The Impact of the Change in Exchange Rate on Economic Growth in Turkey

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ABSTRACT

The Turkish economy has been affected by the recurring populist cycles and resultant economic crises, which have, in turn, unfavorably influenced the growth performance of Turkey. Inspired by the Turkish experience, this study attempts to investigate the change in exchange rate on the growth performance of the Turkish economy by using the production function framework. The data is sourced from the World Development Indicators and Penn World Table. Modern time series techniques are utilized to estimate the production function. Our findings reveal that there is a long-term but unfavorable relationship between the change in the exchange rate and economic growth in Turkey over the 1980-2019 period.

Keywords: Exchange Rate, Macro Instability, Economic Growth, Turkey

ÖZ

Türkiye ekonomisi, tekrarlayan popülist döngülerden ve bunun sonucunda Türkiye'nin büyüme performansını olumsuz yönde etkileyen ekonomik krizlerden sürekli etkilenmiştir. Türkiye deneyiminden esinlenen bu çalışma, üretim fonksiyonu çerçevesini kullanarak döviz kurundaki değişimin Türkiye ekonomisinin büyüme performansı üzerindeki etkisini incelemeye çalışmaktadır. Veriler, World Development Indicators ve Penn World Table'dan alınmıştır. Üretim fonksiyonunu tahmin etmek için modern zaman serisi teknikleri kullanılmaktadır. Bulgularımız, 1980-2019 döneminde Türkiye'de döviz kurundaki değişim ile ekonomik büyüme arasında uzun dönemli fakat olumsuz bir ilişki olduğunu ortaya koymaktadır.

Anahtar Kelimeler: Döviz Kuru, Makro İstikrarsızlık, Ekonomik Büyüme, Türkiye

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INTRODUCTION

There are many factors that affect the economic growth of countries. One of the most important factors is the change in exchange rate, which has a crucial effect on the performance of economies of developed and developing countries. Furthermore, exchange rate has a key role in international trade and finance. For instance, the change in exchange rate may cause on imbalance in countries' current and financial account balances and hence such imbalances, in turn, affects the economy in many ways. One of the crucial effects is on inflation, which causes uncertainty in the economy to grow. In other words, exchange rate fluctuations increase the instability of the economy.

This study attempts to explain the effect of the change in the exchange rate on economic growth. Previous studies revealed that developing countries are more affected by the change in exchange rate. The most important reason is the low variety and rate of production. Developing countries are highly dependent on foreign resources regarding production and consumption. Increasing exchange rates leads to an increase in import prices and cost of production. The reason is that developing countries import the intermediate goods and the raw materials that are used in production.

Turkey is one of the developing countries mostly affected by the change in the exchange rate because Turkey has a recurring instability and inflation problem. The increasing exchange rates combined with the frequent unsound macroeconomic policies implemented by the Turkish government caused inflation spurts and chronic instability episodes in Turkey (Ismihan, 2009). Macroeconomic instability causes an uncertainty in economy. Volatility and uncertainty, in turn, affect the economy negatively in different ways, e.g., via employment growth, economic growth and foreign trade. Investments are also unfavorably affected by volatile exchange rates because they increase risk which has an effect on interest rates.

To sum up, developing countries, remain vulnerable against the increase in exchange rates and associated inflation and this, in turn, harms the economic growth. The main motivation of this study is to investigate and explain the effect of changing exchange rate on Turkey's economic growth in the long-run through inflation and hence instability. Therefore, in this study, the effects of exchange rate on the Turkish economy were analyzed using the production function. The data is taken from Penn World Table and World Bank’s World Development Indicators. Since the most important foreign exchange currency is dollar in Turkey, exchange rate of dollar is preferred in this study.

The rest of the study is organized as follows: The first chapter is the introduction. Chapter two explains the theoretical background and provides the literature review. The third chapter provides the Turkish economic background and the fourth chapter presents the model and the methodology. Then, chapter five provides the empirical results of the study. Last chapter presents the conclusion.

Chapter 2

REVIEW OF LITERATURE

2.1 Exchange Rate Determination

Purchasing Power Parity (PPP) is one of the frameworks which determine the exchange rate in the long-run. PPP implies that monetary policy has no long-term effect on the real exchange rate. Therefore, countries with different inflation rates should expect the bilateral exchange rate to adjust and compensate for these differences in the long run. Absolute PPP which is based on an international multi-good version of the law of one price is used as exchange rate determination theory. Absolute PPP adjusts the exchange rate by equalizing basket prices of goods and services between two countries. In another words, the exchange rate to absolute PPP equalizes the domestic and international prices of a commodity. It suggests that real exchange rate is constant. On the other hand, the Absolute PPP is not valid for some reason and weakens the exchange rate determination theory. Considering these reasons, the presence of non-tradable goods, the cost of transportation, transaction costs such as taxes, and the fact that the exchange rate is not fixed in the short run weaken the absolute PPP in determining the exchange rate (Boyle, 2022).

The relative PPP emphasizes that differences in the inflation rate should be accounted for by the exchange rate between the two countries. The difference in the different monetary policies applied and the inflation rate targets, which are different in each country, should be reflected in the mobility in the exchange rate.

Interest rate parity (IRP) is an important theory for determining the exchange rate. IRP determines the exchange rate by linking interest rates, spot exchange rates and foreign exchange rates and implies. According to the IRP, the returns on investments made in different currencies should be the same regardless of interest rates. IRP is the concept of no-arbitrage in the foreign exchange markets. While covered interest rate parity (CIP) involves using forwards contracts to cover the exchange rates, uncovered interest parity (UIP) involves using the expected spot rate (Hargrave, 2022). CIP defines the relationship between the spot and forward currency rates of two countries and the interest rates. It holds when the difference between interest rates and the forward and the spot exchange rates are equal. UIP can be decomposed in three parts which are purchasing Power Parity, the Fisher equation concerning about the relationship between real and nominal exchange rates and free capital mobility. The expected change in the exchange rates is equal to the bilateral interest rate gap under risk-neutral condition (Hargrave, 2022).

2.2 Theoretical Arguments on the Effects of Exchange Rate

The main aim of this study is to investigate the long-term effect of the change in exchange rates on economic growth in Turkey. Therefore, this section mainly focuses on the effects of exchange rate on economic growth.

The exchange rates affect economic growth in two different ways which are trade and financing channels (Ozkan, 2020). Considering the trade channel, in recent years, depreciation of the domestic currency makes the domestic goods and services cheaper, therefore, it is expected to increase net exports and decrease imports according to Marshall-Lerner conditions. According to Marshall-Lerner conditions, if a country have a zero-trade deficit, the depreciation of domestic currency improves the trade

balance because imports become more expensive and exports become cheaper. The condition is if the absolute sum of a country's import and export demand elasticities is greater than one.

On the other hand, appreciation of the foreign currency increases import prices and directly affects the production costs measured in domestic currency. This, in turn, increase the inflation of countries which depend on foreign resources like Turkey. Another negative effect is that companies have debts that are 80% in foreign currencies (Ozkan, 2020). This makes the debts more difficult to be paid and this results in trade, production and exports to be affected adversely. Turkey has a highly dependent production mechanism and import lots of basic intermediate goods which are used to produce final goods. It prevents to increase in the expected net export income, as well as increases inflation dramatically because Turkey has to buy raw materials and intermediate goods from foreign countries. Therefore, imports increase and produced products' prices grow and it causes higher inflation. Increasing inflation, on the other hand, increases the prices of domestic goods and services, which should be cheaper due to the depreciation of the domestic currency, and causes a decrease in export revenue. In the financing channel, accelerating financial globalization has resulted in the integration of many countries into the international financial system. This integration resulted in high foreign borrowing denominated in foreign currency. With the depreciation of Turkish Lira, foreign debts (in TL) increased day by day and more domestic resources began to be spent to pay these debts. When borrowings are in the public sector, they cause an increase in government debt, and when they are in the financial sector and the private sector, they cause a decrease in economic activities because of a credit contraction. As a result of rising and unpaid debts, there were

attempts by the government to reduce and limit borrowing. Financial channel dominates in the case of Turkey.

These initiatives also constrained productivity and companies' growth initiatives. Therefore, production and national income are negatively affected. To sum up, considering the trade and financial channels, the increase and fluctuation of the exchange rate is a problem that should be prevented for the sake of the development of developing countries such as Turkey. The most fundamental and unfavorable dimension of the effect of the change in exchange rate is their effects on inflation. As the rising and fluctuating exchange rate increases the price of both imported products and raw materials used in production and distorts price mechanism of the country (Ismihan, 2009). Moreover, increasing inflation rises dollarization and declines the demand for domestic currency (see Ismihan, 2009 for additional effects).

