# Real Exchange Rate Volatility on Economic Growth under Intermediate and Flexible Exchange Rate Regimes: Empirical Evidence from Turkey

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## Abstract

The aim of this paper is to analyze empirically the effects of real exchange rate volatility on economic growth under intermediate and flexible exchange rate regimes in Turkey. The cointegration analysis and error correction models are used to test the long-run relationship and short-run effects respectively. The cointegration analysis shows that there is a long-run relationship between all the variables. The estimation results show that real exchange rate volatility has depressing effects on economic growth in both intermediate and flexible exchange rate regimes. The real exchange rate has positive effects on economic growth in the intermediate exchange rate regime and negative effects on economic growth in the flexible exchange rate regime. The inflation rate and financial deepening have positive effects on economic growth in both of the exchange rate regimes. While interest rate has negative effects on economic growth in the intermediate exchange rate regimes, it has positive effects on economic growth in the flexible exchange rate regime. The error correction models support the long-run relationship between the variables and the variables return to their long-run values in a high speed of adjustment.

## 1. Introduction

After the collapse of the Bretton Woods fixed exchange rate system in 1973, many of the developed, developing and emerging market economies adopted the flexible exchange rate regime. In the flexible exchange rate regime, exchange rates are determined freely by demand and supply in the foreign exchange market. The main advantages of flexible exchange rate regime are to pursue an independent monetary policy, its invulnerability to currency crisis and its ability to absorb country-specific real asymmetric shocks. However, the adoption of flexible exchange rate regime by many countries brought into question the exchange rate volatility or uncertainty and its effects on macroeconomic variables, i.e., economic growth, investment, international trade, international capital flows, productivity and financial market

development. It is argued that exchange rate volatility creates an uncertain environment for economic growth, investment, international trade, capital flows, productivity and financial markets and this uncertainty may lead to decrease of these macroeconomic variables.

The origin of the economic growth theory goes back to the Neoclassical growth theory that started with Robert M. Solow in 1957 (Solow, 1957). According to the Neoclassical growth theory, major determinants of long-run economic growth are capital stock, labor supply and technology. In the Neoclassical growth model, the real exchange rate was not one of the major factors that affect the economic growth. The reasons may be the economies were closed and there was no role for exchange rates.

What could be relationship between exchange rate regimes and economic growth? This linkage comes from investment, international trade and productivity. Eichengreen (2008) states that

*"This is not the same as saying that real exchange rate policy can substitute for the presence of a disciplined labor force, high savings, or a foreign investment-friendly climate. But it can help to jump-start growth by encouraging the redeployment of resources into manufacturing and reaping immediate productivity gains. This way of thinking about the issue has the merit, as noted, of explaining why the simple correlation between growth and the level and volatility of the real on the presence or absence of other fundamentals."*

In Turkey, the implemented exchange rate regimes from 1990 to 2001 can be described as intermediate exchange rate regimes (more details are given in Section 3). After the financial crisis on 21 February 2001, flexible exchange rate regime was adopted.

Some of the macroeconomic indicators related with the Turkish economic growth rates in the intermediate and flexible exchange rate regimes are summarised as follows[1]: While average growth rate of real Gross Domestic Product (GDP) was 4 percent in the flexible exchange rate regime period it was 6 percent in the intermediate exchange rate regime period. The ratio of investment expenditures to GDP was 24 percent in the intermediate exchange regime and 25 percent in the flexible exchange rate regime. While inflation rate was 75 percent in the intermediate exchange rate regime period, it was 13 percent in the flexible exchange rate regime period. While openness of the economy to international markets was 40 percent in the intermediate exchange rate regime period, it increased to 48 percent in the flexible exchange rate regime period.

These macroeconomic indicators support Ghosh, Guide, Ostry and Wolf (1996) conclusion. The authors state that while investment is higher under the fixed exchange rate regimes for industrial and upper middle income countries, there is no difference in regarding investment between different exchange rate regimes for lower income countries.

The aim of this study is to analyze empirically the effects of real exchange rate volatility on economic growth under intermediate and flexible exchange rate regimes in Turkey. Since intermediate exchange rate regimes have lower uncertainty about real exchange rates, it is expected that real exchange rate volatility should not have depressing effects on economic growth in the intermediate exchange rate regimes. On the other hand, it is expected that real exchange rate

volatility should have depressing effects on economic growth in the flexible exchange rate regime. To the best of my knowledge there is no empirical study that examines the effects of real exchange rate volatility on economic growth under intermediate and flexible exchange rate regimes in Turkey. This study may also helpful to show the relationship between the exchange rate regimes and economic growth.

## 2. Literature Review

Why do some countries grow faster than other countries? Barro and Sala-i-Martin (2004) gives detailed information about growth theories and empirical analysis of countries' growth experiences. According to the Neoclassical growth theory, the major determinants of long-run economic growth are capital stock, labor supply and technology. The real exchange rate was not at the centre of analyses of economic growth in the first generation of Neoclassical growth models (Eichengreen 2008). The reason for this may be that these were closed economies and there was no role for real exchange rates.

However, with the liberalization of international trade and capital flows, the real exchange rate became one of the most important factors that affect economic growth. Eichengreen (2008) states that keeping real exchange rate at competitive levels and avoiding excessive real exchange rate volatility enable a country to use its resources efficiently for economic growth. Some of the empirical studies that examine the relationship between exchange rate regimes and economic growth can be summarised as follows:

Bayraktutan and Özkaya (2009) examined the relationship between exchange rate regimes and economic growth for 97 countries over the period from 1975 to 2004. The authors found that as compared to flexible exchange rate regime, fixed and intermediate exchange rate regimes have better performance on economic growth, but their effects on economic growth are minimal.

