University of Hull

Macroeconomic Impacts of Exchange Rate Misalignments in Libya

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By

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Abstract

This study attempted to shed light on misalignments of real exchange rate in the Libyan economy. This is the first study that focuses on estimating the real exchange rate misalignments for the Libyan currency in my knowledge. The study took into account the most important characteristics of the Libyan economy, which depends almost entirely on public oil sector. This sector plays a significant role in the stability of inflation and value of the national currency. Oil shocks have had an evident impacts on monetary stability due to the fragility of the economy. This study found obvious proof of great and severe misalignments, in the form of over or undervaluation states of local currency which usually lasted for a long time. The large misalignment in the real exchange rate continuously for a long time in this way misses the opportunity for an appropriate economic climate in order to encourage foreign investment and non-oil exports. Libya as an oil exporting economy tried for many years to improve the external trade sector to increase the non-oil exports, reduce imports and substituting some of them by local products. The main target of that is to maintain the foreign exchange resources for investment projects. Oil crisis had made the economy to suffer from sharp structural imbalances, which has been difficult to overcome.

The study also focused on the impacts of misalignments on economic performance. The main outcome of this part is that, increase in overvaluation states cause negative effects on economic indicators such as a decrease in non-oil GDP and non-oil exports, an increase black market premium and inflation rates. It is also noticed that, overvaluation episodes accompany with unstable economic situations, particularly in recent years. It was also noted that the overvaluation had negative linkage with endogenous variables in the traditional Keynesian model such as real private consumption, real total taxes, real interest rate, real imports, and real gross domestic income. On the other hand, undervaluation states brought many positive aspects to the economy.

The New Keynesian DSGE model, with so-called three-equation model for three associations between output gap, inflation and interest rate rule, was estimated with the same time series data as for the evaluation of macro impacts. This model

discovered that inflation rates relies on GDP gap in the Libyan economy by the slope of the New Keynesian Philips Curve. It also showed that, significant positive association between current inflation deviations to expected future inflation deviations. The parameter for the degree to which the central bank responds to movements in inflation was at a very low level compared with the literature. The DSGE model also predicts expected inflation to fall after the recovery in oil production that started at the end of 2017. This in turn will lower the real exchange rate appreciation and then will shrink overvaluation episodes moving the actual real exchange rate towards the equilibrium path gradually.

Main contribution of thesis lies in measurement of misalignments for Libya, assessing the impacts of such misalignments on the Libyan economy and proposing a simple new Keynesian DSGE model to be suitable for analysing inflation and misalignment in Libya.

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List of abbreviations

ADF	Augmented Dickey–Fuller test
ARDL	Auto Regressive Distrbuted Lags
BME	Black market exchange rate
CBL	Central Bank of Libya
CPI	Consumer Price Index
DSGE	Dynamic stochastic General Equilibrium
ERER	Equilibrium real exchange rate
FIML	Full Information Maximum Likelihood
FM-OLS	Fully Modified Ordinary Least Squares
HP	Hodrick-Prescott
IFS	International Finacial Statistics
INF	Inflation
MIS	Misalighnments of local currency
MS	Money supply
MSM	Markov Switching Model
NER_d	Nominal exchange rate by domestic currency units
NER_f	Nominal exchange rate by foreign currency units
NFII	Net foreign indirect investment
NOP	Nominal Oil Prices
NOX	Non-oil Exports
OECD	Organisation for Economic Co-operation and Development.
OPEN	Trade Openness
OMIS	Overvaluation misalighnments of national currency
PPP	Purchasing Power Parity
P&P	Phillips and Perron test
R	Nominal interest rare
RER	Real exchnage rate
REER	Real effective exchanghe rate
RC	Real private consumption
RG	Real government expenditure

RGDP	Real Gross Domestic Product
RGIM	Real growth rate in imports
RI	Real private investment
Ri	Real interest rate
RM	Real total imports
RMS	Real money supply
RNGDP	Real non-oil gross domestic product
ROP	Real Oil Prices
ROGDP	Real oil gross domestic product
RT	Real totla taxes
RX	Real total exports
RY	Real total income
SDR	Special Drawing Rights
3SLS	Three Stages Least Squares
2SLS	Two Stages Least Squares
UMIS	Undervaluation misalighnments of national currency
VAR	Vector Auto Regressive
WB	World Bank.

Chapter 1 Background of the Study

1.1 Introduction

Exchange rate management has been a crucial and debated topic among academics and policy makers for a very long time, particularly in the case of developing countries. There has been an ongoing discussion about the suitable exchange policy in developing countries. The debates are about the degree of volatility in the exchange rate in the face of internal and external shocks. The assessment of real exchange rate (hereafter RER) misalignment has become more important in recent years, especially in developing countries after the financial crisis 2008. Therefore, the exchange rate is arguably one of the most important unobserved indicators in the economy, because it reflects a country's competitiveness in the international market through the external sector. RER misalignments in the economy resulting in either overvaluation or undervaluation of the national currency are a great interest to policymakers due to a high scale of the degree of economic openness and capital flows. The stable RER considers as a key variable for inflation, economic growth capital inflows, foreign direct investment, and national reserves. Shabsigh and Domac (1999) mentioned that, the RER misalignment is the principal source of economic disequilibrium and a strong association with economic variables that depend on RER movement.

Many countries after the collapse of the Bretton Woods system in the 1970s shifted from a fixed to a flexible exchange rate regime. The new system of exchange rate has increased the volatility of the RER. The impacts of such changes on macroeconomic performance are very varied and require systematic models for economic analysis. These effects have become the major focus of the monetary policy makers in underdeveloped, emerging and advanced economies. After this new system of exchange rate, there has been an ongoing discussion about purchasing power parity (PPP) and RER stabilities (Taylor 2013). The determination of RER misalignments is significantly beneficial for policy makers perceptions. RER overvaluation in numerous African countries has caused a significant deterioration in the external accounts and agriculture sector (Edwards 1989). A country with a sound exchange rate system is more competitive than a country with a distorted exchange rate system (Taylor 2013). Misalignment of RER is a crucial instrument for countries that apply flexible exchange rate regime for growth and stability (Aleisa & Dibooĝlu 2002). Willett (1986) mentioned that the wrong level of RER causes dramatic welfare costs with improper signals and instability in the economy.

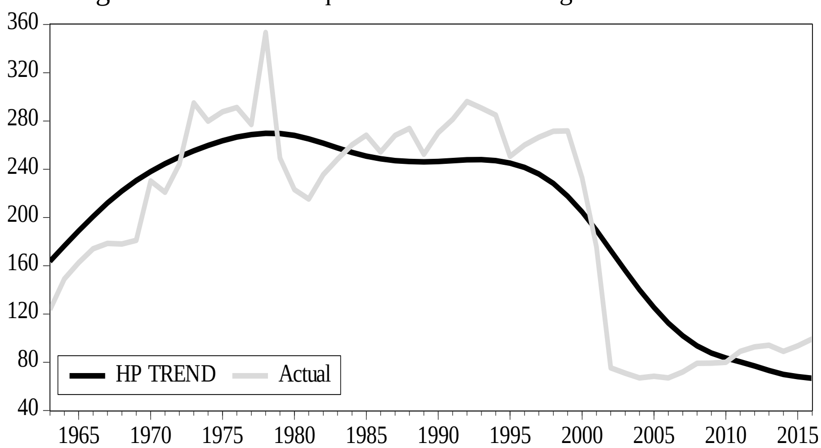
In economic reality, there are different sorts of RER misalignments. Essentially, there are two types of RER misalignments. The first kind is macroeconomic misalignment and the second one is structural misalignment. Macroeconomic misalignments happen when the official exchange rate and macroeconomic policies are not consistent, particularly when monetary policy leads observed RER to deviate from its equilibrium path. Noticeably, an expansionary monetary policy incompatible with the predetermined nominal exchange rate will cause local prices to rise more than international prices; net foreign borrowing will increase, the black market will rise and RER appreciation may take place. Structural misalignment occurs when the variations in the fundamentals of the RER are not reflected in the short term in observed RER fluctuations. For instance, the deterioration in terms of trade will lead to change in the equilibrium path of the RER and the observed RER does not alter in accordance with the equilibrium RER. As a suitable policy to eliminate such misalignments, the country should, for instance, employ foreign reserves as a compensatory policy to overcome such misalignments (Edwards 1989). Theoretically, there are some reasons for separating developing economies from developed economies when studying the concept of RER. First, the vast majority of developing economies predetermine their nominal exchange rates as a fixed or crawling peg exchange rate, particularly since the collapse of the Britain Woods system. Second, the capital account movement is limited due to exchange rate controls, which makes the currencies in these economies non-convertible. Third, the exchange rate in developing countries is mostly a source of uncertainty for consumers, exporters, importers and producers. Fourth, in many developing economies, the black market for goods and foreign exchange is pervasive (Aghevli, et al. 1991).

A country that seeks to have a persistent macroeconomic equilibrium needs to have consistency between monetary and fiscal policies, with a credible nominal exchange rate system. The specification of a predetermined nominal exchange rate puts restrictions on the macroeconomic policy. When the macroeconomic policies and predetermined nominal exchange rate are not consistent, significant disequilibrium is more likely to occur as misalignments. Particularly, in developing countries, the fiscal deficit is usually financed by money supply creation, which leads to an inconsistency between the financial deficit and predetermined nominal exchange rate. Increased money supply will cause a rise in price levels leading to a RER appreciation. Monetary policy may also be inconsistent with the predetermined nominal exchange rate. When the policy makers increase the local credit at levels that exceed the domestic money demand, it will cause an excess demand for both non-tradable and tradable goods. An increase in demand for tradable goods will translate into a large trade deficit (or decrease surplus), generating a reduction in international reserves and a rise in foreign borrowing value over its long-term potential level. The increase in demand for non-tradable goods will lead to increase in price levels, and thus, appreciation in the RER. This appreciation may lead to a high degree of misalignments, as overvaluation states if the determinants of equilibrium RER do not change (Edwards 1989). The best example for this case is Argentina in the 1970s. The country employed a predetermined nominal devaluation of exchange rate in order to shrink the high level of inflation rate. However, the predetermined devaluation was evidently not consistent with the inflation rate needed to reduce the financial deficit (Calvo 1986). In these cases, the inconsistency of policy not only causes an appreciation of the RER but may also cause speculation in the foreign exchange market (Edwards 1989).

Theoretically, devaluation of national currency value is expected to have expansionary impacts on economic growth, though its effective depends on the Marshal-Lerner condition, which supposes that the sum of price elasticity of exports and imports is more than 1. If this condition is satisfied, devaluation will lead to an improvement in the current account, and thus will lead to a rise in total demand. There is also a so-called J-curve hypothesis of impacts of devaluation in the economy. Devaluation firstly has contractionary effects because of the rising costs of imports, and then exports start rising because domestic goods will be relatively cheaper, which thus causes more exports (Bhattarai 2015). On the other hand, devaluation of the national currency may lead to contractionary impacts on output via the price of goods and services, capital outflows, consumption expenditure, and supply problems. After a devaluation, price levels may rise because long-run adjustment does not happen instantly. Therefore, all of these will lead to weak confidence in the economy, and thus may cause a decrease in output. Devaluation usually occurs with capital outflows; at the time of devaluation, a huge amount of foreign capital will go outside the country, whereas no large amount of capital outflows will come back as a result of devaluation. All of these reasons may cause a decline in output. The devaluation of national currency value may influence consumption expenditure because of price increases. Consequently, consumption expenditure will decline, causing a decrease in economic growth. Related government policies have a contractionary impact on output when the government carries out some contractionary policies against the expected inflationary effects of devaluation. Therefore, a decrease in economic growth may occur. It is also supply problems happen when the economy depends heavily on imports as inputs for production processes. Cost of inputs will increase after the devaluation of the exchange rate, which depresses output (Berument and Pasaogullari 2003).

Many studies have estimated the equilibrium RER and misalignments (Edwards 1989) and (Elbadawi, et al. 2012). The equilibrium path is not observable directly, but it can be found via the fundamental variables of the RER. Recent empirical reviews indicate that studying misalignments play a key role in designing policy plans and may serve as a possible predictor of a currency crisis in emerging economies (Kaminsky, et al. 1998). By observing the RER volatility in the Libyan economy it can be noticed that there are large and continued RER misalignments for a long time. Libya as an oil dependent country, is heavily affected by oil sector, which plays a significant role in exchange rate policy and inflation levels leading to considerable RER movements and misalignments as shown in figure 1.

Figure 1. Actual and equilibrium real exchange rate 1962-2016



Source: Author’s work

This study contains six chapters. The first chapter provides the background of this study which is divided into five sections: the introduction, the problem statement, significance, objectives, and the methodology of the study. The second chapter contains an overview of the Libyan economy, provides the most important characteristics and features of the Libyan economy, as well as an explanation of the most important economic indicators related to exchange rate policy and foreign exchange resources. It starts with an introduction and the demography of Libya, then outlines the development of the Libyan currency historically. Consideration is given to foreign exchange in Libya (demand and supply of foreign exchange) including the historical development of the exchange rate regime in Libya, and some problems that the economy has faced during past decades and recently.

The third chapter is about measurement of the RER misalignments and equilibrium. It also involves the concepts of the equilibrium and misalignment of the RER, especially, for developing countries. Chapter four concentrates on the impact of RER misalignments on the main indicators in the Libyan economy, such as real non-oil gross domestic product, price levels, non-oil exports and black market premium. This part investigates the linkage between the misalignments of exchange rate as over or undervaluation states also to find out the impacts of RER misalignments in macroeconomic variables in traditional Kenyan model. Chapter five is about applying a DSGE model for the Libyan economy, employing a New Keynesian model to capture the impacts of the monetary policy role and future expectation for inflation. Chapter six contains concluding remarks and offers some suggestions and recommendations to improve the economic situation.

1.2 Statement of the research problem

Libya, as a rentier economy, depends heavily on oil exports to obtain its foreign exchange. In a country such as Libya, there has been rising concern regarding the effectiveness of nominal devaluation as a policy instrument. Pegged currencies with countries in which exports are primary may experience large RER misalignments. Libya’s exports are dominated by oil and may experience misalignments as a response to external and internal shocks. Misalignments of the RER have created economic instability, distorted investment decisions, income distribution and caused a lack of confidence in local currency. They also weaken international competitiveness, reduce foreign investment at home, cause imbalances in the balance of payments and help to transfer capital abroad. The RER misalignment also affects many economic variables negatively or positively and itself may be affected by them.

There is evidence in the literature that keeping the actual RER nearly to its equilibrium path is a very crucial issue for growth, particularly for countries that avoid overvaluation episodes associated with export-led economic growth (Edwards 1989) and (Elbadawi, et al. 2012). According to our knowledge, the keeping RER very close to equilibrium level may assist policymakers to manage domestic inflation, balance the current and capital accounts, allocate resources and improve competitiveness. A misaligned RER may cause distortion in price level compared with other trading partners, balance of payments etc. Therefore, this study examines the use of exchange rate policies to cause economic imbalanced. Under these circumstances, the question arises whether policymakers play an important role in keeping the RER around the equilibrium path or not. The central questions in this study are: to what extent is the RER in Libya misaligned? What are the impacts of RER misalignments on the main economic indicators, and is there any evident policy from the Central Bank of Libya (hereafter CBL) to control nominal exchange and inflation rates? Our framework fills a gap in measuring the RER misalignments for Libya and studying its impacts on the main economic indicators in the economy with expectations for inflation and misalignments.

1.3 Significance of the study

The continuous movements in the real domestic currency value along with the poor policy of the CBL make the economy unsuccessful. Monitoring RER equilibrium and misalignments are a beneficial strategy for central banks and governments to ensure balance in the economy. The appropriate exchange rate policy is considered as a crucial issue for economic stability. Debate about RER misalignments for Libya is just in its infancy. The Libyan exchange rate policy should be improved to be compatible with today's economic environment. The policy should affect the RER and its determinants to control its misalignments. When the RER movement deviates significantly from its equilibrium value, it requires corrective action by the authorities to put the economy in the right position. A significant and persistent deviation of RER from the equilibrium path may transmit incorrect effects to the economic factors. It has a direct impact on competitiveness through traded goods. RER misalignment may be employed as an instrument to affect the actual indicators in the economy. Fundamentally, RERs are relative prices, and hence volatility of the RER helps to shift resources to reconcile supply and demand (Driver & Westaway 2005).

The main contribution of this study is to provide a measure of RER misalignments and investigate its impacts and future expectations, as well as to suggest policies that can be implemented to stabilise exchange rates. It is anticipated that the results of this study may assist the CBL in considering the deviation of the RER from its equilibrium path as an over or undervaluation states and its economic causes and consequences. It will also be helpful for investors and planners in the private sector in analysing the costs and benefits of projects in the short and long run. To our knowledge, there have been no systematic in-depth studies of these issues for Libya. As in the literature, no systematic work has so far been done in Libya about these issues. Therefore, this work has used a comprehensive methodological technique to evaluate the performance of the exchange rate policy precisely.

1.4 Aims of the study

This study has several sub-objectives are given as follows:

Firstly/ this study will focus on RER to establish the factors that determine it, calculating RER to study the movements in the RER in Libya focusing on the more recent years. The study will try to find the main foreign and domestic determinants of the movements in the RER and estimating its equilibrium and misalignments. After estimating these indicators, the study seeks to assess whether the RER in Libya is out of line according to its long-run equilibrium path as over or undervaluation episodes.

Secondly/ this study also aims to examine the association between RER misalignments and economic performace. This part will discovere the impacts of RER misalignments on some economic indecators such as real non-oil growth, non-oil exports, price levels and black market exchange rate, as well as the impacts of RER misalignmnts on traditional Kenesian Model for Libya.

Thirdly/ the study will also expect the future inflation and RER misalignmnets. A New Keynesian Model, which so-called three-equation model as three associations, output gap, inflation and interest rate rule will be estimated. This model will also help for discovering the association between current inflation and future inflation, the degree to which the CBL responds to movements in inflation and the relationship between output gap and inflation rates.

1.5 Methodology

In order to accomplish the aims and answer the research equations, this study applies time series techniques to estimate the equilibrium path and misalignments of RER. Unit root tests to examine for stationarity and Engle-Granger for co-integration is used to test for the existence of long-run association between RER and its key fundamentals. Fully modified ordinary least squares regression (FM-OLS) is employed to estimate the long run association between actual RER and its fundamentals. This method assists in estimating the long run association between RER and its fundamentales. Hodrick-Prescott filter (HP) is employed to smooth the predicted RER to estimate the equilibrium path and misalignments curve. The Markov Switching Model (MSM) is also applied to quantify the movements of the RER appreciation and depreciation and also misalignments episodes as overvaluation and undervaluation. The purpose of this regression is to obtain the likelihood to moving from one state to another.

This study will also employ Auto Regressive Distributed Lags (ARDL) and Vector Auto Regressive (VAR) to discover the association between RER misalignments and the main macroeconomic indicators. In addition, the Keynesian simultanous equation model is used to obtain the impact of RER misaligments on macroeconomic variables in this model. A Full Information Maximum Liklihood (FIML) method is used to estimate the reduced form parametrers. A Three Stage Least Sequres (3SLS) is also used to estimate the stractural parameters of the Keynesian model. The model of dynamic stochastic general equilibrium (DSGE) is applied to be consistent with the Libyan scenario depending on the New Keynesian Model. The main aim of this model is to assess the role of monetary policy and forecast future expectations for inflation and misalignments depending on GDP gap in the economy.

Chapter 2 the Libyan Economy: An Overview

2.1 Introduction

Libya is an oil-exporting country, which extensively relies on oil production for obtaining foreign exchange resources. For a long period, the dependence on oil stayed almost at the same level, earning more than 90 percent on average of the foreign exchange resources from oil (CBL, Economic Bulletin, 2010). This dependency makes any shocks in oil products rapidly influence the whole economy significantly. The country has faced many difficulties in lack of foreign exchange, when oil prices or oil exports have fallen. However, the structure of the economy determines whether the appropriate policy in order to address the shortage of foreign exchange is an adjustment of the nominal exchange rate or restriction of import quantities with foreign exchange controls. These two polices are the most popular trade polices to control foreign exchange resources. They have a direct impact on the inflation rate, black market premium of foreign exchange and RER misalignment via changes in the inflation rate and nominal exchange rate. The country does not have enough control to reduce the high levels of inflation that it may face. Therefore, high price levels with the official exchange rate almost fixed may create a very high level of misalignment of local currency.

Noticeably, economic policy makers are focusing on the trade and current account, but they have not significantly focused on misalignments in the RER, as a main indicator for improving international competitiveness. In particular, the Libyan economy is always trying to promote non-oil product and non-oil exports in order to create alternative foreign exchange sources other than oil. It is also very important for importing goods and services from abroad efficiently and to provide an appropriate economic environment for local production. In this aspect, the most important developments of the main structural features and policies in the Libyan economy will be reviewed in order to find out the economic structure.

This chapter is divided into nine sections. Section 2.2 describes the location and population of Libya. Section 2.3 is about the main developments of the Libyan currency. Section 2.4 describes the foreign exchange market in the Libyan economy. Section 2.5 focuses on the exchange rate regime in the Libyan economy. Section 2.6 shows the main indicators of the Libyan economy, particularly that related to foreign exchange resources. Section 2.7 describes the main trading partners in exports and imports with Libya. Section 2.8 clarifies the policy of devaluation of the national currency. Section 2.9 concludes the chapter.

2.2 Demography of Libya

Libya is as a small developing country, located in North Africa covering an area of approximately 1,760,000 square kilometres, with a very long coastline about 1900 kilometres next to the Mediterranean Sea (Bait-El-mal et al., 1973). The population was about 6,278,438 in 2017 (CBL, Economic Bulletin, 2018). This is considered a very small population compared with counties around Libya. The country is bordered on the east by the Republic of Egypt and Sudan, on the west by the republics of Tunisia and Algeria and in the south by the Republics of Niger and Chad. Libya has a wide border with neighbouring countries, which is difficult to control borders for the international trade. The imbalance with neighbouring countries has caused Libya to lose many opportunities to maintain foreign exchange or to benefit from its import which are re-exported to neighbouring countries in the barrel market.

2.3 Developments of the Libyan currency

When Libya gained independence from Italy on 24 December 1951, there was no official Libyan currency and monetary sector. Instead, three currencies were traded in Libya prior to its independence, after World War II: the military lira or Mal (which means money in Arabic) in Tripolitania (west of Libya), the Egyptian pound in Cyrenaica (east of Libya) and the Algerian franc in Fezzan (south of Libya). The first Libyan currency was the Libyan pound issued on 24/3/1952, only three months after independence. The issuance of the Libyan pound was the responsibility of an interim committee called the Monetary Committee before the establishment of the Central Bank. The value of the pound was set at equivalent value with the pound sterling. In

1956, the Central Bank was established under the name of "National Bank of Libya", which was assigned to the task of issuing the currency. It was divided into two departments, the issue department and the banking department (International Bank for Reconstruction and Development, 1960).

In 1958, Libya joined the International Monetary Fund (IMF), which required the value of the national currency to be determined in gold or the US dollars. The Libyan pound was valued at 2.48828 grams of gold, or $ 2.8, which was equivalent to one Great British GB pound (GBP). The Banking Law No. 4 of 1963 was issued to confirm the value of the Libyan pound. On 18/11/1967, Britain devaluated the pound sterling, but Libya did not follow Britain in that reduction. The rate changed to £1.16 for 1 Libyan pound. Accordingly, the Libyan pound was pulled out of the sterling. In August 1971, America stopped changing the dollar to gold, and in December 1971 America reduced the value of the dollar by gold for the first time, to be one ounce of gold = $ 38, instead of $ 35. In February 1973, America cut the dollar again to an ounce of gold for $ 42. On 1/9/1971, the name of the Libyan pound was changed to be the Libyan dinar. During the period from 1968, the disengagement from the sterling, until the beginning of 1973, the Libyan pound or the dinar was floated and changed in value depending on the circumstances of the dollar. (International Bank for Reconstruction and Development, 1975). In 1973, the dinar was pegged to the US dollar at a rate of 3.3778$ for one Libyan dinar which continued until 1986 (CBL, Annual Report, 1993).

On 28/3/1986, the dollar was abandoned and the dinar was linked to the Special Drawing Rights (SDR[1]), issued by the International Monetary Fund (IMF), which depends on a basket of five currencies: the dollar, euro, yen, pound sterling and yuan (IMF, 2011). During the 1990s, the Libyan dinar was devalued several times, including the largest devaluation in 2002 because of the lack of foreign exchange at that time. On 01/01 2002, the dinar was devalued dramatically from 1.2240 to 0.6080 SDR for one Libyan dinar, a drop of about 50.3%. On 14/6/2003, the CBL also devalued the dinar by 15% in response to the request of the International Monetary Fund (CBL, Annual Report, 2004). This policy was applied to eliminate the double exchange rate because of the imposition of fees on the sale of the dollar. These fees were about 15%

[1] The SDR is an international reserve asset, issued by the IMF in 1969. Its value is founded on a basket of key international currencies (IMF, 2011).

in the private sector for the Industrial River Tax, with an exemption for the government sector (CBL, Economic Bulletin, 2010). In recent years, following the significant rise in prices of the black market of foreign currencies, the CBL issued a resolution in the beginning of 2018, to impose a tax on selling dollar (CBL, Annual Report, 2018).

2.4 Foreign Exchange Market

In general, the exchange rate can be defined as units of foreign currency required for a unit of local currency (for example, 1 Libyan dinar = 0.80 US dollar). It can also be defined in an inverse way as units of national currency equal to one unit of a foreign currency (for example, 1 US dollar = 1.25 Libyan dinar). Some economists use the first definition and others employ the second one, but both definitions lead to the same meaning. It is noticed that, in the developed countries whose currencies have international acceptance, the first definition is mostly used to compare their currency against other currencies. In the developing countries, the main interest is usually in the foreign currency, as one unit of foreign currency against their local currency as defined by the second definition.

The foreign exchange market is the market where foreign currencies are sold and bought. This market is different from the stock and bond market in that there is no specific location for this market. It consists of buyers and purchasers of foreign currencies, for example exporters and importers, international investors who supply or demand foreign currencies. The main reason for this market is that many international transactions require payment in foreign currencies, not in the local currency. For instance, if a person or a company wants to import computers from Japan, he must sell the local currency to buy the Japanese yen to pay for these imports. Therefor he goes to the foreign exchange market to supply the national currency (Libyan dinars) to get the Japanese foreign currency or any other internationally accepted currency. Thus, imports of goods and services create a demand for foreign exchange, while exporting goods and services generates a supply of foreign exchange. For example, if a Libyan oil marketing company sold a shipment of crude oil to the United Kingdom may pay in sterling or in any other internationally accepted currency, for its crude oil imports. The oil company may change this foreign currency to the Libyan currency to pay for workers. Thus, exports will create a foreign exchange supply (Elfeituri 1992).

2.4.1 Demand and supply of foreign exchange

Foreign exchange demand can be expressed by total import and capital outflows. Since Libya is a small country and its currency is not internationally accepted, all imports and capital outflows are paid in foreign exchange currencies. A number of factors affect the demand and supply of foreign exchange as illustrated in table 1.

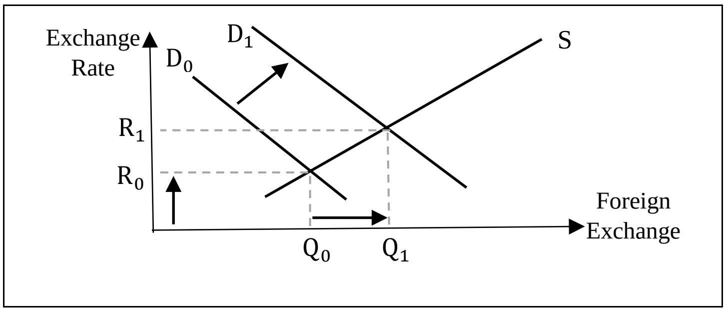
Table 1. Foreign exchange demand factors

1- Income.	2- Level of prices.	3- Interest rate
Local Income increase ↓ Increase spending on domestic products and imports. ↓ Increase the demand of foreign exchange	Domestic prices rise ↓ Demand will change from local products to imports ↓ Increase the demand of foreign exchange.	interest rate decrease ↓ Capital outflows for investment abroad. ↓ Increase the demand of foreign exchange.

Source: Elfeituri (2000)

An increase in income, price levels and a decrease in interest rate will move the foreign exchange demand from D_0 to D_1 increasing the exchange rate from R_0 to R_1 in figure 2. The opposite may also occur in the case of domestic income decrease, reduction of price levels and interest rates increase. These changes will decrease the demand of foreign exchange and the exchange rate. The local income and domestic prices have a positive association with foreign exchange demand, while interest rate has a negative linkage.

Figure 2. Change in the demand of foreign exchange



Source: Elfeituri (1992)

As for the supply of foreign exchange, it can be accounted by the aggregate exports of goods and services as well as capital inflows. A number of factors that can affect the supply of foreign exchange are shown in table 2.

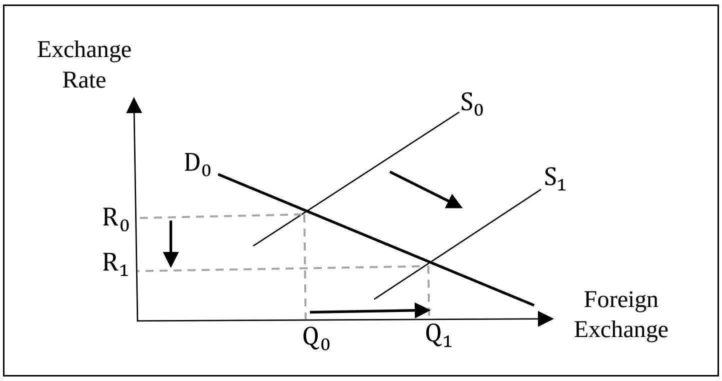
Table 2. Foreign exchange supply factors

1- Foreigners' income	**2-** Level of prices.	**3-** Interest rate
Foreigners' income increase. ↓ Increase the demand for domestic goods and services lead to increase the exports. ↓ Increase the supply of foreign exchange.	Local prices decrease. ↓ Increase the exports and decrease the imports. ↓ Increase the foreign exchange supply.	Interest rate rise. ↓ Increase the inflow to invest in this country. ↓ Increase the foreign exchange supply.

Source: Elfeituri (2000)

Table 2 shows that foreigners' income increase, domestic price level decline and interest rate increase will move the foreign exchange supply from S_0 to S_1 decreasing the exchange rate from R_0 to R_1 and increasing foreign exchange supply from Q_0 to Q_1 in figure 3. The opposite may also occur in the case of foreigners' income decrease, local price level rise and interest rate decrease. These changes will increase the exchange rate and decrease foreign exchange supply. Foreigners' income and interest rate have a positive association with foreign exchange supply, while domestic price level has a negative association.

Figure 3. Change in the supply of foreign exchange

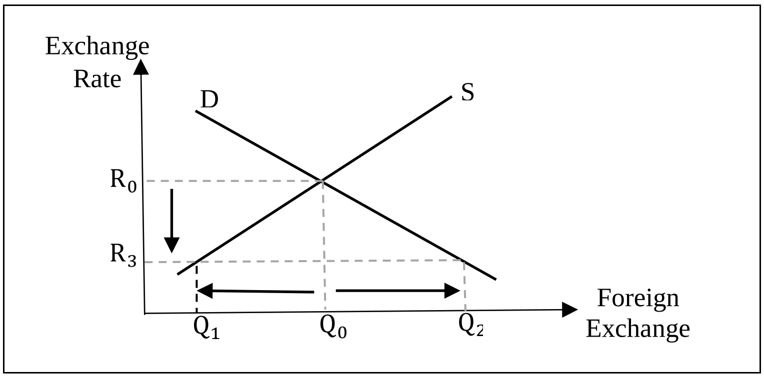


Source: (Elfeituri 1992)

2.4.2 Equilibrium foreign exchange

The balance in the foreign exchange market occurs when the demand side is equal to the supply side. At this level of equilibrium, the balance of payments will be balanced in all external transactions at level R_0 of exchange rate and Q_0 of foreign exchange quantity. Assuming that the exchange rate decreases to R_3 leading to an increase in local currency value, this change will make the demand for foreign exchange greater than the supply. Then, the balance of payments may suffer from deficit $(Q_1 - Q_2)$. This assumption will apply if the country follows the exchange rate system in accordance with the market mechanism, as shown in figure 4.

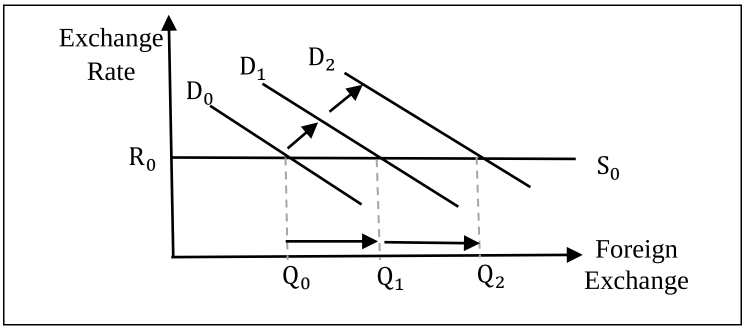
Figure 4. Equilibrium of foreign exchange



Source: (Elfeituri 1992)

On the other hand, when the country follows a fixed exchange rate regime with its full capacity to provide the demanded quantity of foreign exchange, the country will be in a stable situation and the black market for foreign currencies will not appear. The nominal exchange rate will be at level R_0 indicating that there is no presence of the black market when the quantity adjusts from Q_0, Q_2 to Q_3. The level of official exchange rate in that situation should be chosen efficiently. It should be compatible with monetary, fiscal and trade policy in the economy. This situation occurred in Libya in the periods when the country had large amounts of foreign exchange revenues obtained from oil exports compared to the foreign exchange demand. This situation happened in Libya during the 1970s and during 2002 - 2010. Figure 5 shows this case:

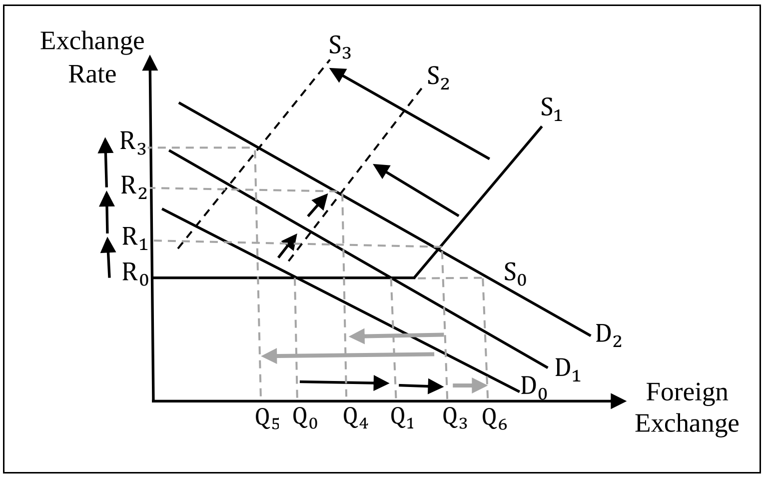
Figure 5. Foreign exchange market with no foreign exchange controls



Source: Elfeituri (1992)

On the contrary, when the country faces a shortage of foreign exchange at the fixed rate, the demand for foreign exchange will increase from D_0 to D_1 without any controls on supply of foreign exchange. Foreign exchange demand will also increase from Q_0 to Q_1 without any foreign exchange rate increase at level R_0 (no black market rate). If the demand increases from D_1 to D_2 , the supply curve will change from S_0 to S_1 to have a positive slope, to express a decline in the supply side. The supply of foreign exchange is not sufficient for the demand, then a black market in foreign exchange will appear. The exchange rate will increase from R_0 to R_1 and the quantity will be just Q_3 instead of Q_6. If there is further decrease in the supply side, the supply curve will shift from S_1 to S_2 to S_3 causing increase in foreign exchange rate in the black market from R_1 to R_2 to R_3 and reducing the quantity from Q_3 to Q_4 to Q_5 as shown in figure 6.

Figure 6. Foreign exchange market with foreign exchange controls



Source: Elfeituri (1992) and Author's work

In the Libyan economy, the country experienced such a black market from the mid-1980s to the end of 1990s when the prices of oil went down sharply. The country suffered from the lack of foreign exchange revenues, but policy makers did not directly increase the official rate of exchange rate to eliminate the black market premium. Instead, they applied severe restrictions on imports and controls on foreign exchange to reduce the foreign exchange demand. All of these policies helped to increase the black market exchange rate.

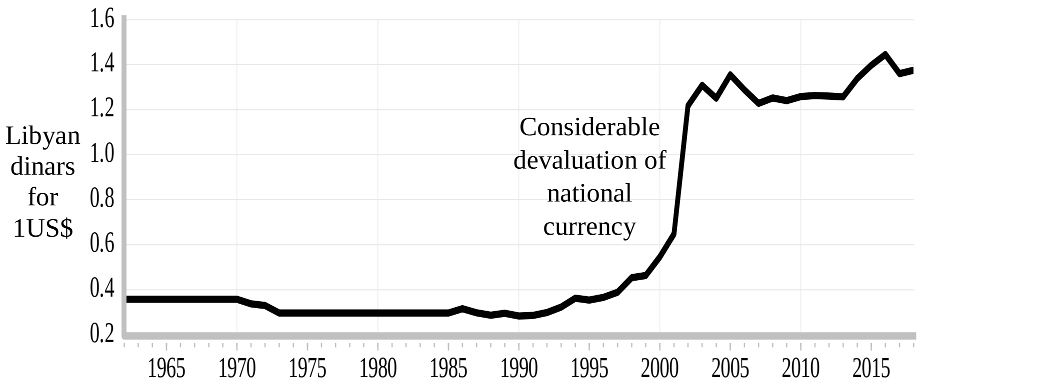
In recent years, the black market in foreign currencies came back at a very high level this time because of the sharp decline in Libyan oil exports. The black market started in in mid of 2014 due to the civil war in Libya after revaluation 2011. The official foreign exchange rate for the US dollar was 1.3960, while in the black market reached about 9.75 dinar for one US dollar of at the end of 2017. It increased more than seven folds because of the decline in the daily average oil production to just 0.4 and 0.5

million barrels during 2015 and 2016 respectively, compared to 2010, it was on average 1.7 million barrel a day (CBL, Annual Report, 2018).

2.5 The Libyan exchange rate regime

The exchange rate of the Libyan dinar was fixed from 1962-1986, except for slight changes during 1970-1973. In 1986, for more flexibility of the exchange rate, the CBL pegged the Libyan dinar to SDR rather than the US dollar. The exchange rate was 1 LY D = 2.8 SDR, with an allowed range to increase or decrease at margin rate 7.5% and changed many times. The main changes in the nominal exchange rate indicator are shown in figure 7. At the beginning of the 1980s, the balance of payments suffered from a considerable deficit due to a huge amount of government expenditure on development projects during the1970s (Central Bank of Libya, Economic Bulletin, 2006).

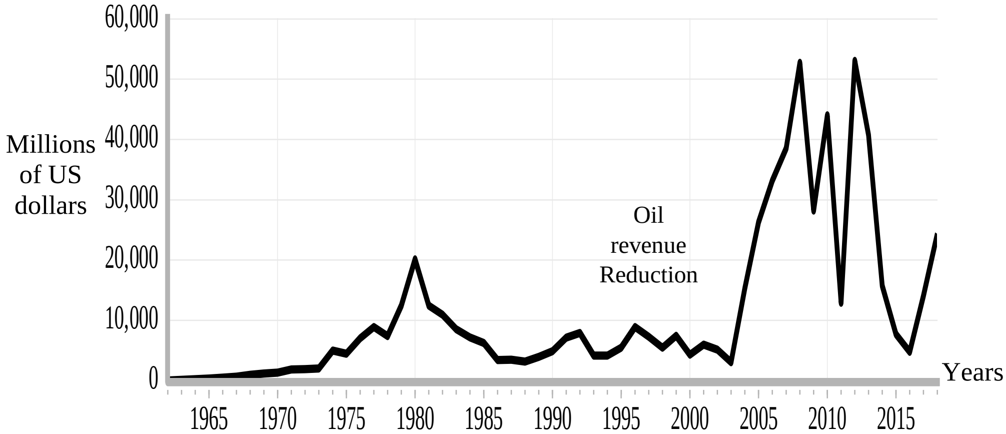
Figure 7. Nominal exchange rate in Libya 1962-2018



Sources: IFS & CBL-economic bulletin, various issues

Also at the mid-eighties, the Libyan economy experienced a reverse petroleum price shock due to the economic recession in industrialized countries, which inversely affected Libyan oil revenues, as shown in figure 8.

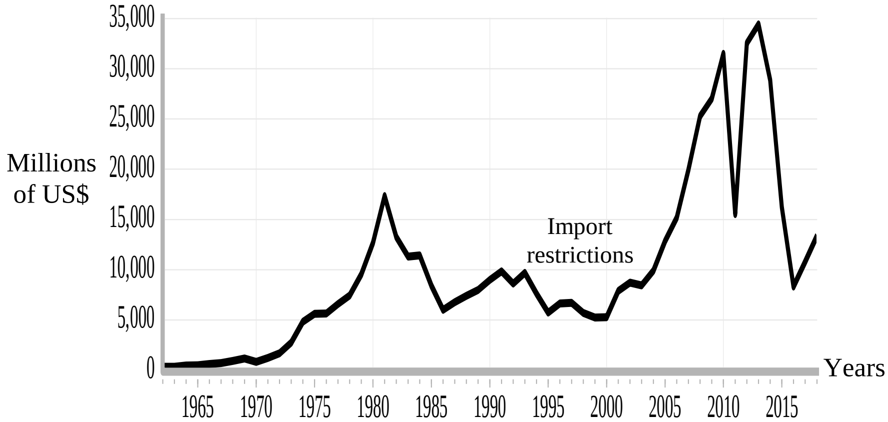
Figure 8. Libyan oil revenues during 1962-2018



Sources: Economic and social data in Libya 1962-2006 & CBL-economic bulletin, various issues

Consequently, the Libyan authorities had to carry out some policies to tackle that deficit. These policies included a direct policy of intensifying import restrictions to restrict imports and foreign exchange controls while keeping the nominal exchange rate at the same rate. These policies affected the value of imports significantly as shown in figure 9. It declined from 17320.29 million US dollar in 1981 to just 6017.07 million US dollars in 1986. This means the total imports in 1986 reduced to just approximately to about 35% of the total imports in 1981 (Elfeituri 1992).

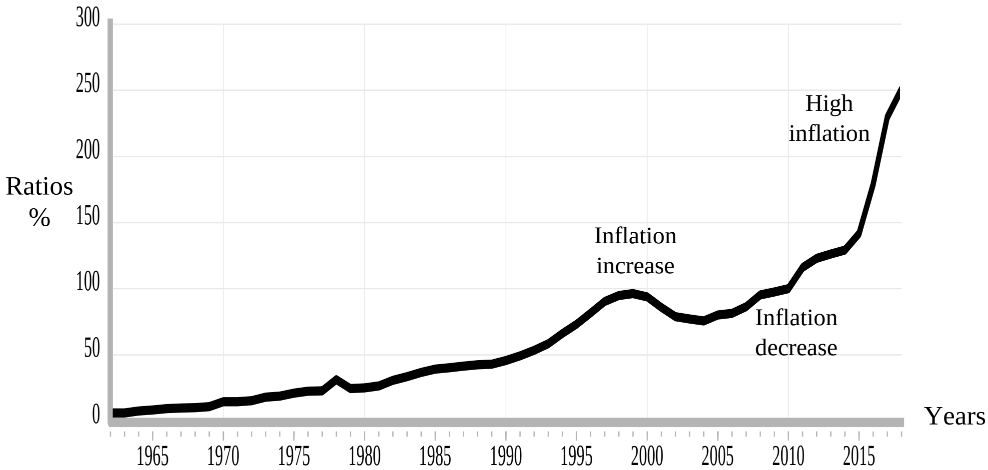
Figure 9. Total imports in the Libya during (1962-2018)



Sources: Economic and social data in Libya 1962-2006 & CBL-economic bulletin, various issues

The large decrease in total imports directly influenced the price level because the Libyan economy greatly depends on imports for the consumption and investment sectors. The price level increased significantly during the 1990s as shown in figure 10.

Figure 10. Consumer prices level 2010 during 1962-2018



Sources: IFS & CBL-economic bulletin, various issues

These policies resulted in two exchange rates in the economy, one announced by the CBL and another one in the parallel market. To counteract this problem, the Libyan monetary authorities applied a new programme during 1999-2001, which allowed sale of foreign currencies through the commercial banks at prices determined by CBL. These prices steadily increased to eliminate the black market of foreign exchange gradually, as well as to realign the domestic price level. On 24.12.2001, the CBL issued Resolution No 49 for the Libyan dinar exchange rate against foreign currencies. This change determined the exchange rate at 1 LYD for 0.77$ which equivalent of 1 LYD for 0.608 SDR. This rate was implemented on 1.1.2002. In addition, on 14.06.2003, the CBL issued Resolution No 17 for adjustment of the Libyan dinar exchange rate to be 1 LYD for 0.5175 SDR. It is a fixed exchange rate of one unit of SDR but the rate of exchange against foreign currencies changes according to the volatility of the basket currencies against the SDR (CBL, Annual Report, 2004).

During 2002-2010, the CBL adapted its policy to shift the economy towards liberal policies and a market economy, including significant changes in the nominal exchange rate. The monetary authorities applied a new policy to achieve some objectives such as stability of prices and economic growth. Despite the sharp devaluation of the local currency, which theoretically could have led to an increase in the prices level, the economy unexpectedly experienced a decline in the level of prices after 2002, as in figure 4. The main reason for this decrease was the rise in the level of imports, which play a crucial role in the stability of prices. In recent years, the lack of foreign exchange led to high levels of inflation and black market exchange rate because of the political strife and blockaded oil infrastructures, which led to lower oil production. Petroleum production decreased from 1.8 million barrels per day in 2009 to just about 0.4 to 0.5 million barrels per day during 2014-2016(CBL, Annual Report, 2017). At the beginning of 2018, the CBL imposes a tax on the sale of the US dollar by about (183%) of the official rate. This policy has made the nominal rate to increase from 1.39 to about 3.90 dinar for one US dollar. The main purpose of this policy is to reduce the black market exchange rate. The CBL did not change the nominal exchange rate officially, is just a tax and will be gradually reduced (CBL, Annual Report, 2018).The tables 3 and 4 show the official exchange rate changes.

Table 3. Exchange rate policies in Libya 1962-2018

Episode	Period	Policy
1	1962-1967	Purely fixed exchange rate policy (Pegged to Sterling Pound).
2	1968-1973	Pulled out of the sterling.
3	1974-1985	Purely fixed exchange rate policy (Pegged to US dollar).
4	1986-2000	Relatively flexible exchange rate (Pegged to SDR).
5	2001-2002	Considerable devaluation of national currency (Pegged to SDR).
6	2003-2017	Flexible exchange rate policy (Pegged to SDR).
7	2018	Imposition a tax on the exchange of the US dollar about (183%) of the official rate.
8	2019	The tax is reduced to about (163%) of the official rate.

Source: CBL- Annual Report, various issues

Table 4. Nominal exchange rate changes

year	NER US dollar / 1LYD	% Change
1962	2.857	-
1970	2.857	0
1973	3.370	17.956
1986	3.226	-4.273
1990	3.571	10.694
2001	1.667	-53.318
2002	0.791	-52.549
2018	0.717	-00.074

Source: IFS- data base & CBL- Economic Bulletin, various issues

2.6 The main indicators in the Libyan economy

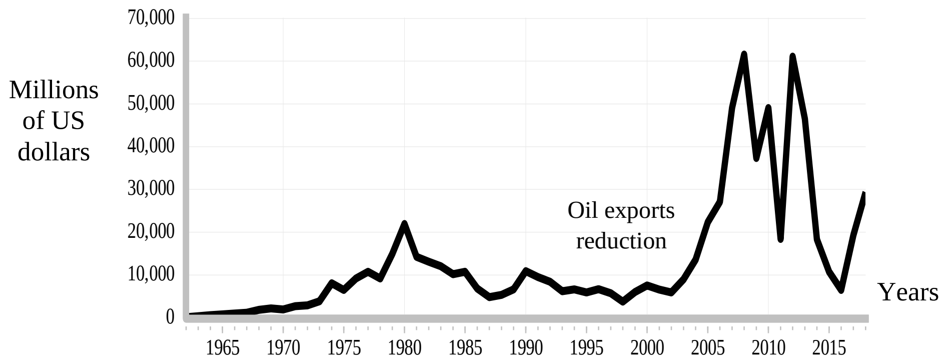
This section will show some economic indicators that related to foreign exchange resources as well as indicators that related to macroeconomic policies. These indicators will explain more about the economy's structure.

2.6.1 Oil exports and non-oil exports

Exports in Libya are divided into two categories, exports of crude oil and non- oil exports. The value of oil exports depends on the oil prices and oil production, as well as on Libya's share in the Organization of the Petroleum Exporting Countries (OPEC). Oil exports began to increase gradually after the Libyan oil exporting was in commercial quantity from the early sixties, which reached about 21909.8 million dollar in 1980. In the early 1980s, oil exports value decreased significantly because of the decline in world oil prices. The lowest value in the eighties was in 1987 just about 4791.4 million US dollars, while by1998 it was just about 3748.4 million US dollars. The value of crude oil exports value increased very significantly after 2002 due to the improvement in oil prices. The highest value of oil exports was in 2008 at about 63016.8 million US dollars.

After the revolution in 2011, the situation changed completely. Oil exports value declined dramatically, not because of the low oil prices this time as oil prices were at a very high level, but due to the civil war and political and security instability. It led to the cessation of production in most oil fields. The lowest value was recorded in 2016 which was just about 6763.4 million US dollars. This decline was the main reason for the unprecedented rise in foreign exchange rates in the black market, with a high level of inflation. By the end of 2017, a gradual increase in the value of oil exports began after the security situation improved, to reach almost 17563 and 28741 million US dollars in 2017 and 2018 respectively. Figure 11 below illustrated all of these changes:

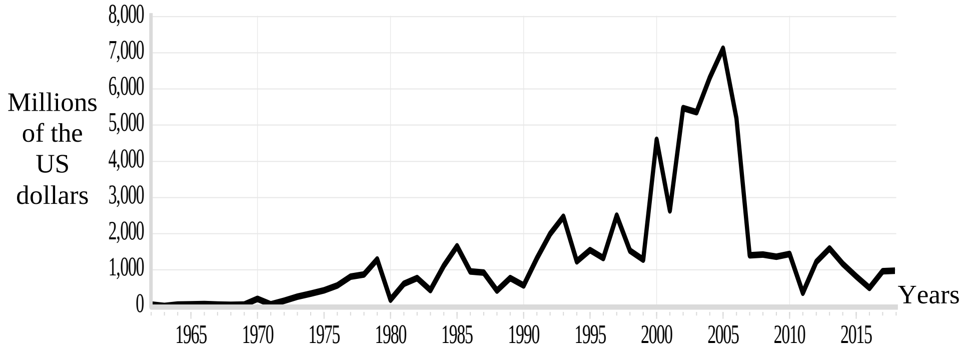
Figure 11. Oil exports in Libya 1962-2018



Sources: Economic and social data in Libya 1962-2006 & CBL-economic bulletin, various issues

As for non-oil exports, the country has tried several times to develop this sector as an alternative source to oil for obtaining foreign exchange. The non-oil exports sector began to appear in the early 1970s, but it was fluctuating and at a low level. This may due to the country's policy of setting a low level of foreign exchange rate (high level of local currency value). This policy stimulates imports to increase but does not motivate an increase in non-oil exports. In addition, the policy makers applied restrictions on imports, including investment imports that affected the domestic industries. The Government also only supported public projects and did not encourage the private sector to promote export-oriented industries. After the considerable national currency devaluation at the beginning of the new millennium, non-oil exports increased sharply during 2000-2006. The highest value was in 2005, about 7374.3 million dollars. The country put in place many development plans to increase the value of non-oil exports after 2002. The considerable devaluation of national currency along with the elimination of restrictions on imports, particularly investment imports, played a significant role in improving the situation. These policies have assisted greatly to increase non-oil exports. In recent years, however the non-oil exports sector has deteriorated significantly due to security and politically instability, as illustrated in figure (12).

