is 6.90 TL and 0.92 Euro. As a result of simple mathematical operation, it is seen that 1 euro is 7.5 TL. Calculating the exchange rate between the two national currencies in dollars is defined as a cross exchange calculation. The exchange rate calculated by this method is described as an indirect exchange rate (Seyidoğlu, 2003).

In the following section, basic information about exchange rate systems will be tried to be given.

1.3. Exchange Rate System

Systems for determining the manner in which exchange rates will occur are called exchange rate systems. The basis of the exchange rate systems is the issue of whether to intervene in the formation of the exchange rate or how to intervene. The main purpose of all systems in determining exchange rates is to determine the exchange rates that keep the balance of payments (Aral, 2015).

There are different opinions in the literature regarding the classification of exchange rate systems. In theory, it is expressed under two main groups as fixed and flexible exchange rate. In this part of the study, it will be examined under three sub-titles as fixed, flexible, and alternative.

1.3.1. Fixed exchange rate system

The exchange rate is defined as a fixed exchange rate to the determination of the exchange rate at a certain exchange level and maintaining the exchange rate previously announced by the central bank, without being sensitive to changes in market demand and supply. In this context, the main feature of the fixed exchange rate system is that exchange rates should be maintained at a certain level (Seyidoğlu, 2003).

In the fixed exchange rate system, the central bank intervenes in the market by trading foreign currency if it deviates from the level announced by the exchange rate. The reason that the central bank intervenes in the foreign exchange market as a buyer and seller is to ensure the stability of the exchange rates (Aral, 2015). Even if the central bank intervenes in sudden fluctuations, it should declare that it will keep the exchange rate constant at a certain level in advance.

Central bank can peg the exchange rate in two ways. First, it is the fixing of the national currency in gold which is known as the most effective approach of the fixed exchange rate. The second is the case of fixing the exchange rate expressed as the Bretton Woods System to the dollar. The exchange rates are constant in the fixed exchange rate system, but the central bank does not have to maintain the determined exchange rate. The central bank can peg its money in a basket of currencies of the countries where it has tight trade relations and its money is reserve money. The currency of economy in question is determined by law and this exchange level is not changed for a while. However, the central bank must hold enough money and gold in order to successfully intervene in the markets (Kızıldere, 2012). For example, in case of a deficit in the balance of payments, since the supply of foreign currency is insufficient in the market, the central bank sells foreign currency to the market, and if the balance of the payments exceeds, it receives the foreign currency in the market (Aral, 2015). Under a fixed exchange rate system, a country reduces its currency in foreign currency (devaluation) when the foreign currency reserves run out. If the country's foreign currency reserves increase enough to increase inflation; increases the value of the country currency in foreign currencies (revaluation) (Yıldırım, 2003).

The application of the fixed rate regime has basic advantages such as minimizing the fluctuations in the exchange rate, eliminating the unbalanced in foreign trade and ensuring price stability (Yaman, 2012). One of the most important advantages of fixed exchange rate regimes is that inflation can be brought under control by fixing the value of a high-inflation country currency to the currency of another country with a low inflation rate and a strong economy. With this method, in which the exchange rate is used as a nominal tool for the economy, the country with high inflation can bring its economy to stability thanks to the monetary discipline and credibility it imports from another country (Kaya, 2009).

The fact that monetary policy is focused on the exchange rate brings along its advantages as well as its disadvantages. One of its major disadvantages is the loss of an independent monetary policy. In the face of internal or external shocks that may arise in the economy, the duration and effect of shocks in the economy increase when monetary policy is not used in line with the needs of the country. In such a case, rapid and drastic adjustments are required in production, prices, employment, and wages with high political and social costs. For example, in a contraction that may occur in foreign demand, it is

necessary to adjust the prices and prices instead of decreasing the exchange rate and cheapening the export goods. Likewise, in a speculative attack against a fixed exchange rate advocating exchange rates, rising interest rates and depletion of international reserves also has a negative impact on economic growth and unemployment (Kaya, 2009).

1.3.2. Mixed exchange rate system

Apart from the fixed and flexible exchange system, the system which carries some features of these two exchange rates and includes more than one type of exchange rate classified according to the degree of flexibility, is referred to as the mixed exchange rate.

1.3.3. Flexible exchange rate system

In the flexible exchange rate system, exchange rates are left to the functioning of the supply and demand forces in the foreign exchange market, just like a commodity under competitive market conditions. In other words, exchange rates are determined at the level where the total foreign exchange demand and the total supply are equal. If there is a change in market demand or supply, it changes in exchange rates in response (Seyidoğlu, 2007).

The exchange rate will fluctuate when the foreign exchange demand or supply moves away from balance, since the flexible exchange rate system is the form of the market mechanism applied to foreign exchange rates. For example, in cases where foreign exchange demand is higher than foreign exchange supply or, in other words, imports are more than exports, excess balance of foreign payments will open deficit and exchange rate will increase. Due to the rising exchange rate, there will be an increase in exports, namely foreign exchange supply, so that the balance of external payments will be directed towards balance again (Aral, 2015). In this context, any change in foreign exchange demand or supply directly affects the country's foreign trade economy. The uncertainty in the flexible exchange rate means the instability of the exchange rate, which can adversely affect international capital mobility and resource allocation. This situation can be considered as one of the disadvantages of the flexible exchange rate against the fixed exchange rate.

Independence of monetary policy is one of the primary advantages in the flexible exchange system. In case of rising prices with the increase in domestic demand, central banks can increase the interest rates and rebalance the economy. Another advantage in the flexible exchange system is that both the flexion in exchange rates and the active use

of monetary policy in asymmetric shocks that countries face, so economic balance can be achieved without requiring serious adjustments in variables such as growth, employment and inflation (Kaya, 2009).

1.3.3.1. Managed floating

Exchange rates in this system are determined according to supply and demand in the market, as in free floating exchange rates. The monetary authorities rebalance the changing balance in the exchange rate market by buying or selling foreign currency, considering the macroeconomic factors and the current economic situation.

The Bretton Woods collapse (1973) caused many countries to switch to this exchange rate system. In economies where exchange rates occur intensely in market conditions, while intervention in exchange rates is minimal, intervention in exchange rates is at maximum level in economies realized by decision units outside market conditions. The managed floating system contains some features of flexible and fixed exchange rates and it is seen that both systems aim to take advantage of the positive aspects and avoid their drawbacks. For example, this system which has the feature of flexibility, plays an active role in the external balance problem of the economy. Also, like the fixed exchange rate system, the stabilization of exchange rates is stated to prevent the distinctive effect of the question economy on global financial and trade movements due to the uncertainty in flexible exchange rate changes. The main purpose of this system is to minimize excessive fluctuations in a short time (Seyidoğlu, 2003).

1.3.3.2. Floating within a band

In such a system, exchange rates are allowed to fluctuate freely within a specified range. This exchange system, which can be perceived as a combination of floating and fixed exchange rate system, brings flexibility and stability. While the average value of the range determined as the central parity gives exchange rate a certainty, the fluctuation of the rates within this range reduces the effect of external shocks. Determining the range in this system is a problem. The very narrow range can bring instability and speculation. Also, the sustainability of this range is essential for trust in this system. The continuously adjusted range can eliminate the expected benefits (Özdemir and Şahinbeyoğlu, 2000).

1.3.3.3. Sliding band

In the sliding band system, unlike floating within a band system, the average value of the range where the exchange rates fluctuate is not fixed. This average value is adjusted for uncertain times. This system is generally applied in countries with high inflation

problems. With this system, it is aimed to prevent overvaluation of exchange rates. However, since the adjustment time of the range is unknown, it creates an uncertainty in the markets, which undermines the reliability in the system (Yaman, 2012).

1.3.3.4. Crawling band

It is a system that envisages the adjustment of the central parity over time within a predetermined interval or in the system. The main determining of the parity is the balance of payments, but forward or backward inflation differences can also be used to determine the parity. If the inflation rate is high in a country, it is possible to apply the interval system without making high rate adjustments in the central parity. In the other case, if there is a mistake in determining the parity, there is a risk of an increase in inflation values, overvaluation of the national currency and exposure of the economy to speculative attacks. Due to these risks, this system should be supported with interest policies.

1.3.3.5. Crawling peg

In this system, the value of a country's national currency is fixed to a fixed value, which is determined on the basis of certain economic indicators and especially changes in the balance of payments. Although it has the same advantages and disadvantages as the directed fixed exchange rate, this system is a stricter system. The difference of this system from fixed exchange rate systems is that when a pressure exists on fixed exchange rates, the necessary adjustment in exchange rates is made periodically, not on impulse. This system prevents excessive real exchange rate appreciation in countries with high inflation. It guides market expectations and provides a certain degree of credibility. In addition, uncertainties are reduced to a minimum, as there is no interval in this system (Gök, 2006).

1.3.3.6. Fixed but adjustable

It is a system known as the Bretton Woods system. In this system, although the rate is fixed, monetary authority does not have to maintain this rate indefinitely. If the determined exchange rate is inconsistent with the applied economic policies, it can be changed in the desired direction. This system contributes to economic stability by reducing exchange rate uncertainty over foreign trade. On the other hand, it is a system suitable for creating a crisis in the economy as a possible adjustment expectation can lead to intense speculation (Özdemir and Şahinbeyoğlu, 2000).

1.3.3.7. Full dollarization

The fact that an economy uses its own currency within the national borders instead of using it means dollarization. Dollarization is divided into two in itself; full and partial. Full dollarization means that a country completely abandons its national currency and uses a foreign currency as its official currency. Partial dollarization means that the economic actors in a country turn to foreign currency financial assets instead of national currency financial assets in order to protect the national currency from depreciation in the high inflation environment (Serdengeçti, 2005).

First, the exchange rate risk that may create value losses or earnings related to this domestic currency has been eliminated due to the use of domestic money has ceased. It can be said as another advantage that any transaction costs arising from the change between reserve money and national currency have been terminated. However, the transition to full dollarization, a country's abandonment of its currency, which is considered as the most important symbol of independence, can be dangerous for the country even if it minimizes exchange rate volatility and monetary discipline (Aral, 2015).

1.3.3.8. Currency board

The currency board is a system that allows the exchange of domestic money against a foreign currency at a fixed exchange rate under a clear commitment. In this system, the money in which the domestic currency is indexed at a fixed exchange rate is called reserve money. However, the money to be accepted as reserve money here must be a fully convertible currency which is generally accepted in international markets. In this context, it is seen that US Dollar and Euro are used as reserve money in today's currency boards (Arat, 2003).

The principle of fixed exchange rate, convertibility and full provision must be provided in order to apply the currency board system. There are two main features that distinguish the currency board system from the fixed exchange rate system. First, the Central Bank's obligation to keep the foreign currency in its reserves at a fixed exchange rate, the more domestic currency in the economy. The other is that the Central Bank will not be able to issue and put on the market local currency unless it is legally foreign currency.

The money board has 3 defining features. First, the nominal exchange rate, anchor money fixed to the unit. Secondly, the central bank has set the minimum monetary amount must keep it as a reserve. Finally, the money board is enacted a law so that it cannot be changed by the administrators. These features restrict the operations of the central bank and increase credibility (Ghosh et.al., 2000).

In the next section, information about the exchange rate volatility will be given.

1.4. Exchange Rate Volatility

In 1973, with the collapse of the Bretton Woods System, which is a kind of fixed exchange rate system, countries left their money to fluctuate. With the transition to the floating exchange rate regime, the mobility of other macroeconomic variables, especially exchange rate mobility, and economic stability or international trade relationship has become a remarkable subject for economists.

Countries make payments arising from their mutual economic activities in foreign exchange, which is the specified currency instead of the national currency, that is, foreign exchange is required for foreign trade. The exchange is the currency of a foreign country, while it is also a price. The expression of the national currencies of the mutual countries in terms of each other is called the exchange rate. Since the trade of the reciprocal country has created capital mobility in the financial markets, it has caused movement in the exchange rate. This mobility in the exchange rate can be expressed as volatility. Furthermore, volatility can be defined as the sudden leaps and falls of a certain variable relative to an average and increases or decreases in exchange rates compared to an average in a certain period constitute exchange rate volatility.

The foreign exchange market is the markets where national currencies are bought and sold. Accordingly, a market generally consists of buyers and sellers. All kinds of economic relations that take place at the international level require exchange between the currency units. The main purpose of the foreign exchange markets is to realize this transformation. In this framework, the stable course of the exchange rate is very important for both the real and financial sectors and therefore the stability of the country's economy. In this context, exchange rate volatility appears as a risk to the stability of the markets (Çörtük, 2007). Therefore, the determination of the exchange rate regime is important to

ensure the economic stability of the countries, so its effects and consequences should be considered.

The main reasons for exchange rate volatility will be discussed in the next section.