Bleaney and Francisco (2007) examined the relationship between exchange rate regimes and growth rate of per capita GDP for 91 developing countries over the period from 1984 to 2001. The authors find that in the developing countries hard pegs are associated with significantly slower growth rates than flexible and soft pegs exchange rate regimes.

Levy-Yeyati and Sturzenegger (2003) examined the relationship between exchange rate regimes and economic growth for 183 countries over the period from 1974 to 2000. The authors find that exchange rate regimes have significant effects on economic growth of developing countries and have

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[1] The variables are calculated using the IFS of the IMF data. The inflation rate data is taken from the Turkish Statistical Institute.

weaker effects on economic growth of industrialised countries. The aouthors also show that less flexible exchange rate regimes are associated with slower economic growth in developing countries.

Chirwa and Odhiambo (2016) give a review of international literature on macroeocomic determinants of economic growth. The authors find that the determinants of economic growth show differences depending on whether the country is developed or developing country. The authors reveal that for developing countries the key macroeconomic determinants of economic growth are based on the order of their importance include exogenous factors (foreign aid, foreign direct investment), fiscal policy, trade, physical capital, human capital, demographics, monetary policy, natural resources and geographic, regional, political and financial factors. For developed countries, the key macroeoconomic determinants associated significantly with economic growth are physical capital, fiscal policy, human capital, trade, demographics, monetary policy as well as financial and technological factors.

Most of the empirical studies find depressing effects of exchange rate volatility on economic growth. Some of the empirical studies can be summarized as follows: Barguellil, Ben-Salha and Zmami (2018) examined the effects of exchange rate volatility on economic growth in 45 developing and emerging market economies for the period from 1985 to 2015. The authors find that both nominal and real exchange rate volatilities have negative effects on economic growth in the countries with flexible exchange rate regime and they have no significant effects in the countries with fixed exchange rate regime. Besides, the impact of exchange rate volatility on economic growth is negative and more pronounced in financially open economies.

Sabina, Manyo and Ugochukwu (2017) finds negative effects of exchange rate volatility on economic growth in Nigeria for the period from 1981 to 2015.

Janus and Riera-Crichton (2015) finds negative effects of real exchange rate volatility on economic growth in a panel of OECD countries for the period from 1980 to 2011.

Onwuka and Obi (2015) examines the relationship between real exchange rate volatility of the country and of the G-3 countries (United States, Japan, Germany/or Euro zone) and the economic growth of developing African countries, namely; Nigeria, Kenya, Ghana, Malawi, Zambia and Mali for the period from 1980 to 2001 and from 2002 to 2013. The authors find that G-3 real exchange rate volatility improves economic growth of developing African countries in the period from 1980 to 2001 and depresses in the period from 2002 to 2013. The developing African country's own real exchange rate volatility has depressing effects on economic growth in both two periods.

Sanginabadi and Heidari (2012) find negative effects of exchange rate volatility on economic growth in İran in the flexible exchange rate regime for the period from 1988 to 2007.

Ndambendia and AL-Hayky (2011) find negative effects of real exchange rate volatility on economic growth in 15 Sub-Saharan African (SSA) countries over the period from 1980 to 2004.

Schnabl (2009) finds negative effects of exchange rate volatility on growth in both Emerging Europe and East Asia. The author states that part of this negative effect can be associated with exchange rate volatility caused by macroeconomic instability.

Schnabl (2007) examines the effects of exchange rate volatility on economic growth for a sample of 41 mostly small open economies at the EMU (European Monetary Union) periphery. The author shows that exchange rate stability leads to more growth and this evidence is especially strong for Emerging Europe which moved from high macroeconomic instability to macroeconomic stability during the observation period. The author also shows that the benefits of exchange rate stability is weaker for the group of industrialized non-EMU European countries where capital markets are more developed.

Regarding Turkey, Ünlü (2015) finds negative effects of exchange rate volatility on economic growth in Turkey for the period from 1998 to 2014.

The exchange rate volatility may have negative effects on key determinants of economic growth, namely, investment, international trade, foreign direct investment and international capital flows. Erdal (2001) shows theoretically that real exchange rate uncertainty decreases real investment spending in either export-oriented or import-competing firms using option pricing techniques. When the opportunity to undertake irreversible investment (such as financial call option) is exercised, it kills the option of investing and the possibility of waiting for new information. Therefore, investment decisions of firms are sensitive to uncertainties over economic environment. Assuming present real exchange rate volatility is a proxy for real exchange rate uncertainty, and investment spending is like a call option, Erdal (2001) shows that real exchange rate volatility causes optimal real exchange rate level to undertake investment to be higher for export-oriented sectors and lower for import-oriented sectors. Thus, the zone of "*inaction*" increases, and real investment spending falls as volatility increases regardless of whether the sector is an export-oriented or import-oriented sector.

Erdal (2017) examines the effects of real exchange rate volatility on investment in the manufacturing sectors of the countries in the quasi-fixed exchange rate regime, i.e., Exchange Rate Mechanism (ERM) of the European Monetary System (EMS), as well as of the countries in the flexible exchange regime. One of the main reasons for the establishment of the ERM was to create a stable exchange rate environment, and thereby induce investment and trade in Europe. The author finds that real exchange rate volatility has depressing effects on sectoral investment of the countries in the flexible exchange rate regime and has no depressing effects on sectoral investment of the countries ERM of the EMS.

Some of the empirical studies that examine the effects of exchange rate volatility on investment, capital flows and foreign direct investment in Turkey can be summarised as follows: Erdal and Pınar (2019) examine the major determinants of economic growth under intermediate and flexible exchange rate regimes in Turkey. The authors show that the determinants of the growth of real GDP show differences depending on the type of exchange rate regimes. While the ratios of investment and government expenditures to GDP, openness of the economy and employment rate have positively significant effects on the growth rate of real GDP in the intermediate exchange rate regime, they have negative or insignificant effects on the growth rate of real GDP in the flexible exchange rate regime. On the other hand, the central bank policy rate has negative effects and inflation rate has positive effects on economic growth in both of the exchange rate regimes.