Figure 12. Non-oil exports in Libya during (1962-2018)



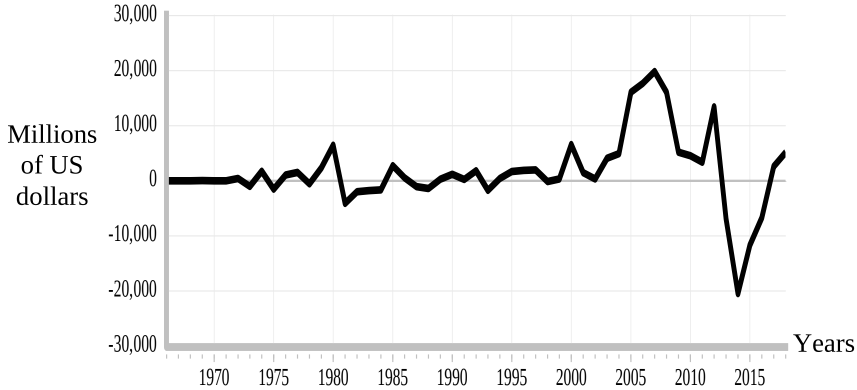
Sources: Economic and social data in Libya 1962-2006 & CBL-Economic bulletin, various issues

2.6.2 Balance of payments

The balance of payments is the balance of all external transactions between residents of a country and abroad during a certain period. All transactions in the balance of payments are recorded either in the form of foreign exchange demand, such as imports and capital outflow, or foreign exchange supply, for instance exports and capital inflow. The balance of payments situation has a direct impact on local currency value, and therefore on price levels, particularly in countries that depend heavily on imports. The Libyan balance of payments in figure 13 shows that the first considerable deficit was in 1981 about -4125 million US dollars. This deficit was due to the beginning of the decline in oil prices, as well as the large expenditures are spent by the government for development projects during the 1970s, which required a great amount of foreign exchange. After that, policy makers had to apply austerity economic policies represented in a great reduction in total imports and strict control of foreign exchange at the official rates. These policies led to remarkable improvements in the balance of payments situation, which continued for a long time. At the end of the nineties, the situation started to improve gradually, and the increase in oil prices at the beginning of the new millennium assisted that trend. The balance of payments achieved a huge surplus, reaching to about 19793 million US dollars in 2007.

After the Libyan revolution in 2011, the surplus in the balance of payments decreased markedly but it quickly recovered in 2012. At the end of 2013, a new situation occurred in the country, the balance of payments suffered from a very sharp deficit, which continued to the end of 2017 as shown in figure 13. The main reason for this deficit was the outbreak of civil war and the closure of oil fields, almost completely in some cases. The highest deficit was in 2014, about -20484.3 million US dollars. The new situation is causing many problems in the economy, such as high level of inflation, black market premium and low economic growth.

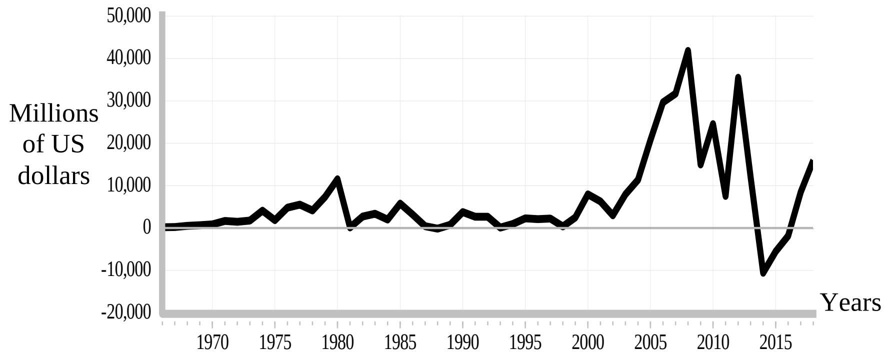
Figure 13. Net payments balance in Libya 1966-2018



Source: CBL-Monetary and financial statistics 2017& CBL-Economic bulletin, various issues

The trade balance is part of the balance of payments. It represents the difference between commodity exports and imports. It highly depends on the oil sector. The level of surplus in this balance is more than the surplus in the total balance. It reached about 41796.6 million US dollars in 2007, while the surplus in the total balance in the same year was about just 16075.9 million US dollars. The trade balance suffered from a great deficit in 2014, about -10554.4 million US dollars as shown in figure 14.

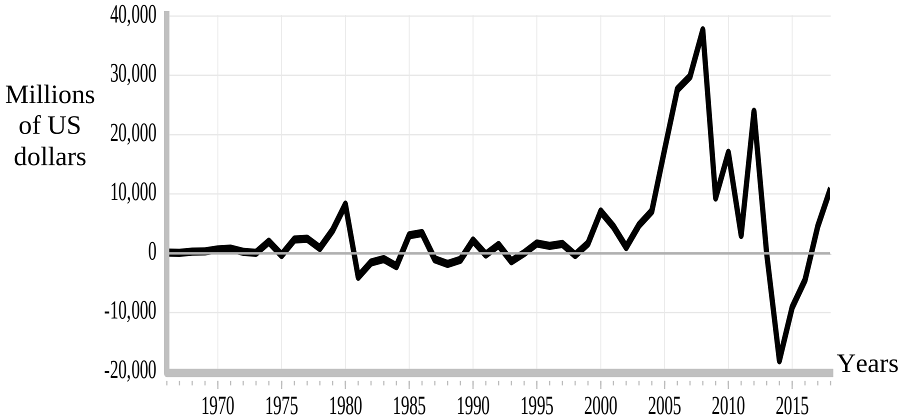
Figure 14. Net trade balance in Libya 1966-2018



Source: CBL-Monetary and financial statistics 2017 & CBL-Economic bulletin, various issues

The reason for that was a sharp drop in Libyan oil exports of crude oil, although the oil prices was at a high level at that time. This value of the deficit was less than the deficit in the total balance, which was approximately -20484 million US dollars. The current account includes other accounts that are not in the trade balance, which includes the services balance, investment income balance and current transfers balance. Always, the current account has a value of surplus less than the value of the trade balance surplus, due to the permanent deficits in other balances in current account. Figure 15 shows that the maximum surplus was in 2008 reached about 37619.3 million US dollars, while it was approximately 41796.6 million US dollars in the trade balance in the same year. The deficit in the current balance is always higher than the deficit in the trade balance for the same reasons. It was about -18067.2 million US dollars in the current account in 2014, while it was just -10554.4 for the trade balance in the same year.

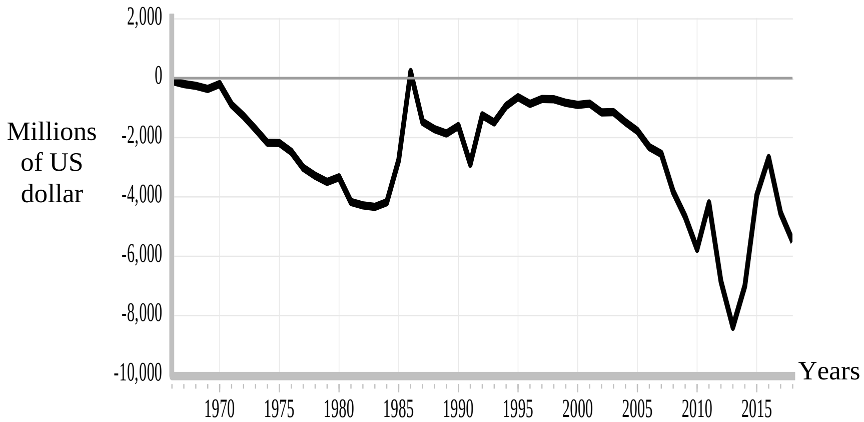
Figure 15. Net current balance in Libya 1966-2018



Source: CBL-Monetary and financial statistics 2017 & CBL-Economic bulletin, various issues

One of the major differences between the trade balance and the current account balance is the balance of services. This balance consists of two sides: debtor and creditor. The debtor side represents the demand for foreign exchange, which means residents' demand for services provided by foreigners such as health and education services. On the other side is the creditor side, which represents residents' supply of services to foreigners. The difference between the two sides in the form of the creditor side minus the debit side gives the net value of the services balance. The services balance had an increasing deficit at high levels during the seventies. The development projects, which were implemented by the government in the seventies, necessitated a large demand for foreign services. This meant an increase in the demand side of foreign exchange, which eventually turned into a demand for import services. On the contrary, in the mid-eighties when the authorities applied austerity policies to reduce imports of goods and services, this led to a significant decrease in deficit in this balance. After 2002, the policy of the government changed to more liberalization to increase imports and less applied foreign exchange controls. The services balance had more deficit due to spending on government projects. The decline in oil revenue due to the civil war in Libya 2014 led to a decrease in demand for foreign services, as shown in figure 16.

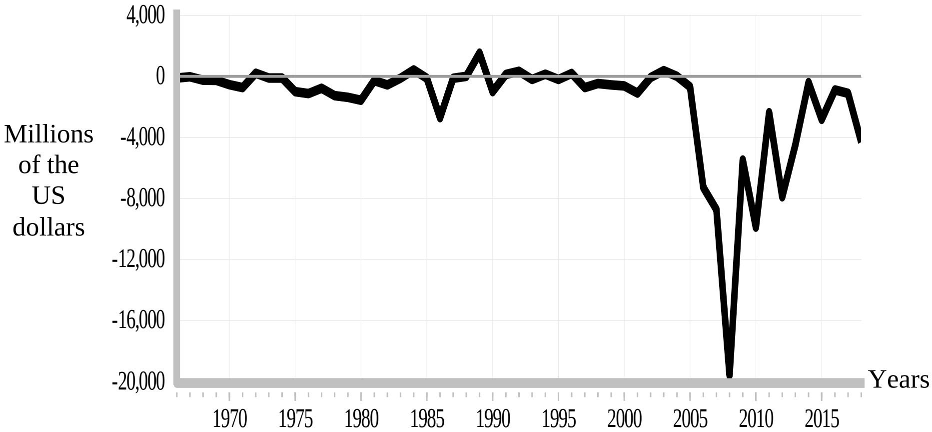
Figure 16. Net services balance in Libya 1966-2018



Source: CBL-Monetary and financial statistics 2017& CBL-Economic bulletin, various issues

The Capital account also plays a significant role in the total balance. In general, the net capital account can be defined as the difference between the movements of capital inflow and capital outflow. Then, a positive value means capital inflows are greater than capital outflows and vice versa. By tracing this curve in figure 17, it is moving depending on the balance of payments situation. When the balance of payments is in surplus, the authorities employ this excess in foreign exchange in the form of capital outflows. The movements of the capital balance reflect the movement in the total and trade accounts. When the country achieves a surplus in its trade account, it transfers this as capital outflow, which in turn causes a deficit in the capital account. In the period 2005-2010, the country earned a huge amount of foreign exchange from oil exports and the capital account witnessed a considerable deficit because of the increase in capital outflows. In a small economy such as Libya, the economy may be unable to absorb all oil revenues in some years; therefore the authorities invest this surplus in the form of buying investment assets abroad.

Figure 17. Net capital account balance in Libya1966-2018

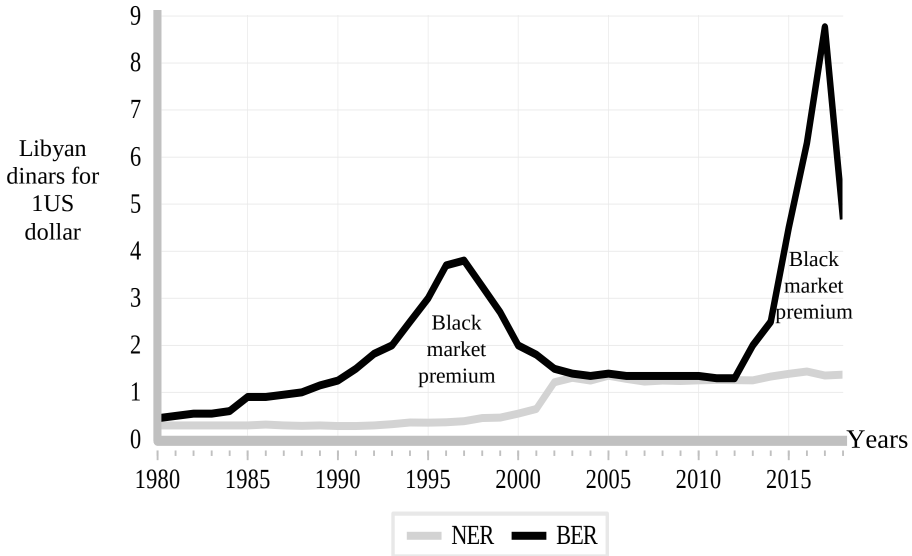


Source: CBL-Monetary and financial statistics 2017& CBL-Economic bulletin, various issues

2.6.3 Black market premium in the Libyan economy:

The Libyan economy witnessed two periods of high levels of black market premium. In both cases, the sharp fall in oil revenues was the main reason for that. The first period of high black market exchange rate started in the mid-1980s when world oil prices went down. This decline led to a sharp decrease in oil revenues and balance of payments deficit. Directly, the authorities restricted imports and tightened controls on changing the Libyan dinar to foreign currencies at the official rate. These policies caused serious problems in the economy. The Foreign exchange black market became larger, with a high level of inflation. The demand for foreign exchange increased in the informal market, driving to a huge difference between the official and black market exchange rates. It reached its peak in 1997 about 3.75 dinar for one US dollar, which is 10 times the official rate, as shown in figure 18. Monetary policy in that period was not well defined to shrink the inflation when this problem started. At the end of the nineties, the CBL allowed commercial banks to sell foreign exchange at prices that gradually decreased to reduce the black market rate. In 2002, the CBL announced a considerable devaluation at 1.21669 LYD for 1 US dollar. The policy makers also removed the restrictions on imports and foreign exchange controls and implemented the devaluation policy at the same time. The situation completely changed and inflation went down noticeably. In the period 2002-2010, the economic situation stabilized, particularly, with the rise in oil prices, which achieved a large amount of foreign exchange reserves. All of these changes made the nominal exchange rate very close to the black market rate.

Figure 18. Official and black market exchange rate in Libya 1980-2018



Sources: CBL-Economic bulletin, various issues & Records of gold shops in Libya

After the Libyan revolution in 2011, the country suffered from a sever lack of foreign exchange resources because of the civil war and oil production decline, although oil prices were at a high level in that time. This led to a high level of black market exchange rate[2].The black market exchange rate increased significantly after mid-2014 to reach at the end of 2017 about 9 times the official rate. During this period, the economy suffered from unprecedented inflation rates as well as a sharp decline in imports, exports, consumption, investment and government spending.

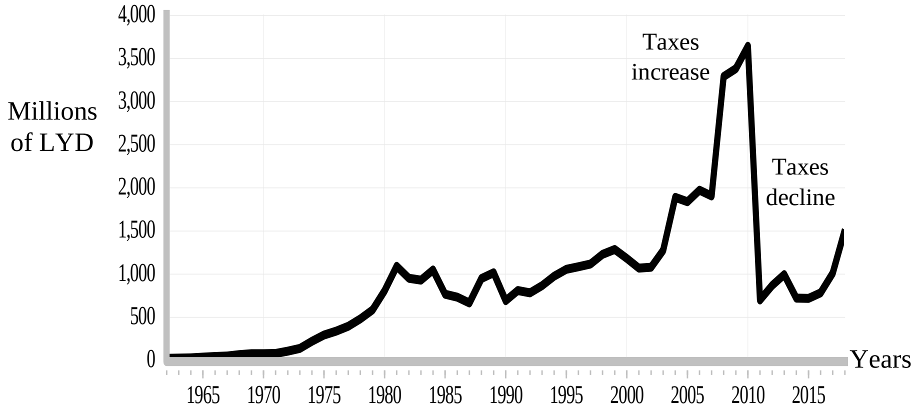
2.6.4 General expenditure and taxes

The Libyan economy depends very heavily, for covering its public expenditure, on revenues obtained from the oil sector. The total tax revenue only represents a very small proportion of total public expenditure. The ratio of total tax revenues to total public spending was just 1.5% percent in 2013. The general expenditure was 65283.5 million LYD, while the tax revenue was just 992.6 million LYD. Total tax revenues in Libya witnessed a remarkable improvement during the period 2000-2010, reaching a maximum value about 3641.4 million LYD in 2010. On the contrary, after the Libyan revaluation in 2011, the country lost control over the collection of its tax revenues, which were just 720.4, 717.3 and 780.9 million LYD during 2014, 2015 and 2016

[2] The black market exchange rate reached 9.50 to 9.75 LYD for 1 US dollar in some days at the end of 2017.

respectively. This sharp decline in total tax revenues does not mean that the country has reduced the tax rate. It means that citizens were evading paying taxes to the government. The country's weakness in tax collection clearly reflected the deterioration of the level of services in all sectors in the country, which is classified as a failed economy, particularly in times when the country suffered from a sharp decline in oil revenues. In the period 2002-2010, the country tried to increase its tax revenues, as shown in figure 19.

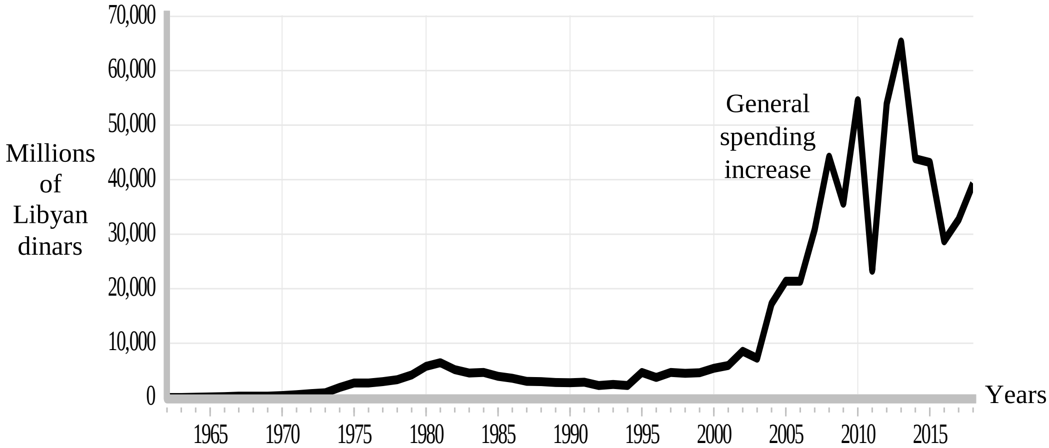
Figure 19. Total taxes in Libya 1962-2018



Sources: Economic and social data in Libya 1962-2006 & CBL-economic bulletin, various issues

However it is still a very small amount compared to the huge scale of public spending, as shown in figure 20. Public spending increased gradually from the discovery of oil until the early 1980s. The country reduced the volume of public expenditure when world oil prices went down, starting in 1982. The country relies heavily on oil revenues to finance public expenditure, rather than tax revenues. In the latter half of the 1990s, public spending increased gradually after world oil prices improved but in the period 2003-2010 it sharply increased due to the significant rise in world oil prices. In 2011, it suddenly decreased because of the revolution against the dictatorial regime, which lasted many months, from February to October 2011. In 2012 and 2013, general spending increased highly because of the state of optimism in building the country and the reparation of citizens for the damages that caused by the war. The closure of oil ports at the end of 2013, and the civil war in 2014 caused general expenditure to fall dramatically to very low levels. Recently, public spending has increased noticeably as government revenues from oil exports have improved.

Figure 20. Total general expenditure in Libya 1962-2018

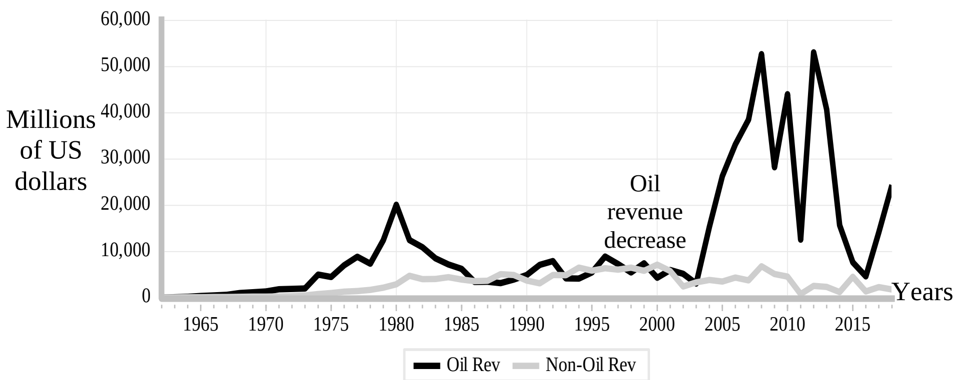


Sources: Economic and social data in Libya 1962-2006 & CBL-Economic bulletin, various issues

2.6.5 Oil revenue and non-oil revenue

Oil revenues increased significantly from the beginning of oil production in commercial quantities until the beginning of the 1980s. It decreased noticeably because of the oil price decline. In the period 2003 – 2010, oil revenue increased sharply because of the oil price recovery. The reverse situation took place after the outbreak of the Libyan revolution in 2011; oil revenues fell significantly because of the decline in exports of crude oil, despite the high oil prices during that period. There is no comparison at all between the value of oil revenues and non-oil revenues, particularly in the period 2003-2010. The differences between total spending and total taxes caused the public budget to suffer from a large deficit, particularly during the oil crises. However, oil revenues improved noticeably in 2017 and 2018 as shown in figure 21.

Figure 21. Oil and non-oil revenue in Libya 1962-2018

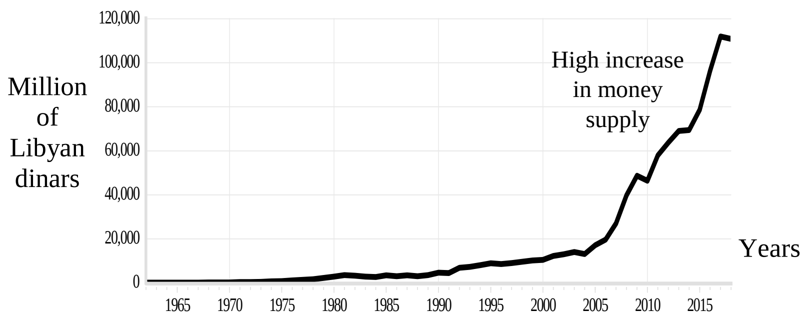


Sources: Economic and social data in Libya 1962-2006 & CBL-Economic bulletin, various issues

2.6.6 Money supply and interest rates

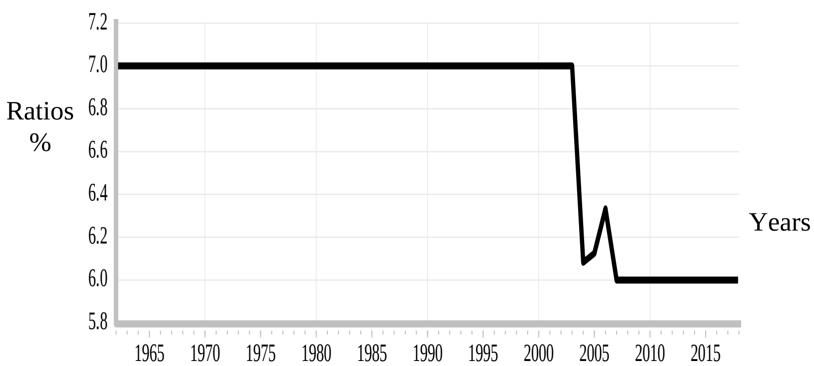
Policy makers in monetary policy focus on changes in money supply. It is the most monetary policy instrument most widely used in Libya. For a long time, the monetary policy makers kept the money supply at a low level, with a high value of Libyan currency. After 2002, the monetary policy was expansionary to increase the money supply. It was necessary to carry out a devaluation of the national currency. In recent years, money supply increased sharply because of the high level of prices and the Libyan dinar lost more than 7 times of its value. Also people began to keep their money in houses instead of banks because of the risk and the deteriorating security situation. All of these circumstances led monetary policy makers to increase the money supply in order to eliminate the problem of lack of liquidity in banks, as shown in figure 22. As for the nominal interest rate, this instrument does not have an important role in monetary policy, which is approximately fixed as shown in figure 23.

Figure 22. Money supply in Libya 1962-2018



Source: Economic and social data in Libya& CBL-Economic bulletin, various issues

Figure 23. Nominal interest rate for lending in Libya during 1962-2018



Source: IFS and CBL-Economic bulletin, various issues

2.7 Exports trading partners

As mentioned earlier, oil represents the vast majority of the total Libyan exports. Therefore, when the revenue of this sector declines, the economy suffers from a significant decline in its performance. Because of structural struggle, the economy has tried several times to develop the non-oil exporting sector to create a balance between these two sectors. In recent years there have not been many trading partners because of the reduction in oil production, as shown in table 5.

Table 5. Export trading partners (more than 1000 million Libyan dinar) in Libya 2007-2018

Year	Trading Partners	Exports Value	% from total exports
2007	Italy	17494	40.1
	Germany	5260	12.1
	Spain	3247	7.4
	USA	3218	7.4
	France	2734	6.3
	China	1407	3.2
	Switzerland	1256	2.9
	Greece	1217	2.8
	UK	1051	2.4
2008	Italy	23422	37.8
	German	7419	12
	France	4578	7.4
	Spain	4219	6.8
	USA	3954	6.4
	Switzerland	2828	4.6
	Greece	2487	4
	China	2343	3.8
	UK	1626	2.6
	Portugal	1365	2.2
	Brazil	1401	2.3
	Netherland	1141	1.8
2009	Italy	12986	36.7
	Germany	3588	10.1
	France	2886	8.2
	China	2873	8.1
	Spain	2721	7.7
	USA	1801	5.1
	UK	1187	3.4
	Greece	1114	3.1
2010	Italy	14437	26.9
	France	7266	13.5
	China	5161	9.6
	Spain	5083	9.5
	Germany	4697	8.8
	USA	2505	4.7
	UK	2204	4.1
	Greece	2103	3.9
	Netherlands	1225	2.3
	Austria	1134	2.1
	Portugal	1119	2.1

Year	Trading Partners	Exports Value	%
2011	Italy	4869	22.8
	Germany	3052	14.3
	France	3039	14.2
	China	2280	10.7
	Spain	1111	5.2
	Tunisia	1031	4.8
2012	Italy	15194	23.3
	Germany	8084	12.4
	China	7294	11.2
	France	6314	9.7
	Spain	4935	7.6
	UK	3069	4.7
	USA	2926	4.5
	Netherlands	2312	3.5
	Switzerland	1623	2.5
	India	1526	2.3
	Australia	1457	2.2
	Tunisia	1164	1.8
2013	Italy	9464	20.2
	Germany	7084	15.1
	France	4906	10.5
	USA	2968	6.3
	Spain	2938	6.3
	Netherlands	2443	5.2
	China	2332	5
	UK	2162	4.6
	Greece	1759	3.8
	Switzerland	1657	3.5
	Tunisia	1180	2.5
	India	1143	2.4
2014	Italy	6929	28.4
	France	2846	11.7
	Germany	2593	10.6
	Netherland	1848	7.8
	Switzerland	1325	5.4
	Spain	1293	5.3
	Greece	1034	4.2

Years	Trading Partners	Exports Value	%
2015	Italy	4760	33.3
	Germany	1675	11.7
	France	1185	8.3
	China	1185	8.3
2016	Italy	2216	24.2
	Egypt	1929	21.1
2017	Italy	3501	19
	Spain	2301	12.5
	France	2020	11
	Germany	1581	8.6
	Egypt	1581	8.6
	China	1537	8.3

Source: IMF, Direction of Trade Year Book (2013) (2017)

The vast majority of exports in Libya are oil; non-oil exports contribute only a very small share. After policy makers devalued the national currency considerably in 2002, the economy became more liberalized to encourage foreign investment. This led to a marked improvement in the non-oil exports sector. However, the high levels of exchange rate misalignments, particularly overvaluation states, may have a negative impact on foreign trade.

2.8 Imports trading partners

Libya deals with many trading partners in imports. The country has tried many times to reduce the volume of its imports and replace them with local industries in order to preserve foreign exchange resources. Such a system may need a very clear trade policy, particularly in exchange rate predetermination. The total imports play a significant role in the economy by affecting inflation and the investments sector. Table 6 shows that, there is a large variation in the number of countries Libya deals with different country in imports side. It is also noticed that in recent years there were a sharp decline in imports because of the dependence on oil exports.

Table 6. Import trading partners (more than 1000 million Libyan dinar) in Libya 2007-2018

Year	Trading Partners	Imports Value	%	Year	Trading Partners	Imports Value	%	Years	Trading Partners	Imports Value	%
2007	Italy Germany	2457 1008	18.7 7.7	2011	Tunisia Turkey	1474 1003	14 9.5	2015	China Italy Turkey France	2877 2501 2156 1190	15.4 13.4 11.5 6.4
2008	Italy China Germany Turkey	4270 1785 1660 1182	21.4 9 8.3 6	2012	China Turkey Italy Egypt Tunisia Korea Greece German	3315 2965 2098 1983 1697 1492 1371 1182	12.8 11.5 8.1 7.7 6.6 5.7 5.3 4.6	2016	China	1301	14.4
2009	Italy China Turkey Germany Korea France Egypt	3748 2203 1979 1723 1358 1123 1102	17.4 10.2 9.2 8 6.3 5.2 5.1	2013	Italy China Turkey Egypt Tunisia Germany Korea France Greece USA	4340 3943 3847 2238 1915 1768 1487 1436 1259 1135	13.1 11.9 11.6 6.7 5.8 5.3 4.5 4.3 3.8 2.4	2017	China	1085	13.5
2010	Italy China Turkey S. Korea France Germany Egypt Tunis	4499 2858 2679 1956 1879 1683 1675 1323	15.8 10.1 9.4 6.9 6.6 5.9 5.9 4.7	2014	Italy China Turkey Egypt Korea Spain	4119 3014 2878 1379 1248 1066	16.5 12.1 11.5 5.5 5 4.3				

Source: IMF, Direction of Trade Year Book (2013, 2017)

2.9 Devaluation of national currency

The devaluation of local currency means that the country's policy makers increases the fixed official foreign exchange rate for one unit of its local currency. This change will make the local currency value lower than before against the foreign currencies, which means an increase in the foreign exchange rate for one unit of foreign currency. When the country applies a fixed exchange rate policy, an increase in its foreign exchange rate is called devaluation. It should be noticed that there are major differences between the devaluation and revaluation of national currency, also depreciation and appreciation of national currency, as shown in table 7.

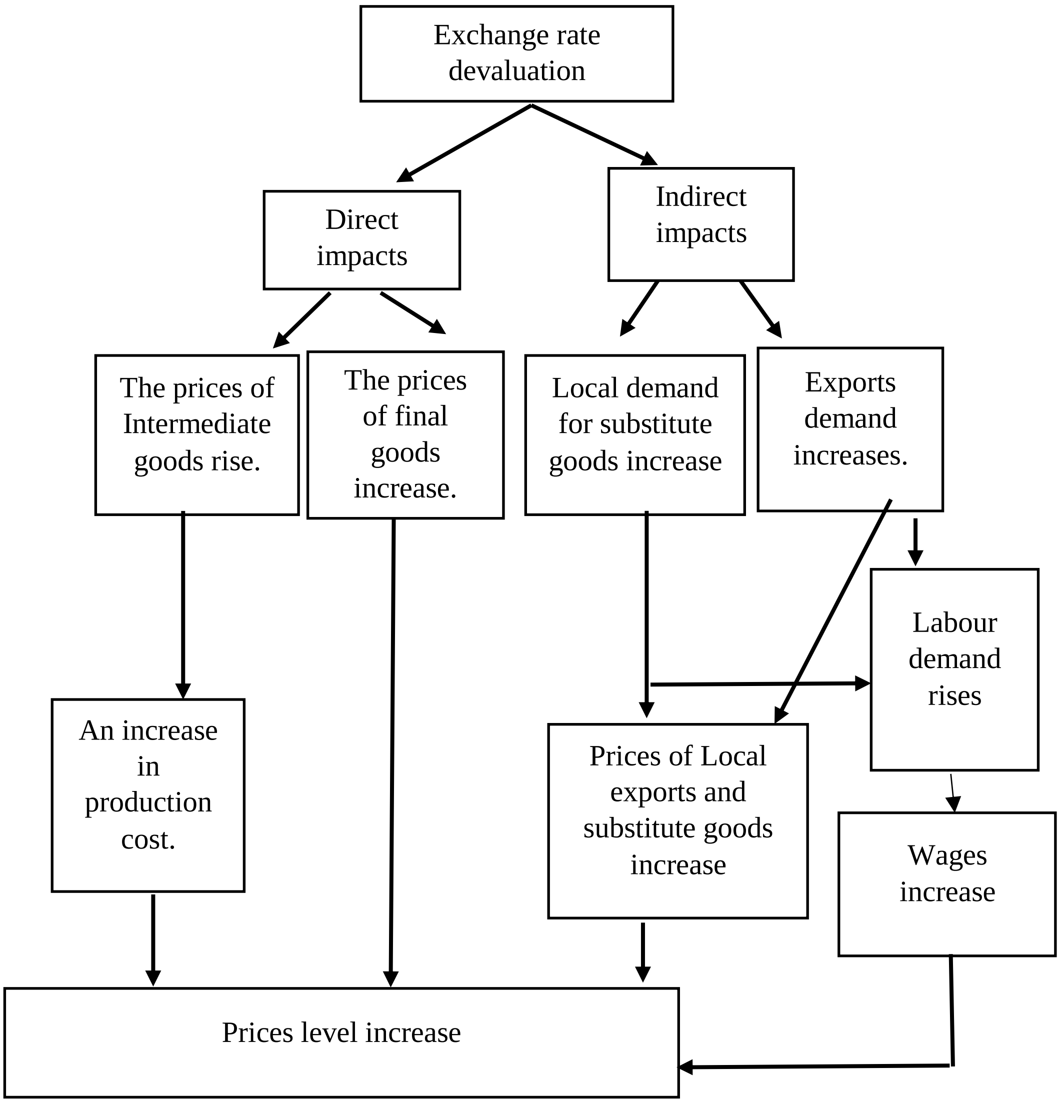
Table 7. Devaluation and revaluation & appreciation and depreciation

Process	Definition
Devaluation of local currency	The country applies a fixed exchange rate regime and its monetary authorities issue a resolution whereby the nominal exchange rate for a unit of foreign currency increases (value of local currency decreases).
Revaluation of local currency	The country applies a fixed exchange rate regime and its policy makers issue a resolution whereby the nominal exchange rate for a unit of foreign currency decreases (value of local currency increases).
Depreciation of local currency	It happens when the nominal exchange rate for a unit of foreign currency increases due to market forces (demand & supply).
Appreciation of local currency	It occurs when the nominal exchange rate for a unit of foreign currency increases due to the currency market mechanism.

Source: Author's work

Theoretically, the devaluation of local currency has direct impact to increase the price level in the home country (final and intermediate goods) particularly if the country depends heavily on imports. It also has indirect impact to rise exports and reduce imports via the increase in the foreign exchange rate. Increase in export demand may lead to increase in labour demand, which in turn will cause wage levels to rise. When the price of local exports increase leads to leading to higher prices for domestic products at home. All import prices, whether final or intermediate goods will increase because the cost of obtaining foreign exchange for imports becomes more expensive. Therefore, the expected effect of a local currency devaluation is a rise in the country's prices, directly and indirectly (Lafleche 1997), as shown in figure 24. This analysis assumes that there are no restrictions on the movement of exports and imports from and to outside the country. From the analysis earlier in this chapter, it was noticed that the significant devaluation of the local currency by the monetary authorities during the period 2001-2002 led to the exact opposite. The main reason for this is that the country implemented economic policies to restrict imports, which led to a very large reduction in imports. Since the Libyan economy relies heavily on imports, this led to a very high level of inflation at the end of the 1990s. After 2000, the policy changed to remove the severe restrictions on imports and foreign exchange controls. Instead the local currency was devalued to provide foreign exchange without any controls. The ultimate effect of this policy was a reduction in the local price level. That is why inflation went down markedly, despite the considerable devaluation of local currency.

Figure 24. Pass-through from an exchange rate devaluation to price levels



Source: Lafleche (1997)

2.10 Conclusion

This part of the study focuses on the most important features in the Libyan economy. Studying these indicators assists us to understand how to estimate the equilibrium RER in this economy, to estimate the misalignments curve, particularly no study has done that before for Libya so far. By studying the most important indicators of the Libyan economy, can be noticed that the heavy reliance on oil has caused major imbalances in the structure of the economy. The role of the non-oil sector is virtually non-existent and it does not contribute to the economy effectively. The Imports sector plays a crucial role in economic stability to reduce inflation and black market exchange rate. This sector highly depends on foreign exchange obtained from oil to cover the imports volume. The country has not actually succeeded in making improvements to the non-oil sector. Policy makers are keeping the nominal exchange rate at almost a fixed rate with large fluctuations of inflation. The high level of inflation is unlikely to be reduced without improvement in oil revenues. The existence of significant differences between the official exchange rate and the black market exchange for a long time has led to economy deterioration and the lack of confidence of citizens and foreigners.

Libya has missed many opportunities to improve the economic situation, despite long-term stability. The lack of integration of monetary, fiscal and trade policies may be the main cause of deterioration of the economic situation. An efficient exchange rate policy is one of the most important policies that should be properly managed to ensure balanced economic transactions. Creating a suitable environment for international trade requires determination of an exchange rate compatible with the level of prices in the country, as well as the price levels for its partner countries in international trade. Setting a semi-fixed exchange rate in an economy that depends entirely on fluctuation in its oil output makes it vulnerable to oil shocks. Libya, as a country where crude oil exports represent the vast majority of total exports, may not care too much about the equilibrium RER and its misalignments. Crude oil exports are determined according to the international quotas imposed by OPEC and not related to the exchange rate policy followed by policy makers. Similarly, oil prices are internationally determining according to global demand and supply. Perhaps that is why we have not found a study dealing with such topics in the Libyan economy. On the other hand, when the economy is suffering from severe oil crisis, the country faces serious economic problems. Monetary and fiscal policies are unable to alleviate high levels of inflation and achieve high non-oil growth. Libya has no developed financial sector to implement effective monetary and fiscal policies.

In recent years, there has been a significant increase in money supply when inflation was at high levels to solve the liquidity problems in banks. Fiscal policy relies on the oil sector to finance the general budget at a very high rate. There is a lack of efficiency in collecting taxes, and high tax evasion. Therefore, when there is a reduction in oil production or oil prices, the budget balance suffers from great deficit. Trade policies have concentrated on restrictions on imports and foreign exchange controls for a long time, while keeping the local currency value high. These policies cause a parallel market for goods and black market for foreign currencies, with high inflation rates. These weaknesses make the economy an inappropriate environment for foreign and local investment, leading to more capital outflows and poor income distribution. Therefore, the next chapter will discuss how to measure the equilibrium RER and misalignments. This issue will be open for Libya for the first time, in order to determine the size of these gaps in the economy.

Chapter 3 Measurement of Equilibrium Real Exchange Rate and Misalignments

3.1 Introduction

One of the significant issues that has caught the attention of authors, economists and policy makers equally is the issue of RER misalignments and equilibrium. RER contributes to internal and external equilibrium simultaneously. It is considered as a pivotal instrument in macroeconomic modifications in small open economies including the existence of trade and exchange controls (Chøwdhury & Ali 2012). Edwards (1989) claimed that the wrong level of RER for a long period would have an opposite effect on the competitiveness and economic performance of developing countries. Consequently, misalignments may help to anticipate currency crises (Holtemöller & Mallick 2013) .In this regard, misalignment in the RER arises when the actual RER deviates significantly from the equilibrium RER path (Edwards 1989). Edwards (1989), Elbadawi and Soto (1994), Razin and Collins (1997) define the misalignments of RER as a continued departure of the actual RER from its equilibrium value as negative or positive signs that cause economic instability, for instance, a decline in the current account and drain of international reserves.

Edwards (1988) and Nilsson (1998) explained that inappropriate macroeconomic policies, structural factors in the economy, and internal or external trade shocks are the main causes of real exchange rate misalignments. It is important to measure the degree of misalignment of the RER because it helps us to identify the determinants of the RER (Mkenda 2000). When there are misalignments of the RER, it will cause a distortion in the price levels and allocation of resources in the economy. A high level of RER appreciation or depreciation may lead to RER misalignments as an over or undervaluation of the national currency reducing the international competitiveness of the recipient country concerned overvaluation of the local currency has a strong linkage to low growth rate and productivity and failure of capital to move to the most lucrative sectors (Chowdhury & Ali 2012). Furthermore, overvaluation was the main cause of the financial crises, such as those in Mexico in 1949, Turkey in 1949 and

2001 and East Asian during 1997-1998 (Sohrabji 2011). On the contrary, persistent undervaluation of the RER may cause economic overheating, which leads to pressures on local prices and resources misallocation between non-tradable and tradable goods (Jongwanich 2009).

In this respect, academics have proposed that undervaluation of national currency and capital controls have been major instruments of an export-oriented development strategy for Germany and Japan after World War II and the East Asian countries (Dooley, et al. 2003). On the other hand, overvaluation caused severe decline in agricultural product in many African countries (The World Bank, 1984). Conversely, undervaluation may bring positive signs to the country; some economies employ this policy to stimulate their current account, a phenomenon called a ‘‘Currency War’’ which has been widely used within the trade relationship (Mozayani & Parvizi 2016). Mostly, developing countries experience considerable overvaluation of the RER, which unfavorably influence the tradable sector by depressing production, decreasing investments, and reducing the volume of exports. Many studies have found that the inactive performance of developing countries is attributed to an unbalanced RER (Ghura & Grennes 1993). Other countries think that overvaluation of national currency avoids the penetration of international inflation into the local economy. The overvaluation state often exists in oil exporting economies, which depended heavily on oil revenues as an exogenous variable. Seemingly, the considerable volume of oil revenue and thus substantial reserves of foreign exchange have helped these countries to determine the nominal exchange rate to be at overvaluation state (Mozayani & Parvizi 2016). Thus, the RER has become the main source of contradictory economic policies (Krugman & Taylor 1978). Edwards (1988) and Ghura and Grennes (1993) mentioned that the RER policy is considered as an important reason for sluggish growth in Africa and Latin America, whereas it is associated with increased growth in Asia.

In general, there are three methods of estimating RER misalignments. The first approach is Purchasing Power Parity (PPP), which uses the deviations of the RER, taking into consideration parity in some specific equilibrium year. The main drawback of this approach is that PPP only allows for monetary sources of exchange rate volatilities and does not hold exchange rate movements attributed to the real factors. Secondly, RER misalignments could be measured by employing the black market premium, as the difference between official exchange and black market prices. This method may not capture RER misalignments in recent years, with increasing international financial integration. Moreover, exaggerates the degree of misalignment for developing economies. It may be suitable for calculating the degree of foreign exchange controls (Ghura & Grennes 1993). Thirdly, RER misalignment is measured with respect to Fundamentals Equilibrium Exchange Rate (FEER)[3] to obtain the equilibrium path, taking the differences between actual and equilibrium level to capture RER misalignments. The single equation includes RER with a group of fundamentals that may act as long-run determinants of the RER. Clark and MacDonald (1999) supported the behavioural model of real exchange rate (BEER), RER is associated with a set of macroeconomic variables using a single equation to capture volatilities in the RER. The FEER evolved by Williamson (1994) explains the path of equilibrium as the level that fulfills external and internal balances simultaneously. External balance means that a current account is consistent with external debt, while the internal balance is determined as the output level consistent with a sustainable rate of inflation and full employment.

The exact measurement of the RER has played a crucial role in the specification of RER misalignments for any economy. The significance and contribution of this work is to fill the gap in Libyan studies by finding the bilateral and trying to achieve multilateral RER. This indicator assists us to specify the equilibrium RER and misalignments. To our knowledge, there are no previous empirical studies such this study for Libya, and this work differs from previous studies conducted for Libya.

This chapter will review the provirus studies on the measurement of equilibrium RER and misalignments in section 2. The third section will explain different methods to measure actual, equilibrium and misalignments of RER. Section 4 is about methodology and data. Section 5 shows the estimating results. Estimate the gap between actual and equilibrium rer will be in section 6. Sections 7 and 8 will focus on the switching between over and undervaluation episodes, as well as real appreciation and depreciation states. Concluding results will be discussed in section 9.

[3] This approach was developed by Williamson (1994).

3.2 Literature Review

Empirical studies on exchange rate modelling and measurement of the real exchange rate misalignment are abundant. Also, a plethora of literature has tried to investigate theoretically and empirically the linkage between real exchange rate movements and economic performance. Some studies focused on the nominal exchange rate and trade balance because it may depend on whether the foreign exchange regime is fixed, flexible or floating. A survey of literature reveals many previous studies that estimated misalignments of exchange rate. However, such research is scorce for oil exporting economies. Such economies have special characteristics namely, heavil dependence on oil revenue and massive foreign reserves, which might make them a good case for research (Dike 2014, 2015). Edwards (1989) was the first to study the equilibrium real exchange rate theory and misalignment level. This study defined real exchange rate misalignments as a deviation of the actual real exchange rate from its equilibrium path.

Lizardo and Mollick (2010) studied oil price volatilities and U.S dollar exchange rates by adding the price of oil to the monetary model of the exchange rate. This study showed that oil prices significantly affected movements in the U.S dollar value against main currencies during 1970 – 2008. Rises in real oil prices caused significant depreciation of the US dollar against oil exporting currencies, for instance, Canada, Russia and Mexico. Conversely, when the real oil prices increase, the oil importing countries' currencies depreciated against the U.S dollar.

Lebdaoui (2013) estimated the equilibrium real exchange rate in Morocco using the fundamentals of real exchange rate. The fundamentals included real net capital flows (NKF), terms of trade (TOT), government expenditure (GOV), index of momentary policy (MOP), foreign reserves and relative productivity (PROD) to estimate the equilibrium path. This study employed quarterly data from 1980Q1 to 2012Q4. The stationarity test indicated that all variables were stationary at first difference, and then this study employed a co-integration test and the Vector Error Correction Model. The findings showed that the major causes of volatility of the real effective exchange rate were because of trade openness, government expenditure, terms of trade, the productivity differential, capital inflow and monetary policy. Based on Hedrick-Prescott (HP) filter to estimate the equilibrium level, the results showed that the maximum overvaluation and undervaluation ranged from about +2.16% under to

−2.80% from the equilibrium path respectively. Additionally, the deviation of the actual real exchange rate from the equilibrium level requires from five to six years to be disposed of.

Aziz and Bakar (2009) estimated the long run impacts of real oil price and real interest rate differential on real exchange rate by using monthly penal data for eight economies over the period 1980 to 2008. This study was conducted in three stages: firstly, the paper examined data integration and found them all to be integrated in order one. Secondly, by employing various penal co-integration tests, it confirmed that the tree variables were co-integrated. Thirdly, the study applied pooled mean group estimation. For net oil importing economies, the results showed a positive and statistically significant effect of real oil price on real exchange rate. Conversely, in net oil exporting economies, no long run association was found between real oil price and real exchange rate.

Chen and Chen (2007) examined the long run association between real exchange rate and real oil prices by employing monthly panel data for G7 countries from January 1972 to October 2005. By applying a co-integration test, the results showed that real oil prices are co-integrated with the real exchange rate. Then the study investigated the ability of real oil prices to predict future real exchange rate returns. The predictive regression estimation found that real oil prices have significant expecting power.

Habib and Kalamova (2007) studied the real oil price effect on the real exchange rate for three oil- exporting economies namely: Norway, Russia and Saudi Arabia. Data for Norway and Saudi Arabia were collected for the period 1980 to 2006 and for Russia, from 1995 to 2006, investigating the impact of real oil prices and productivity differentials against 15 OECD economies' exchange rates. The results revealed that there was a positive long run association between the real oil price and real exchange rate, while there was no effect in the cases of Norway and Saudi Aribia. The varied exchange rate system may not assist in explaining the diverse empirical findings on the effect of prices of oil across economies, which might be because of other institutional policy responses such as accumulation of net foreign assets and their sterilisation.

Hiri (2014) studied the equilibrium real exchange rate of the Algerian dinar (DZD) in order to discover the impact of fundamentals on the actual real exchange rate during the period 1980-2009. This study was in quarterly data using a co-integration technique. The study found that the fundamental factors (oil price, government consumption, liquidity rate, total reserves including gold, net capital flows, capital flows, degree of openness and terms of trade have a significant impact on real exchange rate. Real exchange rate misalignment was found in seven cases over the period of study: undervaluation during the periods: 1981Q1 – 1984Q2, 1988Q1 – 1992Q4, 1994Q2 – 1996Q4, and 2002Q3 – 2008Q2, and the overvaluation during: 1984Q3 – 1987Q4, 1993Q1 – 1994Q1, and 1997Q1 – 2002Q2.

Khan and Choudhri (2004) studied the impacts of Balassa-Samuelson on the long run behaviour of real exchange rate in developing economies. The paper used a panel data sample of sixteen countries to find new proof of Balassa-Samuelson in developing countries. The study discovered that the traded-nontraded productivity differential was an important factor of the relative nontraded good prices. Then, relative prices and terms of trade have an important impact on the real exchange rate. These findings gives strong evidence of Balassa-Samuelson impacts for developing economies.

Spatafora and Stavrev (2003) studied estimated equilibrium real exchange (ERER) rate for Russia. This paper employed productivity and terms of trade to estimate the equilibrium path. The findings confirmed that the ERER reflected by both terms of trade and productivity. The study suggested that the Russian economy should aim for a considerable medium-term current account deterioration and real exchange rate appreciation, perhaps exceeding 10%; this percentage is very sensitive to the estimated long-run oil prices.

Suleiman and Muhammad (2011) studied the long-run association between real effective exchange rate, real oil price and productivity differentials. This study employed annual data from 1980 to 2010 for Nigeria. The major target of this study was to examine whether real oil price volatility and real relative productivity influence the real effective exchange rate. The findings showed that real oil price has a significant and positive impact (real appreciation) on real effective exchange rate in the long- run, while real relative productivity has a significant and negative effect (real depreciation) on the real effective exchange rate. The study also found that the real effective exchange rate appreciated over the period 2000 to 2010.

Aflouk, et al. (2010) aimed to investigate the misalignments of exchange rate for the major emerging economies in Latin and Asia from 1982 to 2010 by using the FEER method to estimate the long run equilibrium path. This study compared its results with the developed economies' situation. The findings confirmed that, in the mid-2000s, misalignments decreased at the global level, but the price of the dollar stayed overvalued against the currencies of the East Asian economies, with the exception of the yen.