1.5. The Reasons of Exchange Rate Volatility

Exchange volatility can be mentioned when the value of exchange rates is unpredictable. Since foreign exchange rates are determined by market forces in flexible exchange systems, all the factors affecting supply and demand related to foreign exchange can affect the equilibrium exchange rate level. These factors are called basic economic factors. In the basic economic factors, changes in the current period and unexpected changes in the future cause unexpected changes in the exchange rate level, making exchange rates more volatile. In the short-term, the target for the long-term balance rate level is exceeded, which may cause volatility to grow further. Inflation and interest rate, changes in the balance of payments, international capital movements, advances in technology, monetary and fiscal policies to be applied that will occur with news and expectations of these policies on the market speculation and a situation of economic and political stability are among the main factors which could cause volatility (Hakkio, 1984). In addition, it can be said that among the factors that affect the exchange rate volatility of a country are the policies, legal restrictions, foreign exchange supply and demands, their own domestic markets and production efficiency in the country with which the country has a commercial relationship.

All the factors determining the foreign exchange supply and demand may also indirectly cause exchange rate volatility to change. The reasons for some important factors affecting the exchange rate and hence the volatility are explained below.

1.5.1. Inflation rate

Inflation rates are one of the effective factors in determining exchange rates. The most common definition of inflation is constant increases in the general level of prices (Kılıçaslan and Esen, 2019). Inflation, i.e. increases in price level, occurs for two reasons; if total demand exceeds total supply and production costs increase. The first is called demand inflation and the other is called cost inflation (Eğilmez, 2012). The increase in the prices of the country's goods, i.e. inflation, causes foreigners to reduce the demand and even the reliability of the goods and money of the country. Exchange rates increase due to decreasing demand for money. In this regard, high inflation creates currency risk because it protects the value of money and prevents it from being stable and convertible.

Changes in the inflation rate with the increase or decrease of the money supply will change the demand for foreign currency due to the demand for imported goods. This will cause fluctuations in the exchange rate. The central bank should use the monetary policy tools in the best way for the country's economy, considering all possibilities. As a result of the policies implemented, the increase or decrease in the inflation rate, that is, constantly changing, causes volatility in the exchange rate and this may lead to deterioration of the economic stability. In addition, it is known that if the supply of money increases more than necessary in a country, it will cause inflationary pressure. Inflationary pressure also indicates that money will reduce purchasing power. Inflation can be press on the exchange rate (Gagnon and Hinterschweiger, 2011).

1.5.2. Interest rate

Interest rates have an important place among the determinants of exchange rate and volatility. Investors or firms intertwined with the economy market will keep their cash assets in currency, which offers higher interest yield. Another reason for the increase in demand for the currency of the country and the appreciation of the country's currency is the high real interest rate. Interest rates have an important place among the determinants of exchange rate and volatility. Investors or firms intertwined with the economy market will keep their cash assets in currency, which offers higher interest yield. Another reason for the increase in demand for the currency of the country and the appreciation of the country's currency is the high real interest rates in the country. Even if there is no increase in the interest rate, investors think that the interest rate will increase, so they buy the currency and their demand for the country's money increases. This situation causes an increase in the exchange rate. The Central Bank provides a decrease in the exchange rate by increasing interest rates to the increase in the exchange rate. It is inevitable to say that these variable situations cause volatility in exchange rates. In addition, if there is an expectation that the central bank will increase interest rates, the demand for the money of the country will increase. Even if the interest rates have not increased, the money of the relevant country will be valued in the short term. Even if there is no increase in the interest rate, investors think that the interest rate will increase, so they buy the currency and their demand for the country's money increases. This situation causes an increase in the exchange rate. The Central Bank provides a decrease in the exchange rate by increasing interest rates to the increase in the exchange rate. It is inevitable to say that these variable situations cause volatility in exchange rates. In addition, if there is an expectation that the

central bank will increase interest rates, the demand for the money of the country will increase. Even if the interest rates have not increased, the money of the relevant country will be valued in the short term (Çağlar, 2003: 83; Walter, 2002: 83-85).

Interest and exchange rate may not be sufficient to explain each other when it comes to the relationship between them, also inflation should be considered. When interest rate decreases, if the expectation for inflation rate is on the rise, then the exchange rate rises. On the other hand, if the interest rate decreases, and the inflation rate expectation is in a decreasing direction and the decrease in interest rate is not to reset the real interest rate, the exchange rate may decrease. Therefore, when interest rate decreases, the exchange rate rising judgment is not always true. Besides these two variables, you should look at inflation and the CDS (Credit Default Swap) premium (Eğilmez, 2019). If the risks increase in an economy that gives a current deficit and tries to finance this deficit with borrowing-weighted foreign financing, it means that foreign exchange inflow to the country will decrease and therefore exchange rates will increase. The graph below explains the situation.

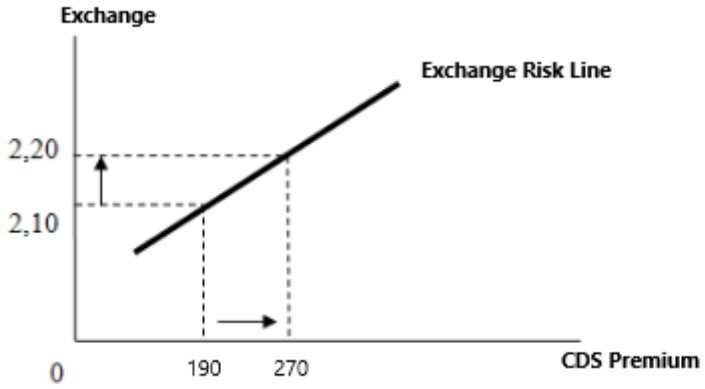

Figure 1.1. Relation between Exchange and CDS Premium

The increase in risks is seen as increasing the exchange rate. There are two ways to reverse this situation; to reduce the risks or to pay the price of the risk increase by paying higher interest to the lenders. In an economy with a current account deficit and financing this deficit mainly through external borrowing, there will be an adverse relationship between interest and exchange rate if risks have started to rise. In other words, this economy will have to give high interest to attract foreign resources and will face the fact of increasing the interest rate as the foreign currency inflow decreases. This situation is shown in the figure below.

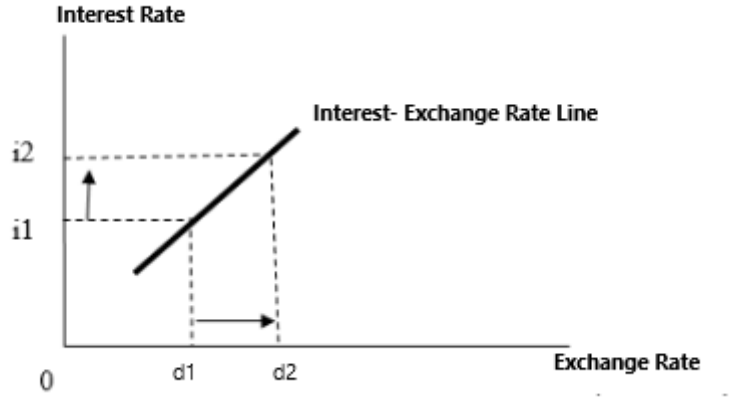

Figure 1.2. Relation between Interest Rate and Exchange Rate

As the figure states, in such a case, interest and exchange rates show the positive relationship. If the exchange rates go up (from d1 to d2), the interests rise (from i1 to i2)[4]. When the amount of foreign currency entering the country decreases or when there is a foreign currency outflow from the country, interest rates rise leading to an increase in foreign currency inflow (Eğilmez, 2014). Based on all these relationship situations, it can be said that there is a strong relationship between exchange rate and interest rates, and there is a two-way relationship between the volatility of exchange rate and volatility of interest rates.

1.5.3. Speculative attacks

Investors change their future expectations regarding the exchange rate, and these changing expectations lead to changes in the current exchange rate. This can be given as an example of the formation of speculative bubbles. In addition to macroeconomic factors, there are three main reasons for exchange rate volatility: changes in expectations due to new information, volatility in market fundamentals, and speculative groups (Engel and Hakkio, 1993). Speculative bubbles are formed in line with market expectations or directly with the effect of speculators for speculation. The starting point of the speculative bubbles is the difference between what it should be and the actual exchange rate. This difference is called speculative bubble when it first leads to expansion and then disappearance (Plihon, 1995: 72). Under the assumption that a sufficient number of investors will increase the value of a currency, regardless of market fundamentals, the speculative bubble may cause the value of the money to increase. The fact that the expectations are correct also increases the belief that the value of the currency will

[4] Source for Figures 1.1. and 1.2. , http://www.mahfiegilmez.com/2014/05/faiz-kur-ve-risk-iliskisi.html

increase, causing investors to demand more from the relevant currency. In this context, this currency can be significantly appreciated even though it has not experienced any changes in the market fundamentals. However, when investors realize that this valuation is not supported by market fundamentals, going on sale will cause the speculative bubble to disappear and the currency to depreciate. Therefore, the behavior of the speculators in the floating exchange rate system may increase the exchange rate volatility (Engel and Hakkio, 1993).

In briefly, investors gain speculation returns by buying the foreign currency they expect to gain in the future when it is cheap and selling it when the value increases. In this way, by creating speculation, they affect the demand for foreign currency and play an effective role in determining exchange rates. Speculations have an effect on currency stability (Çağlar, 2003).

1.5.4. Preferences of exchange rate regime

Exchange rate regime preference has been changing and gaining importance over the last century. While the gold standard was chosen as the exchange rate at the beginning of the 20th century, all developed countries passed the floating rate in the 21st century (Bordo, 2003). Exchange rate volatility has become inevitable with the transition to floating exchange rate. In order to minimize exchange rate volatility and provide economic stability, policy choices or exchange rate regimes to be implemented by central banks are important. For example, the increase in money supply through the expansionary monetary policy of the Central Bank will cause the exchange rate to decrease more in the short term compared to the long term. This situation is expressed as the target excess in the exchange rate and this is the reason for fluctuation in itself. In addition to exceeding the target, the appreciation of the domestic currency and the increase in the calculated returns of foreign investments affect the exchange rates by penetrating variables such as price levels and efficiency (Korur, 2019).

Fixed exchange and monetary union practices cause devaluation while decreasing exchange rate volatility. The flexible exchange system, on the other hand, that exchange rates are decided by the market foreign exchange demand and supply increases exchange rate volatility. In addition, the independence of the central bank is crucial for a stable exchange rate target and inflation to be at reasonable levels (Kuttner and Posen, 2001). Foreign exchange interventions made by the Central Bank are also important to ensure economic stability while applying exchange rate regimes, because, when comparing the

effectiveness and effects of purchase and sale interventions, it is seen that purchase interventions increase the exchange rate, while sales interventions show an increase in volatility (Aysoy and Küçükkocaoğlu, 2016).

1.5.4. Changing in expectations

Exchange rate volatility partially results from volatility in macroeconomic factors on the market basis but sometimes these factors may not be enough to explain exchange rate volatility. For example, exchange rates can vary two or more times in a single day, but changes such as market bases, money supply, real income or the relative quality of investment opportunities will not shift significantly to fully explain such exchange rate changes. Therefore, other factors should contribute to exchange rate fluctuations. Exchange rate volatility can be explained by market expectations. As investors get new information about market fundamentals, expectations may change, and this information leads to volatility. An important source of new information is news of policy change. For example, when central banks announce new monetary growth targets or new tax and spending programs, then the expectations of future changes in exchange rates may change, also this leading to immediate changes in exchange rate. This way, changes in policy can fluctuate exchange rates. However, expectations may change without obtaining new information about market fundamentals (Engel and Hakkio, 1993).

Unexpected budget deficits of governments may also affect exchange rate volatility. Unexpected budget deficits cause real interest rates to rise, and then higher real interest rate will result in capital flow. This case is one of the reasons for exchange rate volatility in the flexible exchange rate system. Also, volatility of exchange rates can be affected in unexpected changes in money stock. The exchange rate reflects the expectations of market participants regarding current growth. If the central banks unexpectedly increase or decrease the money supply, the exchange rates will follow a more volatile direction. If the velocity of circulation of money balances the effect of the change in the money stock, then it will prevent the rise in prices, that is, the rise in inflation, and prevent the exchange rate change (Ertuğrul, 2012).

1.5.5. Balance of payments

The balance of payments, in the broadest sense, is a statistical reports prepared by residents of an economy with residents in other economies to achieve systematic record of the economic transactions which have done within a certain period according to the Central Bank of Turkey (TCMB, 2020). Balance of payments is a one of the most

effective economic variables on the exchange rate. In the economies of the countries when the import is greater than exports, the money of these countries loses their value, therefore, the demand for the currency will decrease. In this context, the demand for national currency will adversely affect the balance of payments. Countries with foreign trade deficit can obtain cheap goods sales and competitive advantage by devaluating, that is, by decreasing the value of their money, and vice versa.