Pınar and Erdal (2018) examine the effects of real exchange rate volatility on foreign direct investment (FDI) in the flexible exchange rate regime (i.e., the period from 2005 to 2016). The sectors are separated as primary (agriculture, mining & quarrying), secondary (manufacturing) and tertiary (services) sectors by taking their interactions with real exchange rate volatility and macroeconomic variables into consideration. The authors find that real exchange rate volatility has positive effects on total FDI inflows and FDI inflows to the manufacturing sector and it has insignificant effects on FDI inflows to agriculture, mining & quarrying and services sectors in Turkey.

Erdal and Pınar (2017) analyze the effects of real exchange rate volatility on sectoral export flows in Turkey under intermediate and flexible exchange rate regimes. The authors use sectoral level export data and it is expected that the using of sectoral level rather than aggregate data may disentangle the relationship between real exchange rate volatility and export flows. The authors show that real exchange rate volatility has negative and statistically significant effects on

sectoral exports flows in both intermediate and flexible exchange rate regimes.

## 3. Foreign Exchange Regimes in Turkey

In the fixed exchange rate regime, the monetary authority fixes the value of its domestic currency to the value of another country's currency, the value of the basket of currencies or the price of gold. The main advantages of fixed exchange rate regimes are to foster investment and international trade by reducing uncertainties about exchange rates and interest rates and by maintaining price stability. In the fixed exchange rate regime, lower exchange rate volatility reduces transaction costs for international trade and international capital flows that contributes to higher growth rates (Schnabl, 2007). Besides, fixed exchange rate regime contributes to macroeconomic stability which is also important for economic growth. The disadvantage is inability to pursue independent monetary policy.

The intermediate exchange rate regimes are in between the flexible and fixed exchange rate regimes. The intermediate exchange rate regimes have remained widespread especially in the developing countries and emerging market economies in spite of impossible trinity theorem, increasing capital mobility and difficulty in controlling exchange rates (Salins and Bénassy-Quéré, 2010). In the intermediate exchange rate regimes, the value of the domestic currency is fixed to another country's currency or a basket of currencies in different forms (i.e., conventional fixed pegs, horizontal bands, crawling pegs, crawling bands, tightly or other managed floating), but the monetary authority do not strict to commit fixed exchange rates as in the case of the fixed exchange rate regimes (Pınar and Erdal, 2016).

In the intermediate exchange rate regimes, periodical adjustments could be made on targeted or fixed exchange rates. The advantage of intermediate exchange rate regimes relative to fixed exchange rate regime is that the monetary policy could be used partially, and the advantage of intermediate exchange rate regimes relative to flexible exchange rate regime is that they are more advantageous to maintain monetary stability. Salins and Bénassy-Quéré (2010) states that when wages are sticky, the intermediate exchange rate regimes dominate both flexible and fixed exchange rate regimes in case the economy is hit mainly by productivity and foreign interest rate shocks.

The exchange rate regimes implemented in Turkey from 1990 to 2001 can be described as intermediate exchange rate regimes (Reinhart and Rogoff, 2002; Bubula and Ötker-Robe, 2002; Pınar and Erdal, 2016). Beginning from the 1990s, *de jure* flexible exchange rate regime was implemented, the Central Bank of Turkey often intervened the exchange rate

volatility. For that reason, the exchange rate regime was called "managed floating". At the beginning of 1995, the value of the Turkish lira was pegged to the currency basket consisted of 1 US dollar and 1.5 Deutsche mark. It was also decided that the monthly value of the currency basket would be increased with respect to expected monthly inflation rates. The Central Bank of Turkey intervened in the foreign exchange market to maintain predicted increase in the currency basket.

Between 1996 and 1999, the Central Bank of Turkey regulated the foreign exchange rate policy with respect to the monetary policy. In this period, since the primary objective of monetary policy was to maintain stability of the financial markets, the exchange rate policy was used to decrease exchange rate volatility. The devaluations were made with respect to expected inflation rates. So, the exchange rate regime implemented in this period can be described as "managed floating with no predetermined path for the exchange rate".

In December 1999, a stand-by arrangement was signed with the International Monetary Fund (IMF) and within the framework of the disinflation program "forward looking crawling peg exchange rate regime" was started to be implemented. The exchange rate increases were determined in accordance with the targeted inflation rate. The value of the currency basket consisted of 1 US dollar and 0.77 euro was announced for one year. But, after the financial crisis on 21 February 2001, this regime was abandoned and flexible exchange rate regime was adopted. Currently, the Central Bank of Turkey intervenes in the foreign exchange market to minimize excessive exchange rate volatility, and in the case of excess foreign exchange supply in the market buy them to increase its foreign exchange reserves.

In the meantime, it would be good to look at the growth rates of real GDP during the intermediate and flexible exchange rate regimes (Figure 1). As can be seen from Figure 1, the economic growth rates were more volatile in the intermediate exchange rate regimes as compared to those in the flexible exchange rate regime, especially when we exclude externally driven global crisis of 2008-2009. Besides, there were substantial slowdowns in economic growth in financial crisis years such as 1994, 2001 and 2009.