Bouzahzah and Bachar (2013) measured the real exchange rate misalignment employing Moroccan data from 1980 to 2012. This study found a long relationship between real exchange rate and its fundamentals, namely, terms of trade, trade policy, and the real GDP growth, the flow of foreign capital, government expenditure and gross fixed capital information. The main aim of this study was to focus on the persistent nature of exchange rate gap of the dirham, particularly in the period when the exchange rate was pegged to a basket of currencies. The results show that persistent misalignment may be by the structural characteristics in the economy, such as productivity, investment and trade policy.

Dogan, et al. (2012) studied the linkage between real oil prices and real exchange rate for Turkey by employing monthly data from February 2001 to June 2011. Turkey is considered as a non-oil exporting developing country that lacks an adequate volume of petroleum resources. This study found a negative relationship between real oil price and real exchange rate, as well as a long run association between real oil prices and real exchange rate by applying co-integration with structural break tests by Kejriwal and Perron (2010).

Dauvin (2014) studied the relation between energy prices and real effective exchange rate for 33 commodity-exporting economies, divided into to two groups: 10 energy - exporting and the others commodity – exporting, using panel data for the period 1980-2011. A panel co-integrating relation between the real exchange rate and its fundamentals was estimated. The main findings of this study was that the real effective exchange rate of both groups reacted to oil prices by the terms of trade. As well, when there is low fluctuation in the oil prices, the real effective exchange rate is not specified by terms of trade, whereas when there is high volatility, the real effective exchange rate follows oil prices.

Cahyono (2008) determined the equilibrium real exchange rate of the Indonesian rupiah in order to investigate the impact of rupiah exchange rate determinants, and to find out a suitable level for the long run trend. The research used quarterly data to cover the period of time, 1999Q1-2006Q4 by using co-integrating regression. The authors explained that relative price of non-traded for traded goods (TNT), and net foreign assets (NFA) have a significant effect on real exchange rate. On the other hand, the terms of trade (TOT), openness (OPEN), and financial globalization (FG) did not have a significant impact on real exchange rate of the rupiah. As for real exchange rate misalignment, it was undervalued during 2000Q1-2002Q1 and 2004Q2-2005Q3, whereas it was overvalued during 2002Q2-2004Q1 and 2005Q4-2006Q4.

Hyder and Mahboob (2006) studied the estimation of equilibrium real effective exchange rate and misalignments in Pakistan from 1978 to 2005 by using annual data. This study used different macroeconomic fundamentals from the literature by Edwards (1988, 1989, 1994), Elbadawi (1994), and Montiel (1997). The study showed that the equilibrium real exchange rate depended on trade openness, terms of trade, relative productivity differential, net capital inflows, workers' remittances and government consumption. The rise in net capital inflows and government consumption led to depreciation of the real effective exchange rate, while increases in relative productivity differential, workers' remittances and terms of trade was associated with appreciation of the real effective exchange rate. The results from the error correction term showed negative sign, which means that the real effective exchange rate converged towards the long run equilibrium path. As for misalignment of real effective exchange rate, it was between −11.1% as an undervaluation state and 20.1% as an overvaluation state, with zero value in some years. This means that the actual real exchange rate not be too far from the equilibrium path.

Aleisa and Dibooĝlu (2002) studied the sources of real exchange rate movements in Saudi Arabia using the VAR model. They found that real shocks play a considerable role in explaining RER movements in Saudi Arabia. They also found that oil production shocks are more responsible for RER movements than real oil price shocks.

Koranchelian (2005) estimated a long run equilibrium real exchange rate level for the Algerian dinar. This study found that the Balassa-Samulson impact moves together with real oil price to explain the equilibrium real exchange rate evolution in the long run in Algeria. The half- life of the real exchange rate deviation from the real exchange rate path was approximately nine months, which is very close to that in other commodity- producing countries. The major finding of this study is that, the Algerian dinar was very close of the path of equilibrium at the end of 2003.

Hosni and Rofael (2015) assessed the real exchange rate (equilibrium and misalignments) in Egypt in the period 1999-2012. This paper used three techniques to estimate the equilibrium real exchange rate (ERER) which are the Purchasing Power Parity (PPP) approach, the Fundamental Equilibrium Exchange Rate (FEER) approach, and the Edwards Model (1989). All techniques found that the Egyptian Pound had had recently been overvalued.

De Jager (2012) estimated the equilibrium real effective exchange rate using Vector Error Correction Model (VECM) for South Africa. The main outcomes presented that a 1 percent rise in the real interest rate differential will cause a 0.8 percent appreciation in REER. In addition, an increase in real GDP per capita by 1 percent induces a 1.3 percent appreciation of the REER in the long term. A 1 percent rise in prices commodity prices relative to prices of oil was found to cause a 0.1 percent appreciation of the real effective exchange rate in the long term, whereas a rise in trade openness was linked with depreciation of REER. As for the government deficit as a ratio of GDP, a 1 percent increase in the government deficit as a proportion of GDP caused depreciation of the REER by approximately 1.5 percent. The error correction term was negative at about 0.28, which means that 28% of the misalignment on average is removed every year.

Bjornland (2003) estimated the equilibrium real exchange rate for Venezuela with respect to its long run equilibrium. This study calculated the equilibrium level by using a structural vector auto regression model (VAR) by identifying four structural shocks: nominal and real demand, supply, and oil price. The impulse responses were consistent with an open economy model economic volatilities, and also highlighted the role of the transmission mechanism of exchange rate in an oil producing country.

Chøwdhury and Ali (2012) studied the determinants of the real exchange rate for Libya using yearly data from 1970-2007 by employing the Auto Regressive Distributed Lags (ARDL) co-integration method. The main result of this study is that there is a long-run equilibrium association between the real exchange rate and its fundamentals. The RER was appreciated with terms of trade and was depreciated with government expenditure, which is not consistent with the Mundell-Fleming impact of fiscal policy. Additionally, RER appreciates with foreign and trade openness, while it depreciates with interest rate. The structural break variables were found to be positive. As for technology and productivity, they had no significant impact on RER. The speed of adjustment towards equilibrium path was very high in the short run; it was 76 percent annually to correct disequilibrium.

Mozayani and Parvizi (2016) examined equilibrium and misalignments of real exchange rate in the Organization of Petroleum Exporting Countries (OPEC) focusing on Iran over the period 1990-2012. The findings showed that the real exchange rate in all OPEC countries was misaligned but in different style ways. Concentrating on the Iranian economy, it was found that, the country had experienced significant volatility due to the foreign exchange changes that were influenced by carrying out two unification policies and international sanctions.

Khomo and Aziakpono (2016) applied the behavioural equilibrium exchange rate approach to obtain the equilibrium real effective exchange rate for the South African rand and examined whether the actual real effective exchange rate was misaligned from its equilibrium path. This study also studied the misalignment episodes by employing a Markov Switching Model (MSM). The results from a co-integration association found that between the real effective exchange rate and its main fundamentals, and the exchange rate was misaligned from time to time during the study period with alternate shifts between under and overvaluation regimes.

Takagi and Shi (2010) investigated the Renminbi (RMB) exchange rate misalignment using quarterly data from 1992-2009. This study applied the Markov Switching Regime to determine possible state shifts of RMB exchange rate between over and undervaluation episodes. The consequences showed exchange rate asymmetry in the duration of exchange rate misalignments with overvaluation states lasting longer than undervaluation.

Noureldin (2017) estimated the equilibrium and misalignments of real exchange rate for Egypt by using quarterly data from 2001Q3 to 2017Q1. This study is interest because of covers a more recent period of the Egyptian economy. The main result of this study is that the Egyptian pound was undervalued by approximately 22.3% in

2017Q1 after application of a new regime, is floating the currency, in 2016Q4. This state went down to 18.5% in 2017Q3 where the real effective exchange rate went up because of the rise in local inflation. This study also found that the most significant determinants of the equilibrium real exchange rate are relative productivity with main trading partners and trade openness. With regard to forecasting of real exchange rate misalignments up to 2020Q4, the study expected that real exchange rate misalignments will shrink quickly because of the high level of inflation, but this would depend on the stabilization of the nominal exchange rate.

From the previous studies, there is a vast theoretical and empirical literature that considers the real exchange rate misalignment is one of the major indicators in determining a country's economic performance. It is also noticed that there are different methodologies for computing equilibrium real exchange rate and misalignment. It is important to measure the misalignments episodes of real exchange rate to avoid some negative impacts that the economy may face in its domestic and foreign transactions. Real exchange rate misalignments are more commonly observed in developing economies, compared to developing countries. Noticeably, no specific research has been conducted to study the Libyan exchange policy systematically, in spite of the many problems that the economy has faced in the past and recent years. However, in a small open economy and oil exporting country such as Libya, the export and import prices are determined in international markets. In this case, the exchange rate just influences the local product of goods and services and local demand for import products; it does not affect the foreign demand for the local products.

3.3 Measurement of real exchange rate

The main difference between the nominal and real exchange rates is that the nominal exchange rate measures the relative rate between two currencies, while the RER is interested in the relative prices of two goods(Edwards 1989). In order to understand the meaning of the RER as a ratio and the nominal exchange rate as a rate, table 8 expresses the differences between them.

Table 8. Nominal and real exchange rate definitions

Nominal exchange rate	**Real exchange rate**
It expresses the rate at which the currencies of two economies can be changed.	It expresses the proportion of what a determined amount of money will buy in one currency compared with what it can buy in others.

Source: David and Scott (2005)

There is no single definition of the RER; this indicator has been studied under a number of different definitions. The first view of the RER was the nominal exchange rate as an amount of national currency per one unit of foreign currency multiplied by the ratio of the foreign prices level to the local level of prices. The main notion was that the nominal exchange rate should be affected by inflationary global changes. In this aspect, a group of writers mentioned the RER by this definition as the PPP exchange rate. The PPP approach is a basic method used in building theoretical models, and is used to forecast exchange rate and determine whether there is an over or undervaluation of the national currency. It is particularly useful for economies that have a large gap between local and foreign inflation rates (Yıldırım 2017).

RER misalignments refer to the deviation of the actual real RER from its long-run sustainable equilibrium level. The first estimation of equilibrium (RER) in the literature was by Gustav Cassel in 1918, employing PPP theory (Jongwanich 2009). The PPP assumption measures the RER as the relative prices of foreign and local consumption and production baskets (Edwards 1989). The theoretical value of the RER and equilibrium level according to the PPP method is just the ratio between local and foreign prices, as follows (Magyari 2008).

$$e_{ppp} = \frac{P}{P^*} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

By considering the nominal exchange rate:

$$RER = \frac{NER_d}{e_{ppp}} \ldots\ldots\ldots\ldots\ldots (2)$$

$$RER = \frac{NER_d}{P/P^*} \ldots\ldots\ldots\ldots\ldots (3)$$

$$RER = \frac{NER_d \, . \, P^*}{P} \ldots\ldots\ldots.. (4)$$

where, the ratio (e_{ppp}) is the theoretical value of the RER according to PPP theory. The prices (P) and (P^*) are the national and foreign prices respectively. The rate (RER) is the real exchange rate as the theoretical value of local currency against another currency. The rate (NER_d) is the nominal exchange rate as units of national currency per a unit of foreign currency. In this method, the exchange rate market value may present deviation from the equilibrium level. This deviations mean over or undervaluation of the local currency. Therefore, the PPP approach can explain the equilibrium and misalignments of RER supposing there are no transaction costs with integration and perfect competition markets as follows (Magyari 2008):

$$RER = \frac{NER_d \, . \, P^*}{P} \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

If RER $> 1 \Longrightarrow$ undervaluation of national currency.
If RER $< 1 \Longrightarrow$ overvaluation of national currency.
If RER $= 1 \Longrightarrow$ equilibrium of national currency.

If we have these variables NER_d , P^* , P in logarithmic form, the equilibrium level will be in zero value as follows:

$$LnRER = LnNER_d + LnP^* - Ln\,P \ldots\ldots\ldots (6)$$

If LnRER $> 0 \Longrightarrow$ undervaluation of national currency.
If LnRER $< 0 \Longrightarrow$ overvaluation of national currency.
If LnRER $= 0 \Longrightarrow$ equilibrium of national currency.

As we know, there are two definitions of the nominal exchange rate; we can define it as units of national currency per one unit of foreign currency (NER_d) or units of foreign currency per one unit of domestic currency (NER_f). Increase (decrease) of NER_d means nominal exchange rate depreciation (appreciation) and conversely for NER_f . The two definitions of nominal exchange make considerable differences in the concept of the RER. If we express the nominal exchange rate as units of local currency per one unit of foreign currency (NER_d) we should multiply this rate by the foreign price level divided by the domestic price level. Alternatively, if we express the nominal exchange rate as units of foreign currency per one unit of local currency (NER_f) we should multiply this rate by the local price level divided by the foreign price level. This mechanism can be explained mathematically as:

$$NER_d = \frac{1}{NER_f} \Longrightarrow NER_d \uparrow (\downarrow) \Longrightarrow \text{ nominal depreciation (nominal appreciation).}$$

$$NER_f = \frac{1}{NER_d} \Longrightarrow NER_f \uparrow (\downarrow) \Longrightarrow \text{ nominal depreciation (nominal appreciation).}$$

Then, the real exchange rate could be expressed by considering these two formulas as:

$$RER_d = NER_d * \frac{P^*}{P} \ldots\ldots\ldots\ldots\ldots (7)$$

Then, increase or decrease of this indicator means ↑ (↓)→ real depreciation (real appreciation).

Or

$$RER_f = NER_f * \frac{P}{P^*} \ldots\ldots\ldots\ldots (8)$$

Thus, increase or decrease of this indicator means ↑ (↓)→ real appreciation (real depreciation).

We can change between the two variables RER_f , RER_d as:

$$RER_d = NER_d * \frac{P^*}{P} \text{ ………… (9)}$$

$$RER_f = \frac{1}{RER_d} = \frac{1}{NER_d * \frac{P^*}{P}} \text{ ………….. (10)}$$

$$RER_f = \frac{1}{NER_d} * \frac{P}{P^*} \text{……….. (11)}$$

$$\frac{1}{RER_d} = NER_f \text{ …………….. (12)}$$

$$RER_f = NER_f * \frac{P}{P^*} \text{……………….. (13)}$$

In general, there are two ways, for calculating the RER. The first one explains the RER as the nominal exchange rate multiplied by price level differences between two countries as an external RER. The second one expresses the RER as the percentage of the local price of tradable to non-tradable goods in the same country as an internal RER (Hinkle & Nsengiyumva 1999). Calculating internal competitiveness depends on prices of tradable and non-tradable goods, which is different from external competitiveness. Some economic researchers have explained the RER taking into account tradable and non-tradable goods. By this definition, the RER is calculated as the ratio between the local relative prices of the tradable to the non-tradable goods, see for example Taylor and McMahon (1988), Dornbusch (1985, 1988), and Krueger (1983). The internal RER can be defined by the conventional way as the relative price of tradable to non-tradable goods as follows (Edwards 1989):

$$RER = \frac{\text{Price of tradable goods}}{\text{Price of non-tradable goods}} \Longrightarrow \text{(Internal RER)….. (14)}$$

By considering the nominal exchange rate to make both goods in the same currency:

$$RER = NER_d * \frac{P_t}{P_n} \text{ ………… (15)}$$

NER_d: Nominal exchange rate expressed as the unit of domestic currency per one unit of foreign currency.

P_t : Price of tradable goods in the home country.

P_n: Price of non-tradable goods in the home country.

A drop in this indicator means an appreciation of the RER causes a rise in the tradable goods price, which will deteriorate the country's international competitiveness[4], The country produces tradable goods less competitively than before, if there is no change in relative prices in the other countries. On the other hand, if there is a rise in internal RER, it means an increase in the relative price of tradable goods leading to improvement in internal competitiveness. Although this definition is logically beneficial, the internal rate of real exchange is not easy to calculate, particularly for developing countries, because of the availability of data for the prices of tradable and non-tradable goods (Edwards 1989). The next definition is more effective operationally to define the RER as follows:

$$RER = \frac{NER_d .\ P_T{}^*}{P_N} \text{................ (16) (External RER)}$$

where, P_T^* is the world prices level of traded goods, P_N is the local price level of non-traded goods, and NER_d is the nominal exchange rate in terms of domestic currency per one unit of foreign currency (Edwards 1989). The wholesale price index is usually used to represent foreign prices of tradable goods, whereas the CPI is used to reflect the domestic prices of non-tradable goods. This study employs proxies because of the data availability on the prices of tradable and non-tradable goods. The wholesale price index[5] (WPI*) in the USA for the world price level of tradable goods and the domestic consumer price index CPI for the local price levels of non- traded goods are used, as follows: Balassa (1964, 1990), (Edwards (1990,1989,1988), and (Cottani, et al. 1990).

$$RER = \frac{NER_d .\ WPI^*}{CPI} \text{.................. (17)}$$

Since this formula measures the relative prices between countries, then, it refers to the external RER as:

$$RER \downarrow \text{ going down } \Longrightarrow \text{ RER appreciation}$$

It may happen if:

$ER_d \downarrow$ (units of domestic currency per one unit of foreign currency)

$WPI^* \downarrow$ or $(CPI) \uparrow$

---

[4] Actually, for a country's international degree of competitiveness, the unit labour cost is better, but in developing countries, this indicator is not reliable and not available as well.

[5] The main reason for employing the US wholesale price index as a proxy for foreign price is that this study focuses on the exchange rate of the LYD against the USD.

All of these changes may lead to deterioration on competitiveness. Going up (real depreciation) in this formula means that foreign goods become more expensive compared to local goods, which in turn improves the competitiveness. In order to summarize RER movements for both definitions as a real appreciation or depreciation, we should follow this mechanism as:

$$RER = NER_d * \frac{P^*}{P}$$ → Going up → RER depreciation. / Going down → RER appreciation.

$$RER = NER_f * \frac{P}{P^*}$$ → Going up → RER appreciation. / Going down → RER depreciation.

As in the PPP assumption, RER values express the equilibrium path for one good between two countries. We can give a numerical example to explain the mechanism of the law of one price assumption for equilibrium and misalignments as overvaluation and undervaluation states of the real exchange rate. Supposing that the price of commodity (X) in the home country is 8 LYD, and the price of the same good in the foreign country is (2 US$). If the nominal exchange rate between the domestic and foreign country is 0.8 LYD = 1US$ or 1.25 US$ = 1 LYD, then the RER for the good (X) will be as follows:

$$RER = 0.8 * \frac{2}{8} = 0.2$$

$$RER = 0.2$$

$$RER < 1 \longrightarrow \text{Overvaluation.}$$

The RER 0.2 means that, the price of (X) good in the foreign country is 1/5 the same good in the home country in real terms. Overvaluation of local currency means that the nominal exchange rate in the domestic country, as an amount of local currency for one unit of foreign currency is expressed by less than its real rate. The nominal exchange rate in this case should be increased to 4 LYD for 1 US$ to reach the equilibrium level as:

$$RER = 4 * \frac{2}{8} = 1$$

$$RER = 1 \longrightarrow \text{Equilibrium}$$

Similarly, this mechanism can be shown by another definition as:

$$RER = 1.25 * \frac{8}{2} = 5$$

$$RER = 5$$

$$RER > 1 \longrightarrow \text{Overvaluation}$$

The RER 5 means that the price of (X) in the domestic country is 5 times of the same good in the foreign country. The nominal exchange rate that can make an equilibrium state should be 0.25 US$ for 1LYD as:

$$RER = 0.25 * \frac{8}{2} = 1$$

$$RER = 1 \longrightarrow \text{Equilibrium}$$

Regarding to formulating the PPP doctrine, RER misalignments arise when there is a deviation from the equilibrium level. This approach supposes that the nominal exchange rate between two economies should be modified to alter the price level for two countries to maintain the RER without changes.

Actually, the economy is dealing with more than one country as trading partners. In this case, we should calculate the real effective exchange rate (REER) to take into account all of these countries in international trade. This indicator can be calculated as follows:

$$REER = \prod_{i \neq j} \left(\frac{E_i \, P_i}{E_j \, P_j} \right)^{\omega_{ij}} \text{..................} (18)$$

where REER is real effective exchange rate as geometric average P_i , E_i are the local prices level (CPI_i) and the nominal exchange rate dominated by US$ units. P_j , E_j are the trading partner's price level (CPI_j) and foreign exchange rate measured by US$ units. ω_{ij} the share of trade for a home country with trading partners compared with total trade. In this formula, the increase (decrease) in the real effective exchange rate indicates an appreciation (depreciation) (Maciejewski 1983). In this study for Libya, there is no available date for the share of trade for the home country with trading partners. Also, there is no available data from international websites. Accordingly, this study relies on bilateral real exchange rate to measure real exchange rate and its misalignments.

However, there are some reasons that may make the PPP approach a misleading indicator to estimate the equilibrium RER, particularly in developing countries. The

PPP doctrine has been subjected to extensive theoretical and empirical criticisms and has many shortcomings as an approach to capture the equilibrium path and misalignments. MacDonald (1995), MacDonald and Ricci (2002), Rogoff (1996), Dornbusch (1982), Montiel and Ostry (1992) and Kiptoo (2009) mentioned that, PPP assumption is not a suitable method and has some weaknesses for finding the long run equilibrium level of the RER. In fact, some writers still reject the concept of calculating the RER by nominal exchange rate term to relative inflation see Maciejewski (1983). However, the criticisms of viewing the RER by employing the PPP approach can be mentioned as follows:

Firstly, the main criticism with PPP is about the choice of local price index to make the PPP test. Many studies employed consumer price index (CPI) for PPP comparisons because this variable is available for the vast majority of countries, especially developing countries. However, the CPI baskets includes a large number of non-tradable goods, which makes it an inaccurate indicator for evaluating competitiveness (Yıldırım 2017). In fact, the producer price index may be better, because it contains a high percentage of tradable goods, but data are often not available (Yıldırım 2017). In practice, CPI for non-tradable goods price is often used in empirical studies for calculating the external RER with the wholesale price index as a proxy for world prices adjusted by nominal exchange rate (Jongwanich 2009). **Secondly**, most developing economies, governments control prices and subsidies for some categories of goods and services. Accordingly, the non-tradable goods prices in developing countries will be less than the prices in developed countries (Magyari 2008).

Thirdly, traded goods should cost the same under perfect competition market (no transaction costs and taxes) with homogeneous products and complete information. Furthermore, there are important differences between the compositions of the basket prices because of the preference of consumers and manufacture production between countries. **Fourthly**, the slow mean return of real level to a constant level where the PPP approach supposes the equilibrium RER does not change for episodes are derived from a simplistic conception. If data of RER are stationary, the speed of adjustment towards the mean is sufficient and fast, in that situation PPP could be held. When the RER converges slowly towards the mean, it is considered inconsistent with the PPP assumption, which only permits short-term deviation from the equilibrium path. Many studies have failed to catch co-integrating associations that are consistent with a stationary RER (Koranchelian 2005). empirical evidence called into question the validity of the PPP assumption; when the RER departs from the equilibrium level for a long time, the PPP approach is inadequate to represent the equilibrium RER, see MacDonald (2000) and Saayman (2007).

Fifthly, it does not take into account the RER fundamentals (Remorini, et al. 2006). Accordingly, many recent studies have moved away from PPP to concentrate on fundamentals. The association between RER and its various fundamentals such as degree of openness, productivity per capita and real commodity price is more realistic to estimate RER equilibrium and its misalignments; See MacDonald and Stein (1999), Hinkle and Monteil (1999) and Williamson (1994). In theory, the weakness of PPP as an indicator of RER equilibrium comes from not taking into account the role of fundamentals of RER (Hossfeld 2010). Therefore, the linkage between RER and main fundamentals should be taken into account to obtain the long run RER equilibrium. In doing so, co-integration techniques should be employed to determine the continual path of the RER.

This chapter measures the bilateral basis of the RER in Libya to capture the equilibrium path and misalignments depending on the nominal exchange rate and the ratio between foreign and local price levels by using single equation method ; see Baffes, et al. (1999). This method will be used to gauge the equilibrium RER and misalignments. It rejects the view that equilibrium RER is not changed, as supposed by the PPP approach. Edwards and Savastano (1999) conducted a survey of the literature on the estimation of RER misalignment, and found that, the vast majority of empirical studies were single equation models and general equilibrium simulation models. In Libya, PPP may not hold because data are often not stationary, supposing that the equilibrium RER might change over time and might not converge towards its mean. These conditions may imply that, the equilibrium RER for Libya may rely on fundamental indicators. For commodity-exporting countries, Sahay, et al. (2002) and Cashin, et al. (2004) found that there was a strong relationship between real commodity export prices and real effective exchange rate movements.

After estimating the RER equation and obtaining the ideal path, the difference between equilibrium and actual RER indicates the RER misalignment. This path represents an appropriate economic indicator to obtain over or undervaluation, as well as the equilibrium level of the national currency. Measurement of RER misalignments starts with computing equilibrium RER by estimating a long-run RER equation. Regarding fundamentals, in many commodity-dependent low-income countries, the real price of commodity exports and RER change together in the long term. The main reason for that is, primary commodities dominate the exports value of commodity exporting countries. De Gregorio and Wolf (1994), Chinn and Johnston (1996) and Montiel (1997) mentioned that volatility in the commodity prices is likely to account for a large share of fluctuations in the terms of trade in these countries. This part of study will follow Cashin et al. (2002) model to obtain the equilibrium and misalignments by considering the following formula (as shown in appendix A) for estimating the RER with its fundamentals as:

$$(NER_f \,.\, P/P^*) = f(\alpha_x \,/\alpha_i^* .\ \alpha_n^* \,/\, \alpha_n \,.\, P_x^* \,/P_i^*) \ldots\ldots (19)$$

where:

- NER_f: nominal exchange rate as units of foreign currency per a unit of local currency.
- $\alpha_x \,/\alpha_i^*$: productivity differential between the export and import (foreign) sectors or between local and foreign tradable sectors.
- $\alpha_n^* \,/\alpha_n$: productivity differential between the foreign and local non-tradable sectors.
- $P_x^* \,/P_i^*$: the price of the primary commodity divided by the price of intermediate goods (the commodity terms of trade) denominated in foreign currency.

The first two terms in the equation above represent the Balassa-Samuelson[6] effect (1964) – if a country experiences an increase in productivity in the commodity sector, this will cause a rise in wages, which leads to an increase in the non-traded good prices. Since the relative price of the primary commodity is determined exogenously, the ultimate impact will be a RER appreciation. The last term in the equation above represents the influence of the terms of trade. A rise in prices of exports causes higher wages, and leads to a rise in the prices of non-traded goods too (Cashin, et al. 2004). As well, an increase in commodity prices may also cause a positive wealth impact, which could increase local demand and thus, the price of non-tradables will increase as well (Alejandro 1982). This study will use some proxies for estimation to be

([6]) See MacDonald and Ricci (2001) for good empirical evidence of the Balassa-Samuelson effect.

appropriate for the Libyan case such as real oil prices, real relative productivity and trade openness.

3.4 Methodology and data

The time series technique of RER is often employed as an appropriate methodology calculate the equilibrium RER (Rogoff 1996). Specifying over and undervaluation states requires identifying the equilibrium RER and its dynamics out of the steady state path. In the long- run, the RER equilibrium is determined by the main related fundamentals. This study will estimate single equation real exchange according to Edwards's (1989) and Elbadawi's (1994) research. The fundamentals applied in this study are those cited by Cashin, et al. (2002). From a methodological point of view, this study will add the trade openness to the model to capture the extensive trade restrictions in the economy. In this model, the relevant equation looks as follows:

$$RER = \beta' F_t + \mu_t \quad \ldots\ldots\ldots\ldots (20)$$

$$RER = f\,(ROP, RRP, OPEN, D_{11})\ ^{7} \ldots\ldots\ldots\ldots (21)$$

$$RER = \beta_0 + \beta_1 ROP + \beta_2 RRP + \beta_3 OPEN + \beta_4 D_{11} + \mu_t \ldots\ldots\ldots\ldots (22)$$

$$\mu_t = RER - (\beta_0 + \beta_1 ROP + \beta_2 RRP + \beta_3 OPEN + \beta_4 D_{11}) \ldots\ldots\ldots\ldots (23)$$

where RER is the actual real exchange rate and (μ_t) is the error term. The parameter (β') is the vector of the estimated model with the permanent components of fundamentals. The variables ROP, RRP , OPEN and D_{11} are the real oil price, real relative productivity per capita, degree of openness and the dummy D_{11} reflects the main changes after the revolution respectively. The fundamentals specify the equilibrium real exchange rate, the systematic relationship between actual real exchange rate and long - run fundamentals is expected. Before estimating the model, the unit root should be examined by conducting the unit root test for all variables. Three unit roots were applied. Augmented Dickey and Fuller (ADF)-(1979), Phillips and Perron (PP)-(1988) and Break point (BP)-(Pierre Perron, 1989) to test the stationarity. Non-stationary variables have time-variant means, indicating that they change away from the mean, which means that they are not temporary movements. If time series variables are not stationary (have unit root), then the first difference should

([7]) These variables may be expressed in natural logarithms to reduce the heteroscedasticity problem.

be taken for that variable to obtain stationary series. If the two tests (ADF, PP) reject the null hypotheses at unit root, then the variables are not stationary at level.

In order to estimate the equilibrium RER, the relationship between the RER and its fundamentals should cope with the technique of co-integration applying the Engle-Granger two steps co-integration procedure. After the first regression, the residuals should be checked whether they are stationary. If the residuals are stationary at level that is indicate that, there is a co-integration relation among variables. After confirming evidence of co-integration between RER and its fundamentals, the appropriate method to estimate the equilibrium path can be determined. Actually, there are several estimation methods to apply after finding co-integration vectors and long run equilibrium RER among variables. The Fully-Modified Ordinary Least Squares (FM-OLS)[8] approach suggested by Phillips and Hansen (1990), the Dynamic Ordinary Least Squares (DOLS) method applied by Saikkonen (1991) and Auto Regressive Distributed Lags (ARDL) applied by Pesaran and Shin (1998). However, we suggest employing FM-OLS to estimate the long-run co-integration equation in order to avoid the parameter bias and endogeneity problems in this model. Co-integrating links between non-stationary series may cause endogeneity in the model that may not be avoided by employing vector auto regressions (VAR's) (Phillips 1995).

After estimating this equation, the RER misalignment can be obtained by taking the difference between the actual and equilibrium level of RER as a percentage from the equilibrium path. The equilibrium RER is found from the fundamentals equation as a predicted value of RER estimation function. The fitted value of the RER estimation will not be selected as an equilibrium path because it may exhibit a substantial degree of short-term ‘noise’, whereas the long-run RER equilibrium will not exhibit this behaviour (Baffes, et al. 1997). Therefore, this study will employ the Hedrick-Prescott HP filter[9] to smooth out the predicted values of equilibrium RER.

([8]) This method was designed by Phillips and Hansen in 1990 to obtain an optimum estimation of co-integration regression. This approach adjusts least squares to account for serial correlation impacts and for the endogeneity in the regressions that arises from the existence of a co-integration association.

([9]) Moving average is sometimes used to eliminate short-run variation in data involving a longer time series but this method is not possible for a country like Libya, where all data are non-stationary at level.

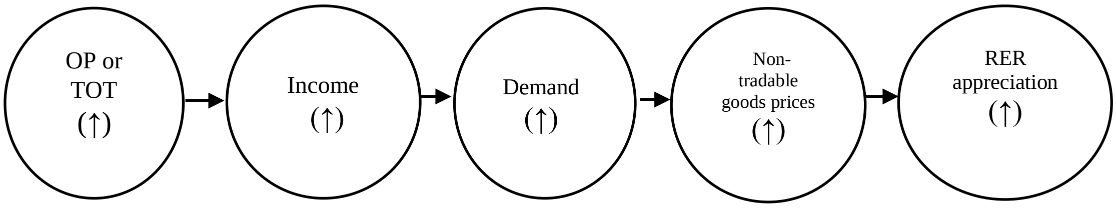
This part will use data covering the period 1962-2016 for RER and its fundamentals. The data were gathered from different sources CBL, IFS, OECD, and World Bank Indicators (WB) as follows:

$(\mathbf{1})$: $\mathbf{The\ real\ exchanbge\ rate}$ $(\mathbf{RER})$: the bilateral RER using WPI^*, CPI (2010 = 100) and the nominal exchange rate defined as units of US$ per one unit of the Libyan currency. An increase (decrease) in this indicator means RER appreciation (depreciation).

(2): The real oil price volatility (ROP): real oil price in US$, computed by deflating the Libyan oil price to the consumer price index (2010=100). It represents the price of a commodity as a proxy of terms of trade. Previous studies indicated that the deterioration of terms of trade more likely causes a depreciation in the RER see (Edwards 1989). It is used to capture the changes in the international economic environment and the impact of external shocks as $[\mathrm{ROP} = \frac{\mathrm{NOP}_{\mathrm{L,t}}}{\mathrm{CPI}_{\mathrm{L,t}}}]$. This variable is calculated as the ratio of Libyan oil prices (average prices of petroleum exporting Libyan companies) and consumer price index from IFS and CBL. The oil price is the major export good affecting the terms of trade in oil exporting economies. Generally, the price of the main exported good is employed as a proxy of terms of trade in these countries (Sossounov & Ushakov 2009) . Terms of trade as a real oil price capture exogenous changes in world price that influence the equilibrium real exchange rate. The oil exporting economies may experience exchange rate appreciation when oil price goes up, and depreciation when oil prices decline, see Akram (2004) and Cashin, et al. (2004). A deterioration of terms of trade may cause an appreciation or depreciation, depending on the income and substitution impacts. When the worsening of the terms of trade causes an increase in demand for non-traded goods it will generate a rise in its price level, which leads to real appreciation. Dağdeviren, et al. (2012) mentioned that, it may cause depreciation when the deterioration of terms of trade leads to decreased demand for non-traded goods. Improvement of TOT as a real oil price increase may lead to a rise in real oil exports, improving the country's position globally. However, an increase in real oil price may cause increase in production resources and then prices of non-tradable goods will go down. To ensure internal and external equilibrium, prices of non-tradable goods compared to tradable goods should be increased to make real exchange rate appreciation change the demand from the non-tradable sector towards the tradable sector (Jongwanich 2009). From the empirical literature, in the developing economies, an increase in (px/pm) leads to RER appreciation because the income impact mostly overcomes the substitution impact, see Baffes, et al. (1997) , Elbadawi (1994) and Williamson (1994). The effects of direct income impact is linked with demand for none-tradable goods, whereas the indirect (substitution) influence is associated with supply of non-tradable goods (Sohrabji 2011). The final impact may be a case of RER appreciation or depreciation as follows:

- **Direct (income) effect**: (Positive association ⟶ Real appreciation)

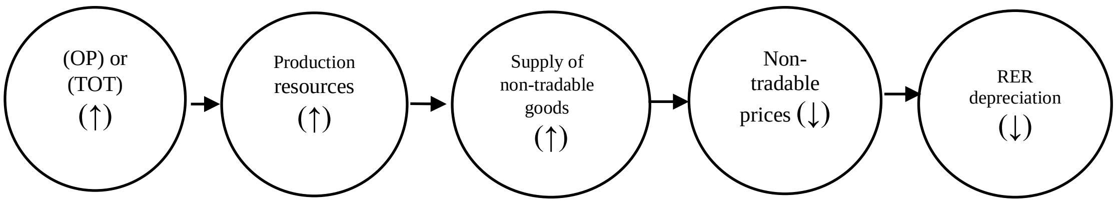
Improvement in terms of trade or prices of oil will make more income and demand for non-tradable goods in the country. Demand increase will raise the prices of non-tradable goods, and then real exchange rate will be appreciated. This association could be explained as:



The definition of RER as: RER = $[NER_f * \frac{P\uparrow}{P^*}]$ → Real exchange rate appreciation

- **Indirect (substitution) impact** : (Negative association ⟶ Real depreciation).

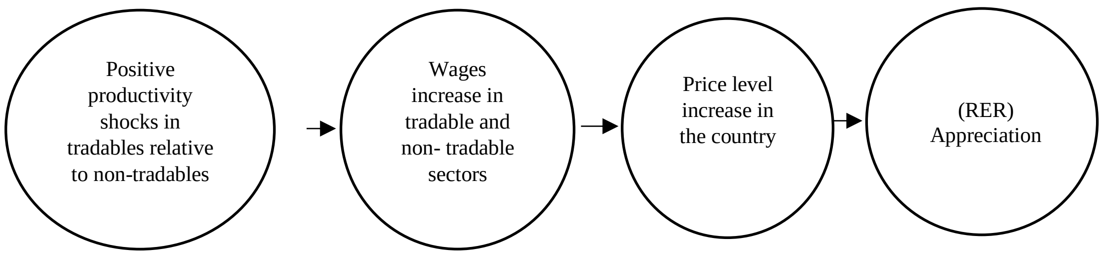
An increasing in terms of trade or oil prices may provide more resources for production to increase the supply of non-tradable goods. Supply increase will decrease the prices of non-tradable goods, and then RER will be depreciated. This linkage might be shown as:



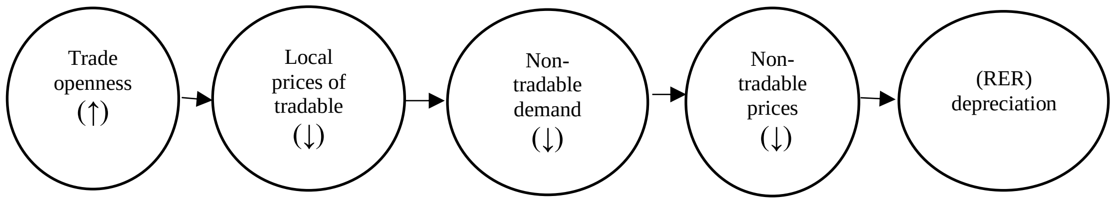
The definition of RER as: RER = $[NER_f * \frac{P\downarrow}{P^*}]$ → real exchange rate appreciation.

Therefore, the final impact of terms of trade increase depends on the strength of income (direct) and substitution (indirect) effects will affect the RER. If the direct effect is stronger than the substitution effect, the final impact will be a RER appreciation while if the substitution effect is dominated it would result in a RER depreciation (Sohrabji 2011). Therefore, from the empirical literature, in the developing economies an increase terms of trade leads to real exchange rate appreciation because the income impact mostly overcomes the substitution impact see Baffes, Elbadawi et al. (1997) ; Elbadawi (1994) ;Williamson (1994). Permanent negative shocks in TOT may cause a decrease in real income, which in term reduces prices of non-tradable causing depreciation of RER (Alejandro 1982) . Edwards (1989) also mentioned that a deterioration in terms of trade would cause an increase in local price of importables (reduce the demanded quantity) to lead to negative income influence and then an equilibrium real exchange rate depreciation.

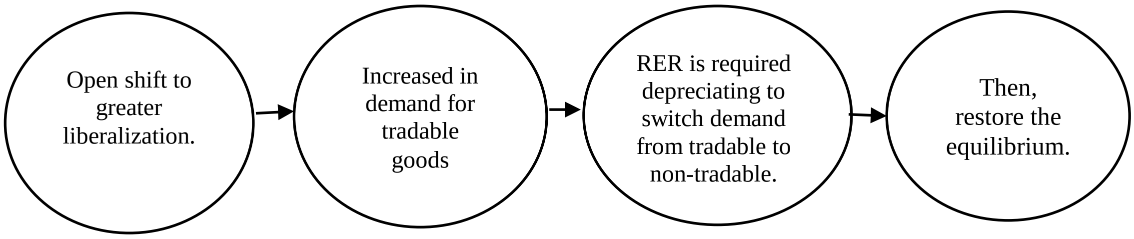
(3) The real relative productivity (RRP) real productivity per capita for Libya to the real productivity per capita for the United States as a proxy for real productivity per capita for the main trading partners of Libya, because of the availability of data for the share of exports and imports with the main trading partners. According to the Balassa-Samuelson effect, an increase in the productivity in the economy may cause RER appreciation. It is measured as a percentage of the real home (GDP) per capita to the real foreign (GDP) per capita as $[RRP_t = \frac{RGDP_{L,t}}{N_{L,t}} - \frac{RGDP_{US,t}}{N_{US,t}}]$. This variable captures the economic performance. The productivity differential investigates whether the Balassa-Samuelson impact is important for RER dynamics in Libya or not. Technology improvement is hypothesized to be associated with an appreciation of exchange rate (Balassa Samuelson effect). The growth rate of productivity in traded goods increases demand and wages in this sector and thus causes a trade surplus, which needs an appreciation to return to the equilibrium level (Atasoy & Saxena 2006). The real relative productivity has a positive relationship with RER, which implies that in this case, it is associated with RER appreciation. This relationship could be illustrated as:



(4) The trade openness (OPEN) is used as a proxy of foreign exchange restrictions and the effects of commercial policy. It is calculated as *(*IMPORTS + EXPORT*)*/GDP. The data were collected from CBL, WB and IMF. The influence of trade openness on RER is not completely clear in the empirical literature, but in general, in developing countries, a rise in the degree of openness is linked with depreciation of the domestic currency to reduce the prices of local tradable goods. Also, economic restrictions may be associated with RER depreciations because these restrictions lead to an increase in the price of domestic importable goods. This relationship is shown as:



Increased trade openness makes prices of imports cheaper and encourages more exports with foreign exchange resources for the country. The local prices of tradables will decrease, producing reduction in demand for non-tradable goods and thus the price of non-tradables will fall. This will lead to a RER depreciation (Terra & Valladares 2010). When there is more liberalisation in the economy, it may cause an increase in demand for tradable goods. Thus, RER is required to depreciate to switch demand towards non-tradable goods to restore internal and external balance (Jongwanich & Kohpaiboon 2013). Then, more trade liberalization may be associated with RER depreciation, as shown:



3.5 Estimating Results:

Before estimating our data about the Libyan economy, we will explain the important features of all the selected data, to give a better understanding of the economy's characteristics. The RER and the major fundamental variables are used in estimating the equilibrium RER over the study period 1962-2016 as shown in figure 25.

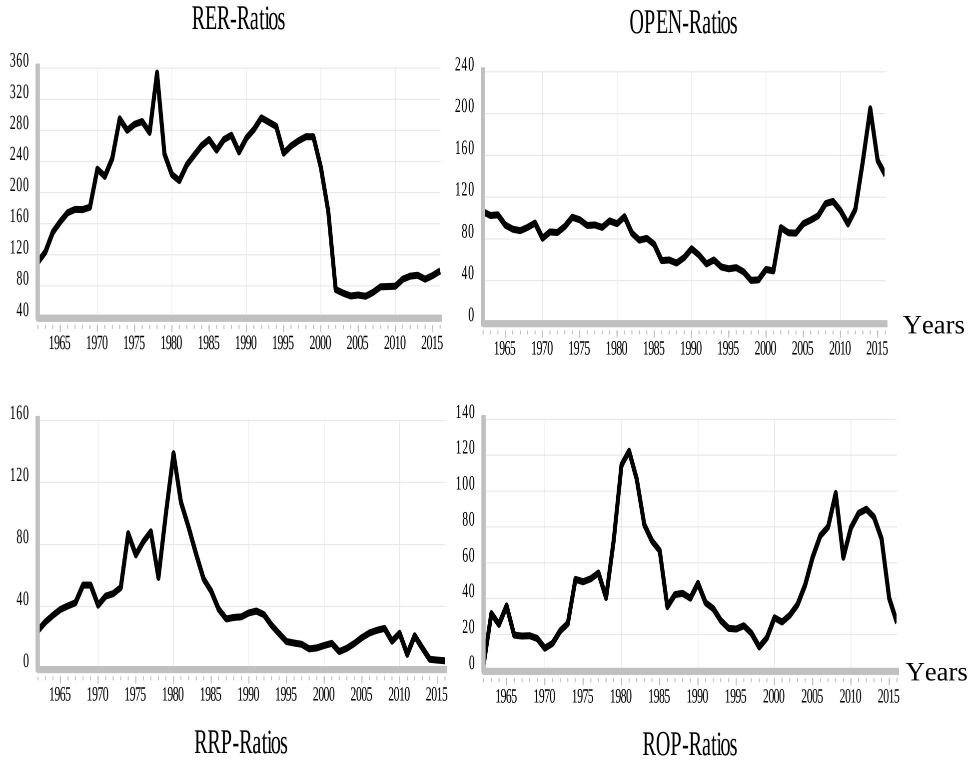
RER: The RER and the major fundamental variables are used in estimating the equilibrium RER over the study period. By definition, an increase in the RER in this model indicates RER appreciation, while a decrease indicates a depreciation. From figure 24, we can notice that there was generally a trend of RER appreciation from 1962 to 1978. After that, there was a significant real depreciation that continued to 1982. During the period 1982-2002, the RER fluctuated as real appreciation and depreciation. In 2002, there was a considerable RER depreciation but in recent years, it started to be gradually appreciated.

ROP: The real oil prices sharply increased during the 1970s, but fell during the eighties and nineties because of the reduction in world oil prices as well as the increase in local inflation. At the beginning of the new millennium, the ROP went up significantly, but after 2014 it went down again because of the same causes; reduction in world oil prices with a high level of local inflation.

RRP: The real relative productivity considerably increased during the 1970s. However there was dramatic decline in the eighties and nineties, which lasted a long time. The reduction was because of the world price decrease at that time. As we know, the Libyan GDP is highly dependent on the oil sector. After 2002, there was an improvement in real relative productivity but not at a high level because of the increase of population. In recent years, real relative productivity decreased because of the considerable decline in oil production.

OPEN: Trade openness remarkably declined during the 1980s and 1990s. The monetary policy authorities implemented austerity policies after the dramatic decrease in the price of oil, to restrict imports. At the beginning of the new millennium, the economic situation completely changed; imports and exports increased. After 2013, the degree of openness fell unusually, due to the reduction in oil production.

Figure 25. Real exchange rate and its fundamentals 1962-2016



Sources: The Organisation for Economic Co-operation and Development (OECD) & IFS & CBL-economic bulletin.

All variables are stationary at the first difference at one percent of significance (99% of confidence), as shown in table 9.

Table 9. Unit root tests (ADF), (P&P) for RER and its fundamentals

Variables	Model	Level (ADF)	First diff (ADF)	Level (PP)	First diff (PP)
RER	Intercept	-1.180	-6.691***	-1.363	-6.707***
	Intercept & trend	-2.200	-6.895***	-2.209	-6.894***
	None	-0.506	-6.755***	-0.544	-6.770***
OPEN	Intercept	-1.421	-6.030***	-1.349	-6.625***
	Intercept & trend	-1.646	-6.553***	-1.521	-12.00***
	None	-0.134	-6.042***	-0.001	-6.663***
ROP	Intercept	-2.172	-6.258***	-2.413	-6.258***
	Intercept & trend	-1.898	-6.228***	-2.205	-6.228***
	None	-0.906	-6.330***	-0.988	-6.330***
RRP	Intercept	-1.458	-7.393***	-1.482	-7.418***
	Intercept & trend	-2.500	-7.419***	-2.501	-7.450***
	None	-1.020	-7.455***	-0.993	-7.484***

Note: */**/*** indicate rejection of null hypothesis of unit root at significant levels 10/5/1 percent respectively

The conventional unit root tests such as ADF may not specify non-stationary time series when they have a structural breakpoint (Perron 1989). The structural breakpoint test is employed to emphasize consequences from ADF and PP tests to be more robust. The Breakpoint results are shown in the table 10.

Table 10. Breakpoint Unite root test

Variables	Model	Level (BP)	First diff (BP)
RER	Intercept	-5.277*	-5.920***
	Intercept & trend	-4.716	-5.854***
	None	-4.114	-5.106***
OPEN	Intercept	-1.866	9.887***
	Intercept & trend	-7.023***	-8.417***
	None	-5.994***	-7.172***
ROP	Intercept	-3.457	-5.082**
	Intercept & trend	-3.152	-5.587**
	None	-2.609	-5.430***
RRP	Intercept	-5.100**	-6.898***
	Intercept & trend	-3.663	-6.731***
	None	-4.045	-6.860***

Note: */**/*** indicate rejection of null hypothesis of unit root at significant levels 10/5/1 percent respectively.

The breakpoint unit root methodology findings indicate that some variables are stationary at level I (0) such as OPEN; however, all variables are stationary at first difference I (1). Consequently, we text the possible existence of a long run linkage (co-integration) among the selected variables. Table 11 showed that, applying the Engle-Granger two steps co-integration procedure. Residuals are stationary at level which confirm that over the long run, the RER moves together with its fundamentals. Hence, the bilateral RER, RRP, ROP and OPEN are associated together by a long run linkage. The fundamentals sufficiently hold developments in the bilateral RER.

Table 11. Stationery test for Residuals with OLS

	Model	Level
Residuals OLS	Intercept	-4.124947***
	Intercept& trend	-4.058071***
	None	-4.162134***
	Model	Level
Residuals FM-OLS	Intercept	-4.598256***
	Intercept& trend	-4.557464***
	None	-4.640772***

Source: EViews 10 outcomes.

After confirming evidence of co-integration between RER and its fundamentals, the FM-OLS approach is applied to estimate the relationship between RER and its fundamentals. The results are shown below in table 12.

Table 12. FM-OLS results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RRP	2.482053	0.392048	6.330999	0.0000
ROP	-1.049076	0.392711	-2.671366	0.0102
OPEN	-2.313496	0.422559	-5.474970	0.0000
D11	124.8918	42.89655	2.911465	0.0054
C	342.0808	33.26449	10.28366	0.0000
R-squared	0.658400	Mean dependent var		198.9127
Adjusted R-squared	0.630515	S.D. dependent var		84.58957
S.E. of regression	51.41802	Sum squared resid		129546.8
Long-run variance	4185.349			

Dependent Variable is RER.

According to the definition of the exchange rate in this study as units of foreign currency per one unit of local currency, going up means a real appreciation, while going down, means real depreciation. FM-OLS findings show that an increase in the ROP and OPEN are associated with RER depreciation, a one-unit rise in the ROP and OPEN causing RER depreciation by approximately 1.05 and 2.31 units respectively. As for RRP, a rise in this factor is linked with RER appreciation. A unit increase in RRP leads to RER being appreciated by about 2.48 units. This study used a dummy variable D_{11} to explain the significant changes that happened in the economy after the Libyan revolution in 2011. This factor has a positive sign, which implies that, it is associated with RER appreciation. All parameters in this estimation are significant at 1% level of significance. In this estimation, we can explain the associations between the real exchange rate and all fundamentals as follows:

The effect of ROP: This variable in this study is employed as a proxy for terms of trade (TOT) because Libya is heavily dependent on oil exports and thus oil prices could be an appropriate variable for terms of trade. In this study, we found a negative linkage (real depreciation) between ROP and RER, which means that there is an indirect o effect between RER and ROP. When oil prices increase and the country obtains a massive amount of foreign exchange resources, increasing local investment and production increase leading to more non-tradable goods being consumed locally. Then, the prices for non-tradable goods go down, resulting in RER depreciation.

Real relative productivity: The real relative productivity effect is related to the Balassa-Samuelson effect. As mentioned, a positive relationship (real appreciation) may exist between RER and RRP according to the Balassa Samuelson effect. The results confirmed that the real relative productivity has a positive sign, which means that the Balassa-Samuelson impact existed in the economy. Positive shocks in the tradable sector may lead to rise in wages in both sectors, tradable and non-tradable. Price level in the country may go up, producing real exchange rate appreciation. Moreover, Khan and Choudhri (2004) concluded that Balassa-Samuelson impacts are related to developing economies and terms of trade also affect the RER.

Trade Openness: The findings indicate that there is a negative impact between RER and OPEN. When OPEN increases, the local prices of tradable and non-tradable may decrease. The reduction in local inflation will contribute to the RER which being depreciated. However, policy makers also may depreciate the RER to switch the demand from tradable sector towards the non-tradable to preserve foreign exchange resources.