According to Fischer, the best indicator of the instability is inflation and it serves the government's ability to manage the economy (Fischer, 1993b). There are many policy-induced macroeconomic indicators in the economy. Inflation rate, GNP ratio and external debt to GNP are examples of these indicators (Fischer 1993a, 1993b). Increase in macroeconomic instability means that one of these indicators increase. Macroeconomic instability negatively affects economic growth since it creates uncertainty. An increase in instability also causes a further increase in inflation. According to Fischer (c) and Agenor, increasing uncertainty reduces the efficiency of the price system and negatively affects growth rates. In addition, the fact that the uncertainty is directly proportional to the risk causes the private investments to be affected and the expected profit to decrease (Fischer, 1993a, b and Agenor 2000). Finally, uncertainty leads to decreased capital accumulation. If instability problem

becomes chronic, the level of foreign direct investment decreases and it affects income distribution.

Consequently, the increase and fluctuations in foreign exchange rate is detrimental for Turkey's economic growth because Turkey has a recurring chronic inflation and macroeconomic instability problem.

2.3 Production Function Approach

This study utilizes the production function framework. The production function reveals how much the input affect the output, in other words, the relationship between input and output. The key elements in the production function are capital, labor and total factor productivity (TFP).

According to Solow, TFP which represents a combination of increases in efficiency in the utilization of those inputs and improvements in technology, is one of the most important variables in growth accounting. Growth studies, therefore, divide the contributions of changes in factor inputs and a residual (TFP) from observable output growth. Cobb-Douglas production function, e.g., like the following standard form, is usually utilized by many researchers.

(1) $\mathbf{Y = A\,K^{\alpha}\,L^{(1-\alpha)}}$

A, K and L indicates TFP, physical capital and labor respectively. The effects of inputs (K, L) and TFP on the output can be analyzed with this production function. In general, almost all previous studies agree on the existence of the effect of human capital on economic growth. Human capital is incorporated to production function as an additional input in neoclassical growth models. In the endogenous growth models, on the other hand, it contains the information that investment in human capital positively

affects economic growth. In the previous researches, the increase in the average educational attainment of the labor increases the production and income per worker. In this study, human capital is used as an input.

(2) $\mathbf{Y = A K^{\alpha} (Lh)^{\beta}}$

where h is human capital index.

The physical and human capital factors affecting output per worker are equally weighted (Mankiw, 1992). It has also been demonstrated that the time people spend education, training, developing and learning new skills has a positive effect on the output per worker. The time people to improve themselves put in production function as an index. In other words, skilled labor is not ignored in this model. Skilled labor causes acceleration and increase in production. Therefore, Human Capital Index and Number of persons engaged data were used while creating variable 'H' in this model. H is formed by multiplying these two variables. After deriving the variable H, the dependent variable Y and the independent variable K were divided by H to derive model in per effective labor form. Dependent variable became Y/H which is output per effective labor, while independent variable became K/H which is capital per effective capital.

(4) $\mathbf{(Y/H) = e^{\theta_0 + \theta_1 e + \theta_2 inf} (K/H)^{\alpha}}$

where $A = e^{\theta_0 + \theta_1 e + \theta_2 inf}$.

In sum, the above production function forms the basis of this study. The motivation of the model is to discover the effect of change in exchange rates on economic growth, which probably causes a decrease in total factor productivity (A) by causing instability via disrupting the price mechanism. Unsound macroeconomic policies are one of the important causes of uncertainty and instability in Turkey (Ismihan, 2009). These

policies, which were implemented to achieve short-term benefits, have unfavorably affected the country's economy in the long run. Undoubtedly, they also affect exchange rates and further contributes to a rise in uncertainty. This study, using the model above, is aiming to investigate how exchange rate effect is reflected on economic growth within the framework of the production function in Turkey.

2.4 Literature Review

The dramatic increase and the volatility in exchange rates have affected Turkey's economy negatively. The change in exchange rates, which has a considerable effect on the economy of not only Turkey but also other countries, has been discussed and analyzed in many studies. A study was conducted on the impact of imbalance in foreign exchange on the Turkish economy between 1998 and 2019 (Ozata, 2020). The main aim of the study was to investigate how exchange rates affect economic growth of Turkey by using ARDL method. As a result of the analysis, it has been revealed that the volatility in exchange rates has a negative effect on Turkey's economic growth. While exports and investments affected Turkey's real GDP positively, volatility in exchange rates and imports affected GDP negatively. Moreover, the exchange rate is used as a policy decision tool. The volatility in exchange rates caused the uncertainty. The most important problem was that Turkey’s production was dependent on import which resulted in an increase in inflation. This study suggested in order to reduce inflation and instability, local production should be developed and diversified.

A study focused on how the uncertainty in exchange rates affects Turkey's exports (Kasman and Kasman, 2005). Cointegration and error correction methods were used. Standard deviation of the growth of the real and nominal exchange rates was used as a proxy of the change in exchange rates. The long-run relationship was analyzed by

using cointegration. As a result, it was revealed that there is a long-term relationship between them. The two most important factors affecting exports are the currencies of the trade partners and the fluctuation in the real effective exchange rate. As a result, it was revealed that there is a positive relationship between exports and the volatile exchange rate. There are other studies which also concluded similar results. Domac (1997), the relationship between exchange rate and economic growth in Turkey between the years 1960 and 1990 was analyzed. Regression analysis was used to investigate the relationship. The negative effect was expressed in another perspective. The study showed that the devaluations had a positive effect on the economic growth. Rodrik (2008) found similar results. The depreciation in real exchange rate has a positive effect on the economic growth of developing countries (such as Turkey).

Yildiz, Ide, and Malik (2016) conducted another study which investigated how the change in exchange rates affect Turkey's economic growth. Contrary to other studies, different approaches about the volatility and effects of exchange rates were discussed. The aim of the study was to facilitate the analysis and to assist the country’s strategic decisions. The change in exchange rate affects the economies of developed and developing countries differently. Undoubtedly, the developing countries are more affected by the exchange rate movements, because their production and consumption are import base, in other words, they depend on foreign sources. In developing countries such as Turkey, fluctuations in exchange rates make economic factors more fragile, which causes the economy to be adversely affected. The exchange rate volatility leads to make capital movements, international trade and production vulnerable. Hence, this study emphasized that exchange rate should be detected and intervened in a timely manner. Developing countries should apply different strategies

to accelerate their growth. Export-led growth is the most popular method. The balance of payment is vital for this strategy. Therefore, the imbalance in exchange rates should not be allowed to create instability. According to this study, the exchange rate can change unexpectedly or spontaneously, and the future value is very difficult to determine today. The best way to control this is to minimize the risk by analyzing the future value of the currency by using risk management techniques. The reason for Turkey's current economic condition is the unsound macroeconomic decisions taken after 1980 (Ismihan, 2009). Nowadays, some factors are vital for the future of the Turkish economy which are interest rate, foreign policies, economic growth and current account deficit. Insufficient domestic savings of the Turkish economy causes a current account deficit and it can be compensated by using foreign savings. As a result, the volatility and the instability in exchange rate affect the Turkish economy negatively.

Another study was conducted by Demir (2010), which investigated the effect of exchange rate fluctuation on the Turkish economy. It investigated how the Turkish economy was affected by growth of employment. Manufacturing factories are amongst those most negatively affected by the change in the exchange rate. It has been statistically proven that the imbalance of exchange rate negatively affects the employment growth of manufacturing firms. Among these affected companies, the worst effect is the companies with higher export share and indebtedness. Despite the 6.6% growth in real GDP between 2002 and 2007, the employment growth was -0.26%, because output is constantly increasing, but employment growth is falling independently of this increase (Demir, 2010). Employment elasticity was used to explore this. The employment elasticity decreased from 0.38 in the early 1990s to 0.30

in the early 2000s. This was a chronic problem for the Turkish economy and has gotten worse over time. This problem can be seen in many developing countries because it causes the use of informal and subcontracted labor. For example, unregistered employment in Turkey constitutes almost half of employment. Large firms as well as small firms employ more subcontractors to avoid exchange rate fluctuations. This creates both an economic problem and allows it to be used politically. The proposed solution to this issue is the use of capital controls. When capital controls are used, both foreign investors are encouraged and foreign currency denominated debts can be controlled. Furthermore, applying quantitative restrictions on markets can improve the local financial system and enable current account deficits to be controlled. To summarize, the problems created by the fluctuation in the exchange rate of developing countries such as Turkey are inevitable.

In order to better analyze how the change and imbalance in the exchange rate affect the economy, it is useful to look at the analyses in other countries too. Pakistan, which is a developing country like Turkey, is also one of the countries affected by the exchange rate. In a study conducted by Javed and Farooq (2009), the volatility in exchange rates and economic growth were investigated between 1982 and 2007. Firstly, the relationship between the manufacturing product and economic growth was analyzed. It was proven that there was a positive relationship between manufacturing product and economic growth. On the other hand, the increase in the money in the domestic reserves affected the economic growth negatively because the increase in domestic reserves decreased the international reserves and slowed the economic growth. As theoretically expected, an increase in imports reduces economic growth. According to analyses, money in reserves and exchange rate has a negative

relationship with growth in the long run, but import and export variables are insignificant. In the short run, however, these relationships yielded different results in different regressions. In some regressions, positive correlations were observed, while in others, negative relationships were observed although there was no significant relationship between economic growth and the exchange rate. All these analyses show that exchange rate is vital for economic growth in the long run.