**Figure 1.** Growth Rate of Real GDP
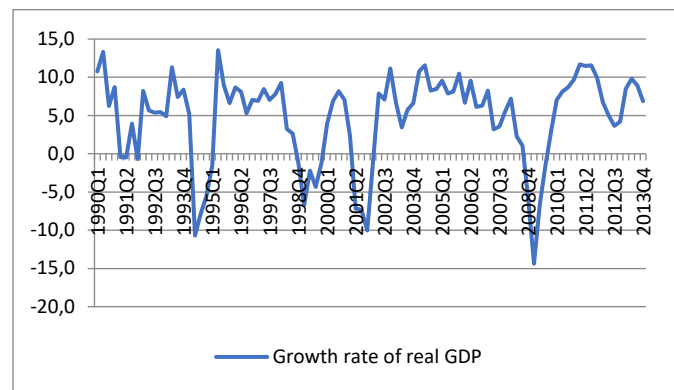


Source: IFS of the IMF

## 4. Theoretical Framework

In the theoretical part of the study, a modified Solow model is used to see the effects of additional growth enhancing shift variables (Bhaskara, 2006). The production function can be written as follows:

$$Y_t = A_o\, e^{(g_1 + g_2 Z)t}\, K_t^{\,p}\, L_t^{\,1-p} \qquad (1)$$

where "$Y_t$" is output, "$A_o$" is the initial stock of knowledge, and grow over time, "$K$" is physical capital, "$L$," is labor, "$g$" is assumed to be a function of growth promoting shift variable "$Z$" and is also some unknown trended variables proxies with time. So, the "$Z$" variable could be openness, foreign aid etc., or a vector of some growth improving variables. Let's take logarithm of both sides of equation. So, the suggestions of this modification are as follows:

$$\ln Y_t = \ln A_o + (g_1 + g_2 Z_t)t + p\ln K_t + (1-p)\ln L_t \qquad (2)$$
$$\Delta\ln Y_t = [g_1 + g_2(\Delta Z_t\, t + Z_t)] + p\Delta\ln K_t + (1-p)\Delta\ln L_t \qquad (3)$$
$$\Delta\ln y_t = [g_1 + g_2(\Delta Z_t\, t + Z)] + p\Delta\ln k_t \qquad (4)$$
$$\Delta\ln y^* = g_1 + g_2 Z \text{ as } \Delta\ln k_t \text{ and } \Delta Z \to 0 \qquad (5)$$

If Z is trade openness, economic growth rate will be higher in more open economies in the long-run equilibrium. Let's now consider non-linear form of this equation:

$$Y_t = A_0\, e^{(p_1\, p_2/Z)t}\, K_t^{\,p}\, L_t^{\,1-P} \qquad (6)$$

In equation (6), if Z is research and development expenditures, the economic growth rate will not perpetually increase with ever increasing research and development expenditures. So, it would be useful to use non-linear specification to see the effects of real exchange rate volatility on economic growth. There are also other macroeconomic variables that affect growth, and so may be considered as control variables or independent variables.

As Chirwa and Odhiambo (2016) state that the determinants of economic growth may change depending on the country's macroeconomic characteristics. In this framework, the variables that may affect economic growth can be determined as real exchange rate, real exchange rate volatility, inflation rate, interest rate, openness of the economy to international markets and financial deepening. So, the following equation is constructed:

$$GROWTH_t = B_o + B_1 REALEXCHANGERATE_t + B_2 REALEXCHANGERATEVOL_t + B_3 INFLATION_t + B_4 INTERESTRATE_t + B_5 OPENNESS_t + B_6 FINANCIALDEEPENING_t + u_t$$

The dependent variable ($GROWTH_t$) is the growth rate of real GDP at time t. The independent variables and expected signs of their coefficients can be described as follows:

$REALEXCHANGERATE_t$ is the nominal exchange rate deflated by inflation rate at time t. The sign of the coefficient is expected to be positive. An increase in real exchange rate

shows depreciation of domestic currency and export volume should increase, import volume should decrease and net exports should increase. An increase in net exports leads do increase of growth rate of real GDP. However, in this study, real effective exchange rate is used as a proxy for real exchange rate. So, an increase in real exchange rate shows appreciation of Turkish lira, then export volume should decrease, import volume should increase and net exports should decrease. The decrease of net exports leads to decrease of the growth rate of real GDP. So, the sign of the coefficient is expected to be negative.

$REALEXCHANGERATEVOL_t$ is the real exchange rate volatility at time t. An increase in real exchange rate volatility creates an uncertain environment for investment and international trade. In such an uncertain environment, investors and traders delay their decisions to obtain more information about real exchange rates. Thus, real exchange rate uncertainty depresses investment and international trade, thereby economic growth. So, the sign of the coefficient is expected to be negative (Erdal, 2017).

$INFLATION_t$ is the inflation rate at time t. High inflation rates increase uncertainty about future price levels. This uncertainty may deter investment decisions of the firms, thereby economic growth. So, the sign of the coefficient is expected to be negative. On the other hand, it is also argued that moderate inflation may increase investment and production, and thereby economic growth. A small increase in output prices stimulates producers to increase their production. This increase in inflation rate may lead to higher economic growth. So, the sign of the coefficient is ambiguous and an empirical issue.

$INTERESTRATE_t$ is the interest rate at time t. Since, the increase of interest rates leads to decrease in investment, economic growth decreases. So, the sign of the coefficient is expected to be negative. On the other hand, high interest rates may not decrease economic growth if there are mechanisms such as low inflation expectations, economy's attractiveness to foreign investors, the technological transfer effect and the accumulation of domestic savings (Drobyshevsky, Trunin, Bozhechkova and Sinelnikova-Muryleva (2017). In these cases, as interest rate increases, economic growth may also increases. So, the sign of the coefficient is ambiguous and an empirical issue.

$OPENNESS_t$ is the openness of economy to international markets at time t. It is expected that countries that are more open to international trade will tend to grow more rapidly, because they can take advantage of larger markets and they can absorb technological developments (Barro and Sala-i-Martin, 2004). As the openness of economy to international markets increases, productivity also increases with the specialization (Erdal, 2017). So, the sign of the coefficient is expected to be positive.