3.6 The gap between actual real exchange rate and its equilibrium path[10]

The PPP method has proven to be a weak approach to demonstrate the long run RER path (Cashin, et al. 2004). Recent studies confirmed that the equilibrium RER is not a single value. This level is over time influenced by fundamentals that affect the internal and external equilibrium RER (Koranchelian 2005). Many studies have tried to estimate the equilibrium path but there is no complete understanding among specialists about how to measure it (Tehranchian 2015). There is no general consensus on equilibrium RER and thus this idea is still subjective (Razin & Collins 1997). Estimating the equilibrium path of the RER and misalignment is a complex issue as the assessment of the RER is an important equation that concerns the measurement of misalignments, not observed indicators such as potential output and non-accelerating inflation rate of unemployment (Magyari 2008). The equilibrium RER fundamentals play a significant role in determining the internal and external equilibrium in the economy. This implies that the economy is growing and the demand for local goods equals the supply side (Edwards 1989). Appreciation of RER means that the domestic currency value is increasing, whereas overvaluation indicates that the local currency value is more than its equilibrium path. In the same way, real depreciation indicates that, the value of the national currency is decreasing, while undervaluation means that

[10] The equilibrium exchange rate path is supposed to be the predicted value of the RER model.

the value of the domestic currency is less than its equilibrium level (Dagdeviren, et al. 2012). The main difference between real appreciation (real depreciation) and overvaluation state (undervaluation state) could be explained as:

Overvaluation means → over- real appreciation. Undervaluation means → over- real depreciation.

Therefore, setting the RER and keeping it at the equilibrium path is considered a big challenge. Misalignments of exchange rate explain persistent deviations from the equilibrium path (Edwards 1989). However, the equilibrium real exchange rate is the level which is considered as the long run value of RER fundamentals. It provides a beneficial instrument in assisting to interpret the macroeconomic outlook (Driver & Westaway 2005). However, a change in RER does not necessarily imply a disequilibrium, because the equilibrium path depends on both RER and fundamentals. In spite of the fact that the equilibrium RER is a function of only real factors, the RER reacts to both the monetary and real indicators (Edwards 1989). The equilibrium RER will be derived depending on the fitted (permanent) values of the RER determinants.

We utilize the Hodrick-Prescott (HP)[11] filter (1997) technique as suggested by Edwards (1989) and Alberola (2003) . The RER misalignment occurs in two forms, overvaluation of the national currency (to make the national currency more expensive) when it is more appreciated than the equilibrium level, whereas it is undervalued (making the national currency cheaper) when it is more depreciated than the equilibrium level (Edwards 1989). The RER equilibrium is defined as the steady- state real exchange rate conditional on a vector of permanent values of fundamentals (Olimov & Sirajiddinov 2008). RER misalignments can be computed as a deviation of the actual RER from the equilibrium level[12]. The presence of the RER equilibrium does not necessary imply that the actual value should be lastingly equivalent with the equilibrium path. Actually, the actual value of RER will usually vary from its

([11]) The technique (HP filter) is widely utilized in the literature to extract the long run or permanent component of a series. To estimate the permanent component, we utilize the smoothing parameter λ of 100 outlined by Hodrick and Prescott (1997). It is employed in this study to remove the fluctuations in short run for the economic fundamentals. It is just keeping the long run trend for the time series.

([12]) Edwards (1988) defined the RER misalignment as a deviation of the actual real exchange rate from its equilibrium path.

equilibrium path, particularly in the short term, but other sorts of persistent differences could be considered as misalignments of RER (Edwards 1989). Some previous studies evidenced that misalignment of exchange rate is more likely to be associated with a fixed exchange rate system compared with a flexible exchange rate regime, see Kemme and Roy (2006), Holtemoller and Mallick (2008) and Caputo and Magendzo (2011). Misalignments of RER are expected to provide signals on some economic indicators in the economy. When the RER diverges from its equilibrium path for a long time, it may cause economic deterioration.

The equilibrium level assures to policy makers that the RER does not provide wrong signals on economic indicators that may cause misallocation of resources and reduce the country's welfare. Misalignments are more likely to happen when the actual RER does not respond sufficiently to variations in the fundamentals (Holtemöller & Mallick 2013). In some countries, the central bank determines how much the RER is out of its long run equilibrium path and observes that periodically. RER misalignments occur when the deviations of the actual RER from the equilibrium path are persistent. Since the major concern of this part is to evaluate to what extent the Libyan dinar is misaligned, the degree of misalignments is calculated as a percentage by using this formula:

$$MIS_t\% = \frac{RER_t - ERER_t}{ERER_t} * 100 \ldots\ldots\ldots\ldots (24)$$

where, RER is the actual RER, ERER is the equilibrium RER and $MIS\%$ is the percentages of RER misalignments. In the equation above, the positive value of RER misalignments means overvaluation of the national currency, while negative values explains undervaluation. The equilibrium level is achieved if the calculated RER misalignment is zero. This formula is taken from Hinkle and Monteil (1999) to account for RER misalignment as a percentage difference between the actual RER and the equilibrium RER path for all observations. In this aspect, it may be important to explain the main differences of the behaviour of RER and misalignments with different exchange rate definitions, shown in table 13.

Table 13. Real exchange rate misalignment definitions

The procedure	Nominal exchange rate definition (1): Units of local currency per one unit of foreign currency)	Nominal exchange rate definition (2): (Units of foreign currency per one unit of local currency)
Appreciation of real exchange rate.	Real exchange rate going down.	Real exchange rate going up.
Depreciation of real exchange rate.	Real exchange rate going up.	Real exchange rate going down.
Overvaluation of national currency.	Real exchange rate misalignments under equilibrium path.	Real exchange rate misalignments over equilibrium path.
Undervaluation of national currency.	Real exchange rate misalignments over equilibrium path.	Real Exchange rate misalignments under equilibrium path.
Actual curve and equilibrium level.	Actual curve under equilibrium path.	Actual curve over equilibrium path.
Real exchange rate misalignments	Overvaluation (-) Undervaluation (+) Of national currency.	Overvaluation (+) Undervaluation (-) Of national currency.

Source: Author's work.

This study follows the definition 2 of the nominal exchange rate to calculate the RER, as described in table 14. Figure 24 explains the actual and equilibrium RER in the same graph, while figure 25 shows the RER misalignments and the equilibrium level. It is clear from the graphs that the RER was misaligned for a long time at high levels. The exchange rate was undervalued from 1962 to 1973; after that the situation significantly changed to overvaluation until approximately the end of the seventies. At the beginning of the eighties, there was an undervaluation state that lasted to about the mid-eighties. The curve between about the mid-eighties to 2002 moved to be overvalued with some fluctuations within this gap. In 2002, the national currency changed sharply to be at a high level of undervaluation after the monetary policy makers in Libya carried out a very considerable currency devaluation to be far below the equilibrium path as an undervaluation gap. Excessive devaluation caused a severe undervaluation during 2001-2010.

After the Libyan revolution in 2011, the RER was again misaligned being overvalued, but this time at a high level. The main reason for that was the high level of local inflation that the country faced after losing control for stability in the economy. Misalignments reached to more than 40% of the equilibrium level in 2016. Correcting the overvaluation states needed the monetary policy authorities to focus on reducing the inflation rate to get very close to the equilibrium. The main reason for RER appreciation under a fixed exchange rate system is due to an increase in prices of non-tradables, while under a flexible exchange rate system, appreciation is more likely to occur through the nominal exchange rate appreciation. RER appreciation in an intermediate regime (between fixed and flexible regime) is more likely to occur due to mixtures of the two reasons (Jongwanich & Kohpaiboon 2013). The misalignment may happen because of economic shocks, shortage, or abundance in foreign or government policy intervention. The misalignment causes misallocation of resources between the non-tradable and tradable sectors, and may lead to an unsustainable position in the balance of payments and cause a currency crisis (Noureldin 2018). In recent years, the RER misalignments has been highly overvalued due to a surge in domestic inflation. All of these changes are shown in figures 26 and 27 while figure 28 shows the annual time change

Figure 26. Actual and equilibrium real exchange rate 1962-2016

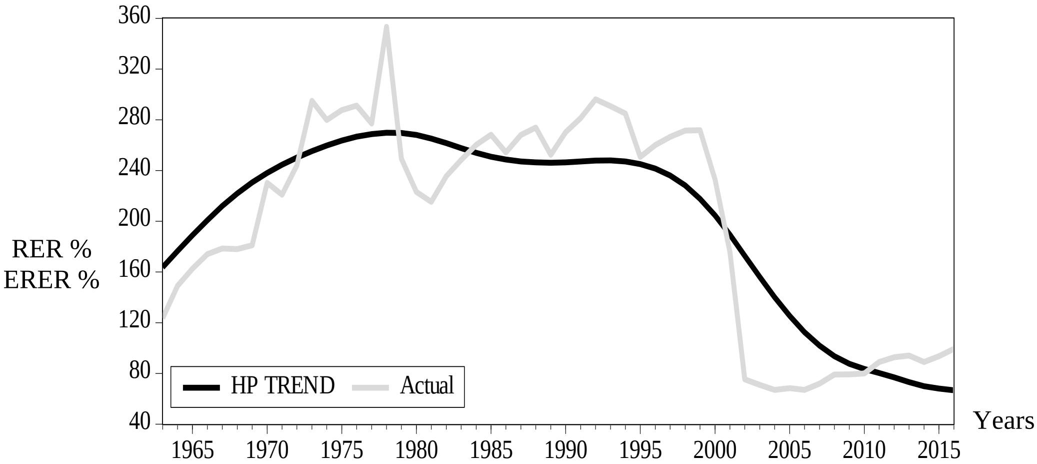
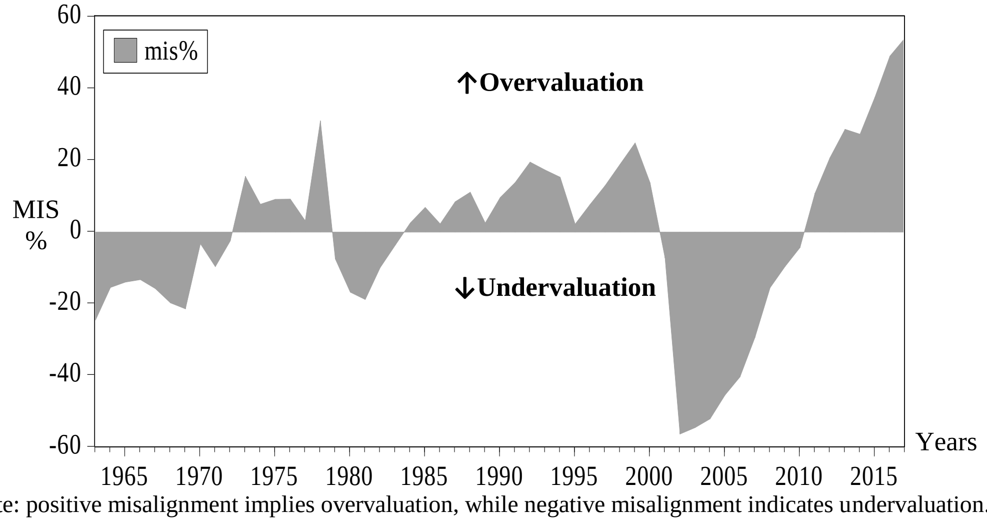
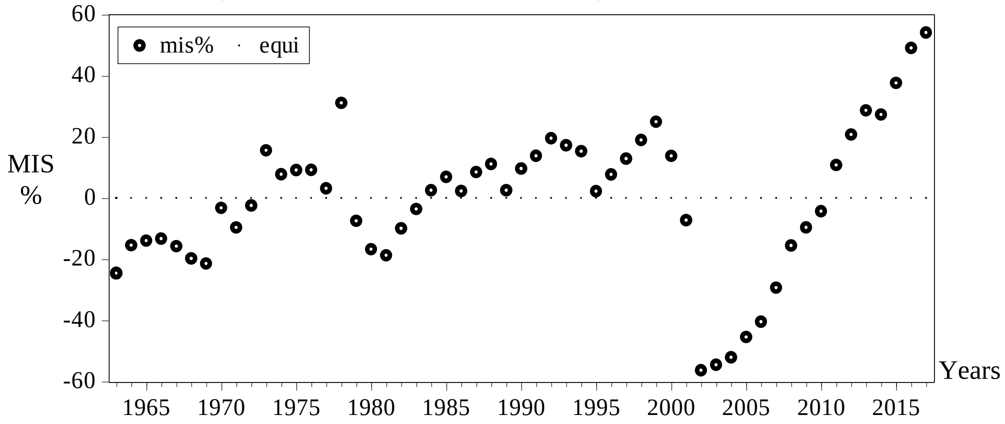


Figure 27. Real exchange rate misalignments 1962-2016



Note: positive misalignment implies overvaluation, while negative misalignment indicates undervaluation.

Figure 28. Time differences of misalignments 1962-2016



Source: EViews 10 outcomes

3.7 Markov – switching regime and real exchange rate misalignments

Hamilton (1989) suggested the Markov switching model (MSM), which is applied for time series data, particularly, for unobservable variables that are likely to shift from one regime to another. This model is used to examine the dynamics of the RER misalignment and the likelihood of the RER misalignments being in one regime (over or undervaluation of the national currency), as well as the probability of switching between the two regimes (the alternative shifts). In general, there are two variables, but the Markov-switching models is not confined to two regimes. It can be employed for more than two regimes. The model supposes that, there are (k) regimes, for example over and undervaluation, real appreciation and depreciation working as a process, normally distributed with different means (μ_1, μ_2) and variances ($\sigma^2{}_1, \sigma^2{}_2$) for regimes (1) and (2). Each case is supposed to follow a Markov process. This model takes the following formula, (see Guo, et al. 2010).

$$\mathrm{mis}_t = \beta_1 S_t + \beta_2 (1 - S_t) + [\sigma_1 S_t + \sigma_2 (1 - S_t)] \epsilon_t \quad \text{for} \quad \epsilon_t \sim N(0, 1) \ldots (25)$$

where mis_t misalignment of the real exchange rate, S_t is a double variable indicating the unobserved regime in the model. The Markov regime assesses the volatility of an unobserved variable S_t that changes between the two regimes and has the next transition likelihood, (see Engle & Hamilton, 1990, Brooks & Persand, 2001)

$$\text{Prob } [S_t = 1 | S_{t-1} = 1] = P_{11}$$
$$\text{Prob } [S_t = 2 | S_{t-1} = 1] = 1 - P_{11}$$
$$\text{Prob } [S_t = 2 | S_{t-1} = 2] = P_{22}$$
$$\text{Prob } [S_t = 1 | S_{t-1} = 2] = 1 - P_{22}$$

Where P_{11} denotes the likelihood of regime (1) being in the same regime as in the previous period. P_{22} Indicates the probability of regime 2 being in the same regime as in the previous period. The probability [1 - P_{11}] represents the likelihood of moving from regime (1) in period (t_{-1}) to regime (2) in period (t) , while [1 - P_{22}] provides the likelihood of moving between periods (t) to (t_{-1}) from regime (2) to regime (1). This model provides the estimation of likelihood of the RER misalignment observations, over and undervaluation at any point in the series. The parameters μ_1 , μ_2 , $\sigma^2{}_1$, $\sigma^2{}_2$ need to be estimated, Hamilton (1989) used maximum likelihood estimation by employing the algorithm for drawing probabilistic inference. This estimation assists us to know whether and when the movements in the time series volatility may be based on fluctuations in the behaviour of a nonlinear interactive filter. The algorithm selects the parameter amounts by applying the maximum log-likelihood function for the time series data (Bazdresch & Werner 2005). The misalignment series of the RER is divided as a 2 regime. Markov switching random walk model that makes both term and variance take different amounts during the over and undervaluation periods. This allows us to know in which period the RER is misaligned for any given point. According to MSM, the misalignment of RER is modelled as a first order Markov process as the next matrix for transition probability as shown in this matrix (Terra & Valladares 2010):

$$p = \begin{bmatrix} p_{oo} & p_{ou} \\ p_{uo} & p_{uu} \end{bmatrix} = \begin{bmatrix} p_{oo} & 1 - p_{oo} \\ 1 - p_{uu} & p_{uu} \end{bmatrix}$$

where: (p_{oo} + p_{ou} =1) and (p_{uu} + p_{uo} =1). This matrix describes the switching regime between the over and undervaluation states as in table 14.

Table 14. Over and undervaluation switching

Process	t_{-1}	t
p_{oo}	Overvaluation	Overvaluation
p_{ou}	Overvaluation	Undervaluation
p_{uo}	Undervaluation	Overvaluation
p_{uu}	Undervaluation	Undervaluation

To obtain the results from the Markov – switching regime, the MSM framework for misalignment series is employed as a dependent variable in this model. This model assists to obtain the probability of regimes at a particular time. The MSM tests whether data was generated as a mixture of two normal distributions as the main parameters for the two regimes. In this study, we have two different states as RER over or undervaluation. MSM results are presented in table 15 for different key parameters, means (μ_1, μ_2) and variances ($\sigma^2{}_1, \sigma^2{}_2$) that underlie the relationship between the two regimes.

Table 15. Markov switching regime results

Parameter	Estimation	Z-Statistic	Prob
μ_1	24.77	5.97	0.0000
μ_2	-36.01	-5.96	0.0000
$\sigma^2{}_1$	2.91	18.53	0.0000
$\sigma^2{}_2$	3.19	19.48	0.0000

Dependent variable is misalignment series

The estimated parameters in table 15 confirm that the mean values of the misalignment series are significantly different under the alternative regimes. The Regime of overvaluation has a positive mean (μ_1=24.77) whereas the undervaluation states have a negative mean ($\mu_2 = -36.01$). The findings indicates that, the overvaluation and undervaluation episodes have nearly the same volatility, it was 2.91 and 3.19 for over and undervaluation regimes respectively. The transition probability between the two regimes is provided in the matrix below:

$$p = \begin{bmatrix} 0.91 & 0.09 \\ 0.11 & 0.89 \end{bmatrix}$$

The values of p_{oo} and p_{uu} provide high rates and stability and are likely to stay in the same regime in the next period. Table 16 explains how long on average the regime will last, as well as the expected duration of each regime. The two percentages 0.91 and 0.89 imply that the scenario stays the same for a long time. It is noticed that the regime switches toward currency overvaluation more than currency undervaluation. The results for the switching probability were about 0.91, 0.09, 0.11, 0.89 for P_{oo} , P_{ou} , P_{uo} and P_{uu}. The value of corresponding constant expected duration for currency overvaluation and undervaluation was 11.59 and 9.25 respectively.

Table 16. Markov Switching transition probabilities (over and undervaluation)

Transition summary: Constant Markov transition probabilities and expected durations		
	1 (t)	2 (t)
1 (t+1)	0.913748	0.086252
2 (t+1)	0.108129	0.891871
Constant expected durations:		
	1	2
	11.59399	9.248175

The expected duration for regime 1 is given by$E(D) = \frac{1}{1-P_{11}}$.

The expected duration for regime 2 is given by$E(D) = \frac{1}{1-P_{22}}$.

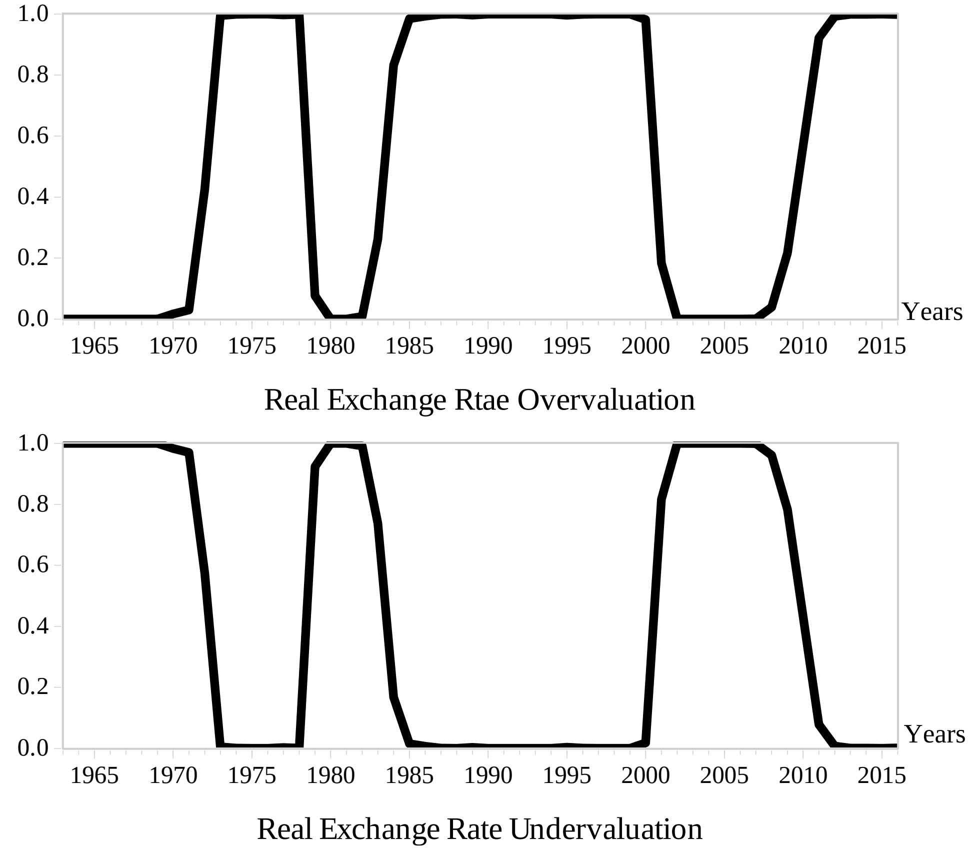
Constant expected duration: (1/0.086252 =11.59399), (1/0108129 = 9.248175).

(1) Overvaluation, (2) Undervaluation.

Source: EViews 10 outcomes

The Markov Switching Model in figure 29 measures the misalignment over time as distinct episodes of over and undervaluation. Misalignments of RER were overvalued during 1971-1979, 1984-2002 and 2012-2016, while they were undervalued during 1962-1971, 1980-1983 and 2003-2011.

Figure 29. Markov Switching Smoothed Regime Probabilities



Source: EViews 10 outcomes

3.8 Markov – switching regime and real exchange rate movements

Movements of RER may lead to currency real appreciation or real depreciation. These changes in the RER provide information about the two regimes (real appreciation or real depreciation) according to the definition of the nominal exchange rate. If the nominal exchange rate is expressed as units of national currency, a rise in the RER curve implies real depreciation, while a decline refers to rate appreciation as shown in figure 30. On the other hand, if the nominal exchange rate is denominated in units of foreign currency, the movements of the RER will be the converse. This study used units of foreign currency for explaining RER movements, and thus the increase (decrease) means appreciation (real depreciation). These calculations could be illustrated as in this formula:

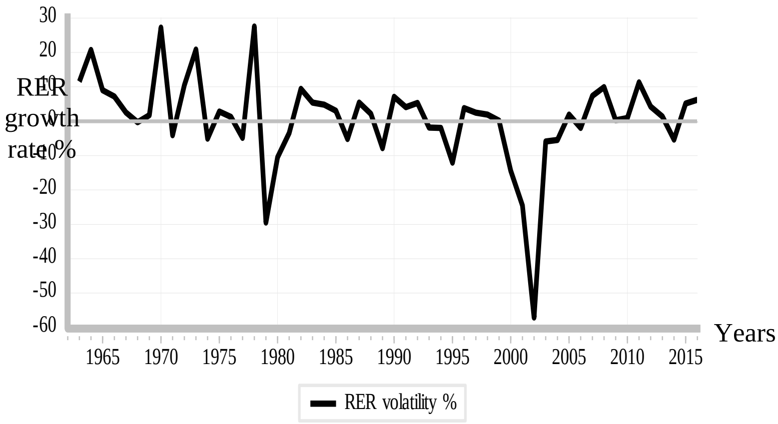
$$\text{RER Growth Rate \%} = \frac{\text{RER}_{\text{end}} - \text{RER}_{\text{initial}}}{\text{RER}_{\text{initial}}} * 100 \ldots\ldots\ldots\ldots\ldots (25)$$

$$= [\ln(\text{RER}_{i,t}) - \ln(\text{RER}_{i,t-1})] * 100$$

$$= \text{Depreciation } (-) \text{or Appreciation } (+)$$

Empirically, the MSM is used for examining the dynamics of real exchange rate movements and likelihood of the Libyan dinar being appreciated or depreciated, as well as the probability of switching between the two states. To do so, we should calculate the growth of the RER to obtain the real appreciation and real depreciation of the national currency.

Figure 30. Real exchange rate growth rate 1962-2016



Source: Author's work

According to MSM, the movement of exchange rate is modelled as a first order Markov process as in the following matrix for transition probability as:

$$p = \begin{bmatrix} p_{aa} & p_{ad} \\ p_{da} & p_{dd} \end{bmatrix} = \begin{bmatrix} p_{aa} & 1 - p_{aa} \\ 1 - p_{dd} & p_{dd} \end{bmatrix}$$

where: (p_{aa} + p_{ad} =1) and (p_{dd} + p_{da}=1).This matrix describes the switching regime between appreciation and depreciation of the real exchange rate as in table 17:

Table 17. Appreciation and depreciation switching

Process	t_{-1}	t
p_{aa}	Appreciation	Appreciation
p_{ad}	Appreciation	Depreciation
p_{da}	Depreciation	Appreciation
p_{dd}	Depreciation	Depreciation

To obtain the findings from MSM, growth rate of the real exchange rate series is used as a dependent variable to estimate the probability of the two regimes. In this part, we have two different states: real appreciation and depreciation of the local currency. The results from the Markov Switching Model are shown in table 18 for the key parameters, means (μ_1, μ_2) and variances $({\sigma^2}_1, {\sigma^2}_2)$. These parameters underline the linkage between regimes, 1 and 2 of the real exchange rate movements, as shown in table 19.

Table 18. Markova switching regime results (real appreciation and depreciation)

Parameter	Estimation	Z-Statistic	Prob
μ_1	2.00	1.92	0.0548
μ_2	-2.18	-0.35	0.7294
${\sigma^2}_1$	1.63	9.28	0.0000
${\sigma^2}_2$	3.11	13.54	0.0000

Dependent variable is the growth rate of RER.
Source: EViews 10 outcomes

The regime of regime appreciation has a positive mean (μ_1 =2.00) whereas the depreciation regime has a negative mean ($\mu_2 = -2.18$). The appreciation and depreciation episodes have nearly the same volatility about 1.63 and 3.11 for appreciation and depreciation regimes respectively. The transition probability between the two regimes is provided in the next matrix below:

$$p = \begin{bmatrix} 0.85 & 0.15 \\ 0.38 & 0.62 \end{bmatrix}$$

The amounts of p_{aa} and p_{dd} indicate the probability of remaining in the real appreciation or depreciation respectively, after that switching to the same state in the next period. The value of (p_{aa}) shows a high stable rate and the likelihood of staying in the same regime in the next period by about (0.85). This result is a high level compared with just 0.62 to remain in the same state for regime (p_{dd}). The transitions between the two regimes (p_{ad}) and (p_{da}) are respectively (0.15) and (0.38), which implies that switching from real appreciation to real depreciation is about 2.5 times less likely than switching from real depreciation to real appreciation. Noticeably, the corresponding expected durations for real appreciation and real depreciation are about 6.67 and 2.62 respectively during the sample period.

Table 19. Markov Switching transition probabilities (real appreciation and depreciation)

Transition summary: Constant Markov transition probabilities and expected durations

	1(t)	2(t)
1(t+1)	0.850140	0.149860
2(t+1)	0.381160	0.618840

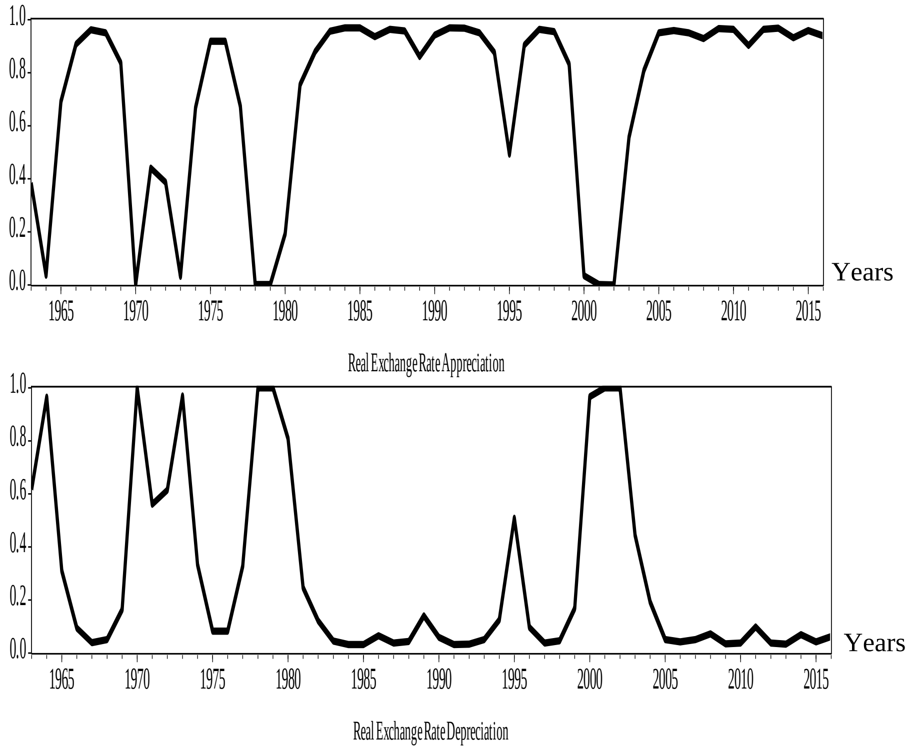
Constant expected durations:

	1	2
	6.672892	2.623569

The expected duration for regime 1 is given by $E(D) = \frac{1}{1-P_{11}}$.
The expected duration for regime 2 is given by $E(D) = \frac{1}{1-P_{22}}$.
Constant expected durations = (1/0.149860) = 6.672892, (1/0.381160) = 2.623569
(1)Appreciation, (2) Depreciation
Source: EViews 10 outcomes

The Markov Switching Model in figure 31 measures the movements of RER over time as distinct episodes of real appreciation and real depreciation. The figures show that RER appreciation states last longer than real depreciation states over time.

Figure 31. Markov switching smoothed regime probabilities (real appreciation and depreciation)



Source: EViews 10 outcomes

3.9 Conclusion

In summary, in this chapter the volatility in RER was measured to estimate its equilibrium and misalignments for Libya. As Libya is an oil exporting country, its real exchange rate is explained by fundamentals, namely, real oil prices, real relative productivity and trade openness. This study found evidence for the existence of a time –varying equilibrium for real exchange rate, as well as, current signs of equilibrium and misalignments of the Libyan dinar in the study period. Real oil prices and trade openness are associated with real exchange rate depreciation, while real relative productivity is linked with RER depreciation. Increase in real oil prices affects production resources to increase the supply of non-tradable goods. Prices of non-tradable goods will decrease causing RER depreciation. This is known as indirect (substitution) effects of income on RER. The positive real relative productivity may increase wages in tradable and non-tradable goods, causing price levels to rise. Increase in prices will make RER to be appreciated. As for trade openness, increase in this indicator may lead to decrease in local prices for tradable and non-tradable goods. More price decrease will cause RER depreciation.

The Oil sector plays a very significant role for determining real exchange rate misalignments in Libya. Foreign exchange resources from oil play a considerable role in affecting inflation and hence, the RER. These episodes are very high and very slow taking a long time to change from one regime to another. It is also noticed that, there has been a high level of overvaluation in recent years because of the high level of inflation with no considerable change in nominal exchange rate. This led to a very high level of black market premium as a result. When the policy makers keep the value of national currency at a high level with a high level of inflation rate as well with foreign exchange controls, it will lead to high levels of black market premium. In a country such as Libya, when the country faces a considerable reduction in foreign exchange resources obtained from oil, policy makers will apply a foreign exchange controls policy, leading to high inflation and then real appreciation and overvaluation states. In some other oil exporting countries, overvaluation may occur because of the revaluation of the national currency, rather than a high level of inflation. As for undervaluation states in the Libyan economy, particularly during 2002-2011, the main reason for these states is nominal exchange rate devaluation accompanied by low levels of inflation at that time. Devaluation of the national currency should be followed by a high level of inflation, but in this case, the elimination of trade restrictions and foreign exchange controls played a significant role in decreasing the local inflation.

The contribution of this chapter is that this study is the first study to measure the exchange rate gap in Libya. To our knowledge, there is no study that has highlighted this important topics about Libya. The policy of exchange rate settings should directly try to keep the actual real exchange rate very close to the equilibrium path. They should try to apply some policies to make the nominal exchange more compatible with the inflation rate, to realign the RER in order to avoid the negative consequences of RER misalignments. After estimating these gaps, the question that arises now is whether such misalignments have obvious effects on economic activity in Libya. The next study the main impacts of real exchanger rate misalignments on the economic performance.

Chapter 4 Real Exchange Rate Misalignments and Economic Performance

4.1 Introduction.

Conceptually, RER misalignment refers to a case in which an actual real exchange rate diverges from the potential real exchange rate. Real exchange rate appreciation more than the ideal path causes overvaluation states of national currency, while undervaluation arises when the real exchange rate is depreciated to less than the equilibrium level. Long-term deviation from the ideal path as an over or undervaluation of the national currency may cause instability in the economy, such as economic growth, price levels, trade balance, black market premium and capital flows. Reinhart, et al. (1997) and Razin, et al (1997) confirmed that overvaluation of the local currency is overwhelmingly the indicator of the inconsistency of the macroeconomic policies that may cause an unsustainable deficit in the current account, increasing the risk of speculative attacks and raising the external debt.

When the real exchange rate is overvalued, it might make the economy less competitive in international markets, while undervaluation may increase inflation. On the other hand, undervaluation of the national currency states may motivate investment and exports, improve the trade balance and thus, increase GDP and make the economy more competitive. However, it may contribute to increase the inflation rate in the economy because of the devaluation of the national currency. This may happen because of the high cost of changing the local currency to foreign currency, making imports more expensive than before. For countries that depend heavily on imports, the inflation rate may increase in the economy.

This chapter focuses on the association between RER misalighnments and some economic indicators that may be influenced by RER misalignments. Section 2 will provide a literature review about the relationship between RER misalignments and some economic indicator such as economic growth, inflation and exports. Section 3 will study the impacts of RER gaps on the real non-oil gross domestic product by employing the ARDL model. Section 4 will study the relationship between RER misalignments and inflation by using ARDL regression. Sections 5 and 6 concentrate on the linkage between RER misalignments and black market exchange rate respectively. Section 7 builds a macroeconomic Keynesian Model to discover the impacts of RER misalignments on the real private consumption, real private investment, real taxes (RT), real imports (RM), real interest rate and real domestic income. Section 8 provides a conclusion about the main results. Basically, this part of the study is intended to the following question: what are the results of over and undervaluation on economic performance?

4.2 Literature Review

Edwards (1989) measured the association between RER misalignments and economic performance. The study found that countries with a real exchange rate was close to the equilibrium exchange rate level performed better compared to countries where the actual exchange rate largely away from the equilibrium path.

Sallenave (2010) studied the association between economic growth and the real effective exchange rate misalignments for the G20 countries during 1980-2006. This study calculated real exchange rate misalignments using the behavioural method BEER to derive the misalignments path. Then, it applied a dynamic panel growth technique including the measured misalignments. The results suggested some significant differences between developed and emerging economies. The degree of exchange rate misalignment is more evident in emerging economies, while the speed of adjustment towards the estimated equilibrium level is slower for developed ones. Regarding to the association between growth and real misalignments, there was a negative relationship between economic growth and misalignments of the real exchange rate.

Aguirre and Calderón (2005) assessed the impacts of real exchange rate misalignment on growth. They measured RER misalignments as the difference between actual and equilibrium levels of the exchange rate for 60 countries during 1965-2003 employing time series and panel data co-integration models. By applying dynamic panel data methods, they found that misalignments reduce economic growth with non-linear impacts. Larger misalignments cause a decline in economic growth.

Toulaboe (2011) investigated the effects of exchange rate misalignment on economic growth in developing economies. This paper used data from 33 developing countries to measure the association between the mean growth rate per capita GDP and misalignments of the real exchange rate. The findings indicated that misalignments are linked negatively with economic growth. This paper mentioned that inappropriate exchange rate policies in many developing countries contributed to the poor economic performance in these countries.

Vinh and Fujita (2007) examined the impact of the real depreciation on inflation and output in Vietnam using the VAR approach. This study found that a real devaluation has positive impact on both output and inflation. The devaluation shock may influence price level and economic growth via increasing the money supply and improving the trade balance. Therefore, the real exchange rate movements may not have a considerable impact on output in the long-run.

Tsen Wong (2013) studied the association between real exchange rate misalignments and economic growth in Malaysia. This study applied the autoregressive distributed lag (ARDL) approach and the Generalized Forecast Error Variance Decomposition. The findings of the ARDL technique showed that a rise in productivity, the real interest rate differential and the real oil price and reserve differential will appreciate the real exchange rate in the long term. The results of the Generalized Forecast Error Variance Decomposition indicateed that productivity differential, the real interest rate, the real oil price and reserve differential are the most essential indicators influencing the real exchange rate fundamentals. Furthermore, the ARDL method provides that a rise in real exchange rate misalignment will reduce economic growth.

Razin and Collins (1997) investigate real exchange rate misalignment and economic growth in both developed and developing countries, calculating RER misalignment by using a simple extension of an IS-LM model of an open economy. The outcomes revealed a non-linear linkage between real exchange rate misalignment and growth. The main results of this study is that very high levels of real exchange rate overvaluation are associated with slow economic growth, while growth is moderate during periods of high and not very high levels of real exchange rate undervaluation.

Shabsigh and Domaç (1999) investigated the impacts of real exchange rate misalignments on economic growth of Jordan, Egypt, Tunisia and Morocco. This paper used three measures to estimate misalignments of real exchange rate, depending on purchasing power parity, black market exchange rate and structured model. The empirical results showed that there is an adverse impact of real exchange rate misalignments on economic growth by employing all measures of real exchange rate misalignments.

Abida (2011) studied the relationship between real exchange rate misalignments and economic countries for the Maghreb countries, including Tunisia, Algeria and Morocco during the period 1980-2008. This paper applied a dynamic panel growth model to measure the role of misalignments on growth. The main finding of this study was that, the coefficient for real exchange rate misalignments is negative, which implies that a more RER appreciation (depreciation) damages (assists) long-run growth based on the definition of exchange rate in this study.

Frikha and Hachicha (2013) studied the effects of real exchange rate misalignments on economic growth for seven MENA countries during the time from 1960-2010. This study utilised the Edwards (1989) theoretical model and ARDL model to deal with misalignment and growth. The results indicate that the association between real exchange rate misalignments and economic growth is negative, while the other economic factors can also affect economic growth. Moreover, the economic growth elasticity taking into account real exchange rate misalignment is very crucial in absolute value in Tunisia, Jordan and Morocco, whereas it was very weak for Egypt, Syria Algeria and Israel.

Iyke and Odhiambo (2015) examined the effect of real exchange rate misalignments on economic growth in sub-Saharan Africa *(SSA)* for 15 countries over the period 1970-2010. This study used a penal data and GMM estimators. The findings reveals that real undervaluation increases economic growth; whereas real overvaluation decreases it. In numbers, this study found that a one-percent change in real undervaluation causes a 2.8 percent rise in economic growth. The recommendation in this study is that countries should deploy real undervaluation as a policy instrument to move resources from the less productive non-traded sectors to the more-productive traded sectors.

Naseem and Hamizah (2013) studied the effects of real exchange misalignments on growth during the period 1991:1-2099:4. Real exchange rate misalignments was estimated based on the Natural Equilibrium Exchange Rate NATREX equilibrium model. This study employed on Autoregressive Distributed Lags (ARDL) with bound test method and co-integration technique. In this study, overvaluation states occured when NATREX path is higher than actual RER and conversely for undevaluation states. Negative (positive) numbres mean an overvaluation (undervaluation). The findings showed a positive and significant linkage between real exchange rate misalignments and economic growth.

Ali, et al. (2015) examined the effects of real exchange rate misalignments on economic growth in Nigeria employing quarterly data over the period 2000-2014. This study computed real exchange rate misalignment by estimating deviations of actual real exchange rate from equilibrium level employing the Behavioural Equilibrium Exchange Rate (BEER) method of Edwards (1989). The findings indicated that the Nigerian naira was overvalued on average by 0.17 per cent over the study period. Furthermore, the study showed empirical evidence for a negative effect of real exchange rate misalignment on economic growth in Nigeria during the study period. In this study, the RER was overvalued when RERMIS had positive signs and undervalued when RERMIS had negative signs. The main recommendation of this study was that the real exchange rate should follow its equilibrium level to promote economic growth in the economy.

Gala (2007) examined the linkage between economic growth and real exchange rate misalignments, calculated according to deviation from purchasing power parity as an equilibrium level. This study employed a panel data technique for 58 developing economies. The main finding was that, there was a negative association between growth and overvaluation of the national currency over the study period 1960-1999.

Shabsigh and Domaç (1999) studied the impacts of the real exchange misalignments on the output of Egypt, Jordan, Morocco, and Tunisia. This study employed three approaches to measure the misalignments of real exchange rate, namely Purchasing power parity, black market exchange rate and structured model. This paper found that there was an adverse impact of RERMIS on output. This study also found theoretical signs for the capital growth and population statistically significant, as well as compatible with the Solow growth model.

Sibanda, et al. (2013) examined the impacts of the real exchange rate on economic growth in South Africa by using quarterly time series data (1994Q1-2010Q4). This research used a Vector Error Correction model to determine the effect of the real exchange rate on output in South Africa. The independent variables in this study were real exchange rate, real interest rate, money supply, trade openness, and gross fixed capital formation. The findings discovered that undervaluation of the national currency noticeably hampers growth in the long run, whilst it increases economic growth in the short run.

Abbas, et al. (2012) studied the association between economic growth, inflation, and real interest rate with the exchange rate for 10 African countries during 1996-2010. The results indicated that the gross domestic product had a significant relationship with the exchange rate while inflation rate and interest had a non-significant association with the rate of exchange of the selected countries.

Elbushra, et al. (2010) studied the impacts of exchange rate reforms on Sudanese economy using computable general equilibrium (CGE) model developed by the International Food Policy Research Institute (IFPRI), also a Sudan social accounting matrix (SAM) was used for the year 2000 as a database improvement in the balance of trade. The results indicated that depreciation (appreciation) of the exchange rate increases (reduces) GDP.

Conrad and Jagessar (2018) studied the effect of real exchange rate movements and misalignments on growth rate of GDP for the Trinidad and Tobago (T&T) economy during 1960 to 2016. The study employed ARDL regression and non-linear impacts. This results indicated that real exchange rate appreciation and both overvaluation and undervaluation states reduced the economic growth. The negative association between economic growth and undervaluation was attributed to T&T’s small and undeveloped manufacturing sector and high import orientation.

Tehranchian (2015) examined the effects of real exchange rate misalignments on inflation persistence for Iran. This study used a Vector Auto Regression technique, and Markov Switching Regression for quarterly data over 1989:4 -2014:3. The study used this formula to calculate RER as $[E * \frac{P^*}{P}]$, where E is nominal exchange rate as units of local currency per one unit of foreign currency, and P^* and P are the foreign and local prices respectively. The findings indicated that the liquidity growth and misalignments of real exchange rate have a positive influence on inflation persistence. Additionally, growth in GDP negatively influences inflation persistence. To examine the nonlinear association between variables, Markov Switching regression was applied by using quarterly data. The results implied that real exchange rate misalignments have a negative impact on unstable inflation, but a positive impact on the stability of inflation.

Giannellis and Koukouritakis (2013) investigated the association between the persistence of inflation rate and exchange rate misalignments for a group of Latin American countries, namely, Venezuela, Mexico, Brazil and Uruguay. This study examined whether the persistence of inflation rate is related to exchange rate undervaluation or not. The results showed that there was strong evidence to suppose this assumption. The results revealed that high depreciation of the national currency led to the inflation persistence, while slow depreciation was related to temporary steadiness of inflation.

Berument and Pasaogullari (2003) assessed the impacts of real depreciation on output and inflation in Turkey by using quarterly data during 1987.Q1-2001.Q3. The results showed that, real depreciation was associated with decreasing output and had inflationary impacts on the Turkish economy, not contractionary. This study suggested that it is not easy to keep currency misalignments at moderate levels. Overvaluation may cause an increase in output but may lead to a financial crisis.

Jongwanich (2009) tested the misalignments of real exchange rate and equilibrium in some developing Asian countries over the period 1995-2008. In this study, an increase (decrease) in real exchange rate was indicated as depreciation (appreciation). This study investigated the association between misalignments of real exchange rate and exports. The findings from this study pointed out that the real exchange rate was overvalued during the financial crisis 1997-1998, but after the crisis, the real exchange rate was undervalued for the People’s Republic of China (PRC), Thailand and Malaysia. The study also found that real exchange rate misalignments have negative effect on total exports. The paper recommended that, monitoring equilibrium real exchange rate and misalignments is a beneficial instrument for economic stability.

Wondemu and Potts (2016) instigated the role of the real exchange rate in stimulating exports value and playing a role in diversification of exports for Tanzania and Ethiopia. The findings indicated that undervaluation of national currency increases the value of exports and boosts their diversification, while overvaluation shrinks export supply. The results also showed that Tanzania experienced undervaluation of the currency for a long time, which led to a good performance of export value and diversification. However, improvement of export quantity and diversification caused a high level of inflation and reserves accumulation in the case of Tanzania.

Nicholas (2008) studied the impacts of real exchange rate overvaluation on manufacturing export performance for the Philippines economy. The study results revealed that the real exchange rate was overvalued for a long time, from 1981 to 2005. This led to, the country is losing its competitive position compared to its trading partners for a long time. Analytically, overvaluation may have promoted imports in the Philippines economy but it had an adverse effect on import substituting industries.

Toulaboe (2016) studied misalignment of exchange rate for seven Asian economies and its effects on US exports. The study employed an autoregressive-distributed lag ARDL method and bound test. The results explained that the real exchange rate was not at a high level in most of the case study economies. The findings also revealed a negative association between US exports and real exchange rate misalignments in the long-run. This study mentioned that, the negative impacts of the real exchange rate will be worse with persistent real undervaluation for these countries.

Haddad and Pancaro (2010) studied how the real exchange rate undervaluation enhance economic growth and exports for the East Asian economies. This study found that, although real undervaluation can encourage exports, thus only applies to low-income economies in the medium term.

Diallo (2011) investigated the relationship between the real exchange rate fluctuations and misalignments with exports for 42 Low-Income and Middle-Income economies. This study used a panel data co-integration method from 1975 to 2004. The results revealed that the real exchange rate volatility and real exchange rate misalignments both had a negative association with total exports. In this study, when the real exchange rate went up meant appreciation while going down meant depreciation, then total export increase was associated with depreciation of real exchange rate and undervaluation of national currency. The findings also showed that real exchange rate fluctuations were more detrimental to total exports than real exchange rate misalignments.

Jian (2007) measured the equilibrium real exchange rate and misalignments for the Chinese economy from 1978 to 2005. This study employed the Engle-Granger (E-G) two-step approach and error correction model to study the effect of RMB exchange rate misalignments on exports. The main findings was a negative association between real exchange rate misalignments and exports performance. More specifically, the greater undervaluation of the Chinese currency led to higher net exports, while greater overvaluation caused smaller net exports in the economy.

Bouoiyour and Rey (2005) applied the behaviour real effective exchange rate approach for the dirham against the European euro (the 15EU15) during the period 1960-2000. This study used the volatility of real exchange rate by standard deviation and employed the NATREX model to estimate the equilibrium and misalignments of the exchange rate. It found that an increase in the volatility of the dirham decreased exports and imports (trade flows). The study also discovered that misalignments as an overvaluation would cause a decrease in exports and an increase in imports, leading to deterioration in the trade balance with the European Union.

Bhattarai and Armah (2005) investigated the impacts of exchange rates on the trade balance in Ghana by using annual time series data from 1970-2000. This paper used co-integration analysis for a single equation model and VAR-Error correction model. A stable long-run association was found between exports and imports with the real exchange rate, as well as contractionary influences of currency depreciation according to Marshal-Lerner-Robinson conditions. The overall conclusion of this study was that, to improve the balance of trade in Ghana, the policy makers should ensure coordination between the real exchange rate and demand management policies.

Bhattarai and Mallick (2013) proposed a dynamic theory of trade and exchange rate for a global economy and used a VAR on time series data of China and the USA on wages, interest rates, exchange rate, GDP, current account balance and the USA trade deficit to discover practical evidence. The study estimated the VAR model according to Sim (1980) and Bernanke (1986) with restrictions by using quarterly data over the period of time 1995:1 to 2009:1. The analysis was limited to five variables, which included the relative wage between China and the USA, interest rate differential, Chinese real effective exchange rate, GDP of China relative to the USA GDP, and the current account balance. The main objective of this study was to investigate how the relative prices of labour, capital and currency affected the economic performance in China and trade balance in the USA. The study found that with free capital inflows and outflows and labour mobility restrictions, the comparative advantage of China and the trade deficit of the USA would both be reduced if China allowed real appreciation of its currency. The welfare of Chinese households and trade imbalance of the USA could be decreased with the high cost of production and prices. On the other hand, higher GDP of China would minimise the USA current account.

Onour and Cameron (1997) studied the association between parallel market premium and misalignments in some developing countries. Since in developing countries the local currency is usually believed to be overvalued, which may depress the current account. If undervaluation happens, it may cause an inflationary situation, but it is considered very important to deduct the misalignment of exchange rate. This solution is difficult in economies that experience a black market exchange rate with a large amount of capital flows outside official data. This study found that the misalignment direction cannot be known without knowing the size of capital flows in the black market. The change level of the exchange rate in the black market is a suitable indicator of real exchange rate changes.

Masunda (2012) investigated the role of real exchange rate misalignments in causing currency crisis in Zimbabwe using annual data over the period 1980-2006. Firstly, this study employed some real exchange rate determinants, namely, government consumption, openness, excess credit, technical progress and capital flows, to explore to what extent the real exchange rate was misaligned. The real exchange rate equilibrium was measured by employing dynamic ordinary least squares DOLS. The findings indicated that the real exchange rate was misaligned based on its determinants. Secondly, this indicator was employed to test the association misalignments of exchange rate and currency crisis. The findings revealed that overvaluation of national currency, external debt, output growth, slackening in the monetary policy and political instability caused currency crisis in Zimbabwe.

Jongwanich (2008) studied real exchange rate misalignment for the Thai economy during the currency crisis 1997-1998. This study measured the equilibrium real exchange rate based on the internal and external balance method. The equilibrium path was calculated by the difference between the actual and equilibrium real exchange rate level. The findings indicated that there was an overvaluation over the period 1991-1997. The reason were a massive amount of net short-term capital inflows and government expenditure. The real exchange rate returned to its long run equilibrium path after the huge depreciation of the nominal exchange rate during the crisis.

In summary, there are abundant studies that have investigated the association between real exchange rate misalignments and growth, inflation exports, currency crises and other macroeconomic variables. Edwards (1989) argued that the real exchange rate should be close to the equilibrium level. In most causes undervaluation may have more favourite impacts on the economy than overvaluation (Razin and Collins 1997). The effects of real exchange rate misalignments may depend on the economic situation. Developing countries are very different from developing countries in the economic structure. Policy objectives also play a very important role in managing the exchange rate misalignments. It also may depend on the specific circumstances that the country faces.