Adeniyi and Olasunkanmi (2019) investigated how the change in exchange rate between 1980 and 2016 affected Nigeria's economic growth. The fluctuations of the exchange rate reached its peak in 2008-2010 and 2014-2016. They found that there is a long-run relationship between variables. While the export value was statistically significant, the import was insignificant. The exports have a positive contribution to the economic growth of Nigeria. It has been found that imports have the opposite effect and deteriorate the economic growth. Inflation, which is one of the other important factors of growth, increased with the growing exchange rate. One of the biggest factors creating inflation in developing countries is the exchange rate. Consequently, this study argues that Nigeria should diversify and increase their production to reduce its external dependence. In addition, it has to take steps to prevent increase in exchange rate and ensure stability and economic growth (Adeniyi and Olasunkanmi, 2019).

Kandil & Dincer (2008) analyzed the effects of exchange rate fluctuations between 1980 and 2004 on the economic growth of Egypt and Turkey. According to the results of the analysis, the changing and increasing exchange rate increased the prices of imported goods. The appreciation of the domestic currency reduced exports and money demand, and an increase in output was observed. In addition to this, inflation increases and instability begins to occur. Due to the inability to produce and import raw materials

and intermediate goods, production becomes more expensive. To sum up, both production and consumption prices increase. Since debts and expenditures are in foreign currency, this causes difficulties in paying debts. Moreover, increasing interest rates make investments riskier. As a result of increased instability and inflation, the price mechanism distorted and the economic growth was affected negatively.

Chapter 3

TURKISH ECONOMY

3.1 A Brief Background on Turkish Economy

In 1980, the Turkish lira was under a fixed exchange rate regime. According to fixed exchange rate regime, external value of the domestic currency was equalized by the Central Bank against foreign currencies at a certain exchange rate and it remained the same until it was changed by the Central Bank. There are various forms of implementation of the fixed exchange rate regime. The first one is the pegged exchange rate regime which bind the domestic currency to a certain reserve currency or to a basket formed by more than one currency. The other one is currency board regime, which prints domestic currency, is also tied to foreign currency inflows. The fixed exchange rate regime would have created an increase in investments because of lower risks. It created a fragile economy against the shocks in the foreign market.

The nominal exchange rate was determined by the Central Bank. The biggest reason for the transition to a fixed and controlled exchange rate regime was the great devaluation in 1980. Due to this policy, the real exchange rate was constantly decreasing between 1980 and 1988 (Ozata, 2020). The main reason was the increase and the competitiveness of domestic products, in other words, encouraging exports. Although the lowest real exchange rate in the history of that period was seen due to the devaluation in 1994, the real exchange rate continued to increase gradually in 2001. After the constitutional crisis, Turkey government switched to the floating exchange

rate regime in March 2001, in fact, it can be said that it had to be switched. The floating exchange rate regime could increase competition in foreign trade and market; this could have removed the fragile structure against external shocks. Moreover, the transition to free exchange rates would have enabled the central bank to sustain more independent monetary policies. Considering the disadvantages, companies, investments and banks would be seriously harmed by a possible increase in exchange rates. Investments and financial transactions would decrease because of growing risks. It would naturally increase the risk premiums. In addition, the increased exchange rate could increase the import inflation of Turkey, which is dependent on foreign sources.

3.2 Growth and Stability Dynamics in the Turkish Economy

In this section, a brief overview of the growth history and instability of the Turkish economy will be provided for the period of 1980-2019. In 1980, there was a coup in Turkey and the government headed by Süleyman Demirel was overthrown. Later, the Turkish government, which led by Turgut Özal, switched to an export-led growth strategy. Between January 1980 and May 1981 Crawling Band regime was applied. This encouraged an export-oriented and liberalized economy. The aims of the program were disinflation, fiscal discipline and sustainable growth. Long-term growth was aimed by taking steps to increase exports instead of import substitution policy with a comprehensive reforms and policies (Kasman and Ayhan, 2006). With these policies implemented, when economic growth increased, domestic debts decreased. Inadequate financial market systems and inspections while applying these policies caused problems in some sectors. Firstly, industrial sector was affected and then some problems arose in the banking sector. When the imbalance in the public sectors caused by political instability was added to these problems, a serious and permanent

macroeconomic instability emerged during the late 1980s and 1990s. (Ismihan, Metin-Ozcan, and Tansel 2005).

Managed Float regime was followed by Turkish government between May 1981 and December 1999. Central Bank of Republic of Turkey declared quotations to nominal exchange rate and Banks were able to regulate exchange rates by 1990. 'By 1990, banks were allowed to determine exchange rates in their operations. Eventually, high capital inflows, supported with high real interest rates, and the implicit usage of exchange rate as an anti-inflationary policy tool caused slowing down the continuous depreciation' (Kasman and Ayhan, 2006). The need for public sector borrowing and short-term domestic borrowing increased in early 1990s and Turkey switched to domestic borrowing policies. Although there was an appreciation in TL, it has caused external deficit, unsustainable fiscal balances, debt-rollover problem and monetization. As a result, devaluation expectations increased by the end of 1993.

In 1994, a new stabilization program was implemented since the financial crises has slowed down when short term monetary measures were taken, interest rates increased, and excessive reserve loses occurred. Inflation increased up to 106.5% and the depreciation against the dollar reached 170.4% (Ismihan, 2009). As a result of this crisis, the macroeconomic instability index reached 0.687. The most important sector affected by this crisis was the banking sector. The main reason for the instabilities and problems in the banking sector was the rise in interest rates on domestic debts. These problems have created an environment in which holding government bonds was more profitable than financing private investment projects. In addition, the politicization of the banks in Turkey decreased the competition of the banking sector and weakened the

system. When the weak banking rules were added to them, the bankruptcy of the banks was inevitable.

In 1999, Turkey implemented a disinflation program containing the foreign exchange anchor to reduce inflation and support the weakening banking sectors. It established the Banking Regulatory and Supervisory Authority (BRSA). The goal was to regulate and supervise the banking sector independently, but this was not able to prevent the crisis in 2001, and eventually, the Turkish economy contracted by 5.7%.

After the 2001 crisis, a stabilization program called " The Programme for Strengthening the Turkish Economy" was implemented which relied on fiscal austerity, free floating regime and structural pillars. In order to overcome troubled banking sector, massive fiscal adjustment, public debt management and privatization, this policy was applied. The applied reforms were successful in reducing both the financial instability of the state and the inflation rate. The development in two main factors revealed a fiscal discipline. Turkey had a more stable economy after 2002 and faced its lowest value since 1980 in the instability index in the 2002-2006 period (Ismihan, 2017). (See figure 1 below which shows the Macroeconomic Instability Index).

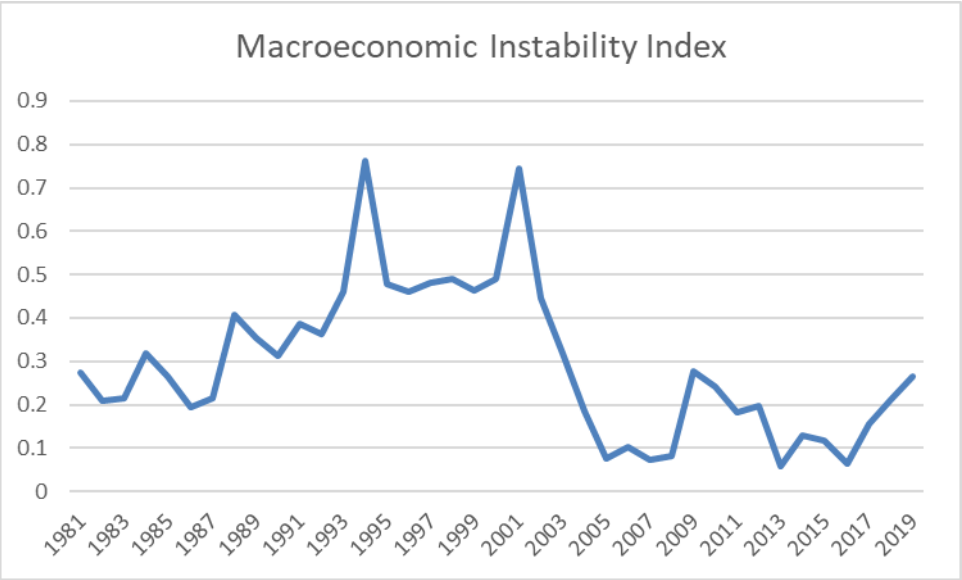

Figure 1: Macroeconomic Instability Index (Ismihan,2017)

Another success of the reforms implemented after 2002 was to increase the financial soundness and reliability of the banking sector. This is one of the main reasons why it was less affected by the effects of the global financial crisis that took place in 2008. Although the banking sector was negatively affected in global financial crisis in 2008, it recovered quickly from these effects (BRSA 2010). Turkey, which was more successful in 2002-2006, followed consumption-based policies after 2006, and as a result, the rise in private borrowing rates combined with the inadequacy of savings began to increase the current account deficit. The fragility in the current account deficit of the Turkish economy, which is dependent on foreign and short-term capitals, caused the Macroeconomic Instability Index to rise again.