$FINANCIALDEEPENING_t$ is the financial deepening at time t. Financial deepening indicates the level of usage financial system by the economic actors in the economy (Erdal, 2018). Financial deepening is measured by the ratio of money supply measure (M2) to GDP. This ratio is also called the monetization ratio in the economy. The degree of an economy's monetization ratio may have important implications on economic growth and can be affected by the conduct of monetary policy, financial sector reforms and financial crises. So, high financial deepening or high monetization ratio affects economic growth positively. The sign of the coefficient is expected to be positive.
$u_t$ is the error term. es.

## 5. Research Method, Data Description and Data Sources

In the empirical part of the study, the effects of real exchange rate volatility on economic growth under intermediate and flexible exchange rate regimes are analyzed in Turkey. The Johansen cointegration test is done to see if there is a long-term relationship between the variables and Error Correction Models (ECM) are estimated to see if there are short-term adjustments for variables to return to their long-run values. The data used in the empirical part of the study is quarterly and covers the period from first quarter 1990 to first quarter 2001 for the intermediate exchange rate regime and from first quarter 2002 to fourth quarter 2013 for flexible exchange rate regime. The estimation equation is as follows:

$$GROWTH_t = B_o + B_1 REALFX_t + B_2 REALFXVOL_t + B_3 INF_t + B_4 INT_t + B_5 OPEN_t + B_6 FINDEEP_t + u_t$$

In this equation, real exchange rate, real exchange rate volatility, inflation rate and interest rate are in logarithmic forms and economic growth, openness of the economy to international markets and financial deepening are in levels, because they are in the ratio form. The dependent variable $GROWTH_t$ is measured by the the growth rate of real GDP. Real GDP is calculated as nominal GDP divided by Consumer Price Index (CPI). Source: International Financial Statistics (IFS) of the International Monetary Fund (IMF). The construction of independent variables and their data sources can be described as follows:

REALFX: Real Effective Exchange Rates Based on Manufacturing Consumer Price Index for Turkey (Index 2015=100, not seasonally adjusted) is used. Source: Federal Reserve Bank of St. Louis Economic Data (FREDII).

REALFXVOL: Volatility can be defined as the standard deviation of the change in value of a financial instrument and is considered a proxy for risk. Barguellil, Ben-Salha and Zmami (2018) state that both nominal and real exchange rates evolve in a highly correlated fashion in the flexible exchange rate regime that explains the non-sensitivity of estimation results regarding whether nominal or real the exchange rate proxy used. In this study, both past 12 months' standard deviation and past 6 months' standard deviation are used as a proxy for real exchange rate volatility. As can be seen in Figure 2, both volatility measures have very similar patterns and move very close to each other. So, volatility measured by standard deviation of past 6 months' real exchange rate is used in the estimations.

**Figure 2.** Real Exchange Rate Volatility Measures
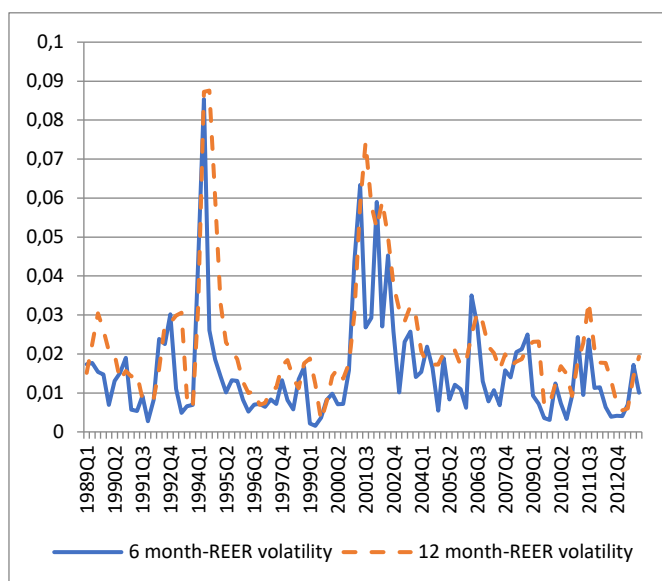


Source: IFS of the IMF

$INF_t$: Inflation rate is the annual percentage change of Consumer Price Index (CPI) (2003 = 100). Source: Turkish Statistical Institute.

$INT_t$: Treasury bill rate is used as a proxy for interest rate. The Treasury bill rate is the average compound interest rates of Treasury's domestic borrowing. Source: The Economic and Social Indicators of the Ministry of Development.

$OPEN_t$: The ratio of foreign trade to GDP (i.e., exports+imports/GDP). Source: IFS of the IMF.

$FINDEEP_t$: is measured by the ratio of M2 to GDP. Source: M2 data is taken from the Federal Reserve Bank of St. Louis Economic Data (FREDII). The GDP data is taken from the IFS of the IMF.

$u_t$ is the error term.

## 6. Empirical Results

The cointegration analysis is done using the variables that are integrated in the same order. Therefore, firstly, all the variables are tested whether they have a unit root. Then, Johansen cointegration test is done if there is a long-term relationship between the variables and the ECMs are estimated to see the short-term adjustments. The E-views econometric program is used in the empirical analysis.

### 6.1 Unit Root Test

Each of the variables is tested using Augmented DickeyFuller (ADF) test whether the variable has a unit root. The ADF test consists of regressing each series on its lagged value and lagged difference terms (Dickey and Fuller, 1981). The ADF test results are shown in Table 1.

The ADF test results show that in the intermediate exchange rate regime all the variables have a unit root at their levels and in the flexible exchange rate regime all the variables, except openness of the economy, have a unit root at their levels. Then, first differences of the non-stationary variables are taken and ADF test is done again. The ADF test results show that the first differences of the variables have no unit root that means they are integrated of order one.