4.3 Real exchange rate misalignments and non-oil gross domestic product

In recent years, there is a big debate about the association between misalignments of the RER and economic growth. Even though misalignments of real exchange rate have not been the main indicator of neo-classical growth models that concentrate on investment and saving, much empirical research is interested in the association between misalignments and growth, particularly in developing countries (Eichengreen 2007). Notably, Edwards (1989) was the first researcher to study the impacts of misalignment of the real exchange rate on economic growth for 12 developing economies during the period 1962-1984. Edwards' model is used with the following fundamentals to measure this association: terms of trade, government consumption, capital account, excess supply of domestic credit, exchange control and technological progress to calculate the real exchange rate equilibrium path. Edwards (1989) found a negative linkage between RER on economic growth.

Since 1970, the vast majority of economies have found that the real exchange rate misalignments and economic growth are negatively associated; overvalued of the national currency caused low per capita economic growth (Sallenave 2010). For instance, Ghura and Grennes (1993) found a significant negative linkage between real exchange rate misalignments and economic growth for sub-Sahara African countries. In Latin American countries, the real exchange rate overvaluation was responsible for deficit in the current account and capital flows. In this respect, many other studies confirmed that the undervaluation of the local currency is linked with high growth, while the slow growth is correlated with overvaluation periods (Bleaney & Greenaway 2001 ; Gala & Lucinda 2006).

Overvaluation may not be a good policy and may lead to external imbalance. It might need low economic growth, while undervaluation may cause internal balance with high inflation (Williamson 1990). Then, Overvaluation reduces economic efficiency and causes misallocation of resources to cause the economic growth to slow down. McPherson and Nieswiadomy (2000) found that an overvalued real exchange rate causes a continuous misalignment of prices between a specific country and the rest of the world. This misalignment has an effect on the production level, the expenditure allocation, distribution and payments level, structure and size of trade flows, the international reserves level and external debt, currency substitution and capital flow. Furthermore, continuous real exchange rate overvaluation harms investors' and consumers' confidence, which influences the level of investment and saving. Rodrik (2008) also debates that overvaluation shrinks economic growth, while undervaluation boosts economic growth. Real exchange rate overvaluation has been predicted to hinder the economic growth while undervaluation may often cause a favourable economic growth environment (Frikha & Hachicha 2013). Naja (1998) mentioned that overvaluation of the national currency is one of the most crucial indicators, blamed for weak economic performance internationally. The case of undervaluation is more profitable for the tradable sector compared to the non-tradable sectors, hence more resources and investments are directed to the tradable sector and less to the non-tradable sector, while overvaluation leads to more investment in non-tradables. Both of these situations cause misallocation in resources and investment. Therefore the economy may grow at a level less than it would in an equilibrium situation. High levels of overvaluation and undervaluation may lead to misallocation of resources and hence, decline in the economic growth. Theoretically, overvaluation hinders exports and then decreases economic growth, while undervaluation supports exports and thus increases economic growth. However, undervaluation may worsen the economic situation with high inflation which may cause depression in growth in the medium term.

From the debate above, it is noticed that misalignments of real exchange rate may influence economic growth and welfare; see Edwards (1989) . All of this evidence confirms that, real exchange rate misalignments could influence economic growth. Accordingly, many empirical studies have found a strong association between RER misalignments and economic performance in Asian, African and Latin American countries. The stable RER promoted growth in the East Asian economies while the continuous misalignments repressed economic growth in African countries (Shabsigh & Domaç 1999). Literature has documented that exchange rate misalignments may hurt economic growth because of the decline in external competitiveness and the misallocation of local resources in the economy. This section aims to examine the effects of RER misalignments and economic growth for the Libyan economy. More specifically, this part will investigate whether over and undervaluation of the RER have different influences on economic growth and whether these impacts depend on the degree of the over and undervaluation states. Our focus will be on non-oil GDP because oil GDP depends on world oil prices and oil production. The investigation here addresses the question "does any departure from RER equilibrium considerably harm non-oil product performance"

4.3.1 Methodology and Data.

This part will to employ developed ARDL-Bounds testing to examine the association between MIS and RNGDP in the Libyan economy during the period 1962-2017. This method was first introduced by Pesaran and Shin (1998) and was improved recently by Pesaran, et al. (2001). The ARDL technique is widely applied for many reasons. Firstly, this regression is applicable regardless of the stationary properties at I(0) or I(1) or mixed results of both (Odhiambo 2009). Then, this model is better than the Johansen (1988) and Juselius (1990) co-integration technique. The co-integration method in these techniques requires specific order degree of integration at level 1. Secondly, the main advantage of employing this model instead of the Johansen co-integration test (1998) and Juselius (1990) is that, the co-integration estimates are just for the long run relationships within an equation system context. The ARDL consequences give the error correction model through a simple linear transformation, which helps to provide the speed of adjustment in the short run, as well as long run equilibrium. Thirdly, it is considered an important solution for endogenous econometric models, which comes from the inverse causality between dependent and independent variables. Therefore, this method mitigates this problem due to this technique is often free of the serial correlation of residuals (Harris & Sollis 2003).

Then, the endogeneity issue with ARDL is less of a problem. This model takes adequate lags for the data generating process for a certain modelling framework (Laurenceson & Chai (2003).

In this aspect, we can apply three major steps. The first step is to examine the stationarity test for variables to avoid the spurious regression issue. The Second is to investigate the long run association in this relationship employing the Bound test for co-integration. Next is an illustration of ARDL models into an Error Correction Model and finding a short-run association and error correction term. Finally, we provide some diagnostic statistics and tests for stability of ARDL estimator. To measure the association between MIS and RNGDP some other variables should be considered into account that may affect RNGDP. The main equation for measuring the association between RNGDP and MIS with some control variables is;

$$RNGDP_t = \beta_0 + D_{02} + \beta_1 OPEN_t + \beta_2 MIS_t + \beta_4 RNGDP_t + \epsilon_t \ldots\ldots (1)$$

where RNGDP represents the real non-oil gross domestic product, MIS is the misalignments of real exchange rate, OPEN is the degree of openness, ROGDP is the real oil gross domestic product and D_{02} is applied as a dummy variable to capture the considerable nominal exchange rate devaluation. After showing an econometric model to measure the interested linkage, the stationarity test should be applied to ensure that, no variable is stationary at I (2). We can apply Auto-regressive Distributed Lags (ARDL) regression and an error correction model as follows:

$$\Delta RNGDP_t = C_0 + C_1 D_{02} + \sum_{j=1}^{p} \beta_j \Delta RNGDP_{t-j} + \sum_{j=0}^{q} \lambda_j \Delta OPEN_{t-j} + \sum_{j=0}^{q} \theta_j \Delta MIS_{t-j} + \sum_{j=0}^{q} \alpha_j \Delta ROGDP_{t-j} + \propto_1 RNGDP_{t-1} + \propto_2 OPEN_{t-1} + \propto_3 MIS_{t-1} + \propto_4 ROGDP_{t-1} + u_t \ldots (2)$$

where Δ is a first difference operator and ε_t is a white-noise disturbance error term. The long-run association between the selected variables can be shown by the Wald test (F-statistic) by putting restrictions on the estimated long-run coefficients of one period lagges level of the variables equal to zero. The Wald or F-statistic is calculated to examine the null hypothesis;

$$H_0: \propto_1 = \propto_2 = \propto_3 = \propto_4 = 0$$

The alternative hypothesis is:

$$H_1: \propto_1 \neq \propto_2 \neq \propto_3 \neq \propto_4 \neq 0$$

Therefore, the calculated Wald or F-statistic will be compared to the critical value tabulated in Pesaran (2001) and Narayan (2005).The lower bound values suppose that all explanatory variables are integrated at order zero I(0), whereas the upper bound values suppose that all explanatory variables are integrated at order one I(1). Accordingly, if the calculated F-statistic is below the lower bound value, then I (0) the null hypothesis of no co-integration cannot be rejected. On the contrary, if the calculated F-statistic is more than the upper bound value, then I (1) the alternative hypothesis of co-integration cannot be rejected. The dependent variable and its determinants are moving together to a long-run equilibrium. If the calculated F-statistic falls between the bound values, there will not be a conclusive inference. Once a co-integration association has been discovered, the long-run and short-run parameters of the co-integration equation should be estimated. The next formula explains the long-run co-integration association model;

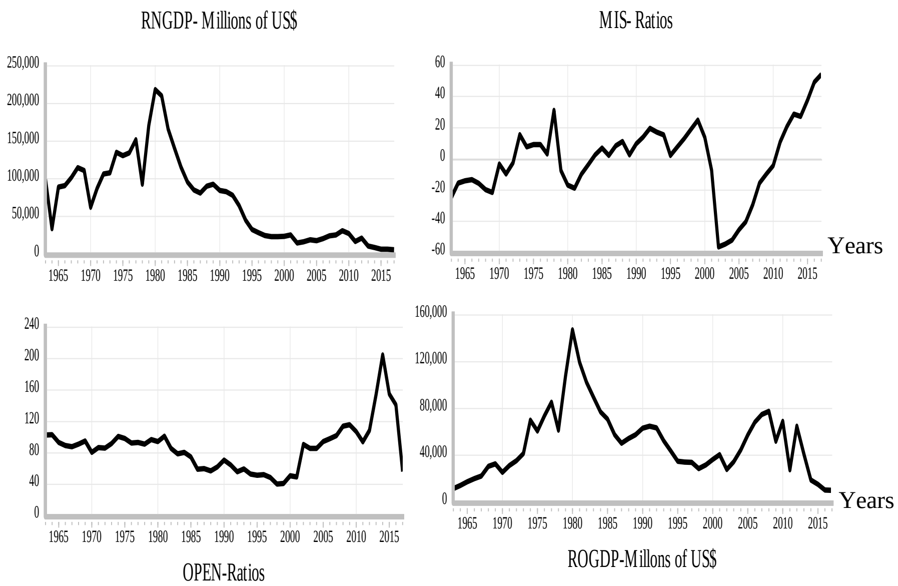
$$RNGDP_t = C_2 + C_3 D_{02} + \sum_{j=1}^{p} \beta_j \, RNGDP_{t-j} + \sum_{j=1}^{q} \lambda_j OPEN_{t-j} + \sum_{j=1}^{q} \theta_j MIS_{t-j} + \sum_{j=1}^{q} \eta_j \, ROGDP_{t-j} + u_t \text{........(3)}$$

The speed of adjustment may take time return to the equilibium level. Therefore RNGDP is likely to be different from its actual level. Then, the adjustment speed of RNGDP can be calculated by estimating the error correction model. The short-run parameters is obtained by estimating the following equation;

$$\Delta RNGDP_t = C_0 + C_1 D_2 + \sum_{j=1}^{p} \beta_j \, \Delta RNGDP_{t-j} \sum_{j=1}^{q} \lambda_j \Delta OPEN_{t-j} + \sum_{j=1}^{r} \theta_j \Delta MIS_{t-j} + \sum_{j=1}^{s} \eta_j \, \Delta ROGDP_{t-j} + \gamma_t \mathcal{E}_{t-1} + u_t \text{......... (4)}$$

where, $\mathcal{E}_{t-1}$ is the error correction term from one period lagged estimated in this estimation. The parameter γ_t measures the speed of adjustment for the model to converge to the equilibrium level. This section also explains the source of data with their measurements and the definition of applied variables. Data were collected from different sources. All variables were sourced from online databases and denominated in US dollars. The ROP is calculated by dividing the average nominal crude oil prices NOP for Libyan companies by CPI as $ROP = [NOP/ CPI] * 100$. Data for nominal oil prices NOP was obtained from CBL-Economic Bulletin. The real relative productivity was measured by dividing the real gross domestic product $RGDP_{LY}$ for Libya dividing by the real gross domestic product for the United States $RGDP_{USA}$ as $RRP = [RGDP_{LY}/RGDP_{USA}]$*100. Data for GDP_{LY} was taken from Economic and social data in Libya 1962-2006 while GDP_{USA} was taken from OECD. Trade openness is calculated by taking the sum of imports and exports dividing by GDP as $OPEN = [IMPORT + EXPORT] / GDP] * 100$. Data for exports and imports were obtained from Economic and social data in Libya and CBL. The real exchange rate misalignment MIS is measured by considering this formula MIS = [(RER – ERER) / ERER] *100 as in chapter 3. Data for nominal oil gross domestic product NOGDP and nominal non-oil domestic product NNGDP are obtained from Economic and social data in Libya and CBL. NOGDP and NNGDP are divided by CPI and multiplied to 100 to obtain ROGDP and RNGDP respectively. This part will focus on the non-oil product because oil product is purely related to the world oil price and oil production. The employed data are shown in figure 32.

Figure 32. RNGDP, RER misalignments and controls during 1962-2017



Sources: CBL-Economic Bulletin (various issues), OECD, IFS and Economic and social data in Libya

4.3.2 Stationarity test

In this section, it is important to perform stationarity tests for all variables to ensure that no series under consideration is integrated at I(2) or higher for ARDL regression. It is argued that I (2) variables may give a spurious F statistic in ARDL regression. F statistics of each series are calculated according to Pesaran, et al. (2001) and Narayan and Smyth (2005) are structured depending on the supposition that all variables should be stationary at I(0) and I(1) or both; none of them is stationary at I(2). Table 20 illustrates that all interested variables are stationary at I (1); none of them are stationary at I (2).

Table 20. Unit root test (ADF) and (PP) for RNGDP, MIS and controls

Variables	Model	Level (ADF)	First diff (ADF)	Level (PP)	First diff (PP)
MIS%	Intercept	-1.391	-6.417***	-1.739	-6.414***
	Intercept &trend	-1.503	-6.417***	-1.835	-6.417***
	None	-1.446	-6.415***	-1.808*	-6.411***
RNGDP	Intercept	-1.369	-8.524***	-1.329	-8.436***
	Intercept &trend	-2.450	-8.617***	-2.450	-8.555***
	None	-1.272	-8.608***	-1.220	-8.514***
OPEN	Intercept	-1.315	-5.034***	-2.344	-3.891***
	Intercept &trend	-1.254	-4.953***	-2.322	-3.843***
	None	-0.048	-5.118***	-1.001	-3.928***
ROGDP	Intercept	-2.092	-8.317***	-2.145	-8.303***
	Intercept &trend	-2.166	-8.511***	-2.088	-8.513***
	None	-0.994	-8.398***	-2.088	-8.383***

Note: */**/*** indicate rejection of null hypothesis of unit root at significant levels 10/5/1 percent respectively.

Source: EViews 10 outcomes

4.3.3 ARDL estimation for RNGDP and MIS

The ARDL system identifies the optimal lag length for ARDL regression according to Hannan – Quinn information criterion is as 2, 2, 3, 0, 3 for RNGDP, MIS, OPEN, ROGDP and D02 respectively. The next stage is to perform a Bound test to estimate the long and short-run association empirically between RNGDP and MIS in Libya, taking into account some other independent variables in the regression. The bounds test findings are reported in table 21. If the Wald or F-statistic falls outside the upper bound, then the null hypothesis of no co-integration will be rejected. The Computed F-statistic value is about 8.57, which is greater than the upper critical value of the Bound test (UCB = 4.37) at the 1% level of significance. This result confirms conclusive proof of a long-run association between RNGDP and the applicable macroeconomic variables. Therefore, this series results in rejection of the null hypothesis.

Table 21. ARDL-F Bound test for RNGDP, MIS and controls

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	8.57	10%	2.20	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Null Hypothesis: No levels relationship

Source: EViews 10 outcomes

Table (22) shows that RNGDP has a negative relationship with MIS in the long run. The negative sign implies that an increase in the MIS curve is associated with a decrease in RNGDP on average. As mentioned before in this study, going up in the MIS curve means one of two things, rising overvaluation levels or reducing undervaluation states. Then, a unit increases (as a percentage) in MIS causes RNGDP to decrease by about 481.99 on average. These results imply that, increase in overvaluation states or decrease in undervaluation states of the national currency are associated with declining in the RNGDP and the adverse also applies. Then, more overvaluation (undervaluation) of national currency tends to shrink (stimulate) RNGDP.

Table 22. ARDL-Long run and error correction regression for RNGDP, MIS and control variables

Long Run				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
MIS	-481.9919	123.1792	-3.912931	0.0004
OPEN	1372.717	119.5417	11.48317	0.0000
ROGDP	0.987351	0.084573	11.67451	0.0000
D02	-119011.3	7441.318	-15.99330	0.0000
C	-65734.64	10065.36	-6.530777	0.0000
EC Regression				
D(MIS)	-822.8299	160.8926	-5.114156	0.0000
D(OPEN)	303.1252	98.61703	3.073761	0.0040
D(D02)	-55396.41	12817.45	-4.321952	0.0001
ECT				
CointEq(-1)	-0.727	0.095	-7.642	0.0000

R-squared	0.810	Mean dependent var	-1593.805
Adjusted R-squared	0.770	S.D. dependent var	20616.53
S.E. of regression	9892.864	Akaike info criterion	21.40806
Sum squared resid	4.11E+09	Schwarz criterion	21.78330
Log likelihood	-546.610	Hannan-Quinn criter.	21.55191
Durbin-Watson stat	1.677		

Diagnostic statistics

Problem	**Test**	**Pro**	**Decision**
Serial correlation	Breusch-Godfrey	0.48	No Serial correlations
Heteroscedasticity	ARCH	0.60	No Heteroscedasticity
Normality (JB_N)	Jarque-Bera	0.81	Error terms normally distributed.
Misspecification	Ramsey RESET	0.35	No functional form misspecification

Source: EViews 10 outcomes

As for OPEN and ROGDP, the signs were positive on both. One unit rise in OPEN and ROGDP yields an increase in RNGDP by approximately 1372.72 and 0.99 respectively in the long run. All parameters are significant at the 1% level of significance. These results are logical and consistent with the Libyan economy characteristics. In Libya, as an oil dependent country, non-oil product relies on the oil sector as well as trade flows, particularly imports. In the short run, also MIS has a negative relationship with RNGDP and OPEN has a positive linkage as well. The EC coefficient has the right sign and is statistically significant at level 1%. This finding confirms that there is a co-integration association among the model variables. The parameter of the error correction term is about (-0.73) at the 1% level of significance. This means that, 73% of disequilibrium or deviations from long-run equilibrium in the past year is corrected in the present year. In other words, short run deviations from our long-run equilibrium are corrected by approximately 73% every year. This finding implies that the speed of adjustment is obviously high in RNGDP; it takes about 1.37 years to return to the equilibrium level following a shock in the system. Therefore, there is a stable long-run linkage between the RNGDP and the selected dependent variables in this estimation. If there is a shock in the system, the negative sign indicates a move back towards the equilibrium.

All diagnostic statistics of the ARDL regression are robust. The model successfully passed the residual tests by applying ARCH Heteroscedasticity test and the Breusch-Godfrey LM Serial Correlation test. The Chi-squared statistics χ^2 ARCH (2) and χ^2SC (2) indicate that there is no heteroscedasticity and no auto-correlation respectively in residuals. The normality of distribution of error terms was also tested, employing the Jarque-Bera test. The p-value is found to be more than 0.05, which means that the regression is normally distributed. In addition, the results of Ramsey RESET confirmed that there is no functional form misspecification in the model. The p-value is found to be more than 0.05. This study also used the Cumulative sum of recursive residuals (CUSUM) and Cumulative sum the squares of recursive residuals (CUSUMSQ) proposed by Brown, et al. (1975) to examine the stability of long-run association parameters. The results confirm that, the long- run coefficients are dynamically and structurally stable because the CUSUM and CUSUM SQUARE stability fall within the critical bounds of both tests. They plot at 5% critical bounds and thus, specification is stable towards the end of the period.

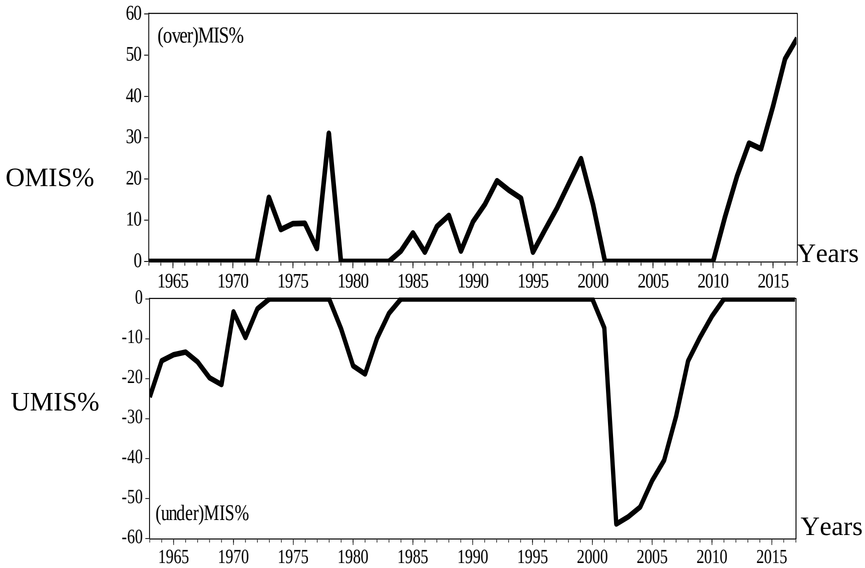
4.4 Non-Linear Effects of MIS on RNGDP

Specifically, to obtain the exact linkage between MIS episodes as over and undervaluation states, we should apply ARDL-dummy variables to measure the changes in the slope parameters in the case of occurrence misalignment gap. In order to investigate these hypotheses, the dummy variables (D_{over}) should be defined to take the value of 1 when the MIS is overvalued, and 0 otherwise. (D_{under}) should be defined as 1 if MIS is undevalued, and 0 otherwise. Then, the overvaluation and undervaluation states should be defined as:

$$OMIS = MIS * D_{over} \quad , \text{ and } \quad UMIS = MIS * D_{under}$$

Figure 33 shows separately the misalignments gap as over and undervaluation episodes.

Figure 33. Over and undervaluation episodes



To test the effect of overvaluation and undervaluation on Real non-Oil GDP, the two models should be estimated as:

$$Y = f(OMIS, controls)$$
$$Y = f(UMIS, controls)$$

where control variables are OPEN and ROGDP). OMIS and UMIS denote the overvaluation and undervaluation episodes of the local currency respectively and Y is the dependent variable. Also, we can measure the changes in the intercept and the slope parameters. The next formula captures the change in intercept as:

$$Y = \alpha_0 + \beta_0 MIS + \beta_1 controls + \beta_2 D_{over} + e_t \ldots\ldots\ldots(5)$$

If $(D_{over}) = 0$, the overvaluation state does not exist, the parameter to express the intercept is just (α_0). If $(D_{over}) = 1$, the overvaluation state exists, then the parameter to express the intercept change will be $(\alpha_0 + \beta_2)$.

In the same way for undervaluation states:

$$Y = \alpha_1 + \beta_3 MIS + \beta_4 controls + \beta_5 D_{under} + e_t \ldots\ldots\ldots\ldots(6)$$

If $(D_{under}) = 0$, undervaluation episodes do not exist, then the parameter to express the intercept is just (α_1). If $(D_{under}) = 1$, undervaluation episodes exist, then the parameter to express the intercept parameter will change to $(\alpha_1 + \beta_5)$.
When the main target is to capture the changes in the slpoe parameter, the equation will change by adding a new variable, which is ($MIS * D_{over} = OMIS$) as:

$$Y = \alpha_2 + \beta_6 MIS + \beta_7 controls + \beta_8 MIS * D_{over} + e_t \text{.........(7)}$$

If $(D_{over}) = 0$, then the parameter to express the association between (Y) and (MIS) will be just (β_6). If $(D_{over}) = 1$, then the parameter to explain the linkage between (Y) and (MIS) will be $(\beta_6 + \beta_8)$.
In the same way, we can put the undervaluation state as:

$$Y = \alpha_3 + \beta_9 MIS + \beta_{10} controls + \beta_{11} MIS * D_{under} + e_t \text{..........(8)}$$

If $(D_{under}) = 0$, then the parameter to measure the linkage between (Y) and (MIS) will be just (β_9). If $(D_{under}) = 1$, then the parameter to express the association between (Y) and (MIS) will be $(\beta_9 + \beta_{11})$.
We can follow the same procedure if we need to obtain both changes (intercept and slope) in the same equation as :

$$Y = \alpha_4 + \beta_{12} MIS + \beta_{13} Controls + \beta_{14} D_{over} + \beta_{15} MISD_{over} + e_t \text{.........(9)}$$

4.4.1 ARDL estimation for RNGDP and OMIS

The ARDL system identified the optimal lag length for ARDL according to Hannan – Quinn information criterion for the suitable ARDL at 2, 2, 3, 0, 3 for RNGDP, OMIS, OPEN, ROGDP and D2 respectively. The next stage is to perform the F-Bound test. The findings are reported in table 23. The Calculated F-value is about 13.11 and greater than the upper critical value of the Bound test (UCB = 4.37) at the 1% level of significance. This result confirms a long-run association between RNGDP and the applicable macroeconomic variables, which are OPEN, ROGDP and OMIS. Therefore, there is a long-term relationship among these variables.

Table 23. ARDL- F bound test for RNGDP, OMIS and controls

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	13.11	10%	2.20	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Null Hypothesis: No levels relationship
Source: EViews 10 outcomes

The findings in table 24 show the ARDL-long run regression and error correction regression. RNGDP has a negative association with OMIS (giving undervaluation states zero value at all years). A unit increase in OMIS decreases RNGDP by about -943.73. Thus there is negative relationship between OMIS and RNGDP.

Table 24. ARDL- Long-run and error correction regression for RNGDP, OMIS and control variables

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long Run				
OMIS	-943.73	209.32	-4.51	0.0001
OPEN	1363.79	103.03	13.24	0.0000
ROGDP	0.97	0.072	13.35	0.0000
D02	-113698.8	5719.98	-19.88	0.0000
C	-57920.72	8791.96	-6.59	0.0000
EC regression				
D(OMIS)	-770.7579	197.3243	-3.906046	0.0004
D(OPEN)	358.7963	97.93617	3.663573	0.0008
D(D02)	-22699.75	11703.34	-1.939596	0.0601
Error Correction				
CointEq(-1)	-0.898769	0.095126	-9.448159	0.0000

R-squared	0.791	Mean dependent var	-1593.805
Adjusted R-squared	0.746	S.D. dependent var	20616.53
S.E. of regression	10391.10	Akaike info criterion	21.50633
Sum squared resid	4.53E+09	Schwarz criterion	21.88157
Log likelihood	-549.1646	Hannan-Quinn criter.	21.65019
Durbin-Watson stat	2.096476		

Diagnostic statistics

Problem	Test	Pro	Decision
Serial correlation	Breusch-Godfrey	0.72	No Serial correlations
Heteroscedasticity	ARCH) Test	0.71	No Heteroscedasticity
Normality (JB_N)	Jarque-Bera	0.48	Error terms normally distributed.
Misspecification	Ramsey RESET	0.11	No functional form misspecification

Source: EViews 10 outcomes

As for OPEN and ROGDP, the sign was positive on both variables. One unit rise in OPEN and ROGDP yields an increase in RNGDP by about 1363.79 and 0.97 respectively. These results are expected in the Libyan case because RNGDP has an obvious dependence on the oil sector and imports. All parameters are significant at the 1% level of significance. Then, an increase in the degree of overvaluation states is correlated with a decrease in the RNGDP and vice versa. More overvaluation of national currency leads to reduce RNGDP.

In the short run also there is a negative relationship between OMIS and RNGDP as well as a positive linkage between RNGDP and OPEN. The Error Correction Term has the right sign and is statistically significant at the 1% level of significance. This result confirms that, there is a co-integration association among the model variables.

The parameter of the error correction model in this model is about -0.90 at the 1% level of significance. It implies that 90% of disequilibrium or deviations from long-run equilibrium in the past year is corrected in the present year. In other words, in the short run, deviations from our long-run equilibrium are corrected at approximately 90% every year. This finding implies that the speed of adjustment is obviously high in RNGDP in the Libyan economy. It takes just 1.11 years to return to the equilibrium level following a shock in the system. There is a stable long-run linkage between the RNGDP and the independent variables. If there is a shock in the system, the negative sign indicates moving back towards equilibrium.

This study will also use on the CUSUM and CUSUMSQ proposed by Brown, et al. (1975) to examine the stability of long-run linkage parameters. The long- run coefficients are dynamically and structurally stable. The CUSUM and CUSUM SQUARE stability falls within the critical bounds for both tests plot at the 5% critical bounds of significance and the specification is stable towards the end of the period. All diagnostic statistics of the ARDL regression are robust. The model successfully passed the ARCH heteroscedasticity test and the LM Test serial correlation. The χ^2 ARCH (2) and χ^2SC (2) statistics accept the null hypotheses of no heteroscedasticity and no auto-correlation in the residuals. The model was also tested for error terms normal distribution using the Jarque-Bera test for Normality. The p-value is over than 0.05, which means that error terms are normally distributed. In addition, the results of Ramset RESET confirmed that there is no functional form misspecification in the model. The p-value is more than 0.05.

4.4.2 ARDL results for RNGDP and (OMIS & MIS)

Now, MIS will be added to the model to capture the changes in the slope parameter when the overvaluation state exists. When we include the two variables in the regression, the final impact of existence of overvaluation states on RNGDP will be accounted by adding or subtracting the OMIS parameter to the MIS parameter. This regression will take this formula:

$$\mathrm{RNGDP} = \mathrm{f(MIS, OMIS, controls)}$$

The ARDL system identifies the optimal lag length according to the Hannan – Quinn information criterion. The optimal distributed lags are 2, 4, 0, 3, 2, 3 for RNGDP, OPEN, ROGDP, MIS, OMIS and D2 respectively. The next stage is to perform a Bound test to estimate the long-run association empirically. The bounds test findings are reported in table 25. The F-statistic value is about 11.67, which is greater than the upper critical value of the Bound test (UCB = 4.15) at the 1% level of significance. This result confirms a long-run association between RNGDP and the applicable macroeconomic variables.

Table 25. ARDL- F-Bounds Test for RNGDP, MIS, OMIS and control variables.

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	11.67	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Null Hypothesis: No levels relationship
Source: EViews 10 outcomes

The results in table 26 for long run linkage shows that the impacts of overvaluation episodes will be calculated as 175.87 + (-2286.92) = -2111.05. The final impact of MIS on RNGDP is negative when an overvaluation state exists. However, all parameters are significant at the 1% level of significant except MIS.The error correction coefficient has the right sign and is statistically significant at the 1% level of significance. A co-integration association among the model variables exists, as in table 26.The parameter of the error correction is about -0.81, which means in the short run, deviations from our long-run equilibrium are corrected at approximately 81% every year. The speed of adjustment is also obviously high; it takes just 1.23 years to return to the equilibrium level following a shock in the system. Therefore, this result indicates that there is a stable long-run linkage between the RNGDP and independent variables. All diagnostic statistics of the ARDL regression are robust.

The model successfully passed the residual tests of heteroscedasticity, serial correlation and normality. In addition, the results of Ramsey RESET confirmed that there is no functional form of misspecification in the model. The stability test depending on the CUSUM and CUSUMSQ reveals the stability of the ARDL model. The long- run coefficients are dynamically and structurally stable. The CUSUM and CUSUM SQUARE stability fall within the critical bounds and the specification at 5% critical bounds.

Table 26. ARDL-Long run and error correction regressions for RNGDP, MIS, OMIS and control variables.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long Run				
MIS	175.87	246.79	0.713	0.4814
OMIS	-2286.92	549.33	-4.163	0.0002
OPEN	1301.15	89.75	14.497	0.0000
ROGDP	0.872	0.06	13.540	0.0000
D02	-103233.7	6997.85	-14.752	0.0000
C	-36780.74	8908.28	-4.129	0.0003
EC regression				
D(MIS)	-1522.043	251.2174	-6.058667	0.0000
D(OMIS)	445.4193	298.0102	1.494644	0.1451
D(OPEN)	219.0346	81.57479	2.685077	0.0115
D(D02)	-85727.06	14857.83	-5.769825	0.0000
Error Correction				
CointEq(-1)*	-0.812434	0.082294	-9.872366	0.0000

R-squared	0.901652	Mean dependent var	-1663.389
Adjusted R-squared	0.867097	S.D. dependent var	20815.51
S.E. of regression	7588.472	Akaike info criterion	20.93476
Sum squared resid	2.13E+09	Schwarz criterion	21.46507
Log likelihood	-519.8364	Hannan-Quinn criter.	21.13741
Durbin-Watson stat	2.205599		

Diagnostic statistics	Test	Pro	Decision
Serial correlation	Breusch-Godfrey	0.41	No Serial correlations
Heteroscedasticity	ARCH) Test	0.47	No Heteroscedasticity
Normality (JB_N)	Jarque-Bera	0.71	Error terms normally distributed.
Misspecification	Ramsey RESET	0.51	No functional form misspecification

Source: EViews10 outcomes

4.4.3 ARDL results for RNGDP and UMIS

The undervaluation states will be tested to obtain its impacts on RNGDP. We will start with putting just UMIS in the model. The ARDL system identifies the optimal lag length for suitable ARDL according to the Hannan – Quinn information criterion as 1, 3, 2, 1, 0 for RNGDP, OPEN, ROGDP, UMIS and D2. The next stage is to conduct a bound test to confirm the long-run association empirically between RNGDP and UMIS in Libya, taking into account some other dependent variables. The bounds test findings are reported in table 27. The Computed F-statistic value is about 4.39, which is greater than the upper critical value of the bound test (UCB = 4.37) at the 1% level of significance. This result confirms the existence a long-run association between RNGDP and the applicable macroeconomic variables.

Table 27. ARDL- F-Bounds Test for RNGDP, UMIS and control variables

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.393874	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Null Hypothesis: No levels relationship
Source: EViews 10 outcomes

The results for long run association in table 28 significantly show a negative sign for the UMIS parameter, about -890.86. This negative parameter means that when undervaluation states (as negative values) go down, RNGDP increases and vice versa. In other words, when undervaluation states go down it implies that this gap is increasing more and this will cause an increase in RNGDP. Then, an increase in this gap will lead to a rise in RNGDP. OPEN and ROGDP have a positive linkage with RNGDP, about 1352.82 and 0.97 respectively because of the dependence on the oil sector and imports volume in the Libyan economy. All parameters are significant at the 1% level of significance. In the short-run also UMIS negatively affects RNGDP, which means an increase in the UMIS gap increases RNGDP. The error correction coefficient has the right sign and is statistically significant. The parameter of the error correction term in this model is about -0.52 at the 1% level of significance. It indicates that, 0.52% of disequilibrium (or deviations from long-run equilibrium) in the past year is corrected in the present year. In the short run, deviations from our long-run equilibrium are corrected by approximately 52% every year. This finding implies that the speed of adjustment is obviously moderate in RNGDP; it takes approximately takes 1.92 years to return to the equilibrium level following a shock in the system.

All diagnostic statistics of the ARDL regression are robust. The model successfully passed the ARCH heteroscedasticity, the Breusch-Godfrey LM test for serial correlation and the Jarque-Bera normality tests. In addition, the results of Ramsey RESET confirmed that, there is no functional form misspecification in the model, p-value is found to be more than 0.05. CUSUM and CUSUMSQ proposed were be employed for ARDL stability. The long- run coefficients are dynamically and structurally stable because the stability of the CUSUM and CUSUM SQUARE fall within the critical bounds for both test plot the 5% critical bounds of significance. The specification is stable towards the end of the period.

Table 28. ARDL- Long run and error correction regression for RNGDP and UMIS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long run				
UMIS	-890.8647	313.4451	-2.842171	0.0070
OPEN	1352.818	180.1404	7.509800	0.0000
ROGDP	0.966666	0.133664	7.232038	0.0000
D02	-118121.6	11537.14	-10.23838	0.0000
C	-68956.43	15621.55	-4.414187	0.0001
EC regression				
D(UMIS)	-990.9962	227.5712	-4.354665	0.0001
D(OPEN)	273.4073	109.3052	2.501322	0.0166
D(ROGDP)	0.929052	0.099337	9.352550	0.0000
Error Correction				
CointEq(-1)*	-0.517955	0.095108	-5.445975	0.0000

R-squared	0.732303	Mean dependent var	-1593.805
Adjusted R-squared	0.696610	S.D. dependent var	20616.53
S.E. of regression	11355.77	Akaike info criterion	21.63749
Sum squared resid	5.80E+09	Schwarz criterion	21.90016
Log likelihood	-555.5747	Hannan-Quinn criter	21.73819
Durbin-Watson stat	2.086014		

Diagnostic statistics

Problem	**Test**	**Pro**	**Decision**
Serial correlation	Breusch-Godfrey	0.84	No Serial correlations
Heteroscedasticity	ARCH) Test	0.71	No Heteroscedasticity
Normality (JB_N)	Jarque-Bera	0.07	Error terms normally distributed.
Misspecification	Ramsey RESET	0.29	No functional form misspecification

Source: EViews 10 outcomes

4.4.4 Real Non-oil product and (UMIS&MIS)

Now, MIS will be added to the model to capture the changes in the slope parameter when the undervaluation state is presented. The final impact of MIS on RNGDP will be accounted by adding or subtracting the UMIS parameter to the MIS parameter. The ARDL regression will take this formula:

$$\text{RNGDP} = \text{f}(\text{MIS}, \text{UMIS}, \text{controls})$$

The ARDL system identifies the optimal lag length for appropriate ARDL according to the Hannan – Quinn information criterion as 2, 3, 3, 4, 0, 2 for RNGDP, MIS, UMIS, OPEN, ROGDP and D2 respectively. The next stage is to conduct the bounds test to confirm the long association between RNGDP and MIS in Libya, with taking into account other independent variables. The bounds test findings are reported in table 30. The F-statistic value is about 11.67, which is greater than the upper critical value of the bound test (UCB = 4.15) at the 1% level of significance. This result confirms a long-run association among variables as shown in table 29.

Table 29. ARDL- F bounds test for RNGDP, MIS, UMIS and control variables

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	11.665	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Null Hypothesis: No levels relationship

Source: EViews 10 outcomes

The long run association is illustrated in table 30. The final impact of undervaluation states will be (2376.471 + (-2273.179) = +103.292). This result means that undervaluation states contribute to increase RNGDP. Then, undervaluation of the national currency has a positive impact on RNGDP. As for OPEN and ROGDP, they have a positive effect as expected. The EC term has the right sign and is statistically significant at the 1% level of significant. The error correction term is about -0.80 at the 1% level of significance. This means that 80% of disequilibrium (deviations from long-run equilibrium) in the past year is corrected in the present year. The speed of adjustment is obviously high in RNGDP; it takes about 1.25 years to return to the equilibrium level following a shock in the system.

All diagnostic statistics of the ARDL regression are robust. The model successfully passed the ARCH heteroscedasticity test and the Breusch-Godfrey Serial Correlation LM test. The model was also tested for error terms normal distribution using Jarque-Bera normality test. The p-value was found to be more than 0.05, which means that the regression is normally distributed. In addition, the Ramsey RESET results confirmed that there is no functional form misspecification in the model. The probability (p-value) was found to be more than 0.05. This study used the CUSUM and CUSUMSQ to examine the stability of long-run association parameters. From the results, the long- run coefficients are dynamically and structurally stable because the CUSUM and CUSUM SQUARE stability fall within the critical bounds; both tests plot at the 5% critical bounds of significance and the specification is stable towards the end of the period.

Table 30. ARDL- Long, short run and error correction regression for RNGDP, MIS, UMIS and control variables

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long Run				
MIS	-2110.146	362.743	-5.817	0.0000
UMIS	2284.363	548.377	4.166	0.0002
OPEN	1301.193	89.647	14.515	0.0000
ROGDP	0.871	0.064	13.553	0.0000
D02	-103319.7	6988.796	-14.784	0.0000
C	-36786.17	8897.269	-4.135	0.0003
EC regression				
D(MIS)	-1076.623	149.0818	-7.221698	0.0000
D(UMIS)	-445.4193	298.0102	-1.494644	0.1451
D(OPEN)	219.0346	81.57479	2.685077	0.0115
D(D02)	-85727.06	14857.83	-5.769825	0.0000
Error Correction				
CointEq(-1)*	-0.812434	0.082294	-9.872366	0.0000

R-squared	0.901652	Mean dependent var	-1663.389
Adjusted R-squared	0.867097	S.D. dependent var	20815.51
S.E. of regression	7515.472	Akaike info criterion	20.93476
Sum squared resid	2.13E+09	Schwarz criterion	21.46507
Log likelihood	-519.8364	Hannan-Quinn criter.	21.13741
Durbin-Watson stat	2.205599		

Diagnostic statistics

Problem	**Test**	**Pro**	**Decision**
Serial correlation	Breusch-Godfrey	0.41	No Serial correlations
Heteroscedasticity	ARCH) Test	0.26	No Heteroscedasticity
Normality (JB_N)	Jarque-Bera	0.71	Error terms normally distributed.
Misspecification	Ramsey RESET	0.51	No functional form misspecification

Source: EViews 10 outcomes

4.4.5 Misalignments and real non-oil GDP, Policy implications

Misalignments of RER will cause a decline in RNGDP. Rising overvaluation or reducing undervaluation episodes will decrease RNGDP while an increase in undervaluation or decrease overvaluation states will stimulate RNGDP. Undervaluation of the Libyan dinar often occurs with stable years with no black market, low inflation and a high level of total growth rate, particularly in oil product. This association might be shown as:

Therefore, RER misalignments can be used as an economic indicator to influence RNGDP. Policy makers can focus on the independent variable in this model to improve the non-oil sectors. Trade openness has a positive effect on RNGDP because the Libyan economy depends heavily on imports for consumption and investments for all sectors in the economy: agriculture, industry and services. In the same line, the relationship between RNGDP and ROGDP is also positive and highly significant. The non-oil sector depends heavily on foreign exchange resources obtained from oil. Monetary policymakers should attempt to influence some economic variables that influence undervaluation of the national currency, for example, devaluation of local currency or keeping domestic inflation at a low level that may constrain real exchange rate appreciation. The central bank of Libya can use these fundamentals to affect the non-oil sectors.

4.5 Real exchange rate misalignments and inflation rates

This part concentrates on the association between the behaviour of inflation and real exchange rate misalignments. The price level is considered a very crucial indicator affecting the economy. A high level of inflation for a long time can adversely influence the economic situation. Inflation rate refers to a state in which prices constantly rise during a certain period (emadzadeh, et al. 2005). This definition focuses on time, which means that inflation should be continued over time. Temporary deviations are not considered a persistence inflation. The nexus between RER misalignments and inflation rate may occur via the import prices. Nominal exchange rate changes, import restrictions and foreign exchange controls affect import prices and are then transmitted into the general price level. This association may appear evidently when the share of imports in the consumer basket is very high, particularly for economies that depend heavily on imports. The devaluation of the national currency will raise the import prices for consumption and investment and subsequently may lead to inflationary pressures. Giannellis and Koukouritakis (2013) stated that, a high level of local currency depreciation caused inflation persistence in selected Latin American countries, namely Brazil, Mexico, Uruguay and Venezuela. Inflation is likely to increase with high levels of real exchange rate undervaluation. Kandil and Mirzaie (2008) found that in the Middle East countries, the devaluation of national currency caused an increase in production prices requirements, and then led to raising the domestic price levels in these countries.

Libya, as an oil exporting country, has witnessed a very considerable nominal devaluation of its local currency, which perhaps theoretically should lead to high inflation levels. However, since Libya applies some restriction on imports and foreign exchange controls, it is noticed from the second chapter in this study that the country witnessed a decline in inflation rate after the devaluation of the national currency in 2002. It caused considerable undervaluation in the national currency, with low of prices. The cancellation of severe restrictions on imports, foreign exchange controls and restriction on the movement of capital flows are the main reasons for not increase inflation, in line with the theoretical assumptions on the devaluation of the local currency.

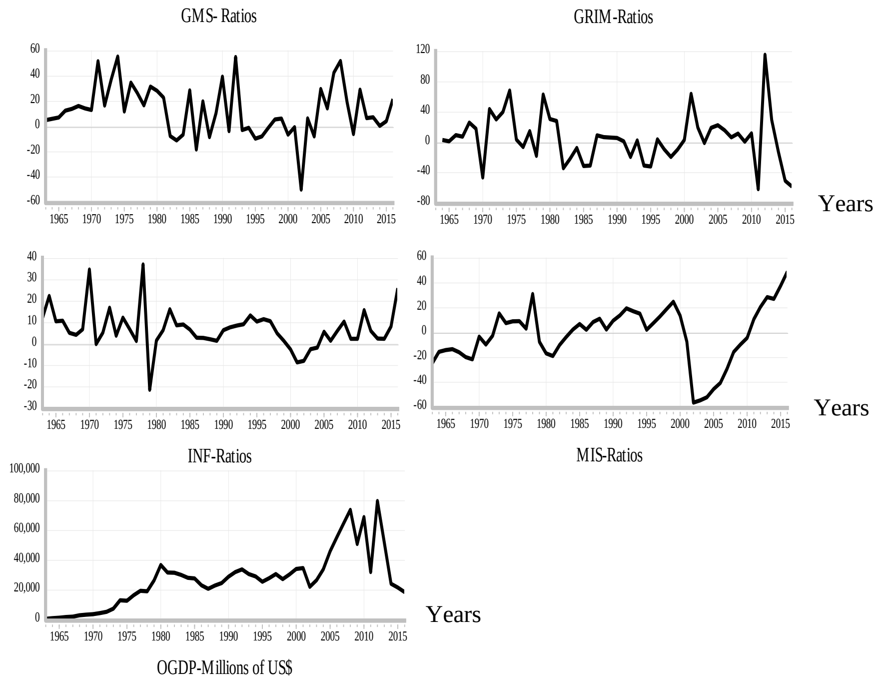
4.5.1 Methodology and Data

This part of study employs ARDL regression and a bound test for co-integration. The Methodology for all these econometric approaches was explained in the section 4.3.1. However, in order to capture the exact association between INF and RER misalignments in the Libyan economy, it is important to take into account some control variables that may affect INF as follows:

$$\mathrm{INF_t} = \mathrm{F}(\mathrm{MIS_t}\,, \mathrm{OGDP_t}, \mathrm{GRIM_t}, \mathrm{GMS_t})$$

where, INF_t is inflation rate, $\mathrm{MIS_t}$ is misalignments of national currency, $\mathrm{OGDP_t}$ is oil gross domestic product, $\mathrm{GRIM_t}$ is growth rate in the real imports and $\mathrm{GMS_t}$ is growth rate in money supply. Data for selected variables was collected from various sources. Data for GMS and INF were obtained from IFS and CBL, for GRIM from CBL and Economic and social data in Libya. All data for estimating the relationship between inflation rate and real exchange rate misalignments are shown in figure 34.

Figure 34. Inflation rate, real exchange rate misalignments and controls



Sources: IFS, CBL-Economic Bulletin, OECD and Economic and social data in Libya 1962-2006

4.5.2 Stationarity results

ADF and PP were performed to examine stationarity of the time series data. Table 31 shows that all selected variables are stationary at I(0), I(1) or both. Thus, the ARDL regression is a very suitable method to avoid a spurious regression. According to Pesaran et al. (2001) and Narayan and Smyth (2005), all variables should be stationary at I(0) and I(1) or both; none of them is stationary at I(2).

Table 31. Unit root test ADF and P&P for MIS, INF and controls

Variables	Model	Level (ADF)	First diff (ADF)	Level (PP)	First diff (PP)
INF	Intercept	-7.105***	-8.931***	-7.135***	-21.945***
	Intercept & trend	-7.326***	-8.945***	-7.328***	-25.867***
	None	-2.925***	-9.030***	-5.048***	-22.222***
MIS	Intercept	1.552	-6.339***	-1.892	-6.339***
	Intercept & trend	-1.603	-6.327***	-1.935	-6.327***
	None	-1.639*	-6.344***	-1.982**	-6.340***
GRIM	Intercept	-5.975***	-11.355***	-5.980***	-20.170***
	Intercept & trend	-6.024***	-11.294***	-5.997***	-20.219***
	None	-5.931***	-11.455***	-5.929***	-19.934***
GMS	Intercept	-3.152**	-14.355***	-6.179***	-16.793***
	Intercept & trend	-3.279*	-14.210***	-6.265***	-16.621***
	None	-2.321**	-14.496***	-4.884***	-16.975***
OGDP	Intercept	-1.892	-11.488***	-2.367	11.425***
	Intercept & trend	-3.381*	-11.551***	-3.374*	11.589***
	None	-0.664	-11.576***	-0.906	-11.510***

Note: */**/*** indicate rejection of null hypothesis of unit root at significant levels 10/5/1 percent respectively.
Source: EViews 10 outcomes

4.5.3 ARDL Results for INF and MIS

The ARDL system identifies the optimal lag length for appropriate ARDL. According to the Hannan – Quinn information criterion at 3, 2, 3, 3, 4, 2 for INF, MIS, OGDP, GIM, GMS and D2 respectively. The bound test for ARDL co-integration should be performed for estimating empirically the long and short-run association between INF and MIS taking into account other control variables. The bounds test results are shown in table 32. If the Wald or F-statistic falls outside the upper bound, the null hypothesis of no co-integration will be rejected. From the results, the F-statistic value is about 9.11, which is greater than the upper critical value of the bound test (UCB = 4.15) at the 1% level of significance. Thus, there is a long-run association between INF and the applicable macroeconomic variables.

Table 32. ARDL – F-bound test for INF, MIS and control variables.

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	9.11	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Null Hypothesis: No levels relationship

Source: EViews 10 outcomes

The long run result indicates that there is a positive relationship between MIS and INF. This finding means that, INF is positively associated with MIS. A one percent rise in MIS will lead to an increase in INF by about 0.11%. As we know, an increase in the MIS curve means an increase in overvaluation of local currency states or a decrease in undervaluation states. Then, more overvaluation (undervaluation) levels will cause more (less) inflation. OGDP has a negative linkage with INF. Increasing OGDP by one unit causes INF to decrease by approximately 0.00028 %. The parameter is very small because the data for OGDP are in millions of dollars, while data for INF are in percentages. An increase in OGDP will make the country more able to control INF. This result confirms that foreign exchange resources from oil lead to reducing INF. GRIM also has a negative impact on INF, when GRIM increases by one percent, INF decreases by -0.21%. This result confirms that imports play a role in inflation. On the contrary, GMS has a positive effect on the inflation rate, as expected. A one percent increase in GMS will cause INF to rise by about 0.18%. This result reflects the role of money supply in increasing INF. All parameters are significant at the 1% level of significance. Table 33 shows the long run, error correction regression and diagnostic statistics of ARDL regression.