The balance of payments can be examined in three domains; the effect of import, export and, import and export together. Import of a country will decrease the value of money since it will increase the supply of that country's money, and this will affect volatility in exchange rates, as this will affect the demand. When a country exports goods, it creates demand for that country's money, and the demand created will cause changes in the exchange rate. If a country has substitute goods in its imports, it may have a great impact on imports due to the increase in import prices or if too many countries are exporting the same goods and services, very small changes in the exchange rates due to the competition between them can cause huge changes in export amounts (Metin, 2019).

1.6. The Effect of Exchange Rate Volatility

Fluctuations in the exchange rate, which is one of the most important prices for the country's economy, have effects on many macro and micro economic indicators. It is possible to say that these effects are generally negative due to the uncertainty environment resulting from the exchange rate volatility and the increased risk. It can be said that the fluctuations experienced have had an impact on important macroeconomic sizes such as investment, growth, and foreign trade. For this reason, modeling and predicting the exchange rate volatility is an important requirement for both investors and central authorities (Özdemir, 2014). However, the fact that also many variables such as income levels, exchange rates, interests, inflation, and taxes of the countries are formulated and all these variables are affected in some way can make it difficult to identify and eliminate some volatilities (Ayhan, 2016).

In the literature, there are more than one empirical and theoretical studies investigating the effect of exchange rate volatility on macroeconomic factors. In this section, some effects of exchange rate volatility on economics will be explained.

1.6.1. The impact on economic growth

Economic growth interacts with microeconomic and macroeconomic variables. Since the increase in volatility can have negative consequences on production,

investment, capital movements, foreign trade, inflation, and interest rates, it also can have negative consequences on economic growth. In developed countries with a strong financial system, exchange rate volatility does not have much effect on growth, but in countries with weak financial system, exchange rate volatility may have important effects on growth (Aghion et.al., 2014). The fluctuation in the exchange rates caused economic growth to slow down, as well as the decline in production, and unemployment increased, and country welfare decreased significantly.

The main aim of economics is to increase the level of prosperity and to ensure economic growth, however, there is no consensus in the economic literature on which currency regime or cost policy can be achieved. It is a generally accepted view that exchange rate volatility is much higher in the floating exchange rate system. Some economists think that the fixed exchange rate system increases investment and thus sustainable growth by reducing uncertainty. Economists who advocate the floating exchange rate system believe that the floating exchange rate system protects countries from external shocks and consequently, stable growth will be achieved (Özçiçek, 2007). Decreasing investments in developing countries, where fluctuations in the exchange rate are experienced, will also decrease production and economic growth will decrease. On the other hand, due to the fluctuations in the exchange rate, interest from monetary policy instruments has increased, causing savings to increase and consumption to decrease. This situation prevents demand-oriented growth policies (Özdemir, 2014). The fluctuation in the exchange rates slow down economic growth, causing a decrease in production, as well as increasing unemployment and decreasing the country's welfare significantly.

1.6.2. The impact on investment

Current theoretical studies show that uncertainties can affect investments positively or negatively, depending on assumptions about adjustment costs, the degree of competition in industries, and risk aversion. It is possible to say that the volatility of the exchange rate has a large negative effect on total investments. One of the factors that negatively affect long-term investment decisions of economic agents is excessive exchange rate volatility because it increases the uncertainty about the future of the economy. Firms engaged in foreign trade will expect to see that their profits will decrease with the increase in exchange rate volatility, and they can avoid entering long-term investment projects without taking risks (Ayhan, 2016).

Foreign direct investments are especially more important for developing countries. In countries where exchange rate volatility is very high, investors may be more reluctant. Therefore, currency movements and uncertainties have an important effect on investors' direct investment decisions abroad. In addition, for foreign investors, the size of the earnings of investment in developing countries, economic regulations, growth rates, and the low course of inflation can become important indicators in basic macro developments. Theoretical discussions examining the relationship between exchange rate volatility and foreign direct investments can be examined under two headings. The first group focuses on production flexibility, while the other focuses on risk aversion. According to the production flexibility approach, more volatility is pre-related to more foreign direct investment (FDI) and greater potential for more capacity and post-production change after exchange rates are observed. In according to the risk avoidance approach, investors calculate the risk they will face when making an investment decision and try to balance this risk. Foreign exchange movements add extra risk to the return on investment because high exchange rate fluctuations cause the certainty equivalent expected exchange-rate level to drop (Goldberg, 2009: 394-395).

Some firms can invest by borrowing money while investing. The uncertain economic environment for firms borrowing in foreign currency causes the investment decisions to be delayed due to the deterioration of balance sheet balances, and thus to move away from employment and growth targets at the macro level. A stable exchange rate will facilitate the earnings and risk assessment of foreign investors when making an investment decision (Dursun, 2015).

1.6.3. The impact on foreign trade

Foreign trade is highly affected by the volatility of the exchange rate since the exchange rate is determined according to the currency between the countries and the international structure. Exchange rate volatility and its impact on foreign trade are even more important for developing countries. In this context, it intervenes with a policy in line with exchange rate volatility in order to avoid negative effects on its economies and trade relations (Vergil, 2002). At the same time, the condition of foreign exchange reserves is also important for the country to intervene in volatility. If the foreign currency reserve status is high, it can establish the exchange rate more quickly, but otherwise, as the capital outflow from the country will become scarce, foreign currency will slow the trade by raising the exchange rates.

The increase in exchange rate volatility, which is the main source of risks and uncertainties, also adversely affects the foreign trade balance. Foreign trade efficiency may decrease significantly due to returns and costs that cannot be precisely calculated due to exchange rate volatility. High volatility of exchange rate for producers who do not like risk makes this risk more costly. Thus, foreign trade is negatively affected by this rising risk cost. The reason for this is that there is a time difference between the signing of the commercial contract and the payment, and the exchange rate will change in this period, reducing predictability. In this case, unexpected exchange rate increases the formation of uncertainty regarding the environment will decrease the benefit expected from international trade. Although there are means of protection against exchange rate risk, not every manufacturer and country have the opportunity to fully and cost-free protection from this risk (Hooper and Kohlhagen, 1978).

The theoretical approaches put forward on the effects of real exchange rate volatility on exports can be categorized under two main headings. As foreign trade firms tend to avoid risk, foreign trade will decrease as increases in exchange rate volatility may increase unexpected costs. In foreign trade, if the payments are made after delivery, unforeseen changes in the exchange rate between the dates of delivery and the payment will increase the uncertainty for the expected profits from exports. Therefore, uncertainty in the exchange rate will reduce profit expectations and exports. So, if protection against exchange rate risk is not possible or too costly, increases in exchange rate volatility will reduce exports. On the other hand, the degree of risk aversion of exporters plays an important role in determining the effect of exchange rate volatility on exports. That is, if the exporter firm has a high degree of risk aversion, an increase in exchange rate volatility will increase the expected marginal benefit of export income, as firms would prefer to produce more to avoid a reduction in export revenue. However, if the exporter firm's risk aversion is low, firms will prefer a trend to reduce their exports, as high exchange rate volatility will reduce the expected marginal benefit of export revenue (Köse et.al., 2008).

2. ECONOMETRIC FRAMEWORK

In this section, some models used in measuring exchange rate volatility will be explained. These models that will be explained are the more popular and more advanced models. Also, unit root tests used in testing basic econometric models will be mentioned.

2.1. Modelling of Exchange Rate Volatility

The uncertainty caused by the exchange rate volatility and the associated risk environment are of great importance for the economies. Measurement of exchange rate volatility has become an increasingly valuable phenomenon, as it has a tight relationship with other macroeconomic factors, affecting a large part of the economy. Unlike other financial market factors, it is extremely difficult to make predictions in foreign exchange rates. This is because, besides the variety of factors that cause volatility, model predictions are difficult and complex. However, it is important and necessary to estimate the volatility of exchange rate volatility in order to maintain monetary mobility and to minimize costs in the market.

Movements in the financial markets and the studies on the magnitude of these movements have brought with it the development of many techniques. As it is known, the constant variance, which is a measure of volatility, is assumed not to change in a certain period of time. However, studies using high frequency data in recent years have revealed that variance is not constant in series such as exchange rate, interest rate, and inflation. For this reason, traditional time series models based on the assumption of fixed variance have become insufficient and modeling techniques that allow changing variance structure to have been developed (Güloğlu and Akman, 2007). Linear models are insufficient to explain many properties of financial time series. Volatility in financial markets occurs in clusters. It is possible to see both high and low values in a period. The effect of a decrease in value prices or an increase in interest rate on volatility tends to be higher than the same amount of price increase or interest rate decrease. The distribution of the returns of financial assets shows fat tail and high average sharpness. These features are called volatility cluster, leverage effect and unpredictability, respectively (Aydın, 2004). For all these reasons, the fixed variance assumption is not valid for exchange rates.

As a result, in order to better understand this dynamic of financial markets and predict the changing volatility over time, Engle (1982) developed the Autoregressive Conditional Heteroskedasticity (ARCH) model, which was taken forward by Bollerslev

(1986) and the Generalized ARCH model (GARCH) has been obtained. In the GARCH model, it is assumed that the weights given to the squares of the past errors have decreased geometrically to a certain extent. This rate is not fixed and is estimated from the available data. ARCH and GARCH models are well designed for the volatility cluster of financial series and fat tail features (Güloğlu and Akman, 2007).

2.2. Conditional Volatility Models

In the literature, models that determine multiple volatility such as Random Walk, Average, Moving Average, Exponentially Weighted Moving Average, Simple Regression, and Exponential Correction Models are described as historical volatility models, and they calculate volatility by using variance or standard deviation of past returns and are used to estimate future periods in this way. The time-varying nature of variance can only be addressed using conditional time series models. Contrary to historical volatility models, conditional variance models use the information set at a particular time *t* more effectively to calculate varying variance and mean over time (Telçeken, 2014). It is known that returns in financial markets do not move together over time, but they are not independent from each other. This movement is accepted as an indication that the error term has different diffusion and the presence of volatility cluster. In this case, it is not appropriate to use the models established under the constant variability assumption to model the financial time series (Unutmaz, 2011).

ARCH group processes are one of the most frequently used methods that provide the correct volatility prediction model in terms of capturing these features in financial time series and their suitability to data. The most frequently used models among these models are ARCH, GARCH , EGARCH, TGARCH and PARCH models.

2.2.1. Autoregressive conditional heteroskedasticity model (ARCH)

Unlike models based on past standard deviations, the ARCH class volatility models do not use sample standard deviations but use conditional variances of returns (Poon and Granger, 2003). The first of the changing variance models has been introduced by Engle (1982). It is an Autoregressive Conditional Heteroskedasticity (ARCH) model. In this model, conditional variance depends on absolute or square value of error terms and standard deviations or variances with conditional lag (Gürsakal, 2011).

Equation of ARCH (p) model in its most general form

$$\sigma_t^2 = \alpha_0 + \sum_{p=1}^{m} \alpha_i \, \varepsilon_{t-i}^2 \quad \textbf{(2.1)}$$

where, α_0 refers constant variable, α_i shows each of the parameter coefficients and ε_{t-i}^2 denotes the square of errors. In the ARCH model, since the ϵ_{t-i}^2 values cannot be negative, the conditional variance equation for all t e values will also not receive negative values. A second constraint in relation to the ARCH model is that the α parameters must be less than 1 of each or their sum, except for the constant term. This constraint is necessary to ensure the stability of the model. Otherwise, the model will have an infinite variance (Engle, 1982). The least squares method and the most likelihood method are used to estimate the parameters of the ARCH (p) model. Under the assumption that the error term is normally distributed, when the sample size increases, the estimators of the least squares method and the likelihood method converge (Çolak, 2013).

With the help of Lagrange Multipliers test (LM), if the above prediction process is considered as an AR (p) model, the presence of the ARCH effect can be tested. The test statistic calculated as LM = (T-p) R^2 has a p degree of freedom χ^2 (chi-square) distribution. In this case,

$$H_0 = \alpha_0 = \alpha_1 = \alpha_2 = \cdots \alpha_p = 0$$

$$H_1 \neq \alpha_0 \neq \alpha_1 \neq \alpha_2 \neq \cdots \alpha_p \neq 0$$

If the LM value is less than the table value of χ_p^2, the null hypothesis can be rejected, and the ARCH effect exists, and the model specification can be decided (Gürsakal, 2011).

2.2.2. Generalized autoregressive conditional heteroskedasticity model (GARCH)

GARCH models, which are the expanded version of ARCH models and developed by Bollerslev, are the volatility model in which the conditional variance is dependent on its own lagged values in addition to the lagged values of the error term. This model is the weighted average of past residue squares, but has decreasing weights that never go to zero entirely (Engle, 2001).