**Table 1.** ADF Unit Root Test Results

| INTERMEDIATE EXCHANGE RATE REGIME | | | |
|---|---|---|---|
| Variable name | Level | First Difference | Second Difference |
| GROWTH | -0.32 | -19.91*** | - |
| REALFX | -1.59 | -5.92*** | - |
| REALFXVOL | -3.52 | -6.55*** | - |
| INF | -0.39 | -4.09*** | - |
| INT | -2.72 | -5.37*** | - |
| OPEN | -1.85 | -2.62* | -18.18*** |
| FINDEEP | -2.08 | 8.52*** | - |
| FLEXIBLE EXCHANGE RATE REGIME | | | |
| Variable name | Level | First Difference | Second Difference |
| GROWTH | -2.59* | -3.55** | -8.06*** |
| REALFX | -3.44** | -6.32*** | - |
| REALFXVOL | -2.35 | -9.03*** | - |
| INF | -2.66* | -2.71* | -7.08*** |
| INT | -2.14 | -5.44 | - |
| OPEN | -3.93*** | - | - |
| FIN DEEP | -0.70 | -2.87 | -29.35*** |

"***" shows that the variable is stationary at 1 % level, "**" shows that the variable is stationary at 5 % level and "*" shows that the variable is stationary at 10 % level. McKinnon critical values for intermediate exchange rate regime: -3.58 for 1 %, -2.92 for 5 % and -2.60 for 10 % level. McKinnon critical values for flexible exchange rate regime: -3.57 for 1%, -2.92 for 5%, -2.59 for 10%.

## 6.2 Cointegration

The Johansen cointegration analysis is done using the Johansen test statistics Trace and Maximum Eigenvalue (Engel and Granger, 1987). The cointegration test results for the growth rate of real GDP, real exchange rate, real exchange rate volatility, inflation rate, interest rate, openness of the economy and financial deepening are presented in Table 2. Both Trace and Maximum Eigenvalue test results show that cointegration exists between all the variables in both intermediate and flexible exchange rate regimes. The existence of cointegration means that there is a long-run relationship between all the variables in both intermediate and flexible exchange rate regimes.

**Table 2.** Cointegration Test Results

| INTERMEDIATE EXCHANGE RATE REGIME | | | | |
|---|---|---|---|---|
| Trace Statistic | | | | |
| All the variables | Eigenvalue | Trace Statistic | 0.05 Critical Value | Probability** |
| None* | 0.73 | 167.22 | 125.61 | 0.000 |
| At most 1 | 0.59 | 107.36 | 95.75 | 0.006 |
| At most 2 | 0.45 | 67.16 | 69.81 | 0.080 |
| At most 3 | 0.36 | 39.88 | 47.85 | 0.226 |
| At most 4 | 0.22 | 19.42 | 29.79 | 0.463 |
| At most 5 | 0.13 | 8.13 | 15.49 | 0.450 |
| At most 6 | 0.03 | 1.66 | 5.84 | 0.196 |
| Max-Eigen Statistic | | | | |
| All the variables | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Probability** |
| None* | 0.73 | 59.86 | 46.23 | 0.001 |
| At most 1 | 0.59 | 40.20 | 40.07 | 0.048 |
| At most 2 | 0.45 | 27.27 | 33.87 | 0.248 |
| At most 3 | 0.36 | 20.46 | 27.58 | 0.310 |
| At most 4 | 0.22 | 11.28 | 21.15 | 0.619 |
| At most 5 | 0.13 | 6.47 | 14.26 | 0.553 |
| At most 6 | 0.03 | 1.66 | 3.84 | 0.196 |

Trace test and Max-Eigenvalue test indicates 2 cointegrating equations at the 0.05 level.
* denotes rejection of the hypothesis at the 0.05 level.
** MacKinnon-Haug-Michelis (1999) p-values.-

| FLEXIBLE EXCHANGE RATE REGIME | | | | |
|---|---|---|---|---|
| Trace Statistic | | | | |
| All the variables | Eigenvalue | Trace Statistic | 0.05 Critical Value | Probability** |
| None* | 0.70 | 142.02 | 95.75 | 0.000 |
| At most 1 | 0.50 | 82.62 | 69.81 | 0.003 |
| At most 2 | 0.40 | 48.64 | 47.85 | 0.042 |
| At most 3 | 0.24 | 24.02 | 29.79 | 0.199 |
| At most 4 | 0.14 | 10.27 | 15.49 | 0.260 |
| At most 5 | 0.06 | 2.98 | 3.84 | 0.084 |
| Max-Eigen Statistic | | | | |
| All the variables | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Probability** |
| None* | 0.70 | 59.39 | 40.07 | 0.000 |
| At most 1 | 0.50 | 33.97 | 33.87 | 0.048 |
| At most 2 | 0.40 | 24.61 | 27.58 | 0.114 |
| At most 3 | 0.24 | 13.75 | 21.13 | 0.385 |
| At most 4 | 0.14 | 7.29 | 14.26 | 0.455 |
| At most 5 | 0.06 | 2.98 | 3.84 | 0.084 |

Trace test indicates 3 and Max-Eigenvalue indicate 2 cointegrating equations at the 0.05 level.
* denotes rejection of the hypothesis at the 0.05 level.
** MacKinnon-Haug-Michelis (1999) p-values.-

The estimation of long-run cointegrating relationship for growth rate of real GDP, real exchange rate, real exchange rate volatility, inflation rate, interest rate, openness of the economy and financial deepening under intermediate and flexible exchange rate regimes are presented in Table 3. As mentioned previously, the cointegration analysis is done using the variables that are integrated in the same order. In the flexible exchange rate regime, openness of the economy does not have

a unit root at its level or it is stationary at its level. So, when estimating the long-run relationship for the flexible exchange rate regime period, openness of the economy is excluded.