Table 33. ARDL-Long run and error correction regression for MIS and INF and control variables

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long Run				
MIS	0.105296	0.036642	2.873634	0.0078
OGDP	-0.000288	6.01E-05	-4.786373	0.0001
GRIM	-0.210279	0.044265	-4.750463	0.0001
GMS	0.183353	0.049065	3.736926	0.0009
D02	8.239258	2.761238	2.983900	0.0060
C	10.86413	1.385369	7.842049	0.0000
EC regression				
D(MIS)	0.640192	0.058052	11.02784	0.0000
D(OGDP)	0.000138	6.48E-05	2.129644	0.0425
D(GRIM)	-0.134775	0.021015	-6.413281	0.0000
D(GMS)	-0.045089	0.026254	-1.717413	0.0974
D(D2)	17.59496	4.494661	3.914636	0.0006
Error Correction				
CointEq(-1)	-1.262832	0.143018	-8.829886	0.0000

R-squared	0.961310	Mean dependent var	0.302735
Adjusted R-squared	0.942552	S.D. dependent var	13.50183
S.E. of regression	3.236172	Akaike info criterion	5.451144
Sum squared resid	345.6027	Schwarz criterion	6.101232
Log likelihood	-119.2786	Hannan-Quinn criter.	5.698701
Durbin-Watson stat	1.922485		

Diagnostic statistics

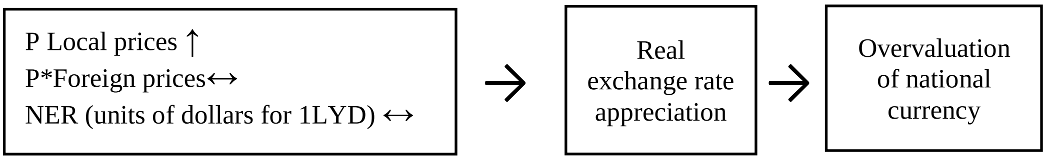
Problem	**Test**	**Pro**	**Decision**
Serial correlation	Breusch-Godfrey	0.92	No Serial correlations
Heteroscedasticity	ARCH) Test	0.36	No Heteroscedasticity
Normality (JB_N)	Jarque-Bera	0.88	Error terms normally distributed.
Misspecification	Ramsey RESET	0.26	No functional form misspecification

Source: EViews 10 outcomes

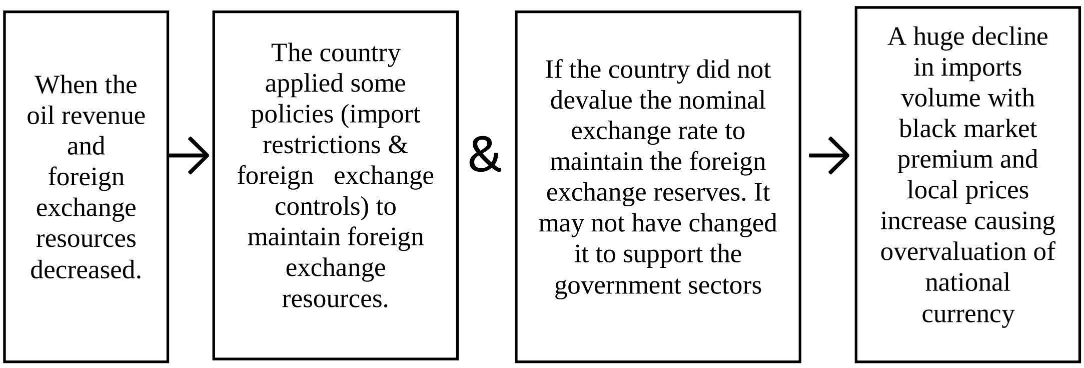
In the short run, MIS and OGDP have a positive impact on inflation, while GRIM and DMS have a negative impact. The lagged error correction term in the short-run model is −1.26, which means that the error correction process fluctuates around the long-run value instead of monotonically converging to the equilibrium level directly. When the process is complete, it rapidly converges to the equilibrium (Narayan and Smyth 2006). The error correction coefficient has the right sign and is statistically significant at the 1% level of significance. All diagnostic statistics of the ARDL regression are robust. The model successfully passed the residual tests of heteroscedasticity and serial correlation. The model was also tested for error term normal distribution using Jarque-Bera Normality. The p-value was found to be more than 0.05, which means that the regression is normally distributed. In addition, employing Ramsey RESET confirmed that there is no functional form misspecification in the model.. The probability of p-value is more than 0.05. This study will also rely on the CUSUM and CUSUMSQ to examine the stability of long-run association parameters. The results, the long- run coefficients are dynamically and structurally stable because the CUSUM and CUSUM SQUARE stability fall within the critical bounds. Both tests plot at the 5% critical bounds of significance and the specification is stable towards the end of the period.

4.5.4 Inflation and misalignments - Policy implications

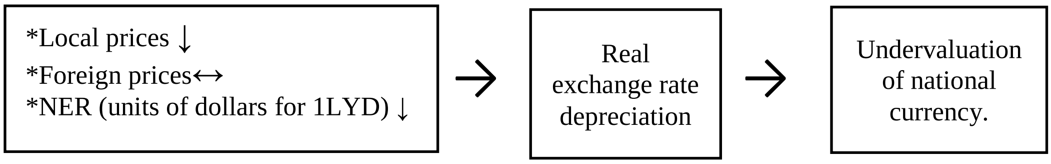
From the previous findings, inflation in Libya is positively associated with the RER misalignments. This association means that an increase in overvaluation levels will increase the inflation rate, while a decrease in undervaluation episodes will decrease the inflation rate. Overvaluation of the national currency comes from RER over appreciation, which in turn may come from local price increases or foreign price decreases or increase in the nominal exchange rate expressed by units of foreign currency. In the Libyan case, during 1982-2000, the country applied restrictions on imports and capital mobility, which led to a high level of inflation. Then, inflation rate was accompanied with overvaluation states. This linkage could be illustrated as follows:



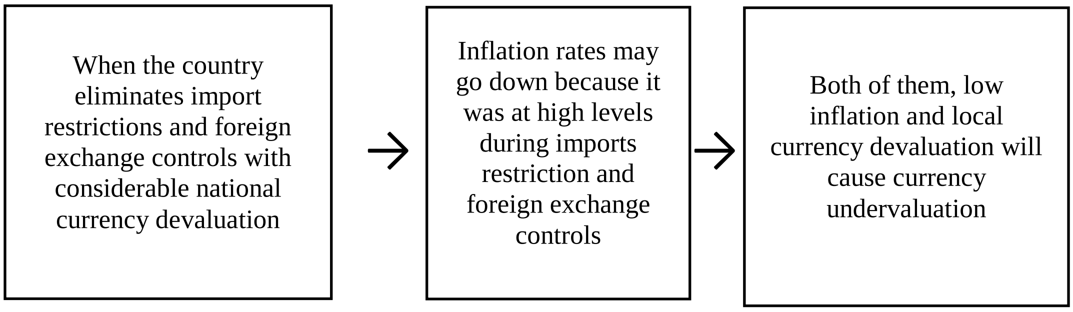
More specifically,



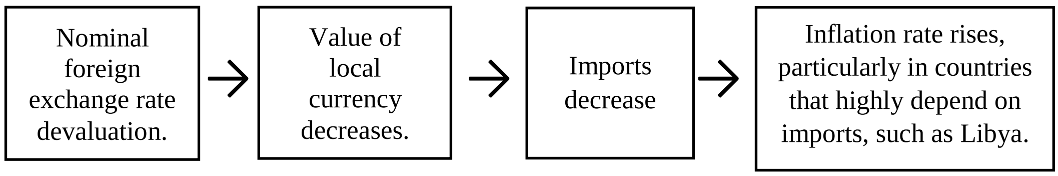
On the contrary, during 2000-2010, the policy completely changed. The restrictions on imports and foreign exchange controls were abolished with significant devaluation of the national currency value. These policies caused a low level of inflation with a dramatic level of undervaluation of the local currency. Thus, during a period of low inflation, the national currency was undervalued. This association could be shown as:



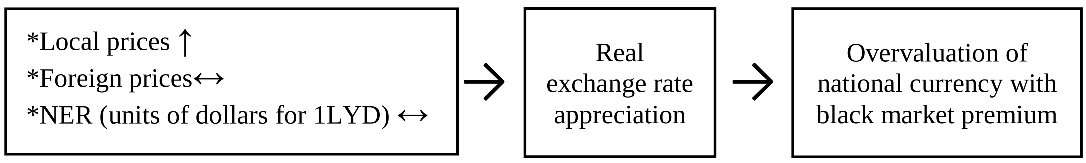
More specifically,



Logically, nominal exchange rate devaluation leads to a decline in the national currency value and then imports volume will decrease, causing price level to increase. An open economy with restrictions on trade and mobility of capital, changes in exchange rate may not have a significant role in changing price levels, as shown below:



In the period 2011-2017, the country suffered from a sharp shortage of foreign exchange resources, which led to a huge level of inflation with no noticeable change in nominal exchange rate. This caused a very high level of overvaluation of national currency. This relationship could be shown as:



Thus, inflation rate is associated with overvaluation gaps because when the country keeps the value of the national currency at a high level, on the other side, the country applies import restrictions and foreign exchange controls. These policies assist to increase the inflation rate, causing overvaluation states. That is why overvaluation is linked with an increase in price levels.

4.6 Real exchange rate misalignments and non-oil exports:

The RER misalignments has an important impact on the volume of exports and its composition. In spite of the fact that there is reasonable agreement that staying away from RER overvaluation is important to preserve external competitiveness, there is no clear agreement on whether maintaining underestimated currency is valuable or not (Elbadawi 1999). Such devaluation of national currency diminishes the proportion of wages and a raises the home country's demand for labour and production, which may happen for two reasons. The first reason is that the cost of local workers becomes less than the cost of foreigner workers, to make the products cheaper and thus, exports may increase. Secondly, an increase in production with a low level of prices in terms of foreign currencies will substitute imports, which in turn helps to reduce the balance of payments deficit (Wondemu & Potts 2016). Dollar (1992) mentioned that RER overvaluation reduces exports volume. Cottani, et al. (1990) argued that unbalanced exchange rates shrank export growth in Latin America, while balanced RER encouraged export growth in Asia.

Despite the importance of the impacts of the real exchange rate and misalignments on exports performance, there is no specific empirical study that investigates the linkage between them in Libya, particularly when the country faces a high level of vulnerability. As known, the nominal exchange rate revaluation (devaluation) causes imports to rise (decline) and exports go down (goes up). Expectedly, RER appreciation (depreciation) movements will cause RER overvaluation (undervaluation) misalignments episodes. Overvaluation of the national currency is likely to reduce the competitiveness of exchangeable goods and so exports fall (Frikha & Hachicha 2013). RER misalignments in terms of overvalued states could adversely influence export value, since overvaluation causes a loss in a country's competitiveness and misallocations of resources toward the non-tradable sector, because there is a limitation on resources to produce tradable goods. At the same time, a persistent undervalued RER may possibly cause economic overheating and higher import prices, thereby putting pressure on domestic prices and generating expected appreciation of the currency in the future. This might also have an adverse influence on export value.

This part aims to discover what level of real exchange rate misalignments affects the value of non- oil exports for Libya. Some other control variables will be taken into account to discover such an association.

4.6.1 Methodology and Data

Unrestricted VAR and restricted VAR could be used in analysing time series properties of a system of variables. VAR models depend on choosing the maximum lag in the VAR model to select lag order. Unrestricted VAR is a time series model originated by Sims in 1980. When it is not possible to determine exogenous and endogenous variables, it is natural to assume that the path of $y_{1,t}$ is influenced by another variable $y_{2,t}$ and the path of $y_{2,t}$ is influenced by another variable $y_{1,t}$. This association is determined simultaneously. The basic assumption of the VAR model can be shown by employing just two variables as:

$$y_{1,t} = a_{10} + a_{11}y_{1,t-1} + a_{12}y_{2,t-1} + e_{1t} \text{......... (10)}$$

$$y_{2,t} = a_{20} + a_{21}y_{1,t-1} + a_{22}y_{2,t-1} + e_{2t} \text{............ (11)}$$

Putting them in matrix form gives:

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \text{.......... (12)}$$

The main advantage of using this method is that the VAR model is appropriate for explaining structural changes, as well as helping policymakers for policy implications in the long term. Each variable in the model should have one equation. Each variable in level should rely on its own optimal lagged values as well as on the optimal lagged values of other variables in the VAR system. The model estimation is often employed for forecasting and impulse responses functions (Bhattarai 2016).

The optimal lag of the model system for the system is chosen depending on specific criteria such as Schwarz Information Criterion (SC), Hannan-Quinn Information Criterion (HQ) and Akaike Information Criterion (AIC). Data for NOX and OPEN were collected from Economic and social data in Libya and CBL, Data for NFII were taken from WB. MIS was calculated by using actual and equilibrium RER depending on data from OECD, CBL and IFS as shown in figure 35. The model specifications are represented as in the following equation:

$$NOX = F\ (MIS, NFIN, OPEN)$$

The reduced form of the VAR model takes this form:

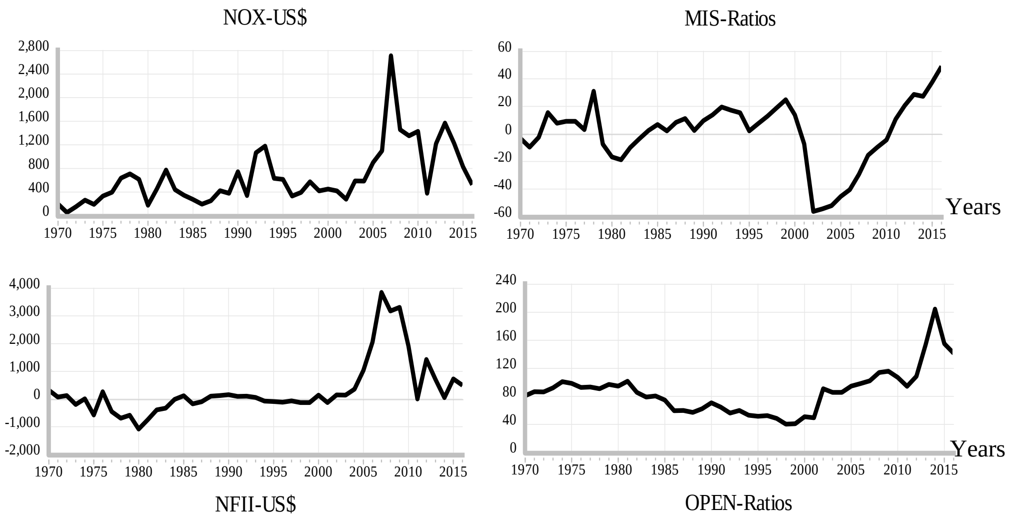
$$NOX_t = \alpha_0 + \alpha_1 NOX_{t-1} + \alpha_2 MIS_{t-1} + \alpha_3 NFII_{t-1} + \alpha_4\ OPEN_{t-1} + e_{1t} \ldots\ldots (13)$$

$$MIS_t = \beta_0 + \beta_1 MIS_{t-1} + \beta_2 NOX_{t-1} + \beta_3 NFII_{t-1} + \beta_4\ OPEN_{t-1} + e_{2t} \ldots\ldots (14)$$

$$NFII_t = \lambda_0 + \lambda_1 NFII_{t-1} + \lambda_2 MIS + \lambda_3 NOX_{-1} + \lambda_4\ OPEN_{t-1} + e_{3t} \ldots\ldots\ldots (15)$$

$$OPEN_t = \varphi_0 + \varphi_1 OPEN_{t-1} + \varphi_2 NOX_{t-1} + \varphi_3 NFII_{t-1} + \varphi_4\ MIS_{t-1} + e_{4t} \ldots (16)$$

Figure 35. Non-oil exports, real exchange rate misalignments and controls



Source: CBL-Economic Bulletin, WB, OECD, IFS and Economic and social data in Libya

4.6.2 Stationarity test for NOX, MIS and controls

Unit root should be examined by using the unit root test for all variables before estimating the model. Two unit root tests were applied, ADF and P&P to test the stationarity. Non-stationary variables mean that all changes are away from the mean, which means that they are not temporary movements. The two tests ADF and PP reject the null hypotheses of a unit root, then the variables are not stationary at the 1% level of significance. However, all variables are stationary at the first difference at one percent of significance (99% of confidence), as shown in table (34).

Table 34. Unite root tests results ADF and P&P for NOX, MIS and controls

Variables	Model	Level (ADF)	First diff (ADF)	Level (PP)	First diff (PP)
NOX	Intercept	-3.327**	-8.900***	-3.303**	-9.825***
	Intercept & trend	-4.090**	-8.833***	-4.171**	-9.751***
	None	-1.792*	-8.995***	-1.582	-9.909***
MIS	Intercept	-1.795	-5.730***	-1.724	-5.730***
	Intercept & trend	-1.700	-5.729***	-1.639	-5.728***
	None	-1.820	-5.743***	-1.742*	-5.743***
NFII	Intercept	-2.089	-4.251***	-2.215	-7.094***
	Intercept & trend	-2.624	-4.196***	-2.860	-7.012***
	None	-1.995**	-4.298***	-2.108**	-7.170***
OPEN	Intercept	-1.210	-5.637***	-1.173	-6.069***
	Intercept & trend	-1.558	-5.462***	-1.446	-10.396***
	None	0.126	-6.0446***	0.336	-6.046***

Note: */**/*** indicate rejection of null hypothesis of unit root at significant levels 10/5/1 percent respectively
Source: EViews 10 outcomes.

4.6.3 Co-integration test

The Johansen (1988) test is employed to examine the presence of long run co-movements. The trace and maximum eigenvalues statistics are illustrated in Tables 35 and 36 respectively. According to the trace test, there is one co-integration vector at 5% of significance, confirming that, over the long run, NOX moves together with MIS, NFII and OPEN. The maximum eigenvalue test gives a different result from the trace test. There is no co-integration relation among the selected variables. Based on maximum eigenvalue, we can apply an unrestricted VAR model to measure the association between NOX and MIS.

Table 35. Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob
None *	0.410	52.531	47.856	0.017
At most 1	0.305	28.772	29.797	0.065
At most 2	0.200	12.371	15.495	0.140
At most 3	0.051	2.353	3.841	0.125

Trace test indicates 1 co-integrating eqn (s) at the 0.05 level.
* denotes rejection of the hypothesis at the 0.05 level.
Source: EViews 10 outcomes

Table 36. Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob
None	0.410	23.759	27.584	0.143
At most 1	0.305	16.401	21.131	0.202
At most 2	0.200	10.018	14.265	0.211
At most 3	0.051	2.353	3.841	0.125

Max-eigenvalue test indicates no co-integration at the 0.05 level.
* denotes rejection of the hypothesis at the 0.05 level.
Source: EViews 10 outcomes

4.6.4 VAR-Lag selection for NOX, MIS and controls

The first step to estimate the unrestricted VAR model is to select the optimal lag for the whole model. According to Final Prediction Error (FPE), Schwarz Information Criterion (SC) and Hannan-Quinn Information Criterion (HQ), the optimal lag is at order 1, while the sequential modified LR test statistic and Akaike information criterion (AIC) suggest lag 4. This study will take lag 1 to run the VAR model. The results for selection criteria are shown in table 37.

Table 37. VAR - Lag Order Selection Criteria for NOX, MIS and control variables

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1068.747	NA	5.49e+16	49.895	50.059	49.956
1	-976.413	163.195	1.58e+15*	46.345	47.164*	46.647*
2	-964.311	19.138	1.94e+15	46.526	48.001	47.070
3	-954.351	13.897	2.70e+15	46.807	48.937	47.592
4	-925.337	35.087*	1.64e+15	46.202*	48.987	47.229

* indicates lag order selected by the criterion

Source: EViews 10 outcomes

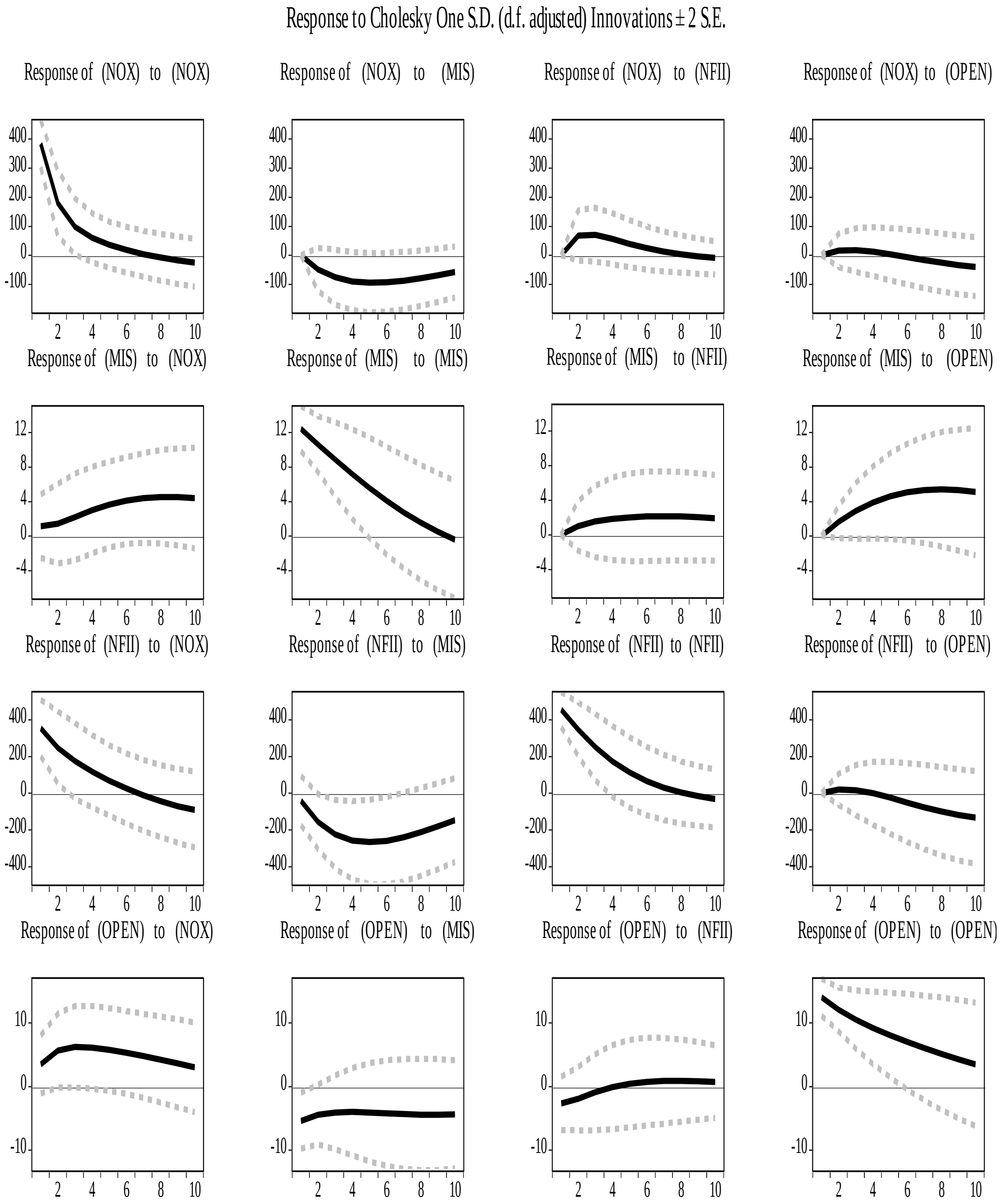
4.6.5 Impulse responses for NOX, MIS and controls

The impulse response shows the reaction of the system as a function of time including some other independent variable that parameterizes the dynamic behaviour of the system. The vertical axis for each diagram measures the level of deviation of each variable from its steady state or base value, while the horizontal axis measures the periods as in figure (36).

The impulse response graphs in the first row show the response of NOX to one standard deviation shock of all variables in the model including MIS. The first column explains the response of all variables including MIS to one standard deviation shock of NOX. Since our interest is to explore the association between MIS and NOX, the interpretation will firstly be about the first row of the impulse response graphs. The response of NOX to one standard deviation of own shocks provides a positive response but in period 7 changes negatively. The response of NOX to one standard deviation change in MIS explains a negative response for the whole period. This result means that one standard deviation increase in MIS will cause a decrease in NOX. More specifically, an increase in overvaluation states or a decrease in undervaluation episodes is accompanied with a reduction in NOX and vice versa. The response of NOX to one standard deviation in NFII is positive and reaches a steady state in period

8. As for OPEN, the response of NOX to standard deviation in OPEN has a weak positive response to period 4; after that, it turns to a negative response.

Figure 36. Impulse responses graphs for NOX, MIS and control variables



Source: EViews 10 outcomes

The first column shows that the response of MIS and OPEN to NOX is positive over time. As for NFII, it has a positive response decrease over time and changes to a negative response after period 7. The second row explains the positive response of MIS to itself, changing to a negative effect after period 9. This means that MIS stay for a long time in the same state before switching. MIS has a positive response if there is a shock in NFII and OPEN, but the response of MIS to OPEN is stronger than to NFII. The third row shows a negative response of NFII to MIS; an increase in MIS reduces NFII. The response of NFII to shock itself is positive and changes to negative after period 8, while its response to shock in OPEN starts to be slightly positive and changes to be negative after period 4. The fourth row negatively illustrates the response of OPEN to the shock in MIS to confirm that an increase in overvaluation states does not encourage greater openness. It also shows that OPEN responds negatively to NFII until period 4 and then changes to respond positively, while OPEN positively responds to itself

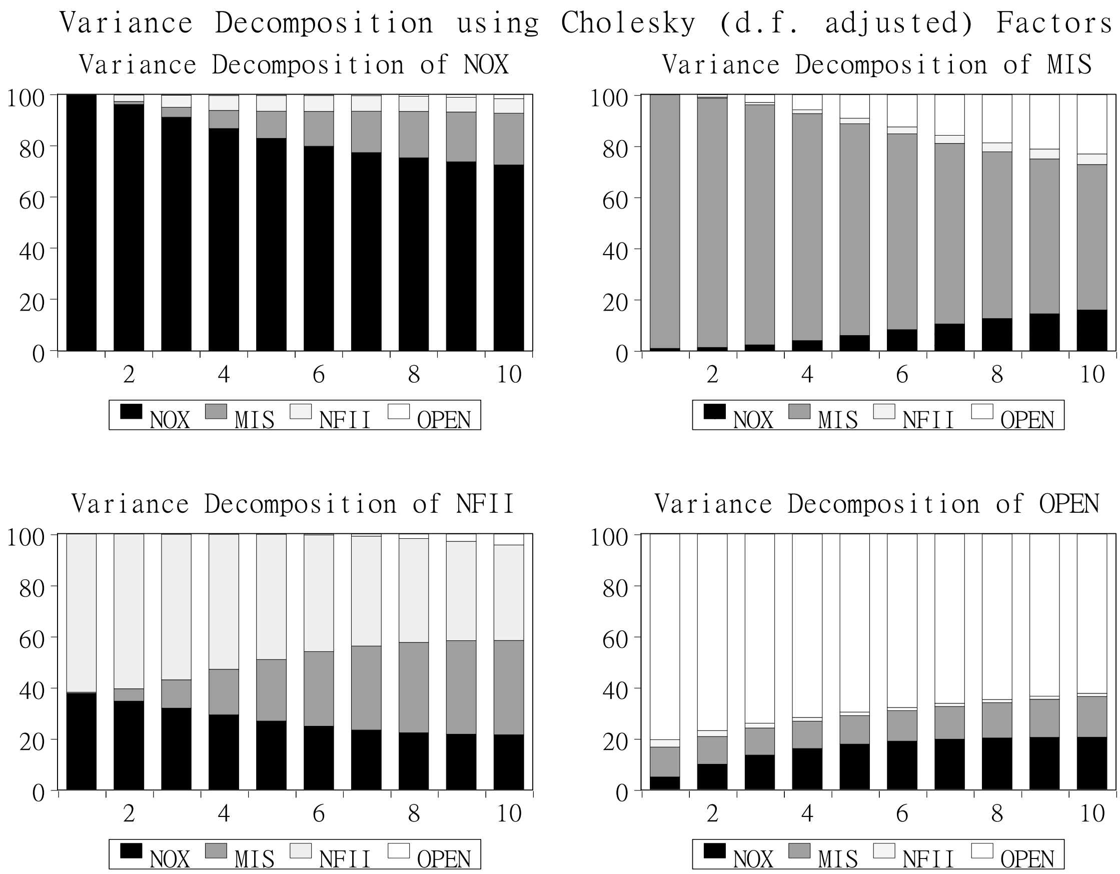
4.6.6 Variance decompositions for NOX, MIS and controls

The variance decomposition shows the dynamic changes of the variables in the model. It explains the relative importance of various structural shocks providing the variance of the forecasting error. From table 37 we can notice that in the first graph for NOX, the variance decomposition of NOX to itself provides the vast majority of variability over the all periods. However, the noticed amount of variability in NOX could be attributed to MIS. It starts with low levels in the short-run to reach about 20% in the long-run. The net foreign investment inflows also play an evident role in the variability of NOX, but less than MIS, which are just less than 7% in the long-run. As for OPEN, it accounts for a very low percentage, less than 2%, in the short and long run. It may need more time to affect NOX.

The second graph shows the variance decomposition of MIS due to NOX, which provides an increase over time to reach to about 16% in period 10. The percentage of variance of MIS due to its self represents the vast majority of variance and decreases over time while OPEN has increasing ratios and reaching approximately 23% in period 10. As for NFII, the variance of MIS due to NFII is very small over time. The third graph explains the variance of NFII due to NOX. The percentage starts from about 38% and decreases over time to teach around 21% in period 10, while MIS has increasing ratios over time to reach approximately 37% in period 10. The variance of NFII due to OPEN is a very low percentage in the same year and it perhaps needs more time to play an important role. The fourth graph illustrates the variance decomposition of OPEN due to NOX and MIS. The ratios increase to reach about 21% and 16% for

NOX and MIS respectively. The variance of OPEN due to NFII is very small, while that due to itself is the vast majority.

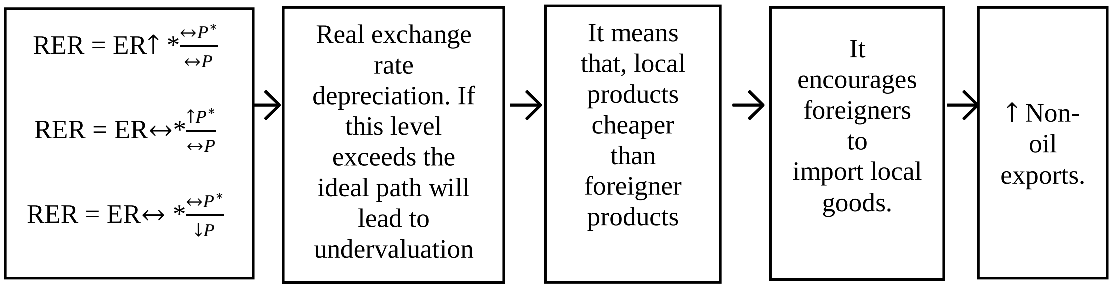
Figure 37. Variance decompositions graphs for NOX, MIS and control variables



Source: EViews 10 outcomes

4.6.7 Non-oil exports and misalignments-policy implications

Theoretically, increased exports are associated with RER depreciation, which may lead to the national currency being undervalued. The undervaluation episodes may come from reducing the national currency value or a decrease (increase) in local (foreign) price levels. These changes will stimulate the home country to export more because of the low costs as shown below:



Conversely, more overvaluation states will cause decline in NOX. Some oil exporting countries specify a very high value of their national currency, which make the local products prices at high level evaluated by foreign currencies, and then exports decrease. Also the high levels of local prices may cause overvaluation of national currency and then a reduction of non-oil exports. In recent years, the high level of inflation caused the Libyan currency to be dramatically overvalued, reducing NOX.

4.7 Black market exchange rate and real exchange rate misalignments

In oil-dependent countries a black market of exchange rate may appear, particularly during oil crises. High levels of black market exchange rate will lead to high levels of local inflation and RER appreciation and overvaluation states. There are two kinds of overvaluation of national currency in these economies. One may occur because of the setting of a very high value on their national currency, especially for very rich oil-exporting countries. Another sort of overvaluation may arise when some of these economies face a crisis in the oil sector, resulting in high inflation rates. Both cases, high national currency vale and high levels of local inflation, may lead to RER appreciation and then overvaluation states. In these economies, there is a considerable association between the oil sector and local price levels.

Oil exporting countries may experience a black market exchange rate for two main reasons. Policy makers evaluate their local currency value at a high level, employing a fixed exchange rate. Foreign exchange demand does not match the supply side of foreign exchange; consequently the black market may arise. Another cause is that, some of these economies are vulnerable to shocks which affect supply of foreign exchange, causing a parallel market in goods and black market of foreign exchange. However, the role of real exchange rate misalignment in currency crisis has not been studied in Libya. This part tries to explore this association between real exchange rate misalignment and black market premium.

4.7.1 Methodology and Data

This part of the study will employ the same VAR model as was employed in section 4.6.1. Unrestricted Vector Auto Regression for Cholesky impulse responses and variance decomposition methods to test the linkage between real exchange rate misalignments and black market exchange rate in Libya. The main advantage of using this method is that the VAR model is appropriate for explaining structural changes as well as helping policymakers for policy implications in the long term. Data for RGDP and OPEN were collected from Economic and social data in Libya and CBL, Data for INF were taken from IFS and CBL, Economic-Bulletin. MIS was calculated by using actual and equilibrium real exchange rate relying on data from OECD, CBL, Economic-Bulletin and IFS. All data in this regression is denominated in US dollars, as shown in figure 38. The model specifications is represented as in the equation below:

BME = F (MIS, INF, RGDP)

The reduced form for VAR model takes this form:

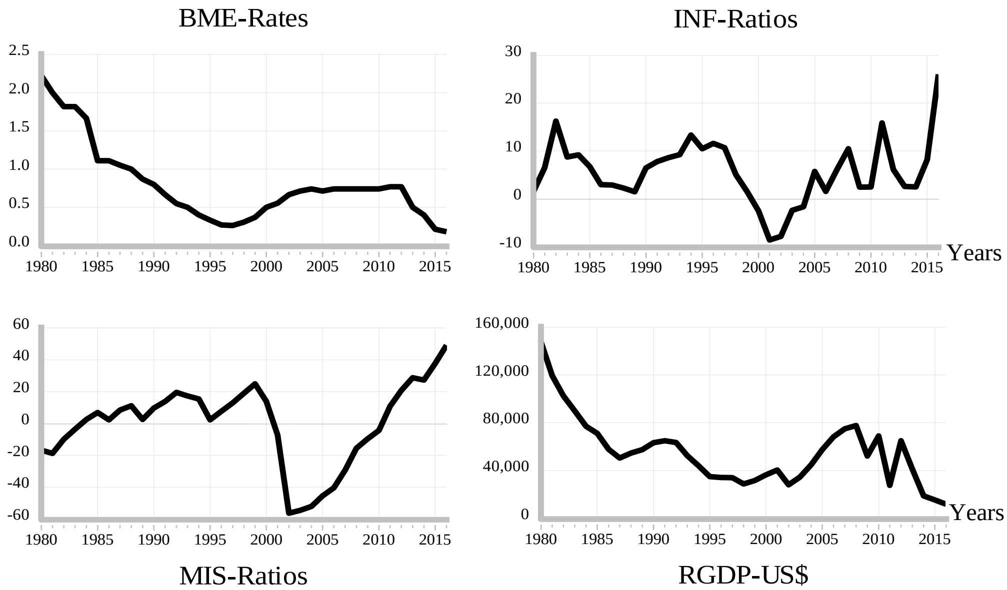
$$\mathrm{BME_t} = \alpha_0 + \alpha_1 \mathrm{BME_{t-1}} + \alpha_2 \mathrm{MIS_{t-1}} + \alpha_3 \mathrm{INF_{t-1}} + \alpha_4\,\mathrm{RGDP_{t-1}} + \mathrm{e_{1t}} \ldots (17)$$

$$\mathrm{MIS_t} = \beta_0 + \beta_1 \mathrm{MIS_{t-1}} + \beta_2 \mathrm{BME_{t-1}} + \beta_3 \mathrm{INF_{t-1}} + \beta_4\,\mathrm{RGDP_{t-1}} + \mathrm{e_{2t}} \ldots. (18)$$

$$\mathrm{INF_t} = \lambda_0 + \lambda_1 \mathrm{INF_{t-1}} + \lambda_2 \mathrm{MIS_{t-1}} + \lambda_3 \mathrm{BME_{-1}} + \lambda_4\,\mathrm{RGDP_{t-1}} + \mathrm{e_{3t}} \ldots (19)$$

$$\mathrm{RGDP_t} = \varphi_0 + \varphi_1 \mathrm{RGDP_{t-1}} + \varphi_2 \mathrm{BNE_{t-1}} + \varphi_3 \mathrm{INF_{t-1}} + \varphi_4\,\mathrm{MIS_{t-1}} + \mathrm{e_{4t}} \ldots.. (20)$$

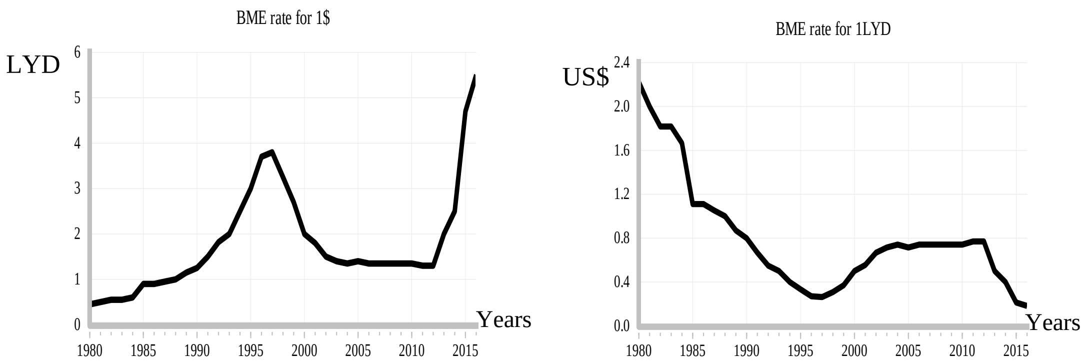
Figure 38. Black market premium, real exchange rate misalignments and controls



Sources: CBL, Economic-Bulletin, IFS, OECD, Records of gold shops in Libya and Economic and social data in Libya.

In this analysis, data for black market exchange rate in Libya will be employed as amounts of US dollar against one Libyan dinar as shown in figure 39. In the case where the official exchange rate is fixed, the black market exchange rate is positively linked to black market premium if expressed in units of local currency for 1US$. If the black market exchange rate is expressed in units of dollar for 1LYD, the association will be negative.

Figure 39. Black market exchange rate by different definitions.



4.7.2 Stationarity test

Unit root should be examined by using the unit root test for all variables before estimating the model. Two unit roots were performed, Augmented Dickey and Fuller (1979)-ADF and Phillips & Perron (1988)-(PP) to test the stationarity. Non-stationary variables have time-variant means, all changes are away from the mean. This means that, it is not a temporary movement. If the time series variables are not stationary (have unit root), then the first difference should be taken for these variables to obtain a stationary series. According to the ADF test, all variables are stationary at first difference except black market exchange rate, while using the P&P test, it is found all variables are stationary at first difference at the 5% level of significance, as it shown in table 38.

Table 38. Unite root tests results ADF and P&P for MIS, BME and controls

Variables	Model	Level (ADF)	First diff (ADF)	Level (PP)	First diff (PP)
	Intercept	-2.292	-3.077**	-3.171**	-4.323***
BME	Intercept & trend	-2.154	-3.0890	-2.480	-4.443**
	None	-2.309**	-2.810**	-3.750***	-3.919**
	Intercept	-1.732	-3.688***	-1.305	-3.740***
MIS	Intercept & trend	-1.670	-3.686**	-1.282	-3.686**
	None	-1.804	-3.653***	-1.371	-3.700***
	Intercept	-2.055	-5.092***	-2.211	-5.092***
INF	Intercept & trend	-1.907	-5.098***	-2.066	-5.047***
	None	-0.991	-5.127***	-1.048	-5.127***
	Intercept	-3.400**	-7.719***	-3.426**	-7.490***
RGDP	Intercept & trend	-3.3661*	-7.715***	-3.367*	-7.529***
	None	-2.695***	-7.357***	-3.016***	-7.176***

Note: */**/*** indicate rejection of null hypothesis of unit root at significant levels 10/5/1 percent respectively

Source: EViews 10 outcomes

4.7.3 Co-integration test

The Johansen (1988) test is employed to examine for the presence of a long run co-movements. The trace and maximum eigenvalues statistics are shown in Tables 39 and 40 respectively. There is no co-integration vector at 5 percent of significance, confirming that over the long run, black market exchange rate does not move together with real exchange rate misalignments, real gross domestic product and inflation rate.

Table 39. Unrestricted Co-integration Rank Test (Trace) for BME, MIS and control variables.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.460	47.574	47.856	0.053
At most 1	0.377	26.003	29.797	0.129
At most 2	0.216	9.453	15.495	0.325
At most 3	0.026	0.925	3.841	0.336

Trace test indicates no co-integration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Source: EViews 10 outcomes

Table 40. Unrestricted Co-integration Rank Test (Maximum Eigenvalue) for BME, MIS and control variables

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.460	21.571	27.584	0.243
At most 1	0.377	16.550	21.132	0.194
At most 2	0.216	8.528	14.265	0.328
At most 3	0.026	0.925	3.841	0.336

Max-eigenvalue test indicates no co-integration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Source: EViews 10 outcomes

4.7.4 VAR-Lag selection

The unrestricted VAR model requires selection of the optimal lag for the model. According to the final prediction error (FPE), Schwarz information criterion (SC), Hannan-Quinn information criterion (HQ), the sequential modified LR test statistic and Akaike information criterion (AIC), the optimal lag is at order 1. In order to obtain the findings, the model will be tried with lag 1 to obtain the best results in terms of stability of VAR model.

Table 41. VAR - Lag Order Selection Criteria for BME, MIS and control variables

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-646.971	NA	5.02e+11	38.292	38.472	38.354
1	-554.384	157.943*	5.59e+09*	33.787*	34.685*	34.093*
2	-546.657	11.363	9.50e+09	34.274	35.890	34.825
3	-533.677	16.033	1.27e+10	34.452	36.786	35.248

* indicates lag order selected by the criterion
Source: EViews 10 outcomes

4.7.5 Impulse responses for BME, MIS and control variables

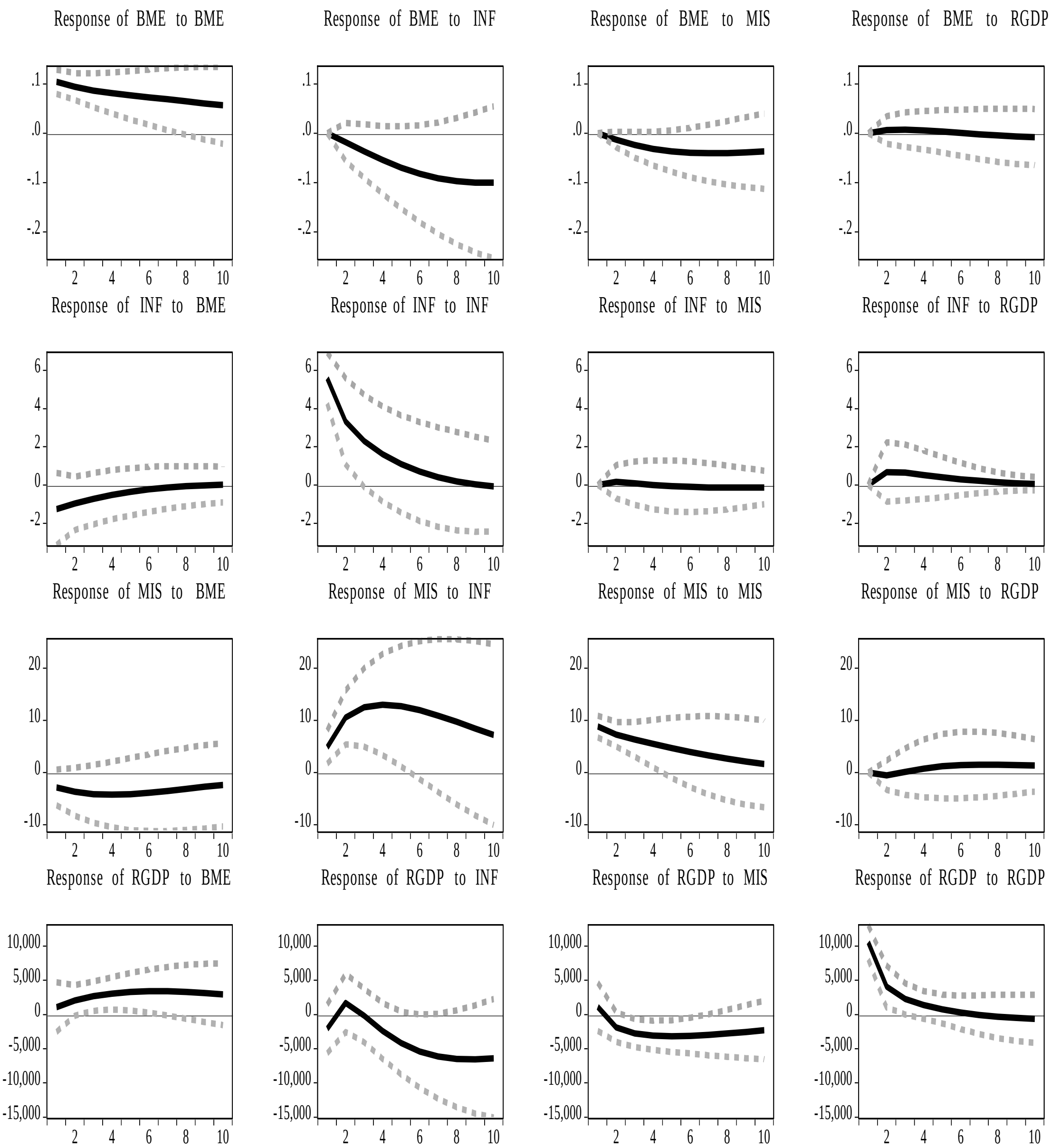
The vertical axis for each diagram measures the level of deviation for each variable from its steady state or base value, while the horizontal axis measures the periods, as shown in figure 40. The impulse response graphs in the first column explain the responses of all variables including MIS to one standard deviation shock of BME. The first row shows the response of BME to one standard deviation shock of all variables in the model. Since our interest is to explore the association between MIS and BME, then this linkage can be found in the first row and column of the impulse responses graphs. In the first row, the response of BME to one standard deviation shock to itself provides a positive response for all periods, heading towards steady state. The response of BME to one standard deviation shock in INF indicates a negative response for the all periods, going away from steady state to reveal a great response of BME. This means that one standard deviation increase in INF will cause increase in BME. Also, one standard deviation shock in MIS has a negative response of BME. More specifically, an increase in the MIS curve (more overvaluation or less undervaluation states) is associated with a decrease in black-market exchange rate (an increase in black market premium). As for RGDP, a one standard deviation as an impulse in RGDP does not have an obvious response in BME. It may need time to arise after 2 or 3 lags. The response of BME to impulse of RGDP may not occur immediately. Libya in most years has massive national reserves to avoid immediate increase in black market exchange rate during oil crises.

In the first column, a one standard deviation shock in BME causes INF to decrease to period 7, and then reaches to steady state. In this case, an increase in BME means a decrease in black market premium. Thus, it will lead to a decrease in INF. As for MIS, an increase in BME an impulse shock (decrease in black market premium) leads to a decrease in the MIS curve. This result is logical where the decrease in black market premium is accompanied with undervaluation of the national currency. A positive shock in BME has positive impact on RGDP. Increase in BME means black market premium decrease causing growth stimulation. Other graphs show other relationships in the VAR model. In the second row, INF has a positive impact on itself and reaches the steady state in period 8. There is no clear response of MIS to INF, while a shock in RGDP causes an increase in INF to reach steady state in period 8.

The third row shows an impulse shock in INF leads to increase in the MIS curve towards overvaluation states. MIS has a positive impact on itself towards steady state. There is a small positive effect running from RGDP to MIS. The fourth row illustrates a very short positive impact running from INF to RGDP and then changing to a very sharp negative impact going away from steady state. Also a shock in MIS is linked with a decrease in RGDP, which means overvaluation states are accompanied by low economic growth. A shock increase in RGDP has a positive impact on itself to period 6 and then changes to a negative effect.

Figure 40. Impulse responses graphs for BME, MIS and control variables.

Impulse and response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2

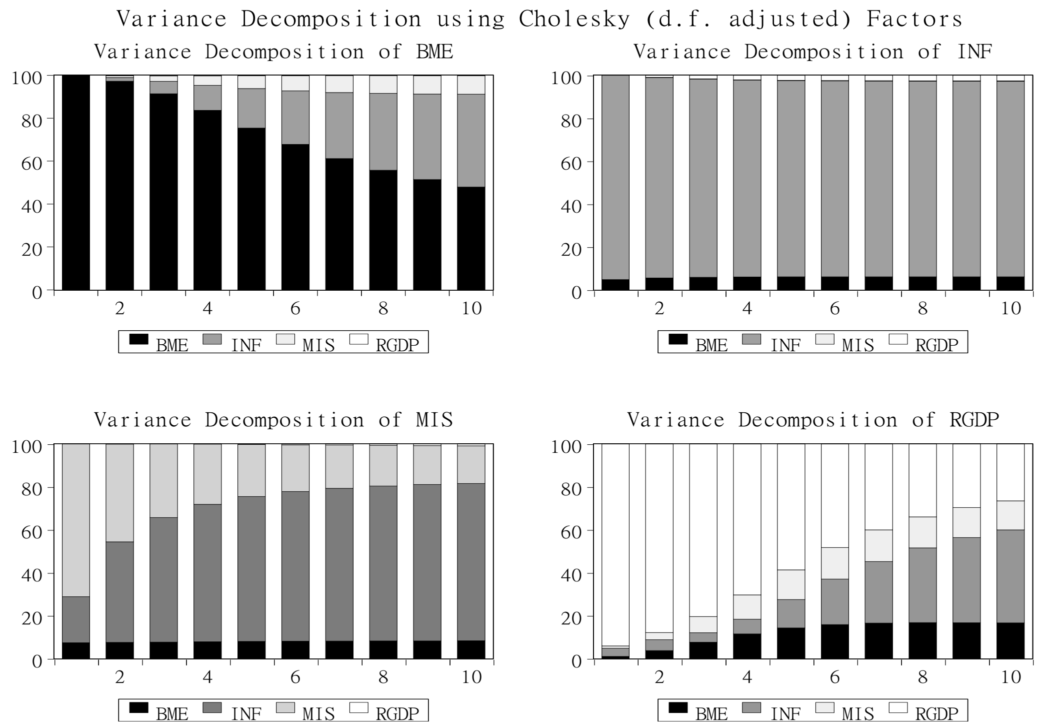


Source: EViews 10 outcomes

4.7.6 Variance decompositions for BME, MIS and control variables.

The variance decomposition shows the dynamic changes of the variables in the model. It explains the relative importance of various structural shocks providing the variance of the forecasting error. The first graph shows that the variance decomposition of the BME to itself explains the vast majority of variability over the whole period in the short-run, but in the long- run it decreases over time. However, there is a noticed amount of variability in BME that could be attributed to INF increasing over time. It starts with low levels in the short run to reach more than 40% in the long run. Also, MIS plays a role in variability of BME but less than INF, which is less than 10% in the long run. As for RGDP, black market exchange rate accounts for a very low percentage of the shocks in the RGDP. The main reason for this low ratio is that, the drop in output may take more time to have evident effect on the black market exchange rate. Libya has large reserves of oil exports in most years, which can avoid black market premium for some time after a decline in oil production as shown in figure 41.

Figure 41. Variance decompositions graphs for BME, MIS and control variables



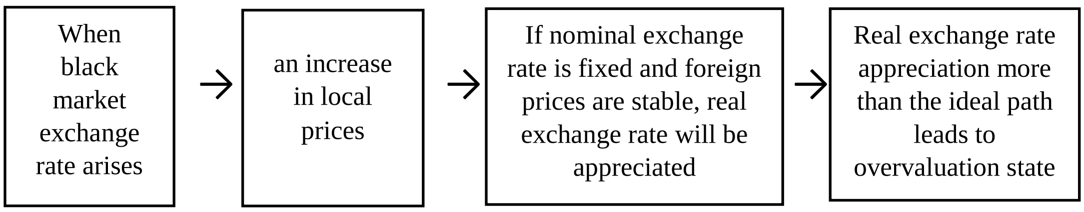
Source: EViews 10 outcomes.