After 2009, there was a recovery in economic growth with financial incentives in 2010-2011. Significant decreases were observed in real interest rates. These were achieved by the increase in government expenditures, and at the end of this period, the contribution of government expenditures to GDP growth reached 25%, but positive effect was short-lived. At the point reached after 2006, the biggest problem was

experienced in productivity. Productivity has almost reached zero point. Total factor productivity growth, which measures of productivity with dividing total production to inputs such as labor and capital, was around 0%.

With the coup attempt in 2016, which added to the political and economic instability and uncertainty, the Turkish economy continued to turn upside down and there was a considerable reduction in economic growth. Moreover, there were dramatic rises in unemployment and inflation. The government aimed to increase the domestic demand by increasing the expenditures again, in order to decline unemployment and inflation. However, after the short-term positive effect, the economy deteriorated again. Foreign direct investment, capital ventures and tourism revenues suffered severely from these unsound decisions. Furthermore, the dramatic increase in the exchange rate, in other words, the great value that the Turkish lira lost against the dollar, and the change in the exchange rate combined with a foreign-dependent economy like the Turkish economy, the economic collapse was inevitable. Investments fell, mainly due to increased exchange rate and restrictions on bank loans. The decrease in investments lead to an increase in unemployment.

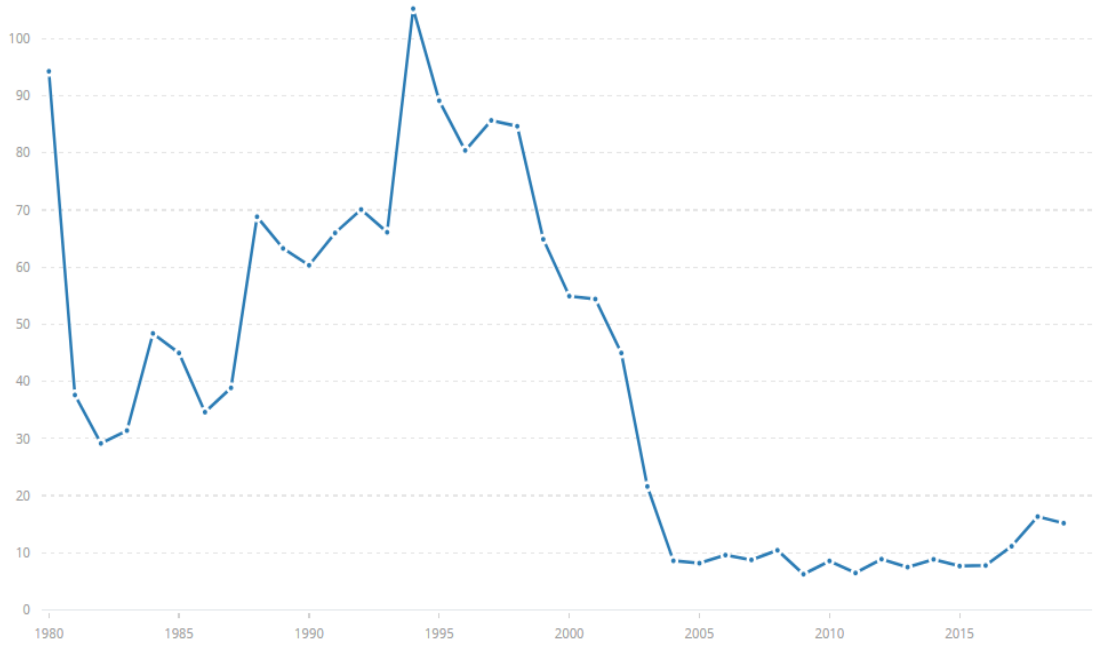

Figure 2: Inflation (Consumer Prices) of Turkey (World Bank Indicators)

Figure 2 shows Turkey's inflation from 1980 to 2019. The inflation rate, which was around 8% in 2016, doubled in 2019 because of political and economic uncertainties and imbalances and reached 16%. According to Turkish government, the reason for the elevation in exchange rates was interest rates and the result was increased inflation. However, most economists in other countries argued that inflation is the reason and the result is interest rate. The Turkish government, which applied policies to reduce interest rates, could not prevent the increase in exchange rates and inflation, and the economy continued to worsen.

The Turkish economy has lost its economic stability since the mid-1970s. Policies implemented to achieve short term gains and populist macroeconomic policies caused the decrease and volatility in the growth performance of Turkish economy. Unsound macroeconomic policies applied have caused budget deficits, increased debts, and high and volatile inflation rates. Fiscal imbalances and increased inflation have both led to

economic crises and became a chronic problem for the Turkish economy. Moreover, economic crises have further increased macroeconomic instability (Ismihan, 2009). The Figure 3 shows the GDP Growth Rate (Annual%):

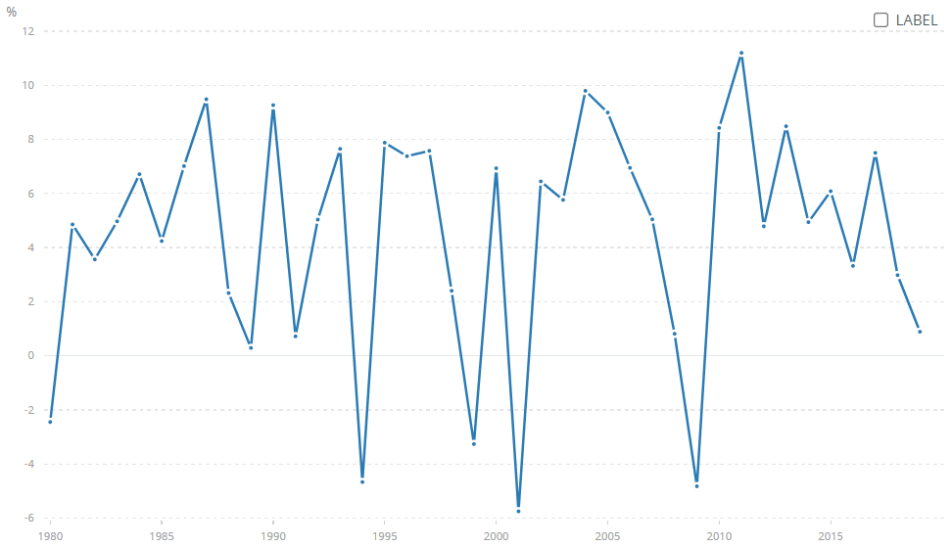

Figure 3: GDP Growth (Annual %) (World Development Indicators)

In conclusion, unsound macroeconomic policies, which pursued to take short-term benefits or prevent short-term shocks, increased uncertainty and volatility in the Turkish economy.

Chapter 4

MODEL AND METHODOLOGY

This study investigates the effects of the change in exchange rate on the Turkey's economic growth between 1980 and 2019. In this chapter, the issues related to the model specification and methodology will be discussed.

4.1 Model Specification

One of the most important assumptions of the framework of the production function model is to assume that the production process features a constant return to scale. This is a standard assumption in many growth studies. Besides, it was determined that there was a high level of multicollinearity in the data. Considering all these, the model was converted to per capita form. Furthermore, the resultant model is augmented by adding inflation and percentage change of exchange rate (via TFP or A) and dividing the variables K and Y with H to derive model to per effective labor (see section 2.2 for more detail). The following is the benchmark model used in this study:

$$\mathbf{(Y/H) = e^{\theta_0 + \theta_1 e + \theta_2 inf} (K/H)^{\alpha}}$$

Y/H: Output per effective labor
K/H: Capital per effective labor
A: $e^{\theta_0 + \theta_1 er + \theta_2 inf}$

After taking the logarithm, the final form of the model is as follows:

$$\mathbf{\ln (Y/H) = \theta_0 + \theta_1 e + \theta_2 inf + \alpha (\ln K/H)}$$

The main goal when establishing the model is to determine the effect of the change in exchange rates on the output per effective labor. As noted earlier most of Turkey's

production and consumption depend on foreign resources. Turkey’s weakness in domestic production causes to import many raw materials and goods and services. Excessive dependence on imports causes the country's economy to be severely affected by exchange rates. The rise in exchange rate is expected to affect the Turkish economy negatively in the long run. Inflation, which is used as a control variable, is also expected to have a negative effect on the economic growth, The last remaining variable, capital per effective labor, is expected to have a positive impact on economic growth.

4.2 Time Series Techniques

4.2.1 Stationarity and Cointegration

Time series (TS) tools were used while empirically analyzing the model. Stationary and cointegration are vital for time series studies. Stationarity variables actually means that the mean, variance and covariance of the variables do not change over time. Stationary must be tested in time series because it directly affects the results of model. Having non-stationary variables in the regression will cause statistical problem in results. Non-stationary variables are analyzed using cointegration techniques. Cointegration tests whether there is a long-run equilibrium relationship between variables and analyses the long-run correlation of two or more non-stationary time series.