**Table 3.** Estimation of Long-Run Relationship

| Dependent variable GROWTH | INTERMEDIATE EXCHANGE RATE REGIME | FLEXIBLE EXCHANGE RATE REGIME |
|---|---|---|
| **Independent variables** | **Coefficient** | **Coefficient** |
| REALFX | 11.98** (3.64) | -2.34** (2.88) |
| REALFXVOL | -0.44** (0.04) | -36.10** (8.89) |
| INF | 10.18** (4.75) | 0.43** (2.38) |
| INT | -1.37** (1.71) | 0.99** (4.12) |
| OPEN | -1.67 (1.23) | - |
| FİNDEEP | 6.95** (8.47) | 0.39** (3.0) |

Note: "**" shows that the variable is significant at 5 % level. The values in the parenthesis are t-statistics. T- statistic table value for intermediate exchange rate regime (45 observations) and for flexible exchange rate regime (48 observations): (45, 48, 0.05) = 1.6775.

As can be seen from Table 3, the sign of the real exchange rate volatility coefficient is negative and statistically significant in both intermediate and flexible exchange rate regimes. These estimation results show that real exchange rate volatility has depressing effects on economic growth in both intermediate and flexible exchange rate regimes in the long-run.

The sign of the real exchange rate coefficient is negative and statistically significant in the flexible exchange rate regime and positive and statistically significant in the intermediate exchange rate regime. Since, real effective exchange rate is used in the empirical part of the study, an increase of real effective exchange rate shows an appreciation of Turkish lira. Therefore, it could be said that while the appreciation of Turkish lira has negative effects on economic growth in the flexible exchange rate regime, it has positive effects on economic growth in the intermediate exchange rate regimes. This positive effect could be interpreted as the dependency of both domestic production and exporting goods on imported intermediate goods. So, an appreciation of Turkish lira leads to cheaper imported intermediate goods for production, and thereby higher production and economic growth.

In Turkey, the highest share of total exports belongs to manufactured goods followed by machinery&transport equipment and miscellannous manufactured goods (Erdal and Pınar 2017). The manufacturing sector production depends heavily on importing goods including energy. So the appreciation of Turkish lira leads to lower production costs for exporting goods, thereby net exports increase, and it causes

higher economic growth. Kızıldere and Kabadayı (2014) also find that the Turkish trade structure is shaped by import dependency and significant reliance on re-exports. Uğurlu (2006) also finds a positive correlation between the real exchange rate and GDP for the period from first quarter of 1989 to third quarter of 2001.

The sign of the inflation rate coefficient is positive and statistically significant in both intermediate and flexible exchange rate regimes. This outcome could be interpreted as inflation rate has positive effects on economic growth in both intermediate and flexible exchange rate regimes. The movements of growth rate of real GDP and inflation rate during intermediate and flexible exchange rate regimes are presented in Figure 3. But, the intermediate and flexible exchange rate regime periods had different characteristics in Turkey and thereby the reasons for positive relationship between inflation rate and economic growth under these two regimes are also different.

In the intermediate exchange rate regime period, while the inflation rate was on average 75 percent, growth rate was around 4 percent. During this period, due to high and volatile inflation rates, the link between inflation rate and economic growth may be disrupted. On the other hand, in the flexible exchange rate regime period, while the inflation rate was on average 13 percent, growth rate was on average 6 percent. The positive relationship between inflation rate and economic growth could be interpreted as moderate inflation may increase investment, and thereby economic growth.

**Figure 3.** Growth Rate of Real GDP and Inflation Rate
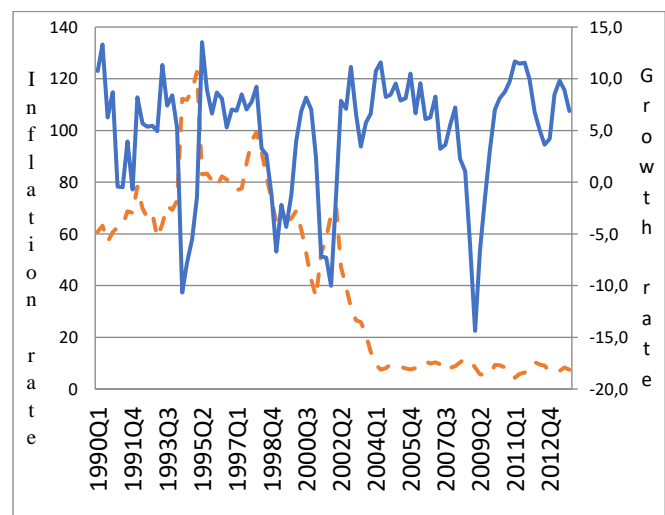


Source: IFS of the IMF

The sign of the interest rate coefficient is negative and statistically significant in the intermediate exchange rate regime as expected in the study. An increase in interest rate

leads to decrease of investment, and therefore economic growth. On the other hand, the sign of the interest rate coefficient is positive and statistically significant in the flexible exchange rate regime. Drobyshevsky, Trunin, Bozhechkova and Sinelnikova-Muryleva (2017) analyze theoretical concepts and international economic practices in high interest rate environments to justify that high nominal and real interest rates may not dampen economic growth if there are mechanisms such as low inflation expectations, economy's attractiveness to foreign investors, the technological transfer effect and the accumulation of domestic savings.

Drobyshevsky, Trunin, Bozhechkova and Sinelnikova-Muryleva (2017) state some countries' experiences, i.e., Brazil (2000−2008), Turkey (2002−2007), India (1980−2013) and Chile (1984−2013), show that economic growth can be seen in high real interest rate environments. The macroeconomic analysis of Turkey during the flexible exchange rate regime period shows that medium-term and long-term economic growth rates are high with high interest rates due to following mechanisms: Firstly, after 2001 financial crisis a rise of interest rates contributed to a decline in the inflation rate and inflation rate volatility.