The variance of INF to itself provides the vast majority of variability over the whole period in the short-run but in the long- run decreases over time. However, there is a very small amount of variability that could be attributed to BME, which is about 6%

in the short and long run. Also, MIS and RGDP, the variance in INF due to these variables represents a very small percentage. The variance of MIS to itself shows a significant percentage but decreasing over time from 71% in period 1 to just 17% in period 10. On the contrary, the variance of MIS due to INF shows increasing proportions over time, from about 21% in period 1 to approximately 73% in period 10. As for BME and RGDP, the variance of MIS due to these two variables shows very small ratios. The variance of RGDP due to itself provides the vast majority of variability and decreases over time from roughly 94% to 26%. As for INF, it has a considerable increasing proportion to explain the variance in RGDP, from about 3% in period 1 to 43% in period 10. The variance of RGDP due to BME and MIS is about 20% in the long-run as a ratio to explain RGDP as shown in figure 41.

4.7.7 Black market exchange rate and misalignments - Policy implication

The association between black market exchange rate and RER misalignments can be explained by inflation rates. When the black market exchange rate increases, the local inflation rate will rise, which in turn may cause RER appreciation. If RER appreciation exceeds the equilibrium level, the RER overvaluation states will appear, as shown below:



In the Libyan economy, it can be easily noticed that black market exchange rate increase is accompanied by oil production decline. Policy makers have tried many times to move the economy to economic liberalization, encourage foreign investment and stabilize the nominal exchange rate. All of these policies may have brought good impacts on the economy, but all of them depend on foreign exchange which comes from oil. Libya cannot achieve stability in the whole economy without stability in the oil sector. Oil crisis in Libya plays a main role in making the RER overvalued, while the stability in this sector helps the government to apply the undervaluation policy to move the economy to economic liberalization, encourage foreign investment and stabilize the nominal exchange rate

4.8 Real exchange rate misalignments and the traditional Keynesian model

This part of the study employs the simultaneous equation system, using Keynesian Model IS-LM models for an open economy dependent on structural equations (Klein 1971) (Fair 1984). Simultaneous equation methods are employed in econometrics to estimate models in which multiple interdependent variables are built by equations linking each other, which considering some exogenous variables. Firstly, we can say that any model is a simultaneous equation model when the dependent variable in one equation is also an explanatory variable in another equation. In this system, dependent variables are called endogenous variables, while variables determined by factors outside the model are called exogenous variable. This part of the study demonstrates the building of an economic equations system for Libya. These models are usually used to forecast the effects of economic policies on some aspects of the economy, such as growth, inflation, and competitiveness. Estimating these equations individually by applying OLS estimators causes biased and inconsistent results because the explanatory variables are correlated to the error term, which breaks the essential assumption related to BLUE for the OLS technique. To overcome this problem, this study applies generalised least square or full information likelihood methods to estimate the reduced form parameters.

4.8.1 Econometric modelling

Consumption is expressed by the disposable income function according to Keynesian economic theory (Minford & Peel 2002).

$$C = a + b\,(Y - T) \;\ldots\ldots\; (21)$$
$$C = b_0 + b_1 Y - b_2 T \;\ldots\ldots\ldots\; (22)$$

where: C is the private consumption, Y is the total income and T is the total taxes.

Tax revenues are relative to income as:

$$T = t_0 + t_1 Y + t_2 M + t_3 G \;\ldots\ldots\ldots\; (23)$$

where T is total taxes in the country.

The investment is positively linked with total product:

$$I = g_0 + g_1 Y + g_2 R \;\ldots\ldots\ldots\ldots\; (24)$$

Imports are linked positively to the local income and negatively to the misalignments of national currency as:

$$M = \varphi_0 + \varphi_1 Y + \varphi_2 MIS + \varphi_3 OPEN \ldots\ldots\ldots\ldots (25)$$

where M is total imports, Y is total GDP, OPEN is the trade openness.

$$X = X_0 \ldots\ldots\ldots (26)$$

where X is the total exports. Total exports is assumed to be an external variable in this model because the vast majority of exports are oil exports depending on the international market.

General spending is also assumed to be an exogenous variable in this model.

$$G = G_0 \ldots\ldots\ldots\ldots (27)$$

Money demand is linked with income and interest rate.

$$\frac{MS}{P} = k_0 + k_1 Y + k_2 R \ldots\ldots\ldots\ldots (28)$$

where MS, P, Y, R are money supply, prices level, total income and interest rate respectively.

Employing the market clearing condition

$$Y = C + I + G + (X - M) \ldots\ldots\ldots\ldots (29)$$

4.8.2 Methodology and data

In this model, using OLS for estimating the structural parameters provides biased and inconsistent parameter estimations. For that reason, we should obtain the reduced form equation for each endogenous variable in the system. They must be only a function of exogenous variable of the model. The simultaneous equation model takes for instance this form:

$$X_1 = a_0 + a_1 X_2 + u_1 \ldots\ldots\ldots (30)$$

$$X_2 = b_0 + b_1 X_1 + b_2 X_3 + u_2 \ldots\ldots\ldots (31)$$

The above system is a simultaneous equations, since X_1 depends on X_2 in the first equation and X_2 depends on X_1 and X_3 in the second equation. Thus, X_1 and X_2 are jointly determined, which means that we have a simultaneous equations system. In this simple model, X_1 and X_2 are endogenous variables, while X_3 is an exogenous variable that is determined outside the system. In this model, we cannot estimate the parameter by employing the OLS method. The main reason for that is, the association between the error term and independent variables. This problem will provide biased and inconsistent estimators (Salvatore and Reagle 2002).

Since, (u_1) links with (X_1) in the first equation.
Then, $(X1)$ links with (X_2) in the second equation
As a consequence (X_2) and (u_1) are correlated.

This problem will cause biased and inconsistent OLS estimations for the first and second equations. Testing for identification problems for all equations is a very important condition for estimating the model equations. There are two conditions should be performed to investigate the identification for a simultaneous equation model. The rank and order conditions as follows:

- **Order Condition**

This condition includes testing the identification condition as (Attiah 2004):

$$\boxed{k - f \geq m - 1} \quad \ldots\ldots\ldots\ldots\ldots..\ (32)$$

where, **k**: number of endogenous and exogenous variables in the model.

f: number of endogenous and exogenous valuables in the equation.

m: number of equations = number of endogenous variables in the model

There are various states that may occur in this case:

$$k - f > m - 1 \ldots\ldots..\ (33)$$

The specific equation is over - identified.

$$k - f = m - 1 \ldots\ldots...\ (34)$$

The specific equation is exactly identified.

$$k - f < m - 1 \ldots\ldots...\ (35)$$

The specific equation is under - identified.

We can get the same results by considering K and F as follows:

$$k = m + x \ldots\ldots...\ (36)$$

where,

m: number of endogenous variables in the model.

x: number of exogenous variables in the model.

And,

$$f = m1 + x1 \ldots\ldots\ (37)$$

where,

m1**:** number of endogenous variable in the specific equation.

x1: number of exogenous variable in the specific equation.

Then

$$(m + x) - f \geq m - 1 \ldots\ldots.\ (38)$$

$$x - f \geq -1 \ldots\ldots\ldots\ldots\ldots\ (39)$$

$$\boxed{x \geq f - 1} \quad \text{......... (40)}$$

Also,

$$x \geq (m1 + x1) - 1$$

$$\boxed{x - x1 \geq m1 - 1} \quad \text{......... (41)}$$

We can get the same results of identification problem by applying any forma 31, 39 or 40. The second condition in this analysis is the rank condition.

- **Rank condition**

This condition states that, for any simultaneous equation models including a number of equations, any equation in this model will be identified if it is possible to find at least one non-zero determinant of matrix of order (M-1) * (M-1), then that specific equation is identified. There are some steps that should be taken into account to test for rank condition. Firstly, each equation in the system should be written each equation equals zero. After that, the coefficient matrix for the whole the system should be found. Secondly, for each row in the particular equation, it should be removed. Thirdly, columns that have non-zero coefficients in the specific equation are struck out. Fourthly, with the remaining coefficients we can make any matrix in order (M-1) (M-1). Any matrix its determinant is non-zero, this equation is identified.

As a summary of the two conditions, any equation is identified as an over or exact identification if:

$$K - F \geq M - 1 \text{............ (42)}$$

This condition states that for a model that contains a number of equations, any one of these equations will be identified if it is possible to find at least one zero-zero parameter from the m-1 level. This means that it is not enough to achieve the rank condition only so that the equation of interest can be identified.

$$\text{At least one determinant } \rho\,(D) \neq 0$$

Using the OLS method to estimate each single equation produces biased and inconsistent outcomes in light of the fact that explanatory variables are associated to error terms, which breaks the basic assumption of BLUE properties for OLS estimation. This weakness is overcome by Full Information Maximum Likelihood (FIML) or generalised least square (GLS) approaches. The estimation of such parameters is subjected to criticism, particularly for forecasting, because the estimated parameters are constant during the forecasting period. Households and firms do not change their choices according to changes in economic policies(Bhattarai 2011). This is known as the Lucas critique (1976) which presented the rational expectation in the model because expected policies have different effects than unexpected policies (Wallis 1980).

Data in this part for private consumption, private investment, general expenditure, taxes, money supply and gross domestic product are taken from economic and social data in Libya (1962-2006) and Ministry of Planning-National Accounts Bulletin (2007-2012). Data for total imports and exports are obtained from economic and social data in Libya (1962-2006) and CBL-economic bulletin. Interest rate date is taken from (IFS) and CBL-economic bulletin. Data is expressed in millions of the Libyan currency in the real form, except for MIS and OPEN, which are expressed in percentages. This model will employ RC, RI, RT, RM, RY, Ri, RX, RG, RMS, OPEN, MIS which are real private consumption, real private investment, real total taxes, real total imports, real total income, real interest rate, real total exports, real general expenditure, real money supply, trade openness and real exchange rate misalignments respectively.

4.8.3 Estimating results:

Before estimating our model, the two conditions for testing identification should be performed to determine the appropriate method to estimate the reduced form and structural parameters:

- **Order Condition**

The results for the order condition are shown in table (42). All the model equations are over-identified. As mentioned before, this condition is not fully sufficient. The rank condition should be tested to confirm these results.

Table 42. Order condition test results.

Endogenous variable equation.	Order condition $K - F \geq M - 1$	Decision
RC	$11 - 3 \geq 6 - 1$ $8 \geq 5$	Over-identified
RT	$11 - 4 \geq 6 - 1$ $7 \geq 5$	Over-identified
RI	$11 - 3 \geq 6 - 1$ $8 \geq 5$	Over-identified
RM	$11 - 4 \geq 6 - 1$ $7 \geq 5$	Over-identified
Ri	$11 - 3 \geq 6 - 1$ $8 \geq 5$	Over-identified

- **Rank Condition**

The identification problem for each equation can be examined by the rank condition as shown in table 43.

Table 43. Coefficients of macro econometric model

	RC	RT	RI	RM	Ri	RY	RG	RX	MIS	OPEN	RMS	CONS
RC	-1	-b_1	0	0	0	b_1	0	0	0	0	0	b_0
RT	0	-1	0	t_2	0	t_1	t_3	0	0	0	0	t_0
RI	0	0	-1	0	g_2	g_1	0	0	0	0	0	g_0
RM	0	0	0	-1	0	q_1	0	0	q_2	q_3	0	q_0
Ri	0	0	0	0	-1	f/k	0	0	0	0	1/k	k_0
RY	1	0	1	-1	0	-1	1	1	0	0	0	0

- Real Private Consumption

To apply the rank condition, firstly, we should delete the row of the equation of interest, as well as all non-zero columns making this matrix:

$$\begin{bmatrix} 0 & t_2 & 0 & t_3 & 0 & 0 & 0 & 0 \\ -1 & 0 & g_2 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & q_2 & q_3 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & 1/k \\ 1 & -1 & 0 & 1 & 1 & 0 & 0 & 0 \end{bmatrix}$$

Secondly, we make at least one matrix of order 5*5 to find the determinants.

$$\begin{bmatrix} 0 & t_2 & 0 & t_3 & 0 \\ -1 & 0 & g_2 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 1 & -1 & 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} + & - & + & - & + \\ - & + & - & + & - \\ + & - & + & - & + \\ - & + & - & + & - \\ + & - & + & - & + \end{bmatrix}$$

$$[+1] \begin{bmatrix} 0 & t_2 & 0 & t_3 \\ -1 & 0 & g_2 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} + & - & + & - \\ - & + & - & + \\ + & - & + & - \\ - & + & - & + \end{bmatrix}$$

$$[+1]\,[-t_3] \begin{bmatrix} -1 & 0 & t_3 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} + & - & + \\ - & + & - \\ + & - & + \end{bmatrix}$$

$$[+1]\,[-t_3]\,[-1] \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} + & - \\ - & + \end{bmatrix}$$

$$[+1][-t_3][-1][1] = t_3$$

Identified.

- **Real Taxes**

Firstly, we should delete the functions row and non-zero columns, thereby obtaining the following matrix:

$$\begin{bmatrix} -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & g_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & q_2 & q_3 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 1/k \\ 1 & 1 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}$$

After that, we should make any matrix in order 5*5 to find the matrix determinant.

$$\begin{bmatrix} -1 & 0 & 0 & 0 & 0 \\ 0 & -1 & g_2 & 0 & 0 \\ 0 & 0 & 0 & 0 & q_2 \\ 0 & 0 & -1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} + & - & + & - & + \\ - & + & - & + & - \\ + & - & + & - & + \\ - & + & - & + & - \\ + & - & + & - & + \end{bmatrix}$$

$$[-1] \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & -1 & g_2 & 0 \\ 0 & 0 & 0 & q_2 \\ 0 & 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} + & - & + & - \\ - & + & - & + \\ + & - & + & - \\ - & + & - & + \end{bmatrix}$$

$$[-1]\,[-1] \begin{bmatrix} -1 & g_2 & 0 \\ 0 & 0 & q_2 \\ 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} + & - & + \\ - & + & - \\ + & - & + \end{bmatrix}$$

$$[-1]\,[-1]\,[-1] \begin{bmatrix} 0 & q_2 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} + & - \\ - & + \end{bmatrix}$$

$$[-1]\,[-1]\,[-1][-q_2] = q_2$$

Identified.

- **Real Private Investment**

$$\begin{bmatrix} -1 & -b_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & t_2 & t_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & q_2 & q_3 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1/k \\ 1 & 0 & -1 & 1 & 1 & 0 & 0 & 0 \end{bmatrix}$$

Now, a matrix in order 5*5 (m-1)*(m-1) should be created as follows:

$$\begin{bmatrix} -1 & -b_1 & 0 & 0 & 0 \\ 0 & -1 & t_2 & t_3 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1/k \\ 1 & 0 & -1 & 1 & 0 \end{bmatrix} \begin{bmatrix} + & - & + & - & + \\ - & + & - & + & - \\ + & - & + & - & + \\ - & + & - & + & - \\ + & - & + & - & + \end{bmatrix}$$

$$\begin{bmatrix} 0 & -b_1 & 0 & 0 \\ 0 & -1 & t_2 & t_3 \\ 0 & 0 & -1 & 0 \\ 1 & 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} + & - & + & - \\ - & + & - & + \\ + & - & + & - \\ - & + & - & + \end{bmatrix}$$

$$\begin{bmatrix} -b_1 & 0 & 0 \\ -1 & t_2 & t_3 \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} + & - & + \\ - & + & - \\ + & - & + \end{bmatrix}$$

$$\begin{bmatrix} -b_1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} + & - \\ - & + \end{bmatrix}$$

$$(-1/\text{k})\,(t_3)\,(b_1) = (-1/\text{k})\,(-t_3)\,(b_1)$$

Identified.

- **Total imports**

$$\begin{bmatrix} -1 & -b_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & t_3 & 0 & 0 \\ 0 & 0 & -1 & g_2 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & 1/k \\ 1 & 0 & 1 & 0 & 1 & 1 & 0 \end{bmatrix}$$

Making a matrix 5*5:

$$\begin{bmatrix} -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & t_3 & 0 & 0 \\ 0 & g_2 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 1/k \\ 1 & 0 & 1 & 1 & 0 \end{bmatrix} \begin{bmatrix} + & - & + & - & + \\ - & + & - & + & - \\ + & - & + & - & + \\ - & + & - & + & - \\ + & - & + & - & + \end{bmatrix}$$

$$[-1] \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & t_3 & 0 \\ 0 & g_2 & 0 & 0 \\ 0 & -1 & 0 & 1/k \end{bmatrix} \begin{bmatrix} + & - & + & - \\ - & + & - & + \\ + & - & + & - \\ - & + & - & + \end{bmatrix}$$

$$[-1][1/k] \begin{bmatrix} -1 & 0 & 0 \\ 0 & 0 & t_3 \\ 0 & g_2 & 0 \end{bmatrix} \begin{bmatrix} + & - & + \\ - & + & - \\ + & - & + \end{bmatrix}$$

$$[-1][1/k][-1] \begin{bmatrix} 0 & t_3 \\ g_2 & 0 \end{bmatrix} \begin{bmatrix} + & - \\ - & + \end{bmatrix}$$

$$[-1][1/k][-1][-g_2 t_3] = 1/k[-g_2 t_3]$$

Identified.

- **The Real Interest Rate Function**

$$\begin{bmatrix} -1 & -b_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & t_2 & t_3 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & q_2 & q_3 \\ 1 & 0 & 1 & -1 & 1 & 1 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} -1 & -b_1 & 0 & 0 & 0 \\ 0 & -1 & 0 & t_2 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 1 & 0 & 1 & -1 & 1 \end{bmatrix} \begin{bmatrix} + & - & + & - & + \\ - & + & - & + & - \\ + & - & + & - & + \\ - & + & - & + & - \\ + & - & + & - & + \end{bmatrix}$$

$$[+1] \begin{bmatrix} -1 & -b_1 & 0 & 0 \\ 0 & -1 & 0 & t_2 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} + & - & + & - \\ - & + & - & + \\ + & - & + & - \\ - & + & - & + \end{bmatrix}$$

$$[+1][-1] \begin{bmatrix} -1 & 0 & t_2 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} + & - & + \\ - & + & - \\ + & - & + \end{bmatrix}$$

$$[+1][-1][-1] \begin{bmatrix} -1 & t_2 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} + & - \\ - & + \end{bmatrix}$$

$$[+1][-1][-1][+1] = 1$$

Identified.

After confirming that all equation are identified, then 2SLS or 3SLS it can be employed (Pindyck & Rubinfeld 1998) to estimate the structural parameters. RC, RT, RI, RM and Ri are five endogenous variables of the system, while RG, MIS, OPEN, RMS and RX are five pre-determined or exogenous variables. Structural parameters should be estimated by choosing the right method such as 2SLS or 3SLS. In the simultaneous equations system, we cannot employ the OLS method to each equation individually, as this technique will produce inconsistent and biased estimates, so we follow these steps to estimate this model simultaneously:

- Making a reduced form of the system.
- Estimating the reduced form parameters.
- Recapturing the structural parameters from the reduced form parameters of the model

The reduced form for this model should be obtained from the national income function as:

$$Y = C + I + G + (X\text{-}M)$$

$$RC = \pi_{00} + \pi_{01}\, RG + \pi_{02}\, RMS + \pi_{03}\, RX + \pi_{04}\, MIS + \pi_{05}\, OPEN \ldots\ldots (43)$$

$$RT = \pi_{10} + \pi_{11}\, RG + \pi_{12}\, RMS + \pi_{13}\, RX + \pi_{14}\, MIS + \pi_{15}\, OPEN \ldots\ldots (44)$$

$$RI = \pi_{20} + \pi_{21}\, RG + \pi_{22}\, RMS + \pi_{23}\, RX + \pi_{24}\, MIS + \pi_{25}\, OPEN \ldots\ldots (45)$$

$$RM = \pi_{30} + \pi_{31}\, RG + \pi_{32}\, RMS + \pi_{33}\, RX + \pi_{34}\, MIS + \pi_{35}\, OPEN \ldots\ldots (46)$$

$$Ri = \pi_{40} + \pi_{41} RG + \pi_{42}\, RMS + \pi_{43}\, RX + \pi_{44}\, MIS + \pi_{45}\, OPEN \ldots\ldots (47)$$

$$RY = \pi_{50} + \pi_{51}\, RG + \pi_{52}\, RMS + \pi_{53}\, RX + \pi_{54}\, MIS + \pi_{55}\, OPEN \ldots\ldots (48)$$

#

4.8.4 Estimating Results:

The findings consist of two types of results, the reduced form and structural form estimation estimations explained as follows:

- **The reduced form results**

Results using the FIML method for reduced form show a negative relationship between MIS and all endogenous variables in this model. MIS has a significant negative relationship with all endogenous variable at the 1% level of significance, except RI. All results for reduced form estimation are shown below. Tables 45, 46, 47, 48, 49 and 50 show a negative relationship between RC, RT, RM, Ri and RY with MIS. This means that an increase (decrease) in overvaluation (undervaluation) states will reduce RC, RG, RM, Ri and RY. The impact of RG on endogenous variables is significantly positive for RC, RT, RM, Ri and RG. All results are significant at the 5% level of significance, except Ri which is just significant at the 10% level of significant. The monetary policy side expressed by RMS has a positive and significant impact on RC, RT, RI, RM and RY. Its impact on Ri is not statistically significant. The effect of total exports is negative on RT and positive on RY at the 5% level of significance. Trade openness has a negative effect on RC, RT, Ri and RY while it positively affects RM.

Table 44. Reduced form results FIML for RC

Variable	Coefficient	Std.Error	t-value	t-prob
RG	0.290	0.060	4.86	0.0000
RMS	0.243	0.035	6.86	0.0000
RX	0.040	0.033	1.19	0.2405
MIS	-92.598	14.64	-6.32	0.0000
OPEN	-114.094	15.74	-7.25	0.0000
Constant	11906.5	1172.0	10.2	0.0000

Table 45. Reduced form results FIML for RT

Variable	Coefficient	Std.Error	t-value	t-prob
RG	0.156	0.020	7.75	0.0000
RMS	-0.044	0.012	-3.66	0.0007
RX	-0.035	0.011	-3.10	0.0034
MIS	-13.555	4.945	-2.74	0.0088
OPEN	-21.7831	5.314	-4.10	0.0002
Constant	2572.17	395.8	6.50	0.0000

Table 46. Reduced form results FIML for RI

Variable	Coefficient	Std.Error	t-value	t-prob
RG	0.089	0.057	1.55	0.1278
RMS	0.091	0.034	2.67	0.0107
RX	-0.007	0.032	-0.23	0.8220
MIS	-7.672	14.06	-0.55	0.5881
OPEN	23.217	15.11	1.54	0.1317
Constant	-2259.66	1126.0	-2.01	0.0509

Table 47. Reduced form results FIML for RM

Variable	Coefficient	Std.Error	t-value	t-prob
RG	0.519	0.050	10.4	0.0000
RMS	0.169	0.030	5.70	0.0000
RX	0.027	0.028	0.97	0.3378
MIS	-48.153	12.30	-3.92	0.0003
OPEN	29.425	13.21	2.23	0.0311
Constant	-1775.20	984.3	-1.80	0.0782

Table 48. Reduced form results FIML for Ri

Variable	Coefficient	Std.Error	t-value	t-prob
RG	0.001	0.0003	1.69	0.0987
RMS	-5.36e-005	0.00018	-0.293	0.7709
RX	-0.0002	0.00017	-1.03	0.3098
MIS	-0.244	0.0758	-3.22	0.0024
OPEN	-0.223	0.0814	-2.74	0.0090
Constant	14.275	6.0640	2.35	0.0231

Table 49. Reduced form results FIML for RY

Variable	Coefficient	Std.Error	t-value	t-prob
RG	0.607	0.086	7.10	0.0000
RMS	0.135	0.0507	2.65	0.0110
RX	0.953	0.0479	19.9	0.0000
MIS	-102.982	20.99	-4.91	0.0000
OPEN	-168.861	22.55	-7.49	0.0000
Constant	17722.5	1680.0	10.5	0.0000

Source: OxMatrex 7 outcomes

- **The structural form results:**

Tables 51, 52, 53, 54 and 55 explain the structural parameters results by applying the 3SLS method. The response of RC to the change in RY is positive and statistically significant but at a very low value. The main reason for that is that the vast majority of the total income in Libya is from oil, which is controlled by the government in the form of national reserves. In the same equation, total taxes has a negative impact on RC. Parameters for RY and RT are significant at the %1 and 10% levels of significance respectively. The RT equation shows positive impacts of RY and RG on RT, whereas RM has a negative impact at the 1% level of significance. RY has a positive impact on RI while Ri has a negative effect at the 1% level of significance. RY and RG positively influence RM while MIS has a negative impact at the 1% level of significance. The Last table shows that, RY has a positive impact on Ri.

Table 50. Structural form results 3SLS for RC

Variable	Coefficient	Std.Error	t-value	t-prob
RY	0.260	0.018	14.80	0.0000
RT	-0.931	0.529	-1.76	0.0854
Cons	4258.93	779.20	5.47	0.0000

Table 51. Structural form results 3SLS for RT

Variable	Coefficient	Std.Error	t-value	t-prob
RY	0.043	0.015	2.88	0.0061
RG	0.187	0.050	3.78	0.0005
RM	-0.302	0.082	-3.69	0.0006
Cons	1059.12	174.70	6.06	0.0000

Table 52. Structural form results 3SLS for RI

Variable	Coefficient	Std.Error	t-value	t-prob
RY	0.092	0.010	9.13	0.0000
Ri	-170.727	56.36	-3.03	0.0041
Cons	-903.192	395.0	-2.29	0.0271

Table 53. Structural form results 3SLS for RM

Variable	Coefficient	Std.Error	t-value	t-prob
RY	0.310	0.014	22.7	0.0000
MIS%	-66.787	12.93	-5.16	0.0000
OPEN	134.608	13.69	9.83	0.0000
Cons	-9915.23	1113.0	-8.91	0.0000

Table 54. Structural form results 3SLS for Ri

Variable	Coefficient	Std.Error	t-value	t-prob
RY	0.0002	8.417e-005	2.04	0.0469
RMS	-0.0003	0.0001686	-1.65	0.1059
Cons	-1.485	1.967	-0.755	0.4544

Source: OxMatrex 7 outcomes

4.9 Conclusion

This chapter examined to study the effects of MIS on some macroeconomic variables in Libya. Through the analysis, it is noted that deep gaps of MIS for a long time have a significant impact on the economy. Overvaluation states are accompanied with negative aspects on the economy, such as low RNGDP and NOX, as well as high levels of INF and BME. An increase in INF may lead to RER appreciation and then overvaluation of the local currency when this level exceeds the equilibrium path. Local products will be more expensive than foreign products, causing a decrease in NOX and then the non-oil GDP. Conversely, decreasing in local price levels will cause RER depreciation and then RER undervaluation if this level exceeds the equilibrium level. Undervaluation states will make local products cheaper than foreign products, leading to an increase in NOX and then non-oil product increases as well. Undervaluation episodes have positive effects, increasing real non-oil growth and non-oil exports with low local price level and black market premium.

Since Libya is an oil exporting country, oil product has a significant role for changing the MIS via INF. When the country suffers from a decrease in oil product because of a decline in world oil prices or drop in oil exports, the supply of foreign exchange will decrease. This will increase the black market for foreign currencies, with a high level of inflation, causing appreciation of the RER. Over appreciation will lead to overvaluation sates of RER. Since Libya is highly dependent on oil revenues for importing, the local price levels will increase, causing RER appreciation if the nominal exchange rate does not change. It also may cause overvaluation states if this level exceeds the ideal path. According to the Keynesian model, endogenous variables in the model are negatively associated with misalignments of national currency. Increasing in overvaluation states reduces RC, RT,RG, RM, RY and Ri. It accompanies with a black market premium with high prices and then RC decreases as a result. RT also decrease because of tax evasion during unstable periods and high levels of inflation. Increased inflation and black market premium will also decrease RM. The Ri is also almost entirely affected by inflation because the nominal interest rate is almost fixed, therefore, an increase in inflation rates will lead to a decrease in Ri. That is why, there is a negative association between MIS and Ri. As for RY, this variable also has negative linkage with MIS because the vast majority of total income comes from the oil sector and so any decline in oil product will cause inflation and real exchange rate appreciation and overvaluation states.

By studying some of the variables in the Libyan economy and its association with RER gaps for Libya, it is clear that dependence on oil is playing a large part of the misalignment of the Libyan currency. With no significant change in nominal exchange rate, a decline in oil product will cause a high level of inflation and considerable increase in black market of exchange rate. In the next chapter, we will study the response of monetary policy to movements in inflation, as well as future inflation expectations by employing the DSGE model.

Chapter 5. A Dynamic Stochastic General Equilibrium (DSGE) Model for a Small Open Economy: Libya

5.1 Introduction

Estimation and calibration of general equilibrium models is largely employed to study the effects and prediction of changing macroeconomic policies on several economic aspects, such as economic growth, exchange rate, inflation rate and investment. Dynamic Stochastic General Equilibrium **(**DSGE) models have become very common as an important instrument for monetary policy in a great number of central banks since the $1990s_s$. These models are dynamic and stochastic models at the same time, which means that they study how the economy changes over time while taking into account that the economy is influenced by random shocks such as oil shocks, technology shocks and changes in macroeconomic policies. Modern economic policy analysis is notably interested in using such models because they vary from macroeconomic models. These models are multivariate time series models that take into account the microeconomic foundations of household decisions and the optimization behaviour of firms that work under monopolistic completion conditions (Gali and Monacelli 2005).

DSGE models are employed to determine sources of volatility, answering questions about structural variations, and estimating and predicting the impact of policy changes (Tovar 2009). Building DSGE models assists monetary policy makers in formulating the appropriate monetary policy in the economy and arranging how the central bank selects the appropriate policy tools in the face of macroeconomic changes (Gali and Monacelli 2005). Additionally, these models help to capture the interaction between policy change and economic agents, as well as describing in detail the economic stochastic shock transmission that occurs in the economy, such as demand and supply shocks. It also allows for the establishment of inter-relationships between structural features of the economy (Sbordone, Tambalotti et al. 2010).

These models are considerably different from CGE models that are deterministic, and the micro-simulations are built on borrowed parameters (Adebiyi and Mordi 2010). The main aim of this model is to simulate ways in which dynamic shocks relate to the endogenous monetary policy, and to investigate the appropriate monetary policy under the policy rule that reflects the behaviour of the central bank (Medina and Soto 2005). The DSGE model helps to assess the monetary policy role as well as the effects of spill-over shocks to other economic sectors (Rabee Hamedani and Pedram 2013). The main idea of DSGE modes is to focus on the optimisation behaviour of economic sectors. These models are built on the supposition of rational economic indicators which form rational expectations about future change in macroeconomic agents (Senbeta 2011).

Developing countries have features that make them different from developed countries: for example, with a large informal sector, vulnerable to external shocks, and undeveloped financial markets. Such characteristics cause various reactions in response to economic shocks. Seeking to apply such models that are taken from developed economies in the study of a developing economy is a significant challenge, which may bring about misleading results. In this respect, the building of such macroeconomic models needs to take into account the differences between them. The Libyan financial market is undeveloped and still in the process of being liberalised, and capital flows are still constrained because of the fixed and flexible nominal exchange rate, and the interest rate does not represent rises in inflation rate and does not reflect the cost of maintaining money in this economy. Therefore, there are limited alternative financial assets to deal with, because DSGE models have not been sufficiently developed in Libya.

Most oil exporting countries depend strongly on oil revenues for stability and economic performance (Romero 2008). Libya as a natural resource-rich economy has suffered from great corruption with misuse of oil revenues causing low economic performance. As indicated by the IMF yearly report (2012), GDP extensively contracted and raw petroleum generation was nearly ended in July 2011, as non-oil product was essentially impacted by the collapse of infrastructure and factors of production. Libya’s oil production accounts for approximately 47 percent of GDP, and oil exports represent about 90 percent of total exports in (2010) (Central Bank of Libya 2015). For countries that are rich with natural resources such Libya, the full use of oil revenue for present consumption is linked with risks due to instability in oil prices and production in the future. This structural characteristic of oil exporting countries poses the question of the appropriate monetary policy for these countries. A small dynamic stochastic general equilibrium model such as the New Keynesian (NK DSGE) model for Libyan economy is applied to capture the future expectations for inflation and exchange rate gap. To do so, this model will evaluate the role of monetary policy and expectations for inflation.

5.2 Literature review

Al-Abri (2014) studied the optimal choice of exchange rate system for a small, open, oil-exporting economy, employing a welfare-based model. This paper applied the standard New Keynesian Small Open Economy technique to three countries; a small oil-exporting country and two large foreign countries. The model also included three sectors: non-traded, traded, and crude oil (primary commodity). The sources of shocks were random monetary (demand), real productivity, and real oil price (supply). The main results of this study were that a flexible exchange rate system can shrink external shocks and consumption instability, as well as improving welfare more significantly in comparison to a fixed regime.

Medina and Soto (2005) analysed the impacts pf oil-price shocks from a general equilibrium stand-point. They improved a dynamic stochastic general equilibrium (DSGE) model for the Chilean economy using a Bayesian technique. This study simulated how monetary policy and other variables might respond to oil-price shocks under the policy rules of the Central Bank of Chile (CBC). This study also simulated counterfactual responses for alternative monetary frameworks in equilibrium wages and flexible prices. The results show that a 13% rise in the real price of oil causes a decline in output of approximately 0.5% and a rise in inflation of around 0.4%. The endogenous tightening of monetary policy is the main reason for the contractionary impacts of real oil shocks.

Kamps and Pierdzioch (2002) studied the relative performance of monetary policy rules and oil price shocks for an open oil economy. This study finds that it is important to distinguish between alternative price indices (CPI, core CPI, and GDP deflator) when modelling the impacts of oil price rises. This result is very important for monetary policy makers and central banks to decide which inflation rate to target.

Romero (2008) developed a general equilibrium model for an oil producing economy with considering a new transmission channel for oil price shocks. The transmission channel is described as an income influence resulting from oil revenue. The author finds that the Phillips curve involves a measure of oil income which causes additional inflationary pressures. The results from impulse response functions demonstrate that the economy responds better to a Taylor rule to affect final goods and oil production, consumption and inflation than to a Taylor rule that reacts only to final goods production. In addition, a central bank could stabilize inflation and output optimally, without trade-offs reacting to inflation and output gaps, and the Taylor rule reacts to consumption and final goods production (Senbeta 2011).

(Poutineau, et al. (2015) studied the major notion of the 3 equation New Keynesian model to examine the dynamics of the model. This study introduced a simple static version of the model that provides the direct reduced forms and the basis for a simple graphical analysis of the macroeconomic equilibrium. It also employed the IRFs analysis to investigate the dynamic adjustment of the economy and have used the variance analysis to assess how an adjustment of values of the key parameters of the model influence the supply and demand side shocks. The main target of this study is to show an evident and simple explanation about the main ideas to solve the New Keynesian models that have become a very important for macroeconomic policy analysis.

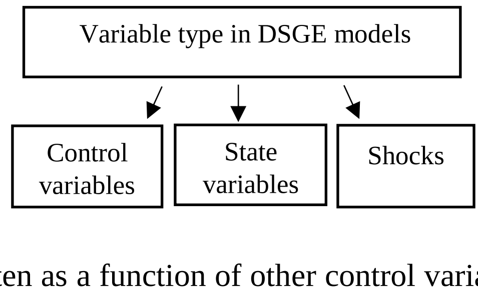
5.3 Methodology and Data:

DSGE models are employed for macroeconomics fields to explain the economy's structure, as models contain systems of equations depending on economic theory. These models depend on expectations of future variables, concluded based on the values of current variables. DSGE models are dynamic system equations, which are subject to random shocks and its expectations explain which policy influences the economy. A DSGE model is a VAR model with optimization-based constraints (economic foundations). The VAR model is the closest modelling methodology to the DSGE model. These two models have advantages and disadvantages, and the most important difference between them are shown in the following table (55) (Giacomini 2013):

Table 55. The main differences between VAR and DSGE

Estimation in VAR models	Estimation in DSGE models
The estimation in VAR models can be made directly from calculated data to employ it for investigating the statistical hypothesis and predicting.	DSGE models rely completely on economic theory and formalize the conduct of economic agents employing microeconomic foundations.
Since VAR models do not depend significantly on economic theory, they cannot reveal structural parameters, which makes them an unstable approach in analysing change in economic policy. Structural micro-founded shocks cannot be identified.	Since DSGE models are based on economic theory, they can cover the whole analysis of the model with a structured interpretation of wide spectrum scenarios and simulation findings. Structural micro founded shocks can be identified.
Traditional models or econometric models are more vulnerable to the Lucas critique.	DSGE models are less vulnerable to the Lucas critique.

This part of the study employs the simplest form of New Keynesian DSGE model, which is the so-called three-equation model, as there are three associations; output gap, inflation and interest rate rule. The basic New Keynesian Model, known as the 3 equation model, reduces the system to three equations corresponding to aggregate demand (AD) and aggregate supply (AS). The AS side is illustrated by the New Keynesian Philips Curve, which explains inflation relying on expected inflation and output gap. The AD curve is represented by the expectation of output gap and inflation. A simulation analysis is applied, employing a dynamic stochastic general equilibrium model, DSGE. The model is suitable for a small open economy such as Libya. This model is estimated as a system, not equation-by-equation (Poutineau, et al. (2015). In DSGE models, concepts of endogenous and exogenous variables are understood relative to a time period. There are three kinds of variables in DSGE models:



Control variables are written as a function of other control variables, the future value of control variables, state variables and expectations. There are no shocks in control variables, and these variables can be observed or non-observed. The control variables are included on the left-hand side in the equations, with one equation for each variable. For any system of equations such as the simultaneous equations model, to obtain solution for that model, endogenous variables should be written within the system as functions of the exogenous variables. In DSGE models, the focus is on how future value expectations influence current values. All parameters should be logically interpreted as in economic theory. State variables should be specified as equations with a one-period lead of the state on the left-hand side. State variables are always unobserved. Shocks in this model describe the evolution of the state variables and are written as an autoregressive processes (Manual Stata 2015). Firstly, the potentially nonlinear structural new Keynesian model equations relating to economic theory will be described for the main sectors in the economy. If there are constraints, then the model must be formalised in dynamic stochastic optimization problems. Secondly, the nonlinear structural model should be written down to a linearized model. Model sectors will be described as follows:

Household Optimization: Household optimization is applied as the equation for the household content of current output Y_t to tomorrow's output (expected value of output)Y_{t+1} , expected level of prices P_{t+1} and nominal interest rate R_t.

$$\frac{1}{Y_t} = \mathcal{B}E_t\left[\frac{1}{Y_{t+1}}\ \frac{R_t}{P_{t+1}}\right] \ldots\ldots\ldots\ldots\ldots (1)$$

Where the parameter $\mathcal{B}$ is households' willingness to delay consumption, a discount factor.

Firm Optimization: The equation for firms relates to the current deviation of price level from its steady state $(P_t - P)$, to tomorrow's value of the deviation of price level from its steady state in the future, $E_t(P_{t+1} - P)$, and to the percentage of actual output Y_t to the steady state of output (natural level of output) z_t .

$$\phi(P_t - P) + \ \Omega - 1 = \ \Omega\left(\frac{Y_t}{z_t}\right)^{\eta-1} + \ \mathcal{B}\ \phi\ E_t\ (P_{t+1} - P) \ldots\ldots\ldots (2)$$

where the parameters $\phi, \Omega,$ and η are correlated with pricing decisions of firms. Firms are influenced by the deviation of price level from its steady state. They are not affected by inflation itself.

Central Bank Policy: The central bank modifies the interest rate in response to the price level and potentially other factors, which will be described in the state variable (u_t). The central bank equation takes this form:

$$\frac{R_t}{R} = \ \left(\frac{P_t}{P}\right)^{1/\mathcal{B}}\ e^{u_t} \ldots\ldots\ldots\ldots (3)$$

where R_t and R are the interest rate and the steady state of the interest rate respectively. The variable u_t is a state variable which describes changes in the interest rate not caused by inflation.

After writing the non-linearized model according to economic theory, the next step is to write the model in a linearized version by applying the deviations from steady state. DSGE will check for linearity and also discover non-linearity. Data must be time series (*tsset*) before employing DSGE. This procedure allows the use of time series data. The previous model is not linearized. In this model, lowercase letters will be used to denote the ratio deviation of variables from the steady state procedure. These equations are popular in the monetary economic literature, as the New Keynesian model. The linearized form of the model will be as follows:

$$y_t = E_t \, y_{t+1} - (r_t - E_t \, p_{t+1}) \ldots\ldots (4)$$

Output-gap (Consumer's Euler equation)

$$p_t = \mathcal{B} \, E_t \, p_{t+1} + \kappa(y_t - z_t) \ldots\ldots (5)$$

New Keynesian Philips Curve

$$r_t = \frac{1}{\mathcal{B}} \, p_t + u_t \ldots\ldots\ldots\ldots (6)$$

Tylor rule equation

where: κ is the slope of the New Keynesian Philips Curve. In this equation prices relay on output gap, and the parameter κ illustrates the degree of this dependency. The parameter κ is taken from the non-linearized version $\eta - 1$ from Equation (2). The model needs to have stochastic process for z_t and u_t. The variable g_t is calculated as a state variable as $g_t = E_t(z_{t+1}) - z_t$.

The model needs to have some specification in the equations in order to become ready for parameter estimation. According to Woodford (2003), y_t should be written as output gap ($x_t = y_t - z_t$) to represent the output gap. The variable z_t is the natural level of output or steady state level.

$$x_t = E_t \, x_{t+1} - (r_t - E_t \, p_{t+1} - g_t) \ldots\ldots (7)$$

$$p_t = \mathcal{B} \, E_t \, p_{t+1} + \kappa x_t \ldots\ldots\ldots (8)$$

$$r_t = \frac{1}{\mathcal{B}} \, p_t + \varphi \, u_t \ldots\ldots (9)$$

The above equations give the structural form of the model. They explain how the function of endogenous control variables x_t, p_t and r_t change as exogenous state variable functions g_t and u_t. Now, the model needs to specify processes for how the state variables change. These state variables should be modelled first as autoregressive processes. The state transition equations for u_t and g_t are predictably specified after the model is linearized, as follows:

$$u_{t+1} = \gamma_u u_t + \zeta_{t+1} \ldots\ldots\ldots (10)$$

Monetary policy shock

$$g_{t+1} = \gamma_g g_t + \xi_{t+1} \ldots\ldots\ldots (11)$$

Technology shock

The terms ζ_{t+1} and ξ_{t+1} represent shocks for state variables. Now the model is complete, and can be used to estimate the parameters. In DSGE models, commands are written to estimate the parameters in a system. All variables will appear on the left-hand side of equations once. The unobserved equation adjusts how DSGE explains all equations in the model. The number of unobserved control equations must be the same as the number of shocks. If the model is not expected to have any shocks, then the no shock option is used. Observed control variables are variables, but state variables are not variables in this dataset. In this model, there are two state variables; g_t and u_t, and the model must have the same number of shocks as observed control variables.

Thus, the model has just two observed control variables to equal the number of shocks in the model. The output gap is modelled as an unobserved equation by employing the *unobserved* option in this model, while inflation and the interest rate are observed state variables. The two variables u_t and g_t represent shocks as state variables. As discussed previously, the state variables are fixed in the current period, and for this reason, F is used in front of state variables to illustrate how they change over time. Equations 1 and 2 determine how the state variable changes depending on the function of the current state variables. In Equations, 10 and 11, shocks ζ_{t+1} and ξ_{t+1} are involved in the model as the state future equation for their current state variable. In this aspect, the state variable should be a non-deterministic variable. If the state variable is selected as a deterministic variable, there will be no shocks in the model. In this case, the model should be modified as having *no shocks* in the equation.

Data in this chapter from 1962-2017 are taken from different sources. The inflation rates are calculated as the growth rate of CPI, which is obtained from IFS and CBL. The nominal interest rate data is also taken from IFS and CBL. The output gap is calculated as the difference between real actual output and potential output divided by potential output. The HP filter is employed to smooth the real actual output to obtain the potential output. Data for real output are obtained from CBL and economic and social data in Libya.

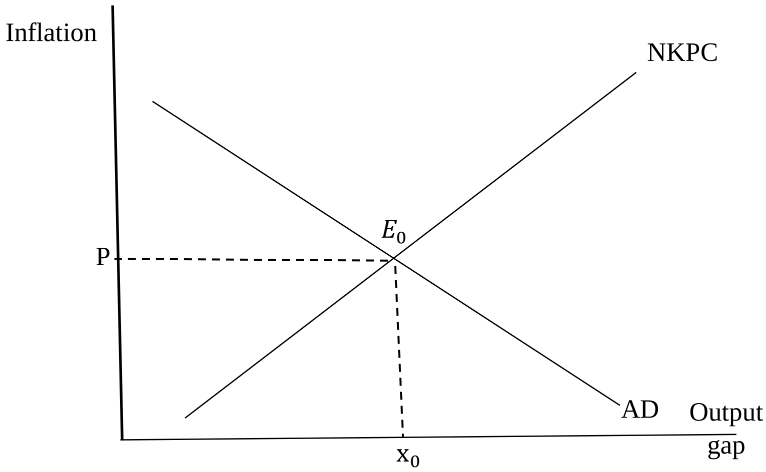
5.4 New Keynesian Philips Curve with demand and supply shocks

Aggregate demand (AD) combines the dynamic IS and the interest rate rule, causing a negative relationship between inflation and output gap for any expectations, while the new Keynesian Philips curve illustrates a positive relationship between the same variables. The equilibrium in the economy is determined by the interaction between the two curves (Gali 2018) as shown in figure 44. The interaction between demand, supply and monetary policy shocks is shown in figure 45.

Demand shocks: If we suppose A as the initial equilibrium point, then the positive demand shock will move the IS curve from IS to IS′ in Figure 46. If the central bank does not react, the temporary equilibrium will be at B, to illustrate a considerable rise in inflation. If the central bank increases the interest rate, then the monetary policy (MP) curve will move left, setting the equilibrium at C. Therefore, the positive demand shock causes an increase in output gap, inflation and interest rate (Poutineau et al. 2015).

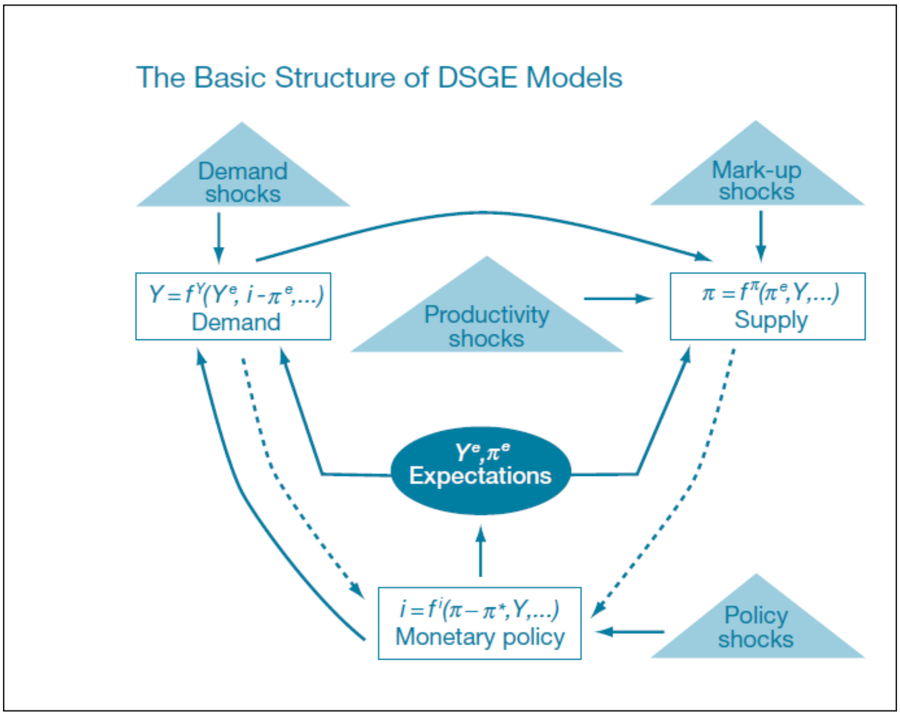
Supply shocks: If there is a supply shock as a decrease in supply, the Philips Curve will move to the left. This change will cause an increase the inflation rate and the central bank will react by increasing the interest rate for any value of the output gap. The final adjustments will set the equilibrium point at level B in Figure 47 (Poutineau et al. 2015)

Figure 42. Basics of the New Keynesian Model



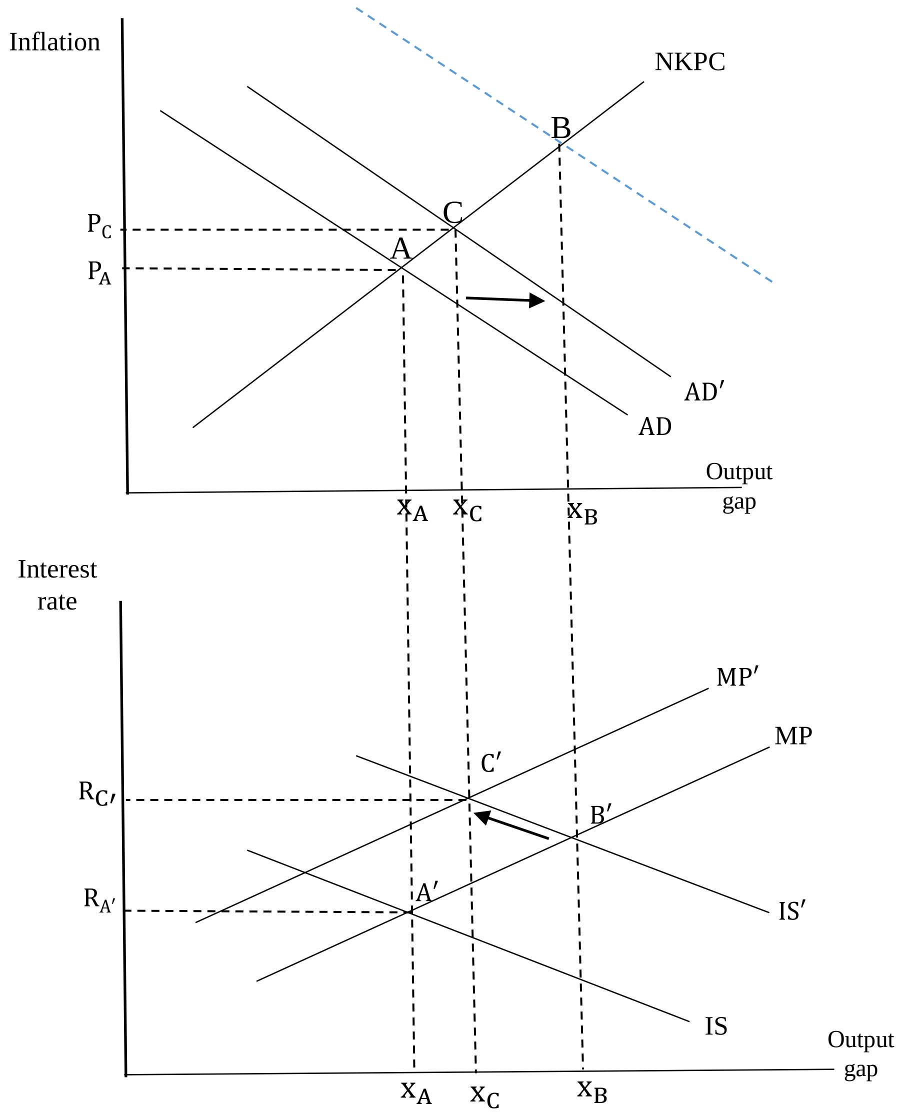
Source: (Sbordone et al. 2010)

Figure 43. Structure of DSGE model Basics of the New Keynesian Model



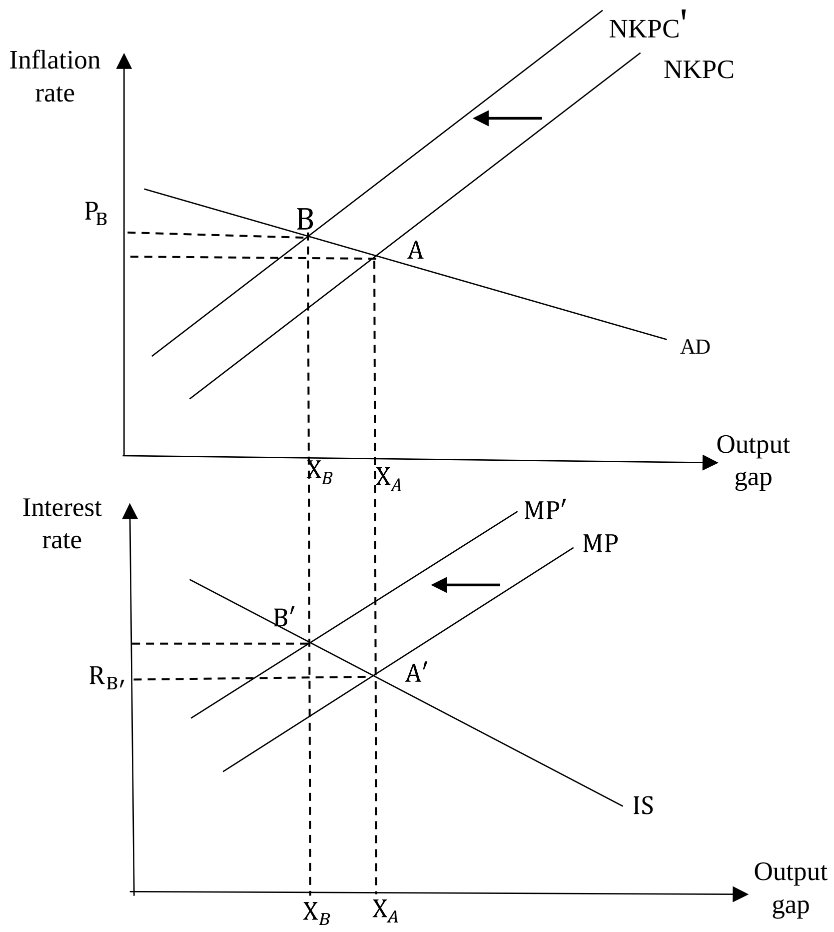
Source: (Sbordone et al. 2010)

Figure 44. New Keynesian supply shocks



Source: (Poutineau et al. (2015)

Figure 45. New Keynesian Phillips curve supply shocks



Source: Poutineau et al. (2015)

5.5 Output gap

The output gap for any economy can be calculated using the difference between the actual real output and the potential output divided by the potential output, as the following formula:

$$\text{Output gap}_t\% = \frac{\text{Atual output}_t - \text{Potantial output}_t}{\text{Potantial output}_t} * 100 \ldots\ldots\ldots\ldots (12)$$

Positive output gap: When the actual output is higher than what the output when the economy at full employment. This occurs when the aggregate demand is too high, and to meet that demand, factories and workers work with a higher capacity than their own. In this case, the actual output will greater than the potential output.