General variance equation for GARCH (p,q) models,

$$\sigma_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \, \sigma_{t-j} \quad \textbf{(2.2)}$$

α_0 refers constant variable, α_i and β_j shows each of parameters coefficients and ε_{t-i}^2 denotes the square of errors. σ_t has normal distribution with conditional variance and GARCH (p, q) model must meet the following conditions;

$$p > 0\ ,\ q \geq 0\ ,\ \ \alpha_0 > 0\ ,\ \alpha_i\ \geq 0,\ \beta_j \geq 0\ for\ \forall j, p$$

The existence of the GARCH structure can also be tested like the presence of the ARCH structure, but only hypotheses are changing.

$$H_0: \alpha_1 = \alpha_2 = \cdots \alpha_p = \beta_1 = \beta_2 = \cdots = \beta_p = 0$$

$$H_1: \alpha_1 \neq \alpha_2 \neq \cdots \alpha_p \neq \beta_1 \neq \beta_2 \neq \cdots \neq \beta_p \neq 0$$

The rule in ARCH is applied here in the same way and the existence of the GARCH effect is tested (Gürsakal, 2011).

2.2.3. Exponential generalized autoregressive conditional heteroskedasticity model (EGARCH)

In the implementation of the ARCH model, some restrictions have been placed on the parameters in the conditional variance equation, since relatively long lags are used, and the fixed lag structure is recommended. ARCH derivative models, which try to explain the change of conditional variance with different models, have been developed in order to eliminate the disadvantages of these limitations and to reach the parameter estimates with negative variance. Bollerslev (1986) proposed the GARCH model by developing Engle's (1982) ARCH model. The GARCH model allows the terms both autoregressive and moving averages to be used in modeling conditional variance. However, standard GARCH models do not consider the asymmetrical effect that good and bad news can have on volatility. Accordingly, EGARCH models recommended by Nelson (1991) are used to investigate the asymmetric effect and minimize coefficient constraints. The EGARCH model reveals the asymmetrical effect, i.e. whether the good and bad news have a symmetrical effect on the variance (Değirmenci and Akay, 2017).

General equation of E-GARH (p,q) model can written as follows.

$$\log \sigma_t^2 = \alpha_0 + \sum_{j=1}^{q} \beta_j \log \sigma_{t-j}^2 + \sum_{i=1}^{p} \alpha_i \left|\frac{e_{t-i}}{\sigma_{t-i}}\right| + \sum_{k=1}^{r} \gamma_k \frac{e_{t-k}}{\sigma_{t-k}} \qquad \textbf{(2.3)}$$

In the equation, α_0 is a constant term and σ_{t-j}^2 shows the past volatility estimations, e_{t-i} represents error term of past periods and $\sigma t{-}i$ shows the conditional standard deviation of past periods. γ_k is the parameter of asymmetry. If the asymmetry parameter is 0, the E-GARCH model is symmetrical. However, this condition should not be met in volatility models. If δ is negative, it is concluded that negative shocks are more effective

than positive shocks. On the contrary, positive shocks are much more effective than negative shocks (Aktaş et.al., 2018).

2.2.4. Threshold GARCH model (TGARCH)

Another GARCH model, the threshold GARCH (TGARCH) model, was proposed by Zakoian 1994, which examines the threshold conditional variance and considers the leverage effect by taking into account that the effect of positive shocks and negative shocks is not symmetric (Parim, 2014). The difference between TARCH and EGARCH models is that the leverage effect is quadratic in the first model and the leverage effect in the other model is exponential (Mapa, 2004). TGARCH model equation is as following.

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \, \sigma_{t-j}^2 + \sum_{k=1}^{r} \gamma_k \varepsilon_{t-k}^2 \theta_{t-k} \qquad (\mathbf{2.4})$$

$$\theta_{t-k} = \begin{cases} 1 & \varepsilon_{t-i} < 0 \\ 0 & \varepsilon_{t-i} \geq 0 \end{cases}$$

In this model, bad news $\varepsilon_{t-i} < 0$, and good news $\varepsilon_{t-i} > 0$, have differential effects on the conditional variance; bad news has an impact of $\alpha_i + \gamma_i$, while good news has an impact of α_i. If $\gamma_i > 0$, bad news increases volatility, and we can say that there is a leverage effect for the i^{th} order. If $\gamma_i \neq 0$, then the new impact is asymmetric. On the other hand, $\gamma_i = 0$ means that the effect of these new news on volatility is not asymmetrical, and in this case the TGARCH model will be equal to the GARCH model (Hossain et.al., 2005).

2.2.5. Power ARCH model (PARCH)

Taylor and Schwert developed the standard deviation GARCH model. Here, unlike many other ARCH class models, the standard deviation is modeled instead of variance. In their published articles, Ding, Garnger and Engle have generalized this model as PARCH (Power ARCH) (Telatar and Binay, 2002). In this model, besides the standard deviation model instead of variance, it is estimated within the model instead of imposing the exponent parameter of the standard deviation, as in conventional ARCH models, and the asymmetry parameter can be added to the model to model the asymmetry. PARCH model turns into APARCH (Asymmetric Power ARCH) model with asymmetry parameter (Çolak, 2013). General form of APARCH (p,q) is as following;

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \, (|\varepsilon_{t-i}| - \gamma_i \varepsilon_{t-i})^{\delta} + \sum_{j=1}^{q} \beta_j \, \sigma_{t-j}^{\delta} \qquad \mathbf{(2.5)}$$

Here, σ_t^2 indicates the volatility estimate for the period t, ω is constant term,$|\varepsilon_{t-i}|^{\delta}$ indicates the past term error terms, α_i is the coefficient of past term error terms, σ_{t-j}^{δ} shows the past volatility estimates, β_j denotes the coefficient of past volatility estimates, γ_i is the asymmetry parameter. The APARCH model has constraints, which are $\delta > 0\ and\ |\gamma_i| \leq 1\ where\ i = 1,2,..,r$. If the model's asymmetric parameter is $\gamma = 0$, then the APARCH model turns into a PARCH model (Çolak, 2013).

2.3. Unit Root Tests

There are multiple tests in the literature such as ADF, PP and KPSS to understand stationary for macroeconomic series, but we can say that the most important and popular of these is the ADF.

2.3.1. Augmented Dickey–Fuller unit root test (ADF Test)

First, ADF unit root test is applied to the with and without time trend logarithms of the time series used in the analysis (Alavinasab, 2013). The test applied by adding the lagged values of the dependent variable to the Dickey-Fuller equations is expressed as the ADF unit root test (Gujarati and Porter, 2009).

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} a_i\ \Delta Y_{t-i} + \varepsilon_t \text{ where,} \qquad \textbf{(2.6)}$$

β_1,β_2, δ are coefficients of the equation, random error term is ε_t and ΔYt that is investigated stationary is variable, Δ indicates the difference of the relevant variable. Two hypotheses are used in practice to determine the existence of the unit root.

H_0: $\delta = 0$ (Series is nonstationary)

H_1: $\delta < 0$ (Series is stationary)

The null hypothesis states that the series is stationary, and the alternative hypothesis is that the series is not stationary. If the null hypothesis is accepted, the series is not stationary, otherwise, the series is considered to be stationary (Griffiths et.al., 2011).

2.3.2. Philips Perron unit root test (PP Test)

An alternative test used to determine whether time series contains unit roots is the Phillips-Perron test and is used to support ADF test results. The test developed by Phillips-Perron in 1988 has different features than the ADF test. Since the model in question is not a parametric model, healthier results are obtained in series that do not show normal distribution (Demireli et.al., 2010).

Phillips and Perron (1988) created a Dickey-Fuller process with more flexible assumptions about error terms. While the ADF test assumes error terms independently and homogeneously, the Phillips-Perron test allows error terms to be weakly dependent and heterogeneous (Aydın, 2004).

The equation of PP Test as follows (Enders, 1995).

$$\Delta Y_t = \beta_0 + \delta Y_{t-1} + \beta_1(t - \frac{T}{2}) + \varepsilon_t \text{ where,} \quad \textbf{(2.7)}$$

T is the number of observations; e is an error term with an expected value of zero but no assumption regarding homogeneity or sequential binding. Also, this test also has two hypotheses, and these are:

H_0: δ = 0 (Series is nonstationary)

H_1: δ <0 (Series is stationary)

The H_0 hypothesis for Phillips Perron (PP) is the existence of the unit root, that is, the alternative hypothesis (H_1) that it is not stationary indicates that the series does not contain a unit root, that is, the series is stationary. If the PP test statistic value is more negative than the critical values of the statistics, the zero hypothesis that suggests the unit root existence is rejected (Demireli et.al., 2010). By comparing the table critical values of Mackinnon and the t statistic values of the pp test, it is decided which hypothesis is accepted and which is rejected (Yamak and Korkmaz, 2005).

2.3.3. Kwiatkowski, Phillips, Schmidt, and Shin unit root test (KPSS Test)

All the above tests test the zero hypothesis that the Y_t time series is integrated into the first, I (1). Otherwise, testing the zero hypothesis where the Y_t time series is I (0) is explained by the KPSS test. KPSS was based on the idea that the time series is stationary around a deterministic trend and is calculated as the sum of a deterministic trend, random walk, and static random error.

It based on two equations.

$$Y_{t=} \alpha_t + r_t + \varepsilon_t \quad \textbf{(2.8)}$$

$$r_t = r_{t-1} + u_t \quad \textbf{(2.9)}$$

Here, ε_t is an independent and identically distributed random variable (iid) , N(0, ${\sigma^2}_\varepsilon$) , r_t is a random walk with variance ${\sigma^2}_u$ and u_t are iid N (0, ${\sigma^2}_u$). KPSS test is based on LM (Lagrange Multiplier) test of the hypothesis that the random walk has a zero variance.

$H_0: \sigma^2{}_u = 0$ (Series is stationary)

$H_1: \sigma^2{}_u \neq 0$ (Series is nonstationary)

In other words, i.e. $H_0: \sigma^2{}_u = 0$ which means that r_t is a constant, against the alternative hypothesis $H_1: \sigma^2{}_u \neq 0$ (Arltova and Fedorova, 2016).

2.3.4. Zivot-Andrews unit root test (ZA Test)

Economic crises in the economic time series over time, structural changes can occur for many reasons such as policy changes and natural disasters. As with most of the econometric methods, in unit root tests, these structural changes occurring in the data may not be considered, which may result in prone results (Yılancı and Özcan, 2010). One of the unit root tests that consider these structural breaks is Zivot Andrews (ZA). In this approach, structural breaks are determined internally.

The following models are discussed for the ZA unit root test (Zivot and Andrews, 1992:254).

$$Y_t = \mu + \beta_t + \delta Y_{t-1} + \theta_1 DU(\lambda) + \sum_{i=1}^{k} \delta_i \Delta Y_{t-i} + \varepsilon_t \quad \textbf{(2.10)}$$

$$Y_t = \mu + \beta_t + \delta Y_{t-1} + \theta_2 DU(\lambda) + \sum_{i=1}^{k} \delta_i \Delta Y_{t-i} + \varepsilon_t \quad \textbf{(2.11)}$$

$$Y_t = \mu + \beta_t + \delta Y_{t-1} + \theta_1 DU(\lambda) + \theta_2 DU(\lambda) + \sum_{i=1}^{k} \delta_i \Delta Y_{t-i} + \varepsilon_t \quad \textbf{(2.12)}$$

There are three different ZA models, Model A is on trend, Model B is on intercept, Model C includes both structural change on trend and intercept. In these models, t refers to time, T_B indicates the break time, $\lambda = \frac{T_B}{T}$ is the relative break show its relative reflection. DU in the model system are dummy variables that represent the average and DT are the break and are defined as follows:

$$DU_t = \begin{cases} 1, & t > TB \\ 0, & otherwise \end{cases} \qquad DT_t = \begin{cases} t - TB, & t > TB \\ 0, & otherwise \end{cases}$$

For the estimation of the break point, that is, the T-2 squares regression is established by the Least Squares method for t=1,2,3,…,T-1, and the date that is in the model that gives the least t statistic for δ, which is the coefficient of the variable Y_{t-1}, is chosen as the breaking point, which gives the least proof to accept the unit root basic hypothesis (Glynn et.al., 2007: 68).

The hypothesis tested for accuracy in this test is the hypothesis δ = 1. After determination of the date of break, δ of the calculated t statistics absolute values Z larger

than a critical value in case of structural breaks, the zero-hypothesis showing the existence of the unit root without is rejected. The alternative hypothesis of the test shows that the trend is stationary, with a structural break in the trend function (Yılancı and Özcan, 2010).