Secondly, high interest rates made the Turkish economy more attractive to international capital flows, and therefore she attracted capital in the form of portfolio investments and bank credits. Additionally, the privatization of state-owned enterprises encouraged foreign direct investment. As a result of these capital inflows economic growth rate increased. Thirdly, high economic growth rates were also encouraged by institutional reforms. During this period, Turkey implemented a banking reform consisting of restructuring, privatization and banking supervision changes, trade liberalization, a tax reform and a labor market reform which contributed to a substantial growth in the proportion of women in the labor force

The openness of the economy variable is excluded from the cointegration analysis in the flexible exchange rate regime due to its stationarity at its level. In the intermediate exchange rate regime, the coefficient of the openness of the economy is statistically insignificant.

The sign of the financial deepening coefficient is positive and statistically significant in both intermediate and flexible exchange rate regimes as expected. The estimation results show that high level of financial deepening affects economic growth positively in both of the regimes in the long-run. The efficient use of financial system by economic actors leads to more investment and, therefore higher economic growth rates.

## 6.3 Error Correction Model

As a third step, the Error Correction Models (ECMs) are estimated. The long-run relationship will be supported if the coefficient of the lag of the error correction model ($ECM_{t-1}$) carries a negative and statistically significant coefficient. Besides, the coefficient of $ECM_{t-1}$ represents the proportion of disequilibrium in the variables in one period corrected in the next period.

To do the ECM estimations, three period lags of the independent variables are included in the regressions and they are estimated. The statistically insignificant variables are dropped from the regressions and the statistically significant ones are kept and the regressions are re-estimated. The residuals of estimated equations are saved as ECMs. Then, the regression using first differences of both dependent and independent variables and the lag of the ECM (i.e., $ECM_{t-1}$) are estimated. The estimation results of these regressions, in other words, ECMs are given in Table 4. As can be seen in Table 4, the coefficient of the $ECM_{t-1}$ is negative and statistically significant in the regression that shows the cointegration is supported. The value of the $ECM_{t-1}$ coefficient shows that the short-run dynamics converge to long-run relationship with a high speed of adjustment.

**Table 4.** Error Correction Model (ECM) Estimation Results

| Dependent variable GROWTH | INTERMEDIATE EXCHANGE RATE REGIME | FLEXIBLE EXCHANGE RATE REGIME |
|---|---|---|
| **Independent variables** | Coefficient | Coefficient |
| ΔREALFX | -1.79** (3.64) | -0.46** (-1.78) |
| ΔREALFXVOL | -4.09** (-3.42) | -0.63 (-1.23) |
| ΔINF | -0.49** (-1.93) | 0.08 (1.36) |
| ΔINT | -0.09 (-0.94) | 0.08 (0.84) |
| ΔOPEN | -0.50** (-2.60) | - |
| ΔFINDEEP | -0.59** (-8.10) | 0.12** (3.97) |
| ECM $_{t-1}$ | -1.21** (-8.06) | -1.71** (-13.20) |

Note: "Δ" shows the first difference of the variable "**" shows the variable is significant at 5 % level. The values in the parenthesis are t-statistics.

## 7. Conclusion

This paper analyzed empirically the effects of real exchange rate volatility on economic growth under intermediate and flexible exchange rate regimes in Turkey. The empirical results show that real exchange rate volatility depressing effects on economic growth in both intermediate and flexible exchange rate regimes. Erdal and Pınar (2017) also show that real exchange rate volatility has depressing effects on sectoral exports flows in both intermediate and flexible exchange rate regimes.

The appreciation of Turkish lira has negative effects on economic growth in the flexible exchange rate regime as expected and it has positive effects on economic growth in the intermediate exchange rate regimes. The positive effects of Turkish lira appreciation on economic growth in the intermediate exchange rate regime period could be interpreted as the dependency of both domestic production and exporting goods on imported intermediate goods. So, an appreciation of Turkish lira leads to cheaper imported intermediate goods for production, and thereby higher production and economic growth.

An increase in inflation rate leads to higher economic growth in both intermediate and flexible exchange rate regimes. But the reasons of this positive relationship between high inflation rate and high economic growth are different in two exchange rate regimes. In the intermediate exchange rate regime, due to high and volatile inflation rate, the link between inflation and economic growth was disrupted, hence in a high inflationary environment economic growth was also high. On the other hand, under the flexible exchange rate regime moderate inflation led to increase of investment, and thereby economic growth. A small increase of output prices stimulates producers to increase their production capacity.

The sign of the interest rate coefficient is negative and statistically significant in the intermediate exchange rate regime as expected. An increase in interest rate leads to decrease of economic growth. On the other hand, the sign of the interest rate coefficient is positive and statistically significant in the flexible exchange rate regime. The positive effects of interest rates on economic growth during the flexible exchange rate regime period could be explained by the intensive re-structuring period after the February 2001 foreign exchange and banking crisis. During the aforementioned period, the banking sector reform, rehabilitation of the public finance and institutional structuring together with the privatization process of state-owned enterprises attracted international capital flows. The success of the comprehensive structuring program and supportive external environment positively affected the confidence of consumers and investors, and therefore the economic growth.

The openness of the economy variable is excluded from the cointegration analysis in the flexible exchange rate regime due to its stationarity at its level. In the intermediate exchange rate regime, the coefficient of the openness of the economy is statistically insignificant. The financial deepening of the economy has positive effects on economic growth in both intermediate and flexible exchange rate regimes. The financial deepening ratio is affected from the conduct of monetary policy, financial sector reforms and financial crises. So, high financial deepening affects economic growth

positively. The error correction model estimation results show that the short-run dynamics converge to their long-run values with a high speed of adjustment.

Consequently, it could be concluded that the implemented exchange rate regime is important for economic growth. This study shows that real exchange rate volatility may have depressing effects on economic growth and avoiding exchange rate volatility enables countries to use their resources efficiently for economic growth. Of course, exchange rate regimes cannot substitute the high savings, labor force and foreign investment friendly environment, but it can help to growth by encouraging the movements of resources into the manufacturing sectors and receive productivity gains in a short period of time.

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