Cointegration implies that the series can be considered cointegrated if at least two series are not stationary, but their linear combination is stationary. In other words, when two or more series have similar or related long-run trends, they are said to be cointegrated. This shows that individual TS variables may be unstable and diverge in the short run, while converging towards dynamic equilibrium in the long run.

Cointegration is vital as it provides a method to control the spurious regression problem in non-stationary series. It also helps to differentiate both long and short-term relationships.

4.2.2 Unit Root Tests

The Unit Root test is a test that reveals whether the time series variables are stationary or non-stationary. Null hypothesis indicates that times series variable is non-stationary and has a unit root, while alternative hypothesis indicates that the time series variable is stationary and no unit root. Unit root tests are generally performed by using the Augment Dickey Fuller test.

4.2.3 ARDL Approach

According to the unit root test results, ARDL method should be used in estimating the model if the data contains the mix of variables with and without unit roots. The ARDL method, which is based on the Ordinary Least Squares (OLS) method, is not only suitable for stationary variables, but also for non-stationary variables. The most important feature of the ARDL method is that it supports to explain both short-term and long-term relationships. Moreover, ARDL approach separates the long-term relationship from the short-term dynamics and enables to identify more realistic long-term results.

The ARDL method uses the cointegration technique to clarify the long-term (cointegration) relationship. While, testing for the existence of cointegration, there are two limits which are upper limit and the lower limit. Upper limit assumption is that all variables have a unit root in [I(1)]. Conversely, lower limit assumes that all variables have no unit root in [I(0)]. Null hypothesis states that there is no long-term relationship, whereas alternative hypothesis states that there is a long-term relationship. In order to

reject the null hypothesis, the calculated F-statistics value must be higher than the 5% upper limit. On the other hand, if the value is below the 5% lower limit, the null hypothesis is not rejected and it is revealed that there is no cointegration. If a value is in between the two limits, the test result is uncertain. For the empirical results of the model to be meaningful (not spurious), the null hypothesis must be rejected.

4.2.4 Diagnostic and Stability Checks

A series of tests are performed for diagnosing the problems of the ARDL model and testing its stability. Diagnostic tests are Normality Test (Jarque-Bera), Serial Correlation (LM) Test, White Test and Ramsey Rest Test. While normality test confirms that the errors are normally distributed, the LM test determine whether the autocorrelation problem has affected the model or not. The White test is applied to investigate the heteroscedasticity problem and the Ramsey Reset Test is used to investigated the misspecification problem (Shukur and Mantalos, 2004). In addition to diagnostic tests, stability tests were performed also. As Brown applied in his study in 1975, CUSUM (Cumulative Sum) and CUSUMSQ (Cumulative Sum Square) tests were used to test stability (Turner, 2010).

Chapter 5

EMPRICAL RESULTS

In this section, the empirical results obtained from the study will be provided and explained. First of all, information about the data is given, and then the results are explained step by step.

5.1 Data

Data are taken from World Bank's World Development Indicators (WDI) and Penn World Tables (PWT). In the model, Y is real GDP at constant 2017 national prices (in mil.), K is capital stock at constant 2017 national prices (in mil.) and H is derived by multiplying human capital index and number of persons engaged (in millions) which is indicated by L. LYH (ln Y/H) is output per effective labor which is used as dependent variable, LKH (ln of K/H) which is capital per effective labor, INF (inflation, consumer prices (annual%)) and E (percentage change of TL/dollar rate) are used as independent variables.

5.2 Time Plots of the Data

The figures 4, 5, 6 and 7 below show the time plots between 1980 and 2019.

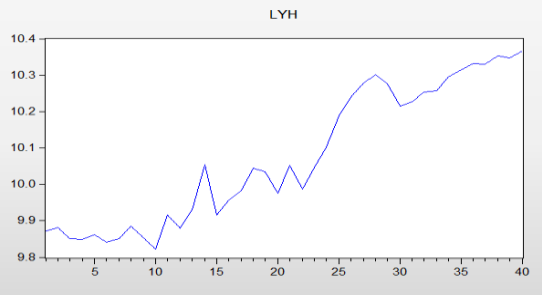

Figure 4: Time Plot of LYH

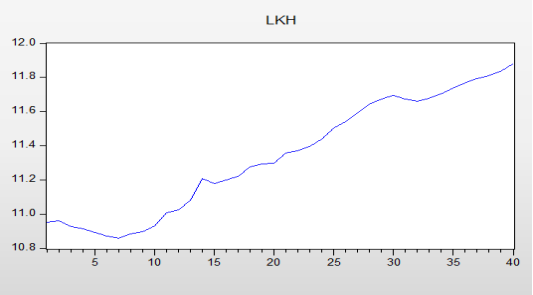

Figure 5: Time plot of LKH

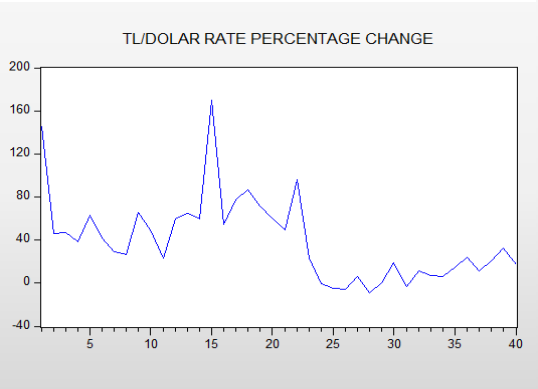

Figure 6: Time plot of E

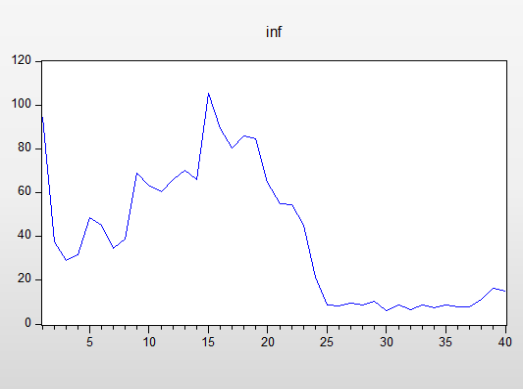

Figure 7: Time plot of INF

When the time plots of LYH and LKH variables are examined, a positive but unstable trend is seen from 1980 to 2019. The increase in these variables over time shows that they are possibly non-stationary not stationary at the level. Although graphical analysis is useful, only the result obtained from the graphs is not sufficient. Therefore, unit root tests should be applied.

5.3 Unit Root Test (ADF) Results

Formal unit root test should be applied before choosing the type of empirical method mentioned in Chapter 4. Augmented Dickey-Fuller (ADF) test was used to investigate the TS properties of the data and ADF test results are included in this section. According to the ADF Test results, the null hypothesis indicates that the data has a unit root, while the alternative hypothesis, there is no a unit root of the data. Table 1 shows the results of this test. The table below includes test statistics and p-values.

Table 1: Unit Root Test Results

Augmented Dickey Fuller Test				
Variables	**Level**		**First Difference**	**The order of Integration**
	With Trend	**No Trend**	**Without Trend**	
LYH	-3.390801 (0.0673)	-0.426755 (0.8945)	-7.900748 (0.0000)	I(1) [I(0) at 10%]
LKH	-2.949486 (0.1590)	0.831750 (0.9934)	-4.656580 (0.0006)	I(1)
Inf	----- -----	-1.963839 (0.3009)	-7.321983 (0.0000)	I(1)
E	----- -----	-2.223553 (0.2016)	-10.33937 (0.0000)	I(1)

Note: Trends are excluded for Inf and E since they do not have apparent deterministic trend. This is also in line with the theoretical expectations.

According to the results, apart from the variable LYH, there is no variable that rejects the null hypothesis of unit root at the level. The variable LYH is trend stationary at 10% (exactly at 6.73% significance level). All variables reject the null hypothesis at first difference. Finding the possibility of the mix of both I(0) and I(1) variables ARDL method should be used in this study.

5.4 Empirical Results

When using the ARDL model, Schwarz information criteria was chosen as the model selection criteria. The Bounds Test was applied to analyze whether there is a long-term relationship or not. According to the results of the test, the F-statistics value is 5.965 and this value is greater than the critical limit values at 5% significance level (you can see the EViews results in Appendix B). Therefore, we can reject the null hypothesis and there is a meaningful long-run relationship. Table 2 below shows the long-term results of the model.