2.3.5. Lee-Strazich unit root test (LS Test)

Zivot Andrews (ZA) and Lumsdaine – Papell (LP) unit root tests assume that there is no structural break in the basic hypothesis that indicates the existence of the unit root and obtain critical values according to this assumption. Lee and Strazicich have demonstrated that the alternative to the basic hypothesis used in these tests should not be stationary with structural break. Because the alternative of the basic hypothesis may be the existence of structural breaks, which indicates that the structural root with root may be present in the series examined. The rejection of the basic hypothesis may actually cause researchers to accept that the series under study is stationary in the trend with structural break, while the series is stationary in the difference with breaks. To eliminate this problem, Lee and Strazicich developed the Lagrange Multipliers, which were introduced to the literature by Schmidt and Phillips, based on the unit root test, as an alternative to the ZA unit root test, and as an alternative to the LP unit root test, the Lagrange Multipliers unit root test (Yılancı, 2009).

The equations of LM as following.

$$y_t = \delta Z_t + e_t \qquad e_t = \beta e_{t-1} + \varepsilon_t \qquad \textbf{(2.13)}$$

Here, Z denotes the vector containing external variables, while ε denotes the residuals.

Model A; $D_t = \begin{cases} 1 & t \geq T_B + 1 \\ 0 & otherwise \end{cases}$ Model AA; $D_{jt} = \begin{cases} 1 & t \geq T_{BJ} + 1 \\ 0 & otherwise \end{cases}$

Model A is used for unit root testing, which allows single level breakage. TB shows the breaking time. Model AA is used for unit root testing, which allows two level breaks. It can be obtained by substituting $[1, t, D_t]'$for $Z_t$in model 1 to show the shadow variable that takes the value 0,in model A. When comes to in model AA, it can be obtained by substituting $[1, t, D_t, DT_t]'$ for $Z_t$in model 1 to show the shadow variable that takes the value 0.

Model C; $DT_t = \begin{cases} t - T_B & t \geq T_B + 1 \\ 0 & otherwise \end{cases}$ Model CC; $DT_{jt} = \begin{cases} t - T_{Bj} & t \geq T_B + 1 \\ 0 & otherwise \end{cases}$

Model C, which allows for a single break in both trend and intercept. Model CC which allows two breaks in intercept and trend. It can be obtained by substituting $[1, t, D_t, D_t]'$for $Z_t$in model 1 to show the shadow variable that takes the value 0,in model C. When comes to in model AA, it can be obtained by substituting $[1, t, D_{1t}, D_{2t}, D_{1t}, D_{2t}]'$ for $Z_t$in model 1 to show the shadow variable that takes the value 0.

While the process of creating data involves breaking under the basic hypothesis ($\beta = 1$), it is in the form of an alternative hypothesis ($\beta < 1$). LM unit root test statistics are obtained from the following regression:

$$\Delta Y_t = \xi \Delta Z_t + \phi \zeta_{t-1} + \mu_t \quad \textbf{(2.14)}$$

In this expression, $\zeta_{t-1} = Y_t - \psi_x - Z_t \zeta_{t-1}$ and t=1,2, ...,T. ξ is the coefficients obtained from the regression of ΔY_t according to ΔZ_t. ψ_x is obtained with $Y_1 - Z_1 \xi$. LM test statistics are obtained by ϖ, which is the t statistic that tests the unit root basic hypothesis. In order, to determine the break points, the value of ϖ test statistic is minimum are selected.

$$LM_\omega = inf_\lambda \varpi(\lambda) \quad \textbf{(2.15)}$$

In here, observations T, for j=1,2..., shows the break point TB_j where $\lambda = \frac{T}{TB_j}$. Critical values for a single break LM unit root test is obtained from Lee and Strazicich (2004), while critical values for a two break LM unit root test can be obtained from Lee and Strazicich (2003). If the obtained test statistic is greater than the critical value, the structural break unit root hypothesis is rejected (Yılancı, 2009).

2.4. ARDL Bounds Test

The cointegration method cannot be used if the variables are not stationary of the same order, some are the first difference, and some are stationary at the level. ARDL (Autoregressive Distributed Lag) Method, Pesaran and Smith (1997) put forward by to overcome the mentioned difficulties, is a method used without the need to know whether the variables in the system contain unit root or not. The method, also known as Boundary Test, is used when some of the variables are level, some are first-order stationary. It is applied in two stages, similar to Engle and Granger's (1997) method. In the first stage, the lags related to the differences of the variables and the first lagged values of the level

values are also included, and the existence of a long-term relationship in this equation is tested with the standard F test (Erdoğan and Bozkurt, 2008).

To explain the ARDL model with an example equation, in here, there is two variables. As the number of variables increases, variables are added to the basic equation of the model, both by taking the differences of the first order and normally.

$$\Delta Y_t = \alpha + \sum_{i=1}^{m} \beta_1 \Delta Y_{t-i} + \sum_{i=1}^{m} \beta_2 \Delta X_{1t-i} + \beta_3 Y_{t-1} + \beta_4 Y_{t-1} + \varepsilon_t \quad \textbf{(2.16)}$$

Here, the basic hypotheses tested in this equation relate to the existence of cointegration between variables. The H_0 says that there is no cointegration, and the H_1 is otherwise.

$$H_0: \beta_3 = \beta_4 = 0$$
$$H_1: \beta_3 \neq \beta_4 \neq 0$$

In the model in which the lag level has been determined by considering the AIC and SC criteria for the series, the critical values to which the relevant hypothesis will be tested has been given by Pesaran (2001) after the decision has been made that there is no autocorrelation. Different table values are used according to the presence of an intercept and deterministic trend and the restrictions on both intercept and trend. If the calculated F statistic is above the critical upper and lower values, it is decided to have a long-term relationship between the series, and if the lower limit is below the value, the absence of the relationship is decided. If the calculated statistic is between the two values, a decision on the long-term relationship cannot be reached (Erdoğan and Bozkurt, 2008). Then, ARDL limit test should be done again.

In ARDL boundary test approach, the first step is to interpret F statistics according to critical values and to test the existence of a long-run relation. If there is a relationship, short- and long-term coefficients are calculated and interpreted. The long-term relationship equation is as follows.

$$Y_t = \alpha + \sum_{i=1}^{m} \beta_1 \Delta Y_{t-i} + \sum_{i=1}^{m} \beta_2 X + \varepsilon_t \quad \textbf{(2.17)}$$

Then, short-term relationship is estimated by using a period-lagged value of the error term obtained from the long-term relationship.

$$\Delta Y_t = \alpha + \sum_{i=1}^{m} \beta_1 \Delta Y_{t-i} + \sum_{i=1}^{m} \beta_2 \Delta X_{1t-i} + \beta_3 \varepsilon_{1t-1} + \varepsilon_t \quad \textbf{(2.18)}$$

The term error refers to how much of the short-term imbalance obtained in the long-run equation will be overcome in the long-run. The coefficient of the relationship to the lagged value of the error term is expected to be statistically significant and negative (Erdoğan and Bozkurt, 2008).

3. ECONOMETRICAL ANALYSIS

In this section, the related literature about the study, the data set used for the study, the results of the applied method are presented. After this section, the results were evaluated in the last section.

3.1. Literature Review

There is vast array of studies related to our study. These studies vary based on the use of countries, sample period and methods used. However, most of the time series are carried out by using mostly ARDL Bounds testing, VAR, and Panel Data Analysis. To save the space, instead of giving the details of these studies, we prefer to summarize them as shown in Table 3.1.

Fang (2009), Kasman (2005), Serenis and Tsounis (2012 and 2013), Senedzia (2017) who are working on import and export and exchange rate volatility, found a negative relation between export and exchange rate volatility.

Table 3.1. A Summary of The Literature about the Exchange Volatility, Export, and Import

Authors	**Period**	**Countries**	**Variables**	**Methods**	**Conclusion**
Baharumshah (2001)	1980-1996	Malaysia, Thailand and US, Japan	Exchange Rate, Foreign and Domestic Income, Trade Balance	VAR Model	No-relation exchange rate and trade balance at short and medium term
Vergil (2002)	1990-2000	Turkey, US Germany, Italy, France	GDP, Consumer Price Index (Domestic and Foreign), Exchange Rate	VECM	Exchange volatility has significant negative effect on export
Bredin et.al. (2003)	1978-1998	Irish and EU Countries	Foreign Income, Export, Relative Price, Exchange Volatility	VECM	Exchange volatility has significant negative effect on export on short run, otherwise in the long run

Table 3.1. **(Continued)** A Summary of The Literature about the Exchange Volatility, Export, and Import

Vita and Abbot (2004)	1993-2001	UK and 14 EU Countries	Export, Import, Exchange Rate, Economic Growth	ARDL	Exchange volatility has significant negative effect on export from UK to EU countries
Kasman et.al. (2005)	1982-2001	Turkey, 9 Trading Partners of Turkey[a]	Foreign Income, Relative Price, Export and Exchange Rate	Co-integration and ECM	The relation of exchange rate volatility and export is negative in short term, otherwise in long term
Türkyılmaz et. al. (2007)	1999-2007	Turkey	Export, Import, Exchange Rate	VAR Model	One-way causality from exports to exchange rate volatility, bidirectional causality exchange volatility and imports
Byrne et.al. (2008)	1989-2001	US and 6 European Countries	Export, Import, Exchange Rate, Domestic Output	Panel Data Analysis	Negative relation between exchange rate volatility and bilateral trade flows
Fang et.al. (2009)	1979-2003	US and 8 Asian Countries[b]	Exchange Rate, Export, Foreign Income	DCC bivariate GARCH-M model	Negative impact of exchange rate risk on exports for Indonesia, Japan, Korea, the Philippines, and Taiwan during depreciation, for Japan, Singapore, and Thailand during appreciation

Table 3.1. **(Continued)** A Summary of The Literature about the Exchange Volatility, Export, and Import

Baum and Caglayan (2010)	1980-1998	US and 13 Countries[c]	Exchange Rate, Export, Import, GDP, Consumer Price Index	Engle-Granger Regression	Effects of exchange volatility on bilateral trade flows is positive
Oskooee and Harvey (2011)	1971-2006	Malaysia and US	Exchange Rate, Export, Import, GDP,	VECM	Neither negative nor positive effects of exchange volatility on bilateral trade flows
Serenis and Tsounis (2012)	1973-2010	Germany, Sweden, and U. K	Exchange Rate, Export, GDP	VECM	Negative effects from volatility to exports
Serenis and Tsounis (2013)	1990-2012	Crotoria and Cyprus	Exchange Rate, Export, GDP	VECM	Negative effects from volatility on exports for Croatia
Khan et.al. (2014)	1970-2009	Pakistan and Trading Partners; UK and US	Exchange Rate, Export, Import	Panel Data Analysis	Exchange volatility has significant impact on trade terms
Asteriou (2016)	1995-2012	Mexico, Indonesia, Nigeria, and Turkey	Exchange Rate, Export, Import, GDP	ARDL	Exchange volatility has significant impact on trade terms just for Turkey
Senadza and Diaba (2017)	1993-2014	11 Sub-Saharan Countries[d]	Exchange Rate, Export, Import	Panel Data	Negative effects from volatility to exports in the long run
Latief and Lefen (2018)	1995-2016	7 Developing Countries[e]	Exchange Rate, Export, Import, Foreign Direct Investment	Panel Data	Negative effects of exchange volatility on international trade

Note: ECM: Error Correction Model, VECM: Vector Error Correction Model, DCC: Dynamic Conditional Correlation ***a:*** Germany, United States, United Kingdom, Italy, France, Netherlands, Spain, Belgium, Greece ***b:*** Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand ***c:***UK, Canada, Germany, France, Italy, Japan, Finland, Netherlands, Norway, Spain, Sweden, and Switzerland ***d:*** Gambia, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Nigeria, Sierra Leone, Tanzania, Uganda and Zambia ***e:*** Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka

As can be seen from the summary of related literature in Table 3.1, the relationship between export, import and exchange rate volatility has been studied by some researchers. As seen above the studies in the table, exchange rate variability has little effect on imports while it has a significant effect on exports. Although this effect is not definitely negative or positive, it also changes in the short and long term. For example, Senedzia (2017) found that exchange rate volatility had an adverse effect on exports in short run but had a positive effect in the long run. In the table, the related studies on Turkey has been found that the effect exchange volatility is effective on imports and exports. Also, in all studies, exchange rate volatility has been obtained using different ARCH/GARCH models.

3.2. Methodology and Data

In our study, the monthly nominal exchange rate (exch), import (imp) and export (exp) series[5] for the period 2000:01-2019:12 are obtained from Electronic Data Delivery System (EVDS) of the Central Bank of Republic of Turkey and all econometric analyses have been performed with the help of EViews 9. Before carrying out any empirical analysis, we first examine the time series plots of variables. Figure 3.1 shows time series plots of variables.