Table 2: Long-Run Results (Dependent Variable = LYH)

Variable	**Coefficient**	**Std. Error**	**t-Statistics**	**p-Value**
LKH	0.499634	0.028458	17.55707	0.000
INF	0.000192	0.000631	0.304388	0.7630
E	-0.001210	0.000519	-2.330540	0.0269
C	4.443178	0.328532	13.52435	0.000

The coefficient of LKH is 0.499634 and its p-value is 0.000. As expected, it is statistically significant. This means that 1% increase in capital per effective labor will increase output per effective labor by 0.50% while holding all other variables constant. In another words, there is a positive relationship between output per effective labor and capital per effective labor. The variable 'E' is the main variable of interest. The p-value of this variable is 0.0269 which indicates that the variable is statistically significant. This is in line with the theoretical arguments as explained in chapter 2. According to the results, a one percentage point increase in the exchange rate reduces the output per effective labor by 0.12%, ceteris paribus. In contrast, the inflation is not statistically significant. The change in exchange rate is explained by the difference between Turkey's inflation and the US inflation via Purchasing Power Parity (PPP). According to PPP, this can be shown as: $E = \pi_{Turkey} - \pi_{US}$. Due to the use of dollars in this study, the difference between Turkey's inflation and the US inflation is used to explain the change in the exchange rate. US inflation is stable and has not changed dramatically for a long time. Therefore, Turkey's fluctuations in inflation are naturally reflected in the exchange rate changes. Inflation and percentage change in exchange rate graphs are shown below and it is clear that there is a common trend between the two variables.

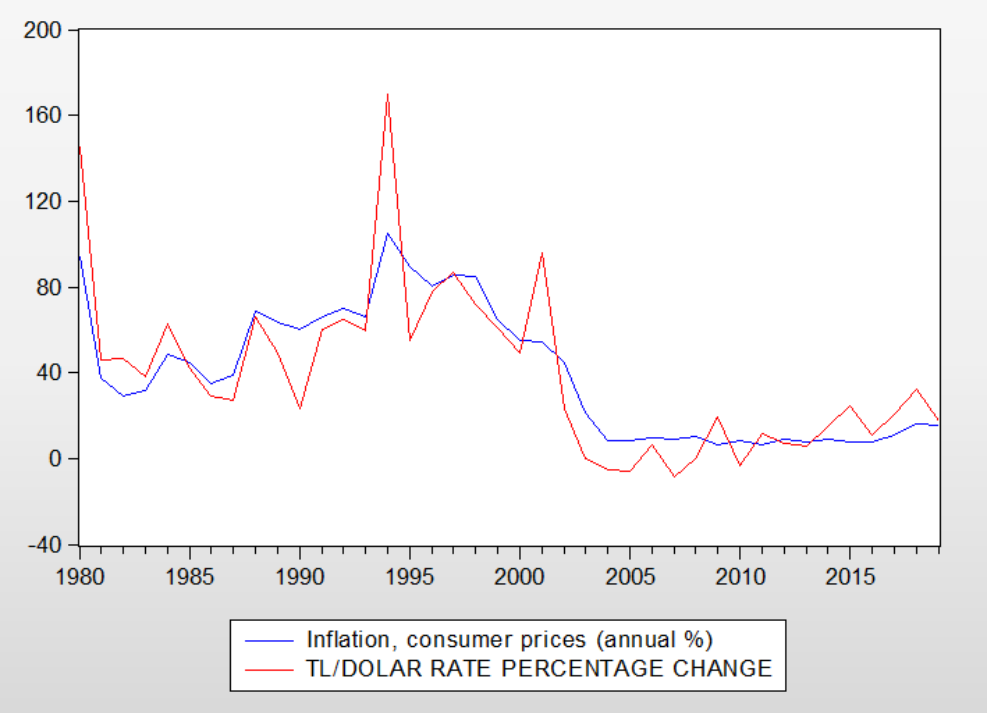

Figure 8: Graph of Inflation and the Percentage Change of Tl/dollar Rate

It can be said that inflation turns out to be statistically insignificant because of the tight relation between the exchange rate and inflation. Percentage change in exchange rate and inflation are used in the models separately, and the coefficients are almost the same and it is seen that the effect on growth is negative and significant (see Appendix C). According to results of estimated models in Appendix C, the strong relation between exchange rate and inflation could be the reason of statistically insignificant inflation.

On the other hand, trade openness was also used as the control variable (See Appendix C) but we found that it is statistically insignificant which shows that trade openness did not affect the model. For this reason, it was decided not to use it in the original model.

When we return back to the main results, there is a long-term negative relationship between the change in exchange rate and GDP per effective labor. As noted earlier, according to Fischer, the best indicator of instability is inflation. Inflation is of great issue especially in developing countries that depend on foreign resources. Undoubtedly, inflation is one of the most important problems of Turkey. In many of the studies conducted in the past, it is revealed that one of the most important factors that increased inflation in Turkey is the unsound macroeconomic policies implemented by the government. These policies have increased the uncertainty day by day and distorted Turkey's price mechanism. First of all, it was expected that the increase in the exchange rate would make domestic goods cheaper and exports to increase, but it was not as expected. This is partly due to exchange rate pass through to inflation. Turkey's production mechanism, which is highly dependent on imports, contrary to expectations, prevented domestic products from becoming cheaper and the expected income could not be obtained. Moreover, it increases inflation. As noted earlier, companies have debts that are 80% in foreign currencies. Companies' debts continued to increase and engaged in domestic production had difficulty in paying their debts due to their foreign currency-based debts. The depreciation of Turkish Lira (TL) leads to increase in government debts and decrease in economic activities. Since the debts are difficult to pay, credit contraction applied from the government and it decreased economic activity of the companies. In addition, it not only caused the price of the products import from abroad to increase, but also the prices of the products produced. When the production became more expensive, the prices of the goods sold increased dramatically and the purchasing power of the people began to decrease day by day. To sum up, the main factor behind all these factors is the chronic problem of Turkey which is inflation and inflation increases the instability of the economy. This change in

exchange rates caused a dramatic increase in inflation, which severely affected Turkey's economic growth negatively.

As Gülçin Özkan stated in her study in 2020, the decrease in the value of domestic currency did not cause an increase in exports and a decrease in imports, contrary to expectations (Ozkan, 2020). Increasing dollar exchange rate increased import prices and production costs which causes a dramatic inflation. The debts failed to pay and the government to use its own resources to pay the debts. Furthermore, the demand for domestic currency has decreased and continues to decrease. As a result, instability was observed in the economy and the price mechanism of the country distorted. This instability is also reflected in interest rates and has been seriously affected investments. To summarize, the rising exchange rate adversely affected two main factors which are instability and inflation. It distorted price mechanism and affected economic growth via financial and trade channels negatively.

In addition to the long-run relationship, the short-run relationship should be analysed by using Error Correction Model. Table 3 shows the Error Correction Model.

Table 3: Error Correction Model (Dependent variable: dLYH)

Variable	**Coefficient**	**Std. Error**	**t-Statistics**	**p-Value**
D(LYH(-1))	0.240052	0.101239	2.371134	0.0246
D(LKH)	1.056518	0.117253	9.010600	0.0000
D(LKH(-1))	-0.560206	0.152119	-3.682687	0.0009
D(INF)	0.001382	0.000455	3.038551	0.0050
CointEq(-1)*	-0.639263	0.109729	-5.825810	0.0000

Note: D represents the difference (change) operator.

Dependent variable is LYH which stands for the change difference in output per effective labor. The CointEq (-1) [error correction term] value is -0.639263. The CointEq (-1) value is between 0 and -1, and it is statistically significant. This confirms that the model has an error correction mechanism. According to the results, there is no short-term relationship between percentage change in exchange rate and economic growth. Although inflation has a statistically significant short-run positive relationship, it is negatively (see Appendix C) affecting economic growth in the long run. This result is consistent with the slogan regarding unsound policies that they provide 'short-run gain but long-run pain'.

5.5 Diagnostic Tests

Diagnostic test results are shown in table 4. (You can see EViews results in Appendix D)

Table 4: Diagnostic Test Results

Diagnostic Test	**p-values**
Serial Correlation (LM Test)	0.3660
White Test	0.9788
Ramsey Reset Test	0.5475
Normality (Jarque-Bera)	0.223775

In serial correlation test, null hypothesis specifies that there is no autocorrelation. The p-value of the test is more than 5% critical value. It indicates that the null hypothesis cannot be rejected and there is no autocorrelation problem. The second-row of the table shows White Test which tests heteroscedasticity. The p-value is higher than 5% significance level which indicates that we cannot reject the homoscedasticity described

in the null hypothesis. Consequently, there is no heteroscedasticity problem in this model. The Ramsey Reset Test shows whether there is a misspecification, while the normality (Jarque-Bera) test determines if error terms are normally distributed. The p-values of both tests are greater than 5% critical value indicates that there is no misspecification problem and the error terms are not normally distributed.