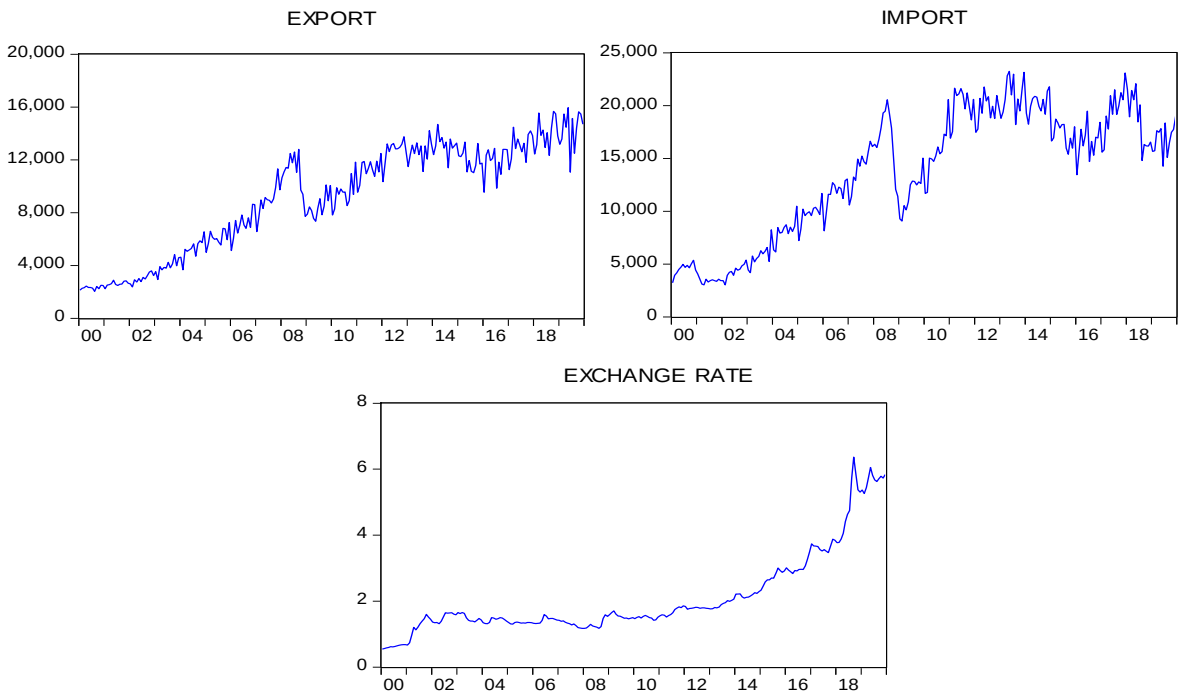

Figure 3.1. Time Series Plots of Variables

[5] Total import and export have been used for import and export series, respectively. The exchange rate data is in the form of USD ($) buying.

As is seen in Figure 3.1, all variables do not seem to be stationary with structural break(s). Figure 3.2 also shows the time series plots of first differences of variables.

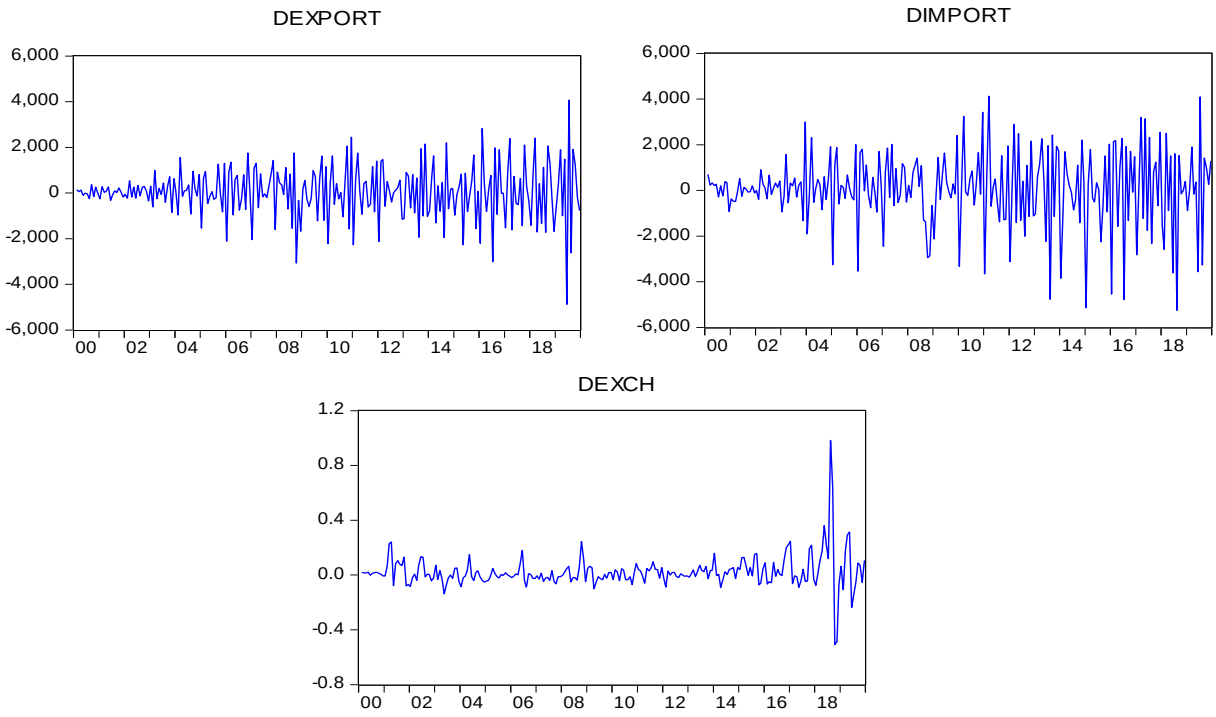

Figure 3.2. The Time Series Plots of First Differences of Variables

Figure 3.2 illustrates that the first differences of variables seem to be stationary. Thus, to determine whether or not they are stationary in their first differences, we perform both traditional unit root test of ADF, PP and KPSS as well as structural unit root tests of Zivot-Andrews and Lee-Strazicich (2004, 2003).

3.2.1. Unit root tests results

Unit root tests were carried out to understand the level of stationary and the dates of breaks of macroeconomic variables used in the study. Table 3.2 presents the results of unit root tests results of macroeconomic variables which are used in this study.

Table 3.2. Unit Root Tests Results [6]

Variables	ADF	PP	KPSS	Zivot-Andrews	Lee-Strazicich
EXCH	-4.146067*	-4.423529*	0.411789 *	-4.536792 *	-2.723170 (2013-M04)
DEXCH	-10.64465*	-10.20254*	0.110213 *	-11.26491 *	-9.177980 (2003-M01)
EXPO	-1.917491	-7.341662*	0.665426 *	-3.522158 *	-4.660020 (2013-M05)

[6] To denote the first differences of variables, we add D in front of levels of variables. Thus, DIMPO, DEXPO and DEXCH respectively denotes the first differences of import series the first differences of export series and the first differences of exchange rate series.

Table 3.2. (Continued) Unit Root Test Results

DEXPO	-7.364198*	-71.53093*	0.022249	-3.522158 *	-15.04453 (2008-M03)
IMPO	-2.761449	3.033504	0.353526 *	-4.128969	-4.468709 (2007-M11)
DIMPO	-4.541797*	-25.47477*	0.045512 *	-4.128969	-10.86418 (2010-M06)
	* indicates that the "H_0: Serie has a unit root" hypothesis has been rejected for ADF and PP tests at the 5% significance level, and the "H_0: Serie is stationary" hypothesis for the KPSS test cannot rejected. Values given in tables show that s: constant, t: trend test equations are used in unit root tests.				

The unit root test results given in Table 3.2 shows that the series are not stationary at their levels: but, stationary at their first differences.

3.2.2. ARCH model tests results

In this section, nominal exchange rate volatility will be estimated with the help of ARCH/GARCH models. The basic GARCH model accepts that negative and positive shocks of the same absolute magnitude have the same effect on future conditional variances. However, the asymmetry effect is one of main characteristics of many financial time series. The asymmetry effect means that the time series in asset prices where an unexpected decline tends to increase volatility more than an unexpected increase of the same size (Öztürk, 2006).

In this study, EGARCH model introduced by Nelson (1991) explaining asymmetry in error variances has been used, because EGARCH (1,1) model has been found appropriate considering the parameter significance and AIC, SC, and Log Likelihood criteria together. The conditional variance model as follows.

$$log\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \left|\frac{u_{t-i}}{\sigma_{t-i}}\right| + \sum_{j=1}^{q} \beta_j (log\sigma_{t-i}^2) + \sum_{n=1}^{m} \gamma_n \frac{u_{t-n}}{\sigma_{t-n}} \qquad \textbf{(3.1)}$$

In this model, the logarithm of conditional variance is taken, that is, the condition of non-negative conditional variance is provided. The γ_n coefficient in the model indicates the presence of an asymmetric or leverage effect. For the existence of asymmetric effect, γ_n must be negative and statistically significant. The coefficient β_j should be positive and lower than 1 in order to ensure stability. There is no obvious case for other coefficients, ω, α . Table 3.3 presents the results of the estimated AR (1) - EGARCH (1,1) model.

Table 3.3. EGARCH (1,1) Estimation Results

Mean Equation			
Variables	**Coefficient**	**Standard Error**	**Probability**
C	0.011431	0.003884	0.003
AR (1)	-0.105130	0.041643	0.011
Variance Equation			
γ_1	-5.199054	0.081102	0.000
α_1	1.486157	0.140690	0.000
ω	0.474150	0.108753	0.000
β_1	0.195997	0.016538	0.000

When the Table 3.3 is examined, it is seen that the coefficient γ_1 is significant and negative. This means that exchange rate volatility has an asymmetric impact on imports and exports. It shows that there are asymmetric effects in variances.

After obtaining the volatility series by using AR (1) -EGARCH (1,1) model, we tested whether or not volatility series are stationary by using ADF, PP and KPSS unit root tests and Table 3.4 gives the findings of these tests.

Table 3.4. The Unit Root Tests Results of Exchange Rate Volatility

Variables	**ADF**	**PP**	**KPSS**	**Zivot-Andrews**
Exchange Volatility	0.000	0.000	0.328	0.688

When the table is examined, it is seen that the level values of the volatility series are level stationary. Since exports and imports are first deference stationary, that is they are I(1) and volatility series is level stationary, that is I(0), to determine the effects of exchange rate volatility on imports and exports, we will use ARDL Bound testing approach.

3.2.3. ARDL bounds tests results

As is well known, the ARDL Bounds testing approach, which is proposed by Pesaran (2001) allows the examination of the relationship between different degrees of integrated variables. One of the advantages of this approach is that the variables to be used in the model can be I (0) and/or I (1). Another advantage of this approach is that it can provide statistically more reliable results compared to conventional cointegration tests since it uses the unconstrained error correction model (UECM). The most important

feature of the error correction model is that it includes information about short and long run dynamics between variables (Akel and Gazel, 2014).

The first stage of the implementation of this approach is to determine the appropriate lag length. At this stage, variables are tested with different combinations of lags, and the model that gives the lowest value according to the information criteria (AIC, SIC or HQ) is selected as the appropriate model.

In this study, 2 separate ARDL test results for three different variables are examined. Firstly, the optimum lag length has been determined as 4, considering the minimum AIC value (APPENDIX -1), in the case that import is dependent, exports and exchange rate volatility are independent variables. The UECM equation for the ARDL model is as follows and after the following regression equation is estimated, the F Bounds test is performed to determine a long-term relationship.

$$\Delta\text{IMPORT}=\alpha_0 + \sum_{i=1}^{m} \beta_{1i}\Delta IMPO_{t-i} + \sum_{i=0}^{n} \beta_{2i}\Delta EXPO_{t-i} + \sum_{i=0}^{p} \beta_{3i}\,\Delta EXCHVOL_{t-i}$$

$$+\beta_4 ECM_{t-i} + \gamma_1 IMPO_{t-i} + \gamma_2 EXPO_{t-i} + \gamma_3 EXCHVOL_{t-i} + \varepsilon_i \qquad \textbf{(3.2)}$$

Determining the F statistic value is the first step to implement the ARDL test.

$$H_0 = \gamma_1 = \gamma_2 = \gamma_3 = 0$$

$$H_1 \neq \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq 0$$

In this case, the null hypothesis H_0 implies that there is no co-integration between variables. If the statistical value of F is greater than the critical upper limit value, the H_0 is accepted, otherwise it is rejected. However, if the statistical value of F is any value between the lower and upper limit, it means that there is not enough evidence for the acceptance or rejection of the H_0, therefore other cointegration tests should be applied.

Table 3.5. ARDL Bounds Test Results of Import

Predicted Equation: IMPORT = f (EXPORT, EXCHVOL)		
F-Statistics	6.359804 (0.00)	
Optimal Lag Length	[3,4,2]	
Level of Significance	**Critical Values**	
	Lower Bound	**Upper Bound**
%1	4.13	5
%5	3.1	3.87
%10	2.63	3.35
Diagnostics Test Results	**Statistics**	
$\boldsymbol{R^2}$	0.660101	
Adjusted $\boldsymbol{R^2}$	0.641810	
F-statistics	36.08970	

According to Table 3.5, the F statistic value calculated at 5% significance level is greater than the upper bound value, which indicates the existence of a cointegration relation between the variables, so H_0 hypothesis has been rejected. Accordingly, it is possible to say that there is a long run relation between import and export and exchange rate volatility.

The existence of a long run equilibrium relations between variables is determined by the F test. After this determination, the parameters reflecting the long-term relationship have been estimated and the results are given in Table 3.6. The estimation has been made as a following equation.

$$\text{IMPORT}=\alpha_0 + \sum_{i=1}^{m} \alpha_{1i} IMPO_{t-i} + \sum_{i=0}^{n} \alpha_{2i} EXPO_{t-i} + \sum_{i=0}^{p} \alpha_{3i} EXCHVOL_{t-i} + \varepsilon_i \quad \textbf{(3.3)}$$

Table 3.6. ARDL [3,4,2] Model Results

Predicted Equation: IMPORT = f (EXPORT, EXCHVOL)			
Variables	**Coefficients**	**T-statistics**	**p-Value**
IMPORT(-1)	0.435771	6.025337	0.000
IMPORT (-2)	0.258660	2.972265	0.003
IMPORT (-3)	0.173761	2.071402	0.039
EXPORT	1.105736	12.17264	0.000
EXPORT (-1)	-0.168754	-1.764646	0.079
EXPORT (-2)	-0.053825	-0.477333	0.636
EXPORT (-3)	-0.357648	-3.443267	0.000
EXPORT (-4)	-0.337648	-4.119096	0.000
EXCHVOL	-22.28738	-7.665418	0.000
EXCHVOL(-1)	-30.82282	-7.665418	0.000
EXCHVOL(-2)	-22.92101	-6.725942	0.000
SER02	-662.5150	-1.337959	0.182
C	106.5662	0.946306	0.345
Diagnostics Test Results		**Statistics**	
$\boldsymbol{R^2}$		0.974167	
Adjusted $\boldsymbol{R^2}$		0.972777	
F-statistics		700.7895 (0.000)	
Breusch-Godfrey Serial Correlation LM		0.7963	
Jarque-Bera Normality		14.13228 (0.000854)	

In addition, diagnostic test results of the ARDL model are given in Table 3.6. Accordingly, it is understood that there is no serial correlation according to the Breusch-Godfrey Serial Correlation LM test and the error term has a normal distribution according to Jarque-Bera Normality. Detailed results of these tests are presented in ANNEX-1. Also, in order to detect the presence of the heteroskedasticity problem in the analysis under the White test has been performed.

Long-term estimation results and coefficients calculated as a result of the ARDL model are presented in Table 3.7.

Table 3.7. ARDL Model Long Run Results

Predicted Equation: IMPORT = f (EXPORT, EXCHVOL)		
Variables	**Coefficients**	**t-statistics (p-values)**
EXPORT	1.414065	12.421064 (0.000)
EXCHVOL	-576.8342	-3.927148 (0.0001)
SER02	-5026.374	-1.207755 (0.2284)
C	808.497553	-0.616554 (0.5381)

The relation between import and export and exchange rate volatility can be interpreted as follows; according to the results in Table 3.7, exchange rate volatility and exports have an impact on imports. Looking at the coefficients, the effect of exchange rate volatility is negative, while the effect of exports on imports is positive. There are two different meanings for import, changing in the exchange rate causes an adverse change on the import variable and the changing in exports causes a positive change in imports.

The CUSUM Test graph has been used to investigate the stability of the predicted ARDL model, that is to determine the structural breaks of the variables using the squares of the error terms to determine whether there are structural breaks related to the variables, also it is presented in Figure 3.3.

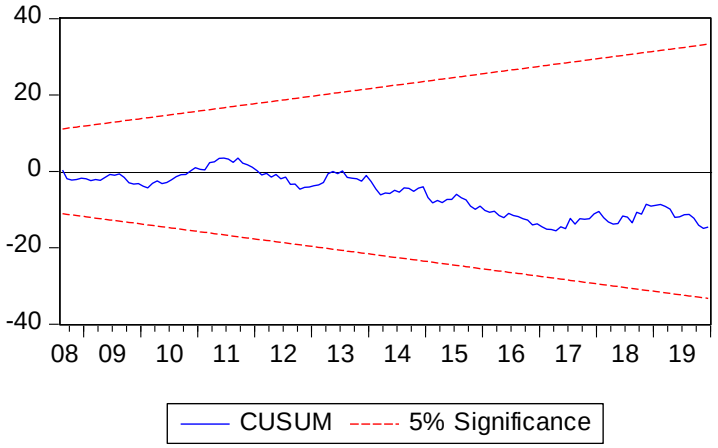

Figure 3.3. Cusum Test Graph of Import Equation

If CUSUM statistics stay within the critical limits of 5% significance level, the zero hypothesis is accepted, which indicates that the variable coefficients in the ARDL model are stationary, otherwise the zero hypothesis is rejected. In the rejected case, ARDL model estimation should be made again by using artificial variables to eliminate structural breaks and ensure the stability of variables. In the CUSUM test chart given above, the ARDL model is applicable because the statistics are between the limits.

Table 3.8. ARDL Model [3,4,2] Error Correction Model Results

Predicted Equation: IMPORT = f (EXPORT, EXCHVOL)			
Variables	**Coefficients**	**T-statistics**	**p-Value**
DIMPORT(-1)	-0.433614	-7.202234	0.000
DIMPORT(-2)	-0.175785	-2.901144	0.004
DEXPORT	1.104634	15.988158	0.000
DEXPORT(-1)	0.751016	7.531412	0.000
DEXPORT(-2)	0.697382	6.926035	0.000
DEXPORT(-3)	0.336255	4.819525	0.000
DEXCHVOL	-22.479474	-2.499253	0.013
DEXCHVOL(-1)	23.141483	2.501007	0.013
D(SER02)	-486.5576	-0.699260	0.485
CointEq(-1)/ECM(-1)	-0.132937	-5.462695	0.000
Cointeq=IMPORT-(1.4141*EXPORT-576.8343*EXCHVOL-5026.3742*SER02+808.4976)			

The estimation has been done according to the below equation and is the variable error correction term shown with ECM (-1).

$$\Delta IMPORT=\alpha_0 + \sum_{i=1}^{m} \beta_{1i}\Delta IMPORT_{t-i} + \sum_{i=0}^{n} \beta_{2i}\Delta EXPORT_{t-i} + \sum_{i=0}^{p} \beta_{3i}\Delta EXCHVOL_{t-i} + \beta_4 ECM_{t-i} + \varepsilon_i \quad \textbf{(3.4)}$$

In the ARDL error correction model, a significant cointegration has been detected between all variables and imports in the short term. In the error correction model, ECM (-1) coefficient is statistically significant and negative. This means that deviations from balance occurring in the short run can approach balance in the long run. According to the results of Table 3.8, the estimated value of this coefficient is -0.13 and it shows that deviations from the long-term balance following short-term shocks can be eliminated after 1 period, 13 %, that is, the adaptation process is slow.

A second case that is examined in this study is that exports are dependent, exchange rate volatility and imports are independent. This situation has been examined in the same way as the above stages. The optimum lag length has been determined as 6, considering the minimum AIC value (APPENDIX -2).

Table 3.9. ARDL Bounds Test Results of Export

Predicted Equation: EXPORT = f (IMPORT, EXCHVOL)		
F-Statistics	9.391420 (0.00)	
Optimal Lag Length	[6,2,2]	
Level of Significance	**Critical Values**	
	Lower Bound	**Upper Bound**
%1	4.13	5
%5	3.1	3.87
%10	2.63	3.35
Diagnostics Test Results	**Statistics**	
$\boldsymbol{R^2}$	0.732645	
Adjusted $\boldsymbol{R^2}$	0.716847	
F-statistics	46.37507	

When the Table 3.9 is examined, the F statistic values are above the 5% both bound values, so it is possible to reject the H_0 , and that indicates there exists a cointegration between the variables.

After being revealed the existence of a long run equilibrium relation between the variables with the F test the parameters reflecting the long-term relationship have been

estimated and the findings are given in Table 3.10. The estimation has been made as a following equation.

$$\Delta EXPORT=\alpha_0 + \sum_{i=1}^{m} \beta_{1i}\Delta EXPORT_{t-i} + \sum_{i=0}^{n} \beta_{2i}\Delta IMPORT_{t-i} + \sum_{i=0}^{p} \beta_{3i}\,\Delta EXCHVOL_{t-i} + \beta_4 ECM_{t-i} + \varepsilon_i \quad \textbf{(3.5)}$$

Table 3.0. ARDL [6,2,2] Model Results

Predicted Equation: EXPORT = f (IMPORT, EXCHVOL)			
Variables	**Coefficients**	**T-statistics**	**p-value**
EXPORT(-1)	0.189563	2.985827	0.003
EXPORT(-2)	0.190396	3.326568	0.001
EXPORT(-3)	0.121527	2.521159	0.012
EXPORT(-4)	0.204691	4.200305	0.000
EXPORT(-5)	0.034829	0.720397	0.472
EXPORT(-6)	0.132163	2.712345	0.007
IMPORT	0.436548	14.82259	0.000
IMPORT(-1)	-0.223857	-5.257495	0.000
IMPORT(-2)	-0.129688	-3.174627	0.001
EXCHVOL	9.783904	1.544773	0.123
EXCHVOL(-1)	22.11232	3.608725	0.004
EXCHVOL(-2)	15.55672	2.471063	0.014
SER01	-761.3169	-3.092505	0.002
C	146.1836	1.373306	0.171
Diagnostics Test Results		**Statistics**	
$\boldsymbol{R^2}$		0.977269	
Adjusted $\boldsymbol{R^2}$		0.975926	
F-statistics		727.5671 (0.000)	
Breusch-Godfrey Serial Correlation LM		0.3129	
Jarque-Bera Normality		26.29166 (0.000002)	

The diagnostic values of the ARDL model are presented in Table 3.10 and according to these results, it has been determined that there is no serial correlation problem, heteroscedacity problem, and the variables have normal distribution. More detailed results of these tests are given in APPENDIX-2.

Table 3.11. ARDL Model Long Run Result

Predicted Equation: EXPORT = f (IMPORT, EXCHVOL)		
Variables	**Coefficients**	**t-statistics (p-values)**
IMPORT	0.654434	11.877418 (0.000)
EXCHVOL	374.139957	3.188457 (0.001)
SER01	-6002.558	-2.193848 (0.029)
C	1152.576	1.320192 (0.188)

When Table 3.11 is analyzed, it is seen that imports and exchange rate volatility have an impact on exports and this effect is positive. The changing in imports and exchange rate causes a positive change on exports. However, the positive effect caused by the volatility of the exchange rate is much larger than the effect from the import. Also, the fact that the import coefficient is lower than the export coefficient is one of the indicators that Turkey is an import-dependent export country.

CUSUM Test statistical values were examined in order to understand whether the variables used in ARDL model prediction have structural breaks and the stability of the model.

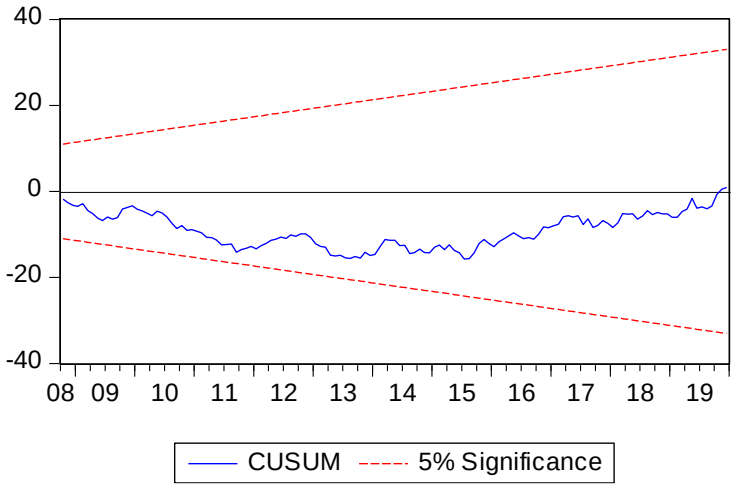

Figure 3.4. Cusum Test Graph of Export Equation

It is possible to assume that the coefficients of the variables used in the ARDL model are stationary and that there is no structural break, since the CUSUM Test statistic value is within the 5% significance limits.