5.6 Stability Tests

Two stability tests were performed. These tests are CUSUM and CUSUM SQUARE tests which allow to interpret the stability of model. Figure 9 and Figure 10 show the graph of the results of the CUSUM Test and CUSUM SQUARE tests, respectively. The dashed lines indicate the confidence bounds at the 5% significance level. The values of the test results (solid lines) are within the lines, which means stability for the ARDL model**.**

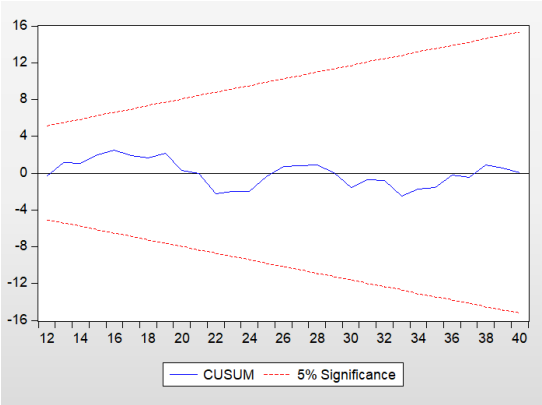

Figure 9: Cusum Test Result

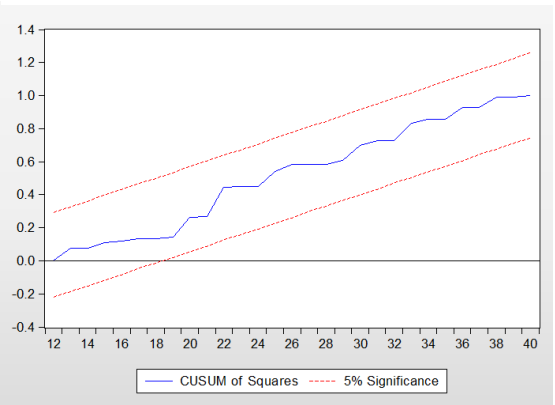

Figure 10: Cusum Square Test

Chapter 6

CONCLUSION

The main purpose of this thesis is to analyze how the change in exchange rates affect economic growth in the long run in Turkey over the period 1980-2019.

Exchange rates have been very critical throughout Turkey's economic history. It affects economic growth via trade channel and financial channel. Our findings reveal that there is a long-term but unfavorable relationship between the change in the exchange rate and economic growth in Turkey over the 1980-2019 period.

In recent years, Turkish Lira has been losing value against foreign currencies. The most important reason behind this is the unsound macroeconomic policies followed by Turkish government which weakened the price mechanism and created a substantial increase in uncertainty. In addition, since Turkey is an import-dependent country, it relies heavily on foreign resources.

Inflation should be kept under control for a stable economic growth. However, due to increasing exchange rate, inflation peaked and led to a rise in macroeconomic instability. Cost of production also increased due to higher raw material prices. Inflation also negatively affected companies' domestic currency value of foreign debts and their ability to pay debts. This contributed to already slowing production rates to decline even more.

According to the main result of this study, most important policy suggestion is that in order to obtain optimum results over the long-run, in the short-run unstable policies should not be followed. This is because such unsound policies increase the uncertainty in the economy in the long-run and increased uncertainty negatively affects the investments and overall productivity (TFP) in the country. Central bank independence is essential for Turkey's long-term growth and development. This study has several limitations. One of the limitations is that the percentage change of TL/Dollar rate was used as the main variable. Most European countries have introduced the use of the euro as of 1999. However, there is approximately 20 years of data and a longer-term analysis is required in this work, the dollar rate was used in this study. Further research can be done using other currencies or a basket of foreign currencies when quarterly data is available on key variables.

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APPENDICES

Appendix A: Covariance Analysis

Covariance Analysis: Ordinary
Date: 06/08/22 Time: 16:00
Sample: 1 39
Included observations: 39

Correlation Probability	LY	LL	LK
LY	1.000000 -----		
LL	0.972078 0.0000	1.000000 -----	
LK	0.995904 0.0000	0.966084 0.0000	1.000000 -----

Appendix B: The Main Model

Dependent Variable: LYH
Method: ARDL
Date: 07/18/22 Time: 17:08
Sample (adjusted): 3 40
Included observations: 38 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Schwarz criterion (SIC)
Dynamic regressors (2 lags, automatic): LKH INF E
Fixed regressors: C
Number of models evalulated: 54
Selected Model: ARDL(2, 2, 1, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LYH(-1)	0.600789	0.154949	3.877341	0.0006
LYH(-2)	-0.240052	0.120988	-1.984093	0.0568
LKH	1.056518	0.146768	7.198583	0.0000
LKH(-1)	-1.297327	0.288946	-4.489856	0.0001
LKH(-2)	0.560206	0.202096	2.771981	0.0096
INF	0.001382	0.000660	2.094580	0.0451
INF(-1)	-0.001260	0.000478	-2.633134	0.0134
E	-0.000774	0.000299	-2.589401	0.0149
C	2.840359	0.627586	4.525849	0.0001

R-squared	0.989122	Mean dependent var	10.08584
Adjusted R-squared	0.986121	S.D. dependent var	0.187964
S.E. of regression	0.022144	Akaike info criterion	-4.579111
Sum squared resid	0.014220	Schwarz criterion	-4.191262
Log likelihood	96.00311	Hannan-Quinn criter.	-4.441117
F-statistic	329.6090	Durbin-Watson stat	1.785233
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LYH)
Selected Model: ARDL(2, 2, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 07/18/22 Time: 17:09
Sample: 1 40
Included observations: 38

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.840359	0.627586	4.525849	0.0001
LYH(-1)*	-0.639263	0.134310	-4.759591	0.0000
LKH(-1)	0.319397	0.069883	4.570479	0.0001
INF(-1)	0.000123	0.000397	0.309258	0.7593
E**	-0.000774	0.000299	-2.589401	0.0149
D(LYH(-1))	0.240052	0.120988	1.984093	0.0568
D(LKH)	1.056518	0.146768	7.198583	0.0000
D(LKH(-1))	-0.560206	0.202096	-2.771981	0.0096
D(INF)	0.001382	0.000660	2.094580	0.0451

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LKH	0.499634	0.028458	17.55707	0.0000
INF	0.000192	0.000631	0.304388	0.7630
E	-0.001210	0.000519	-2.330540	0.0269
C	4.443178	0.328532	13.52435	0.0000

EC = LYH - (0.4996*LKH + 0.0002*INF -0.0012*E + 4.4432)

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LKH	0.499634	0.028458	17.55707	0.0000
INF	0.000192	0.000631	0.304388	0.7630
E	-0.001210	0.000519	-2.330540	0.0269
C	4.443178	0.328532	13.52435	0.0000

EC = LYH - (0.4996*LKH + 0.0002*INF -0.0012*E + 4.4432)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	5.965223	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Actual Sample Size	38	Finite Sample: n=40		
		10%	2.592	3.454
		5%	3.1	4.088
		1%	4.31	5.544
		Finite Sample: n=35		
		10%	2.618	3.532
		5%	3.164	4.194
		1%	4.428	5.816

ARDL Error Correction Regression
Dependent Variable: D(LYH)
Selected Model: ARDL(2, 2, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 07/18/22 Time: 17:14
Sample: 1 40
Included observations: 38

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LYH(-1))	0.240052	0.101239	2.371134	0.0246
D(LKH)	1.056518	0.117253	9.010600	0.0000
D(LKH(-1))	-0.560206	0.152119	-3.682687	0.0009
D(INF)	0.001382	0.000455	3.038551	0.0050
CointEq(-1)*	-0.639263	0.109729	-5.825810	0.0000

R-squared	0.846489	Mean dependent var	0.012768
Adjusted R-squared	0.827882	S.D. dependent var	0.050036
S.E. of regression	0.020759	Akaike info criterion	-4.789638
Sum squared resid	0.014220	Schwarz criterion	-4.574166
Log likelihood	96.00311	Hannan-Quinn criter.	-4.712974
Durbin-Watson stat	1.785233		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.965223	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Appendix C: Sensitivity Analysis

Dependent Variable: LYH
Method: ARDL
Date: 07/18/22 Time: 17:35
Sample (adjusted): 3 40
Included observations: 38 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Schwarz criterion (SIC)
Dynamic regressors (2 lags, automatic): LKH INF
Fixed regressors: C
Number of models evalulated: 18
Selected Model: ARDL(1, 2, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LYH(-1)	0.547286	0.124638	4.390992	0.0001
LKH	1.147093	0.136418	8.408679	0.0000
LKH(-1)	-1.281415	0.278274	-4.604864	0.0001
LKH(-2)	0.339144	0.170899	1.984476	0.0558
INF	-0.000654	0.000231	-2.834856	0.0079
C	2.256198	0.614253	3.673074	0.0009

R-squared	0.984761	Mean dependent var	10.08584
Adjusted R-squared	0.982380	S.D. dependent var	0.187964
S.E. of regression	0.024950	Akaike info criterion	-4.399922
Sum squared resid	0.019921	Schwarz criterion	-4.141356
Log likelihood	89.59852	Hannan-Quinn criter.	-4.307926
F-statistic	413.5790	Durbin-Watson stat	1.959713
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LYH)
Selected Model: ARDL(1, 2, 0)
Case 2: Restricted Constant and No Trend
Date: 07/18/22 Time: 17:36
Sample: 1 40
Included observations: 38

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.256198	0.614253	3.673074	0.0009
LYH(-1)*	-0.452714	0.124638	-3.632219	0.0010
LKH(-1)	0.204821	0.063091	3.246459	0.0027
INF**	-0.000654	0.000231	-2.834856	0.0079
D(LKH)	1.147093	0.136418	8.408679	0.0000
D(LKH(-1))	-0.339144	0.170899	-1.984476	0.0558