Table 3.12. ARDL Model [5,1,1] Error Correction Model Results

Predicted Equation: EXPORT = f (IMPORT, EXCHVOL)			
Variables	**Coefficients**	**T-statistics**	**p-value**
DEXPORT(-1)	-0.686655	-11.929063	0.000
DEXPORT(-2)	-0.505255	-9.479466	0.000
DEXPORT(-3)	-0.379283	-6.926436	0.000
DEXPORT(-4)	-0.171671	-3.134382	0.002
DEXPORT(-5)	-0.133491	-3.013049	0.002
DEXCVOL	10.521879	2.021155	0.044
DEXCHVOL(-1)	-16.392438	-2.952203	0.003
DIMPORT	0.446202	16.343707	0.000
DIMPORT(-1)	0.137222	3.648798	0.000
DSER01	530.371550	1.224694	0.222
ECM(-1)	-0.131997	-7.172095	0.000
Cointeq=EXPORT-(374.1400*EXCHVOL+0.6544*IMPORT-60002.5589*SER01+1152.5762)			

$$\Delta\text{EXPORT}=\alpha_0 + \sum_{i=1}^{m} \beta_{1i}\Delta EXPORT_{t-i} + \sum_{i=0}^{n} \beta_{2i}\Delta IMPOR_{t-i} + \sum_{i=0}^{p} \beta_{3i}\,\Delta EXCHVOL_{t-i} + \beta_4 ECM_{t-i} + \varepsilon_i \quad \textbf{(3.6)}$$

The same comments can be made as in table eight, that is, there is co-integration between all variables. ECM (-1) results are negative and statistically significant. This indicates that deviations from equilibrium occurring in the short term can getting closer to balance in the long term.

4. CONCULUSION

In this study, short and long run relation between exchange rate volatility and imports and exports has been investigated by using the monthly data between 2000 and 2019 with the ARDL Bounds testing approach. It has been found a long run relation between export, import and exchange volatility. There is a relation between exchange volatility and import and it is negative, but the relation of export and exchange volatility is positive. Also, there is a positive relationship between import and export. According to the results of the error correction model, in the short run, a relationship has been detected between all variables.

Since exchange rate volatility have significant effects on both imports and exports, this effect should be considered for each trading partner in the implementation of trade policies. Due to its negative effects on imports, Turkey should increase its domestic production capacity of imported goods. Policies which are limiting imports should be implemented, and imports should be replaced by domestic products, thereby reducing imports, and ensuring an export-based economy.

Turkish economy is dominated by partial dollarization, but dollarization should be minimized. Local currency (TL) deposit interest can be positively applied on inflation rates, public tenders can be made in local currency (TL), and a restriction may be imposed on foreign exchange shopping. But most importantly, a stable economic policy should be implemented, and these policies should be towards closing the current account deficit.

In addition, the use of alternative energy resources, technological investment and quality workforce should become more of an issue. Along with incentives to increase foreign trade efficiency, creating competition in foreign trade may also be important for the foreign trade balance.

In future studies, long-and short-term relationships between import and export indices and exchange rate volatility on a sectoral basis can be investigated within the framework of different models of co-existence and causality. In addition, the differences between developing countries and developed countries can be investigated with the variables in question.

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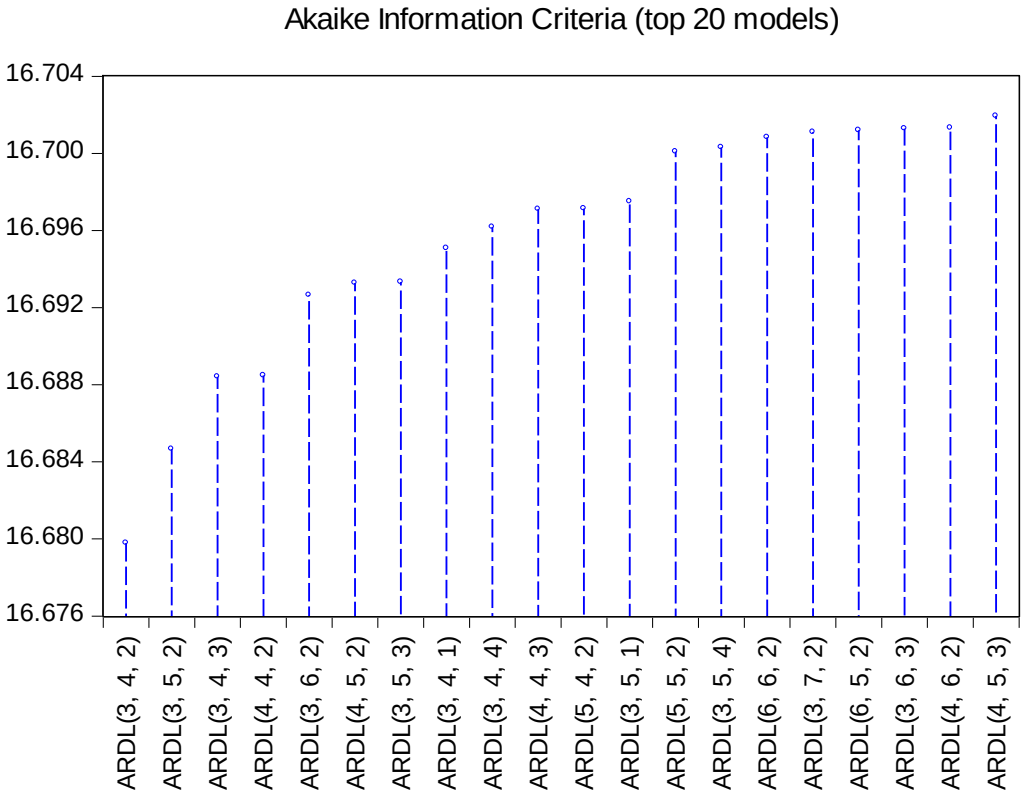
APPENDIX

APPENDIX-1

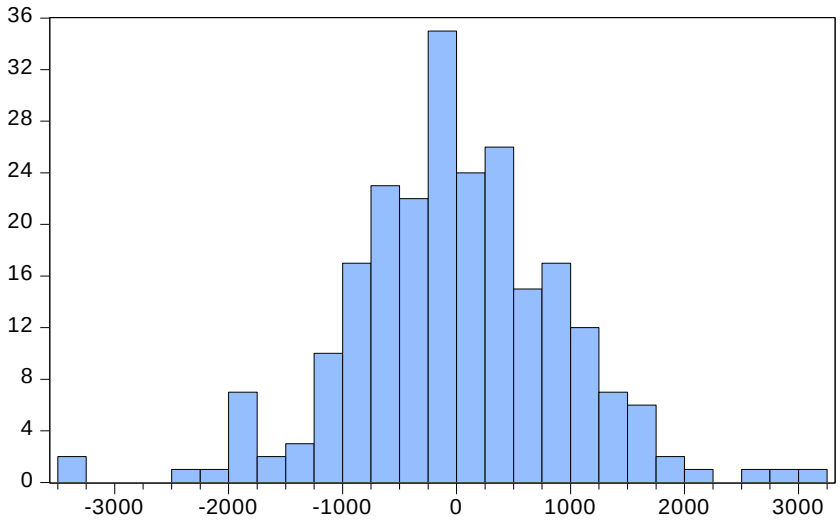


Serial Correlation LM Test Result

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.228067	Prob. F(2,221)	0.7963
Obs*R-squared	0.486089	Prob. Chi-Square(2)	0.7842

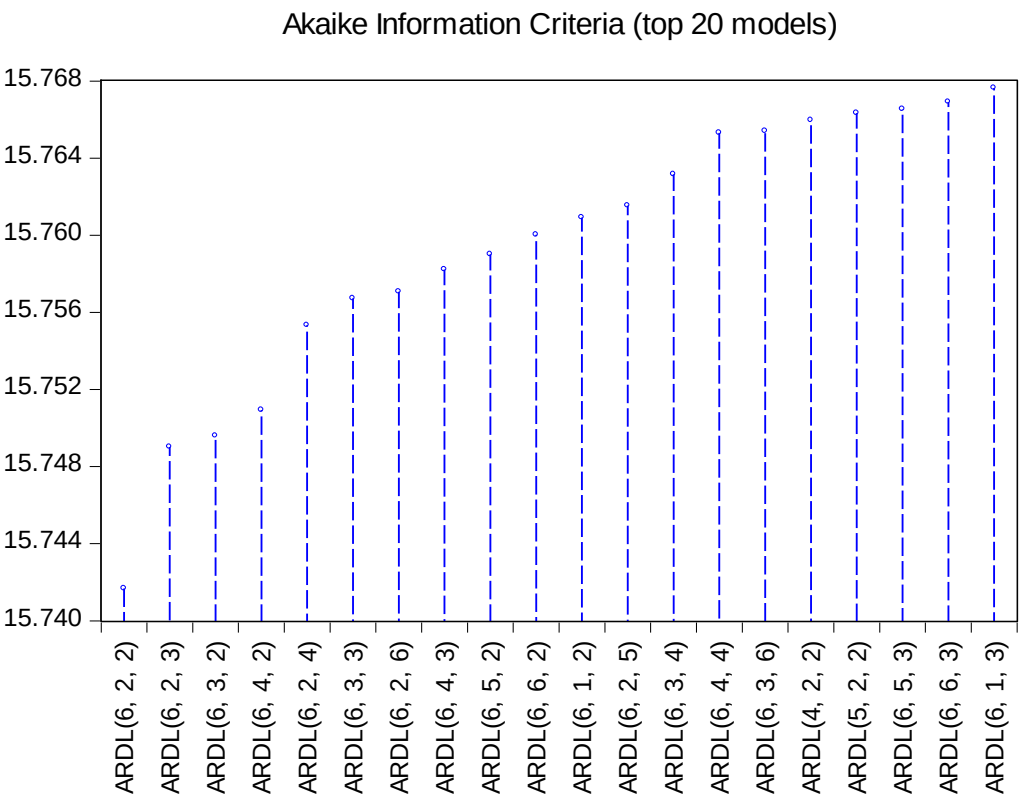
Jarque Bera Histogram- Normality Result



Series: Residuals
Sample 2000M05 2019M12
Observations 236

Mean	-4.59e-12
Median	-53.47837
Maximum	3031.270
Minimum	-3390.925
Std. Dev.	949.5513
Skewness	-0.111611
Kurtosis	4.177860
Jarque-Bera	14.13228
Probability	0.000854

APPENDIX-2

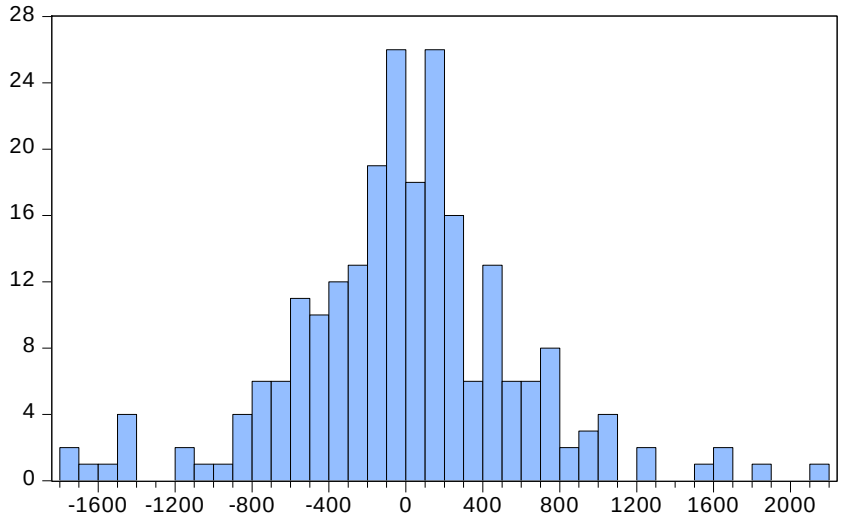


Serial Correlation LM Test Result

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.168108	Prob. F(2,218)	0.3129
Obs*R-squared	2.481092	Prob. Chi-Square(2)	0.2892

Jarque Bera Histogram- Normality Result



Series: Residuals
Sample 2000M07 2019M12
Observations 234

Mean	-5.92e-13
Median	-8.535930
Maximum	2193.255
Minimum	-1769.187
Std. Dev.	596.8974
Skewness	0.080840
Kurtosis	4.634148
Jarque-Bera	26.29166
Probability	0.000002