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LKH	0.452430	0.042068	10.75465	0.0000
INF	-0.001445	0.000477	-3.031486	0.0048
C	4.983718	0.486843	10.23681	0.0000

EC = LYH - (0.4524*LKH -0.0014*INF + 4.9837)

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LKH	0.452430	0.042068	10.75465	0.0000
INF	-0.001445	0.000477	-3.031486	0.0048
C	4.983718	0.486843	10.23681	0.0000

EC = LYH - (0.4524*LKH -0.0014*INF + 4.9837)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	3.731932	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Actual Sample Size	38		Finite Sample: n=40	
		10%	2.835	3.585
		5%	3.435	4.26
		1%	4.77	5.855
			Finite Sample: n=35	
		10%	2.845	3.623
		5%	3.478	4.335
		1%	4.948	6.028

Dependent Variable: LYH
Method: ARDL
Date: 08/15/22 Time: 16:45
Sample (adjusted): 2 40
Included observations: 39 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Schwarz criterion (SIC)
Dynamic regressors (2 lags, automatic): LKH E
Fixed regressors: C
Number of models evalulated: 18
Selected Model: ARDL(1, 1, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LYH(-1)	0.535522	0.102739	5.212451	0.0000
LKH	0.889216	0.131286	6.773126	0.0000
LKH(-1)	-0.677712	0.151501	-4.473323	0.0001
E	-0.000666	0.000132	-5.025360	0.0000
C	2.297038	0.430533	5.335336	0.0000

R-squared	0.984569	Mean dependent var	10.08059
Adjusted R-squared	0.982754	S.D. dependent var	0.188359
S.E. of regression	0.024736	Akaike info criterion	-4.441903
Sum squared resid	0.020804	Schwarz criterion	-4.228625
Log likelihood	91.61710	Hannan-Quinn criter.	-4.365381
F-statistic	542.3525	Durbin-Watson stat	1.600003
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LYH)
Selected Model: ARDL(1, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 08/15/22 Time: 16:46
Sample: 1 40
Included observations: 39

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.297038	0.430533	5.335336	0.0000
LYH(-1)*	-0.464478	0.102739	-4.520950	0.0001
LKH(-1)	0.211504	0.057780	3.660496	0.0008
E**	-0.000666	0.000132	-5.025360	0.0000
D(LKH)	0.889216	0.131286	6.773126	0.0000

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LKH	0.455359	0.035988	12.65312	0.0000
E	-0.001433	0.000417	-3.438998	0.0016
C	4.945419	0.415367	11.90616	0.0000

EC = LYH - (0.4554*LKH -0.0014*E + 4.9454)

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LKH	0.455359	0.035988	12.65312	0.0000
E	-0.001433	0.000417	-3.438998	0.0016
C	4.945419	0.415367	11.90616	0.0000

EC = LYH - (0.4554*LKH -0.0014*E + 4.9454)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	12.83321	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Actual Sample Size	39		Finite Sample: n=40	
		10%	2.835	3.585
		5%	3.435	4.26
		1%	4.77	5.855
			Finite Sample: n=35	
		10%	2.845	3.623
		5%	3.478	4.335
		1%	4.948	6.028

Dependent Variable: LYH
Method: ARDL
Date: 07/18/22 Time: 17:38
Sample (adjusted): 2 40
Included observations: 39 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Schwarz criterion (SIC)
Dynamic regressors (2 lags, automatic): LKH E OPEN
Fixed regressors: C
Number of models evalulated: 54
Selected Model: ARDL(1, 1, 0, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LYH(-1)	0.560884	0.103424	5.423169	0.0000
LKH	0.861006	0.131609	6.542174	0.0000
LKH(-1)	-0.697426	0.150603	-4.630884	0.0001
E	-0.000730	0.000140	-5.223485	0.0000
OPEN	0.001162	0.000879	1.321828	0.1953
C	2.537212	0.463019	5.479712	0.0000

R-squared	0.985345	Mean dependent var	10.08059
Adjusted R-squared	0.983125	S.D. dependent var	0.188359
S.E. of regression	0.024469	Akaike info criterion	-4.442213
Sum squared resid	0.019758	Schwarz criterion	-4.186280
Log likelihood	92.62315	Hannan-Quinn criter.	-4.350386
F-statistic	443.7670	Durbin-Watson stat	1.621249
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LYH)
Selected Model: ARDL(1, 1, 0, 0)
Case 2: Restricted Constant and No Trend
Date: 07/18/22 Time: 17:39
Sample: 1 40
Included observations: 39

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.537212	0.463019	5.479712	0.0000
LYH(-1)*	-0.439116	0.103424	-4.245790	0.0002
LKH(-1)	0.163580	0.067685	2.416780	0.0213
E**	-0.000730	0.000140	-5.223485	0.0000
OPEN**	0.001162	0.000879	1.321828	0.1953
D(LKH)	0.861006	0.131609	6.542174	0.0000

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LKH	0.372521	0.083566	4.457818	0.0001
E	-0.001662	0.000510	-3.258596	0.0026
OPEN	0.002646	0.002204	1.200452	0.2385
C	5.778006	0.874014	6.610885	0.0000

EC = LYH - (0.3725*LKH -0.0017*E + 0.0026*OPEN + 5.7780)

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LKH	0.372521	0.083566	4.457818	0.0001
E	-0.001662	0.000510	-3.258596	0.0026
OPEN	0.002646	0.002204	1.200452	0.2385
C	5.778006	0.874014	6.610885	0.0000

EC = LYH - (0.3725*LKH -0.0017*E + 0.0026*OPEN + 5.7780)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	10.84164	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Actual Sample Size	39		Finite Sample: n=40	
		10%	2.592	3.454
		5%	3.1	4.088
		1%	4.31	5.544
			Finite Sample: n=35	
		10%	2.618	3.532
		5%	3.164	4.194
		1%	4.428	5.816

Appendix D: The Stability and Diagnostic Tests

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.615311	Prob. F(1,28)	0.4394
Obs*R-squared	0.817109	Prob. Chi-Square(1)	0.3660

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 07/18/22 Time: 17:20
Sample: 3 40
Included observations: 38
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LYH(-1)	-0.150196	0.246970	-0.608154	0.5480
LYH(-2)	0.062314	0.145415	0.428523	0.6715
LKH	0.003053	0.147802	0.020654	0.9837
LKH(-1)	0.163975	0.358204	0.457769	0.6507
LKH(-2)	-0.129046	0.261641	-0.493219	0.6257
INF	2.01E-05	0.000665	0.030207	0.9761
INF(-1)	-0.000133	0.000511	-0.261126	0.7959
E	-2.99E-05	0.000303	-0.098652	0.9221
C	0.457865	0.860154	0.532306	0.5987
RESID(-1)	0.248478	0.316768	0.784418	0.4394

R-squared	0.021503	Mean dependent var	-2.61E-15
Adjusted R-squared	-0.293014	S.D. dependent var	0.019604
S.E. of regression	0.022292	Akaike info criterion	-4.548217
Sum squared resid	0.013915	Schwarz criterion	-4.117273
Log likelihood	96.41612	Hannan-Quinn criter.	-4.394891
F-statistic	0.068368	Durbin-Watson stat	1.987054
Prob(F-statistic)	0.999885		

Heteroskedasticity Test: White

F-statistic	0.208681	Prob. F(8,29)	0.9869
Obs*R-squared	2.068477	Prob. Chi-Square(8)	0.9788
Scaled explained SS	0.845236	Prob. Chi-Square(8)	0.9990

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 07/18/22 Time: 17:21
Sample: 3 40
Included observations: 38

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.003173	0.006052	-0.524284	0.6041
LYH(-1)^2	0.000101	0.000159	0.631167	0.5329
LYH(-2)^2	-2.80E-06	0.000131	-0.021330	0.9831
LKH^2	-8.37E-05	0.000151	-0.553280	0.5843
LKH(-1)^2	0.000102	0.000327	0.311081	0.7580
LKH(-2)^2	-6.74E-05	0.000215	-0.313225	0.7564
INF^2	-8.87E-08	1.35E-07	-0.659115	0.5150
INF(-1)^2	6.75E-08	9.47E-08	0.712492	0.4819
E^2	1.58E-08	4.84E-08	0.327161	0.7459

R-squared	0.054434	Mean dependent var	0.000374
Adjusted R-squared	-0.206412	S.D. dependent var	0.000449
S.E. of regression	0.000493	Akaike info criterion	-12.18698
Sum squared resid	7.06E-06	Schwarz criterion	-11.79913
Log likelihood	240.5526	Hannan-Quinn criter.	-12.04899
F-statistic	0.208681	Durbin-Watson stat	2.442539
Prob(F-statistic)	0.986886		

Ramsey RESET Test
Equation: UNTITLED
Specification: LYH LYH(-1) LYH(-2) LKH LKH(-1) LKH(-2) INF INF(-1) E C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.608884	28	0.5475
F-statistic	0.370739	(1, 28)	0.5475

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000186	1	0.000186
Restricted SSR	0.014220	29	0.000490
Unrestricted SSR	0.014034	28	0.000501