Negative output gap: When the actual output is less than what the economy can produce at full employment. This gap means that there is excess capacity in the economy due to weak demand. In this case, the actual output will greater than the potential output.

(Jahan and Mahmud 2013).

The output gap in the Libyan economy is affected by the size of the oil product, in which it is noted that positive gaps (actual output > potential output) coincides with an increase in the value of oil product. On the other hand, negative output gaps (actual output < potential output) are accompanied by a decline in the oil product. In the Libyan case, aggregate supply controls aggregate demand, not vice versa. Figures 48 and 49 show actual output, potential output and the output gap in the Libyan economy from 1992-2017.

Figure 46. Actual and potential GDP in Libya 1962-2017

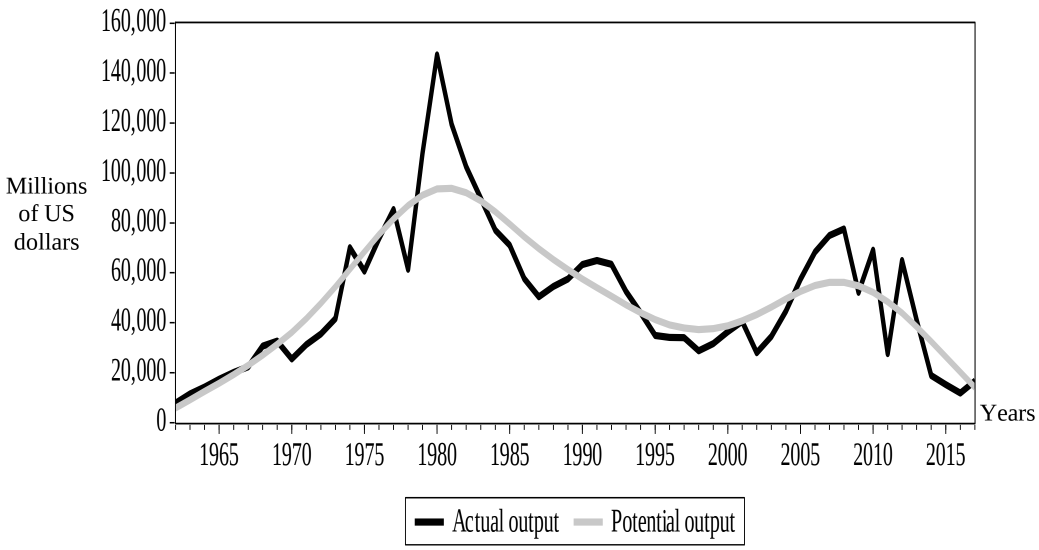
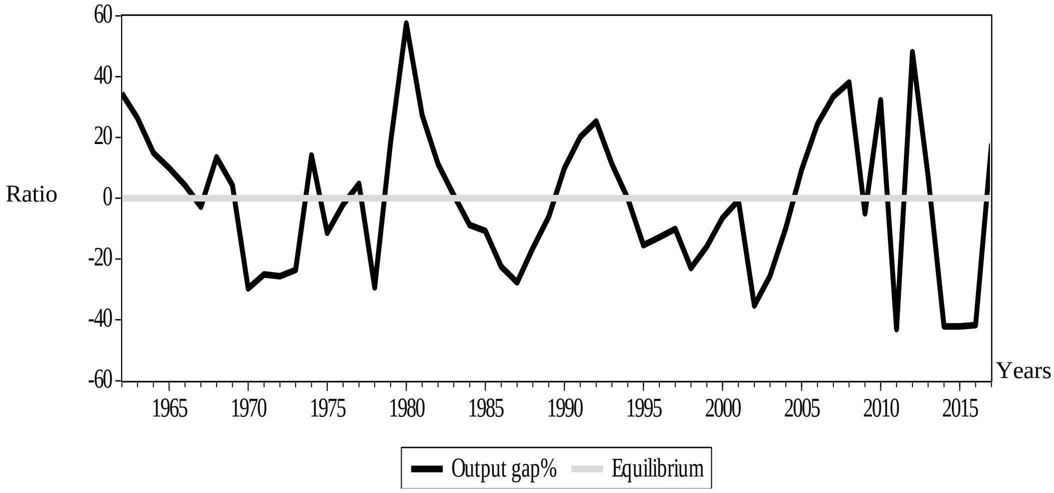


Figure 47. Output gap and equilibrium path 1962-2017



5.6 DSGE Results

This section will estimate the New Keynesian model parameters, policy matrix parameters, and state transaction matrix parameters, as well as plotting and evaluating the impulse response functions (IRFs) and forecasting values of inflation as observed control variables. The structural parameters of the DSGE model are shown in Table 56.

Table 56. Structural parameters of the DSGE model

	Coef.	Delta-method Std. Err.	z	p>z	[95% Conf.	Interval
Structural						
beta	0.7550571	0.0740723	10.19	0.000	0.609878	0.9002362
kappa	0.1799761	0.1029105	1.75	0.080	-0.0217248	0.381677
rhou	0.7176721	0.0811079	8.85	0.000	0.5587034	0.8766407
rhog	0.9553373	0.0372759	25.63	0.000	0.8822779	1.028397
Sd (e.u)	15.112	.			.	.
Sd (e.g)	0.0443965	0.0149755			0.0150451	0.073748

Log likelihood = -181.09049

Kappa is known as the slope of the New Keynesian Philips Curve. This equation explains that prices rely on an output gap. The value of this parameter is positive at 0.17, as predicted by theory, and is statically significant. This parameter explains the impacts of output gap on inflation. Beta has two roles in this model: one role is the relationship between current inflation deviations and expected future inflation deviations; while the other role is the association between interest rate deviations and inflation deviations. The value of the parameter $\mathcal{B}$ is high and positive, at 0.75, and is statistically significant. This result means that there is a high level of response of current inflation to expected future inflation. $1/\mathcal{B}$ is the inverse of $\mathcal{B}$ in the Taylor rule equation. This parameter represents the degree to which the Central Bank responds to movements in inflation, as shown in the table 57.

Table 57. Response of Central Bank to movements in inflation

	Coef.	Std. Err.	z	p > z	[95% Conf.	Interval]
_n1_1	1.324403	0.1299261	10.19	0.000	1.069753	1.579054

An optimal value for $1/\mathcal{B}$ in the literature is 1.5. In the table above, this parameter is around 1.32, which means that low response of Central Bank. Both state variables are highly persistent, with persistence parameters of 0.72 and 0.96 for u and g respectively. The estimated standard deviations of the shocks are also shown. The shock to the state variable u has a high standard deviation, at 15.112. The shock to the state variable g has a very low standard deviation, at 0.04.

5.6.1 Policy Matrix

This matrix explains the model's control variables as a function of the model's state variables. It is considered a part of the state-space form of the DSGE model to explain how the state variables influence the control variables as a policy matrix. Table 58 shows the impact of a one-unit shock to a state variable on the control variable. The first row explains the policy equation for inflation as a function of the state variables. One shock in the state variable (u) causes a decrease in inflation of approximately -0.75. One shock in (g) causes an increase in inflation of about 2.28. As for the GDP gap, a unit shock to the state variable (u) reduces the GDP gap by around -1.92, while a unit shock to the state variable (g) raises the GDP gap by 3.53. In addition, one shock to the state variables u and g increases the interest rate by about 0.0007347 and 3.02 respectively. All results are statically significant except for the response of the interest rate to a shock in (u).

Table 58. Policy matrix results

	Coef.	Delta-method Std. Err.	z	p>z	[95% Conf.	Interval
P						
u	-0.7545024	0.073965	-10.20	0.000	-0.899471	-0.6095337
g	2.281964	0.88426	2.58	0.010	0.5488457	4.015081
x						
u	-1.920533	0.8322519	-2.31	0.021	-3.551717	-0.289349
g	3.533274	1.900544	1.86	0.063	-0.1917236	7.258272
r						
u	0.0007347	0.0010792	0.68	0.496	-0.0013805	0.0028499
g	3.02224	0.961206	3.14	0.002	1.13831	4.906169

5.6.2 Transition Matrix

The state transaction equation relates to future values and explains the state vector in the next period as dependent on the state vector in the current period. Each state transaction matrix parameter is the impact of a unit shock to a state variable on one period in the future. In this matrix, some parameters are zero because of a lack of numerical precision. A unit shock to the state variable (u) increases the expected future value of u by approximately 0.71, while a unit shock to the state variable (g) raises the expected future value of g by about 0.95. Just these two parameters are statically significant, as shown in Table 59.

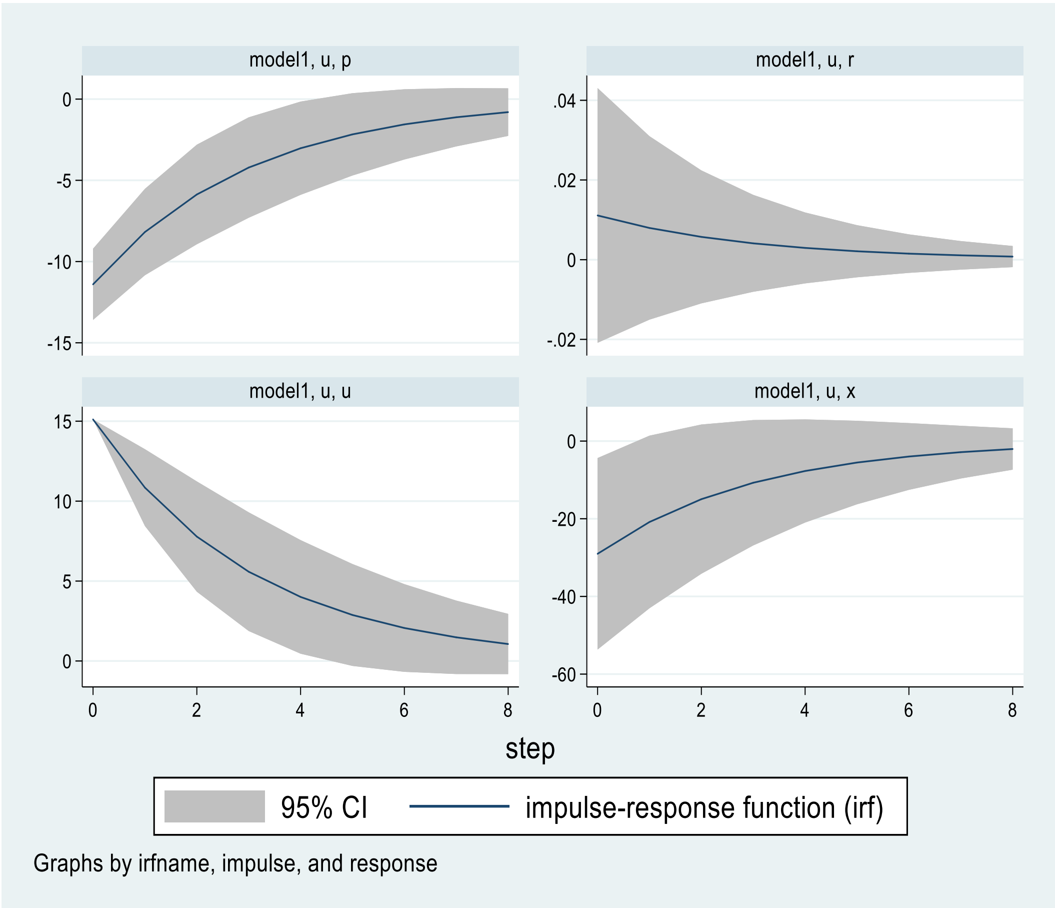
Table 59. Transition matrix of state variables

		Coef.	Delta-method Std. Err.	z	p>z	[95% Conf.	Interval
F.u							
	u	0.7176721	0.0811079	8.85	0.000	0.5587034	0.8766407
	g	-4.44e-16	2.55e-11	-0.00	1.000	-4.99e-11	4.99e-11
F.g							
	u	0	(omitted)				
	g	0.9553373	0.0372759	25.63	0.000	0.8822779	1.028397

5.6.3 Impulse Response Analysis

This technique assists in tracing the path of state or control variables in response to a shock to a state variable, in order to compare between two parameter sets. This section will graph the impulse response for variables in the model to a shock in each state variable. A shock to u causes no significant change in r while temporally increasing u itself. This shock also leads to temporary reduction in the inflation and output gap as shown in figure 50.

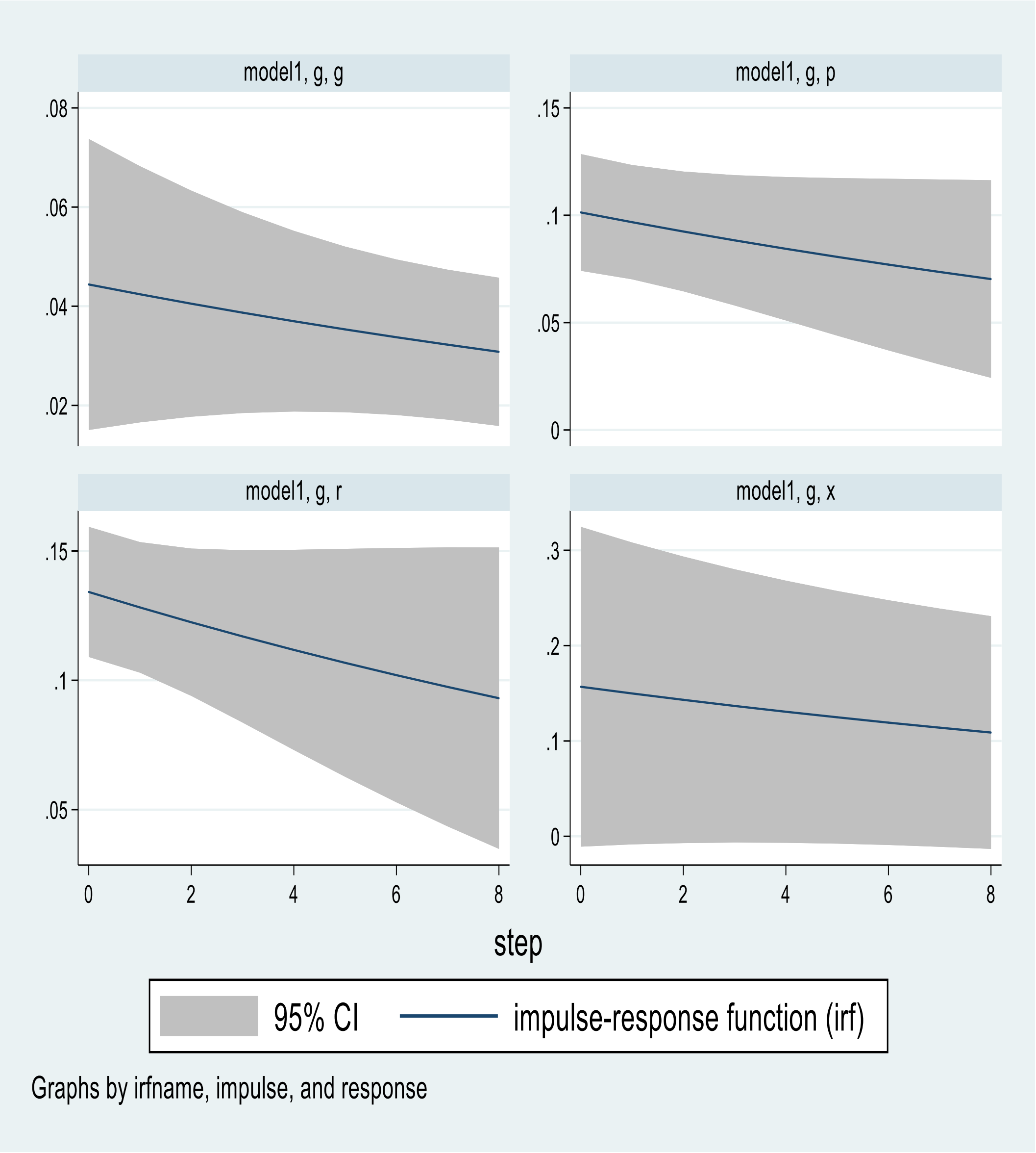
Figure 48. DSGE Impulse responses to u



Source: STATA 15 outcomes

A shock to g causes a rise in all control variables in the model; r, p, x and u itself as shown in figure 51.

Figure 49. DSGE Impulse responses to g



Source. STATA 15 outcomes

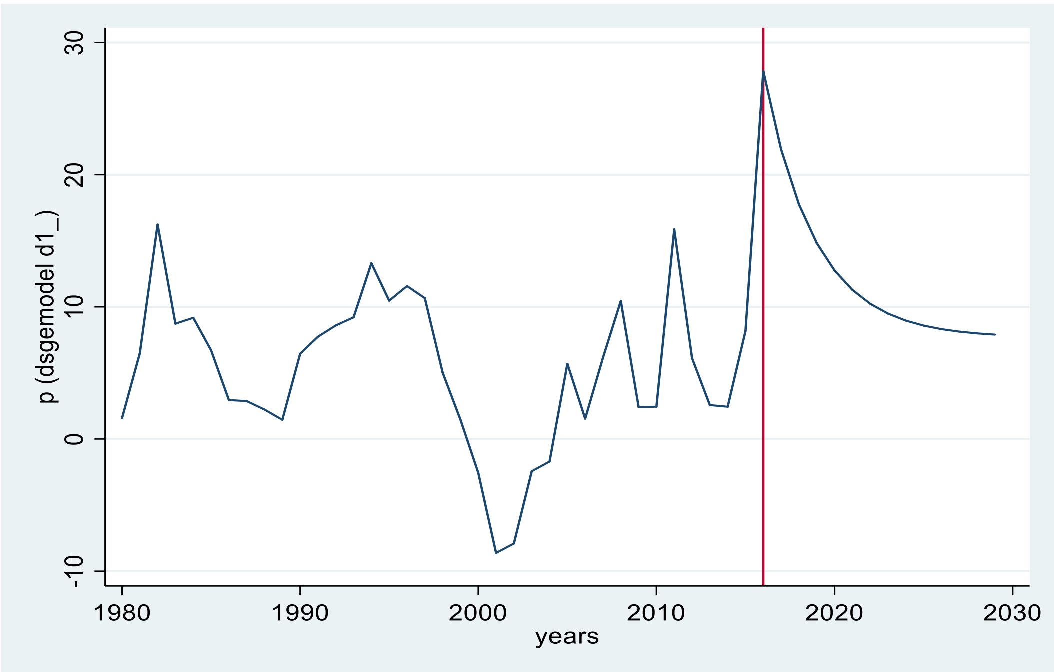
5.6.4 Forecasting

This section predicts values the inflation rate as a control variable. The model forecasts t P will decline smoothly because of the recovery of oil product. Table 60 shows the future inflation expectations, and Figure 52 illustrates the expected inflation graph.

Table 60. Inflation rate forecasting

```
. forecast solve, prefix(p) begin(2017)

Computing dynamic forecasts for model dsgemodel.
------------------------------------------------

Starting period:  2017
Ending period:    2029
Forecast prefix:  p

2017:  ...............
2018:  ...............
2019:  ...............
2020:  ..............
2021:  ..............
2022:  ..............
2023:  ..............
2024:  ..............
2025:  ..............
2026:  .............
2027:  .............
2028:  .............
2029:  .............

Forecast 2 variables spanning 13 periods.
```

Figure 50. Inflation rate forecasting.



Source. STATA 15 outcomes

5.6.5 DSGE - saddle-path stability

The command, `estat stable`, shows saddle-path stability to find initial values for which the model is saddle-path stable. This test is necessary for estimation and interpretation of the parameters of DSGE models. Saddle–path stability is required for solving the state-space in DSGE models. The model parameters can only be estimated if the state-space form can be solved. Saddle-path stability depends on structural parameter values. The generalized eigenvalues of a matrix designed from structural parameter values are given below. The eigenvalues are stable when their absolute value is less than one. In addition, the model is saddle-path stable when the number of stable eigenvalues equals the number of state variables in the model. The results in Table 61 confirms that the model is saddle-path stable.

Table 61. DSGE stability results

	Eigenvalues
stable	0.7177
stable	0.9553
unstable	1.238
unstable	1.324
unstable	7.492e+16

The process is saddle-path stable

Source. STATA 15 outcomes

5.7 Conclusion

This chapter has revealed that inflation rates in the future depends strongly on current inflation and the CBL has a low response to inflation changes. Also, the inflation rate is influenced by output gap which depends closely on oil products. Output gaps in Libya are very high because of the shocks in aggregate supply represented by oil product shocks in the economy. The output gap after 2017 changed to a new situation, in which a positive gap was seen (in which actual output was greater than the potential output) after recovery in the oil sector, which in turn may help to reduce inflation rates. Libya depends strongly on oil for export, and thus, aggregate supply shocks affect the demand side and then affect inflation rates. Positive output gaps are associated with an increase in oil product, while negative output gaps are linked with oil product decrease. A decline in oil product will cause an aggregate supply decrease, and then aggregate demand will decrease as well, but not by the same percentage, leading to inflation increases. In the same way, a rise in oil product will lead to an aggregate supply increase and then the aggregate demand will increase, but not by the same ratio, causing an inflation decrease. In the Libyan economy, oil product shocks are the major source of macroeconomic volatility and output gap is strongly influenced by aggregate supply. The appropriate monetary policy may assist in stabilizing unwanted fluctuation in the economy.

The DSGE estimations have also tried to predict the inflation rate for the future because the RER misalignments in the Libyan economy strongly depend on inflation rates; particularly in recent years. As mentioned previously, an inflation decrease with fixed nominal exchange rate and global price stability will lead to RER depreciation and reduce overvaluation gaps. The RER misalignment curve is then expected to fall after the recovery in oil sector and the decline in local price levels. A decrease in overvaluation states will help the country to improve its external international competitiveness. If RER depreciation exceeds the equilibrium path, then the state may change to an undervaluation episode. The country needs such improvements to increase non-oil products and non-oil exports, and reduce the premium between the official and black market exchange rate.

Chapter 6. Conclusion and Policy Implications

This study has attempted to estimate RER misalignments for Libya in order to understand the magnitude of these misalignments, their effects on the most important macroeconomic variables, and future expectations for inflation and misalignments. Since Libya is an oil exporting country and relies on oil very much in obtaining its foreign exchange resources, the oil sector plays a significant role in rectifying RER misalignments. Oil exporting countries are especially vulnerable to oil shocks because these countries are highly dependent on oil exports to finance their public budgets. The findings clearly demonstrate that there are great and severe misalignments, as over and undervaluation episodes of local currency last for a long time. The large and continuous RER misalignments over a long period preclude the opportunity to provide an appropriate economic climate in order to encourage foreign investment and non-oil exports. Making the RER in Libya close to the equilibrium path builds confidence for all citizens and foreigners in all trade transactions.

This study finds evidence for the existence of very large misalignments of RER, as over and undervaluation of the Libyan currency which is maintained for a long time in the same state. ROP and OPEN are associated with RER depreciation, while RRP is linked with RER appreciation. Increases in ROP affect production resources to increase the supply of non-tradable goods. Prices of non-tradable goods will decrease with no considerable change in nominal exchange rate, leading RER to depreciate. This is known as the indirect (substitution) effects of income on RER. As for OPEN, an increase in this indicator may lead to local prices decreasing for tradable and non-tradable goods. More local price decreases may cause RER depreciation. A positive shock in RRP also raises wages in tradable and non-tradable goods, causing local prices to go up. Increases in price levels may appreciate RER, particularly with a fixed exchange rate regime. This result confirms the existence of Balassa Samuelson effects in the Libyan economy. The dynamic likelihood of misalignments of the RER and the probability of switching between over- and undervaluation states are too high and very slow, taking a long time to switch from one regime to another. Also, the switching periods of RER appreciation and depreciation states show that the RER appreciation regime remains for longer than the RER depreciation regime.

As discussed earlier, high dependence on oil with a fixed exchange rate system may lead to high levels of RER appreciation in times of oil crisis. Since RER appreciation, more than the equilibrium path, will lead to overvaluation episodes of national currency, then the high level of overvaluation states in recent years can be attributed to the high level of inflation with no considerable change in nominal exchange rate. This has led to very high levels of black market premium on the exchange rate as a result. Black market exchange rate plays a role as an adjustment instrument when inflation is not compatible with the official exchange rate, in order to adjust transactions from inside the country to abroad and vice versa. Import and export to and from Libya are not profitable in situations of high inflation unless the foreign currency obtained from exports is converted at black market rates.

This study also focused on the association between RER misalignments and specific economic indicators. The main outcome of this part of the study is that increase in overvaluation states negatively links with RNGDP and NOX, while associating positively with BME and INF rates. It is also noticed that overvaluation episodes are accompanied by unstable economic situations: particularly in recent years. The reduction in oil production with a fixed exchange rate regime will increase the black market premium and price levels, and then promote RER appreciation and overvaluation states. The association between oil product and states of RER overvaluation will occur in the Libyan economy frequently as long as it is strongly dependent on the oil sector. On the other hand, increases in undervaluation states has brought positive aspects to the economy compared with overvaluation episodes, such as rises in RNGDP and NOX, as well as decrease in BME and INF. When the country receives abundant foreign exchange earnings from the oil sector, it can provide foreign exchange for all who request it without foreign exchange controls. Therefore, there will be no black market for exchange rate with a low inflation rate causing RER depreciation and undervaluation states for national currency.

Increase in overvaluation states also causes a decline in RC, RT, Ri, RM and RY, since RER overvaluation is associated with a drop in oil output. This association leads to a rise in INF and BME, and then to decreases in RC, RT, RM and RY. As for Ri, this indicator is negatively associated with INF because the nominal interest rate is almost fixed, and then will be negatively linked with RER appreciation. Conversely, a recovery in the oil sector will help INF to decrease because of the possibility for the CBL to sell any quantity of foreign exchange currencies at the official rate, with no black market premium. Low INF with no black market premium will help undervaluation states to occur, and an increase in undervaluation episodes may cause an increase in RC, RT, RM, Ri and RY.

Overvaluation episodes for national currency influence economic growth negatively, and their effect is strongly significant. In spite of the fact that undervaluation might enhance economic growth in the short run, in the long run however, the RER undervaluation may adversely influence economic growth. The effect of misalignment of RER on economic growth, then, heavily relies on the country; whether developed or developing. It is worth highlighting that each economy, whether it is a developing or developed economy, should maintain the actual RER close to the equilibrium path, as any misalignment is liable to cause serious consequences. Policy makers might not play a significant role in influencing inflation that comes from a shortage of foreign exchange resources: particularly during high levels of overvaluation. On the contrary, policy makers may have more ability to influence undervaluation states, because they can devaluate the local currency compared to overvaluation states.

When policy makers do not change the nominal exchange rate with foreign exchange controls, this leads to high levels of black market premiums, followed by a high level of inflation rate and then real appreciation, and then overvaluation episodes. In a country such as Libya, when the economy faces a considerable reduction in foreign exchange resources obtained from oil, policy makers will apply a foreign exchange controls policy which leads to high inflation rates and then real appreciation, causing overvaluation states. This situation has happened in recent years, and during the eighties and nineties of the last century. In some other rich oil exporting countries, the overvaluation state may occur because of the revaluation of national currency value, and not from high levels of inflation. As for undervaluation state in the Libyan economy, particularly during 2002-2011, this came from a considerable nominal exchange rate devaluation with low levels of inflation rates. The general belief is that devaluation of national currency should be followed by an increase in inflation levels, but in the Libyan case, the elimination of severe trade restrictions on import and foreign exchange controls led to a significant decrease in local inflation. However, a decrease in local prices will lead to real depreciation, and when this level exceeds the equilibrium path will lead to undervaluation episodes.

Libya as an oil dependent economy has tried for many years to improve its external trade sector to increase the volume of non-oil exports and non-oil products, reducing the volume of imports and substituting some of these for local products. The main target of this is to maintain foreign exchange resources for investment projects, as well as to create a new source for foreign exchange resources other than oil. The oil sector in Libya dominates the whole economy, and therefore, with any crisis in this sector, the economy suffers from sharp structural imbalances which are difficult to overcome. The country accumulated a huge quantity of national reserves without any clear plan to spend them on development projects: particularly in 2000-2001. Improving the exchange rate policy in Libya will not only improve the non-oil exports sector, but will also lead to the substitution of large imports that the country imports. The first stage in maintaining foreign exchange and ensuring that there is no deficit in balance of payments is to substitute imports. Libya as a small economy may not have a developed non-oil export sector for more non-oil exports. Policy makers must work on developing the non-oil sector by improving the exchange policy and not accepting misalignments that leave this sector damaged. Non-oil producs would improve the economic situation, making oil crises less severely felt than they are now. This cannot be achieved in the presence of an official exchange rate that may not be at all compatible with inflation fluctuations.

This study also employed a New Keynesian Model, in which a three-equation model with three associations; output gap, inflation and interest rate rule was used, applying the DSGE model. The parameter for slope for the New Keynesian Philips Curve is positive. This result confirms that local price levels rely positively on the output gap in the Libyan economy. In a country such as Libya, the GDP gap heavily depends on oil products and the aggregate supply determines the aggregate demand not the opposite. The findings also show significant positive association between current inflation deviations to expected future inflation deviations. The parameter for the degree to which the central bank responds to movements in inflation is found to be at a low response. The DSGE expectation for inflation rates is predicted to go down after the recovery in oil production, which started at the end of 2017. This in turn will reduce RER depreciation and then will shrink the overvaluation episodes.

Policy makers in the CBL should focus on calculating RER misalignments for the Libyan economy and report data for this indicator periodically. The CBL should have a significant role in resolving these issues, to narrow the gap between actual RER and the equilibrium path, via affecting RER fundamentals. This study has found evidence that an undervaluation policy is more suitable for the Libyan economy than overvaluation states. Potentially, making the Libyan currency undervalued and not too far from the equilibrium path, to support the non-oil sectors, could be considered an appropriate policy for Libya, and could prevent the emergence of a black market in foreign currencies. It is also an optimal exploitation of the huge oil revenues coming from oil, as the best way to improve the economy's structure.

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Appendixes

Appendix A. Theoretical Framework for RER fundamentals in oil exporting country:

The demand and supply side will be described for the oil exporter's economy and foreign countries. This model is built on a small, open economy which produces two kinds of goods; non-tradable good and exportable. Exportable goods are linked to the production of a primary commodity good, which includes for example petroleum production (crude oil). The both goods are produced locally and factors are mobile. The model assumes that labour can freely move from sector to sector, and then wages must be at the same level across sectors, as well as having perfect competition in the non-tradable sector. The model is adopted by Cashin (2004) as a simple static framework to concentrate on the long run factors that affect real exchange rate volatility (Habib and Kalamova 2007).

1: Local Production (Domestic Firms)

This part represents the supply side in the local economy. The domestic economy has two sectors; an exportable sector or primary commodity sector as an exporting tradable goods sector, and a non-tradable sector, which consists of a number of firms producing non-traded goods. Put simply, it would be assumed that the labour factor is required to produce two different sorts of goods. The profit maximisation problems function is identical, as:

$$MAX_{L_i}\,\Pi_s = P_s\,Y_s - W_s L_s \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Subject to $$Y_s = \alpha_s\,L_s \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where (P) represents prices, (Y) is production, (W) is wages, (L) is labour, (α) is labour productivity, and (s) denotes the total production of non-tradable and exportable production (n + x). Importantly, due to the fact that labour can freely move, wages (W) are equalised across sectors, (wL) is labour costs, and (α L) technology.

Exportable sector (primary commodity sector).

$$Y_x = \alpha_x\,.\,L_x \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Non-tradable sector.

$$Y_n = \alpha_n\,.\,L_n \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Where, *x:* stands for exportable goods, *n:* is non-tradable goods, *L:* is the quantity of labour needed for producing exportable and non-tradable goods, and *a:* represents the labour productivity of each sector. Profit optimization in both sectors provides equations of prices that depend on wages and productivity as two conditions:

$$P_x = W/\alpha_x \quad \ldots\ldots\ldots\ldots\ldots (5)$$

$$P_n = W/\alpha_n \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

In the equilibrium state, the marginal productivity of labour will be equal to real wages in each sector, taking into account that the prices of the primary commodity are exogenous and there is perfect competition in the non-tradable sector. Then, prices for the non- oil tradable sector can be written as follows:

$$P_n = (\alpha_x / \alpha_n) .P_x \ldots\ldots\ldots\ldots\ldots (7)$$

Therefore, the prices of the non-tradable goods p_n to the prices of primary commodity p_x is entirely specified by technology and required conditions.

$$(P_n / P_x) = (\alpha_x / \alpha_n) \ldots\ldots\ldots\ldots\ldots (8)$$

Thus, the productivity differential between the two sectors is the main determinant of the relative price of non-tradable goods to exported goods p_n/p_x . A rise in the oil price will then increase wages in the oil sector, causing an increase in the level of wages and prices of the non-tradable sector.

2: Local Consumers (Domestic Household)

The economy has a continuum of homogenous individuals who supply labour inelastically $(L = L_x + L_n)$ to consume tradable and non-tradable goods that are produced domestically. The tradable (imported) goods are not locally produced and are imported from outside the country, and primary goods are not consumed locally. In order to maximize utility, consumers select the consumption of tradable and non-tradable goods to increase the level of utility. Cobb-Douglas, as the following function, expresses household preferences and solves the utility problem under the wealth constraint:

$$MAX_{c_n, c_t}\ u = (C_n)^{y} (C_t)^{1-y} \ldots (9)$$

Subject to $$P_n C_n + P_t C_t = WLH \ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Where C_n is the consumption of the non-tradable goods, and C_t is the consumption of imported goods from abroad. Composite consumption $C = \tau . C_n^{y} . C_t^{1-y}$ is the aggregate consumption of imported (tradable) and domestic (non-tradable) goods with $\tau = 1/[y^{y}(1-y)^{(1-y)}]$ being a constant. The household is supposed to cover the cost of aggregate expenditure by using total wealth (WLH). The consumer price index of the oil exporting economy, which is found by solving the optimization problem, is a geometric average with weights ɣ and ɣ-1 for prices of tradable and non-tradable goods respectively. The minimum cost of a unit of consumption is provided by:

$$P = (P_n)^{\gamma} . (P_t)^{1-\gamma} \ldots\ldots (11)$$

Where P is the consumer price index, and P_t is the price of a unit of the tradable goods imported from the foreign region in domestic currency. The low unit price is expected to hold for the imported (tradable) goods:

$$P_t = P_t^{*}/e \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

Where P_t^{*} is imported goods prices (tradable) denominated in foreign currency, and e is the nominal exchange rate, defined as units of foreign currency per a unit of domestic currency.

3: Foreign Production (Firms) and Consumption (Household)

The previous analysis assumes that the primary commodity is totally exported; local agents do not consume it. Additionally, the local economy imports goods that are produced abroad. Foreign countries are involved in three different sectors: a final sector, an intermediate sector, and a non-tradable sector. Foreigners use labour as the only factor to produce and consume non-tradable goods, as this function:

$$Y_n^{*} = a_n^{*} . L_n^{*} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

In order to produce the final good, the foreign economy uses an intermediate good. In producing the intermediate good, labour is used as the only factor. In this sector, the production function for all firms will be represented by:

$$Y_i^{*} = \alpha_i^{*} . L_i^{*} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

Profit maximization problems in the non- tradable and intermediate sectors are similar to the optimization problem of firms in the oil exporting country.

$$MAX_{l_j}\ \Pi_j^{*} = P_j^{*} Y_j^{*} - W^{*} L_j^{*} \ldots\ldots\ldots\ldots (15)$$

Subject to $$Y_j^{*} = \alpha_j^{*} L_j^{*} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (16)$$

Where (j) denotes the total production of non-tradable and intermediate goods (n + i). The prices depend on wages and productivity as two conditions:

$$P_n^{*} = W^{*}/\alpha_n^{*} \ldots\ldots\ldots\ldots\ldots\ldots (17)$$

$$P_i^{*} = W^{*}/\alpha_i^{*} \ldots\ldots\ldots\ldots\ldots\ldots (18)$$

Identical to the oil-producing country, because wages are equal across sectors, the prices of non-tradable goods in terms of the prices of intermediate goods can be shown as:

$$P_n^* = (\alpha_i^* / \alpha_n^*)\ P_i^* \ldots\ldots\ldots\ldots\ldots (19)$$

The production process for final goods includes two intermediate inputs. The first is the primary commodity (crude oil), which is produced by a group of countries, one of them the local economy. The second factor is intermediate goods, which are produced across the rest of the globe. Final production is also named as tradable goods, which are produced by collecting the oil good (Y_x^*) and foreign intermediate input (Y_i^*). The maximization problem in this sector will be as in the following function:

$$MAX_{y_x^*, y_i^*}\ \Pi_t^* = P_t^*\ Y_t^* - (P_x^*\ Y_x^* + P_i^* Y_i^*) \ldots.. (20)$$

$$\text{Subject to} \quad Y_t^* = \omega(\ Y_i^*)^{\theta}\ .\ (Y_x^*)^{1-\theta} \ldots. (21)$$

Where: $\omega = 1/\theta^{\theta}(1\text{-}\theta)^{1\text{-}\theta}$ is a constant. The solution to the problem gives the cost of one unit of the traded good, denominated by foreign currency, as the geometric average of oil good and intermediate good prices:

$$P_t^* = (P_i^*)^{\theta}\ .\ (P_x^*)^{1-\theta} \ldots\ldots\ldots (22)$$

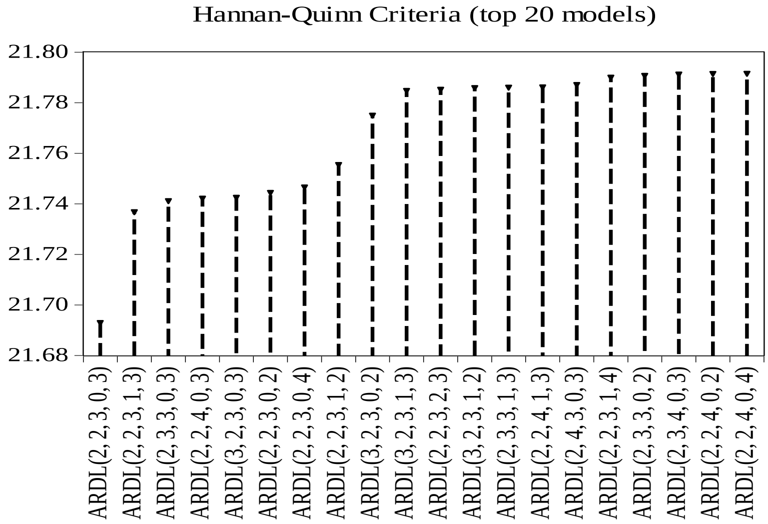
The supply of labour is assumed to be inelastic to the different sectors. Consumers in the foreign economy are expected to consume the non-tradable and final good. Thus, the consumer price index (P^*) for the foreign country is represented in the equation as follows:

$$P^* = (P_n^*)^{\gamma}\ .\ (P_t^*)^{1-\gamma} \ldots.. (23)$$

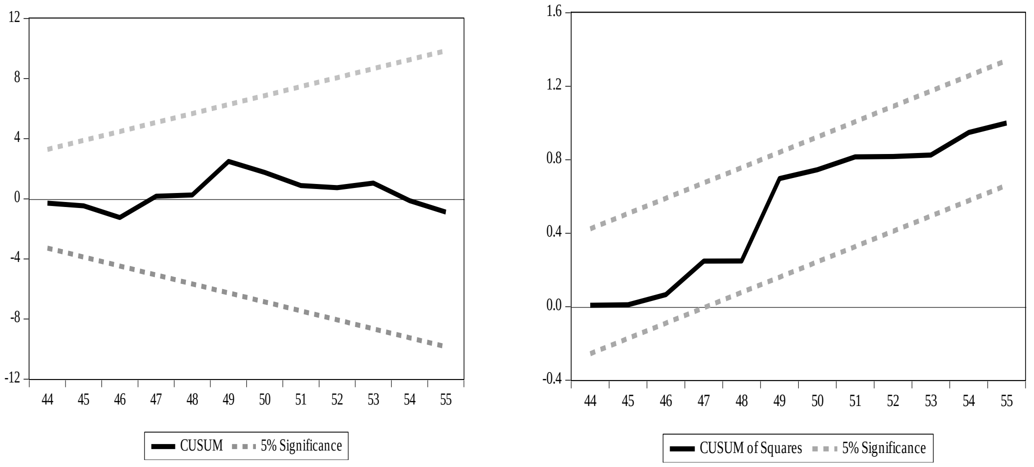
The last scenario relating the oil exporting country to foreign economies concerns the high importance of determining how the real exchange rate is identified for the oil producing country. The real exchange rate in the local economy is specified by functions (11) and (23), where, e is the nominal exchange rate as units of foreign currency per unit of domestic currency.

$$(e\ .\ P/P^*) = f(\alpha_x / \alpha_i^*.\ \alpha_n^* / \alpha_n\ .\ P_x^* / P_i^*) \ldots\ldots (24)$$

Appendix B. ARDL - MIS, RNGDP and control variables

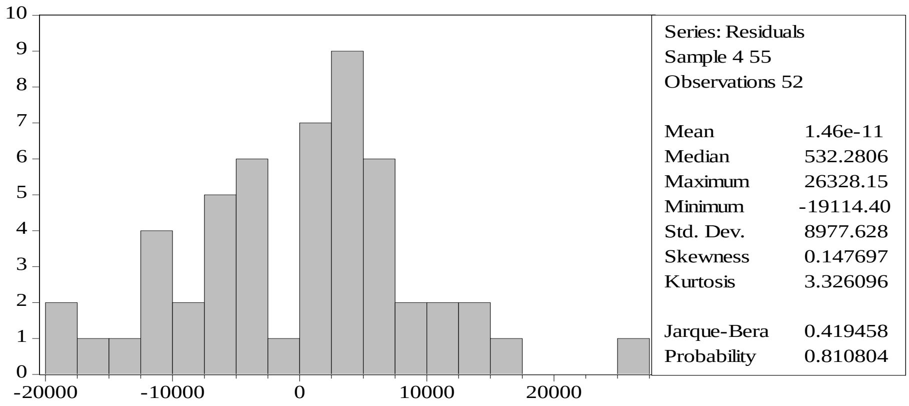


Plot of Cumulative Sum of Recursive Residual & Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level.

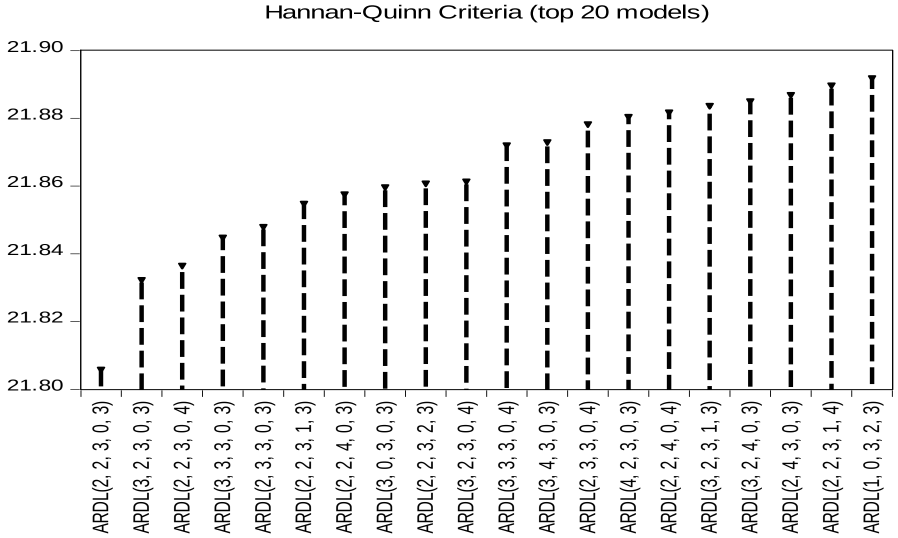
Normality test:



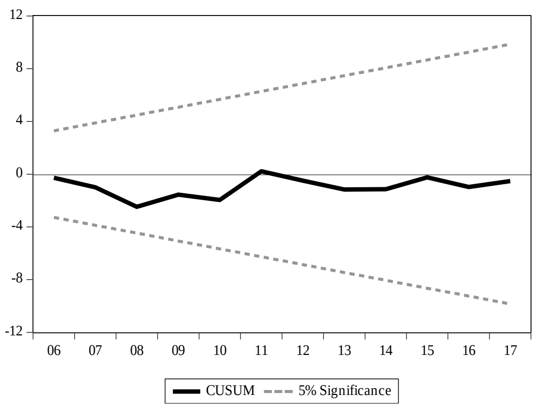
ARDL-Error Correction Regression for RNGDP, MIS and controls

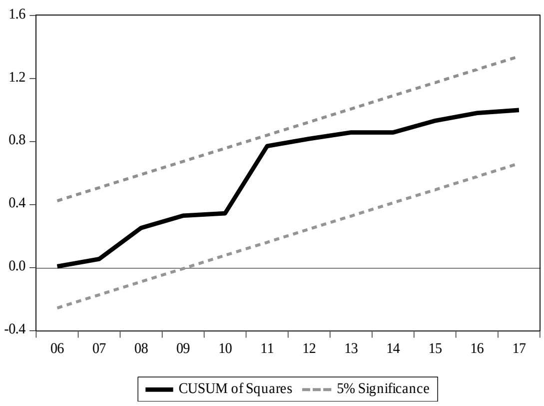
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RNGDP(-1))	0.311519	0.084545	3.684668	0.0007
D(MIS)	-822.8299	160.8926	-5.114156	0.0000
D(MIS(-1))	515.6356	186.3196	2.767479	0.0088
D(OPEN)	303.1252	98.61703	3.073761	0.0040
D(OPEN(-1))	-527.9287	124.3072	-4.246970	0.0001
D(OPEN(-2))	-428.5600	124.8309	-3.433125	0.0015
D(D02)	-55396.41	12817.45	-4.321952	0.0001
D(D02(-1))	64318.27	14259.54	4.510542	0.0001
D(D02(-2))	27786.55	11429.18	2.431194	0.0200
CointEq(-1)*	-0.727336	0.095176	-7.642033	0.0000
R-squared	0.810377	Mean dependent var		-1593.805
Adjusted R-squared	0.769743	S.D. dependent var		20616.53
S.E. of regression	9892.864	Akaike info criterion		21.40806
Sum squared resid	4.11E+09	Schwarz criterion		21.78330
Log likelihood	-546.6095	Hannan-Quinn criter.		21.55191
Durbin-Watson stat	1.676555			

Appendix C. ARDL - RNGDP, OMIS and control variables



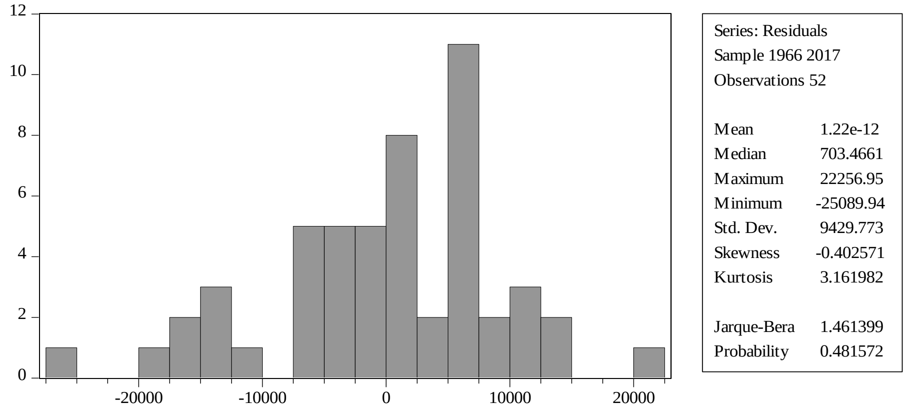
Plot of Cumulative Sum of Recursive Residual & Cumulative Sum of Squares of Recursive Residuals





The straight lines represent critical bounds at 5% significance level

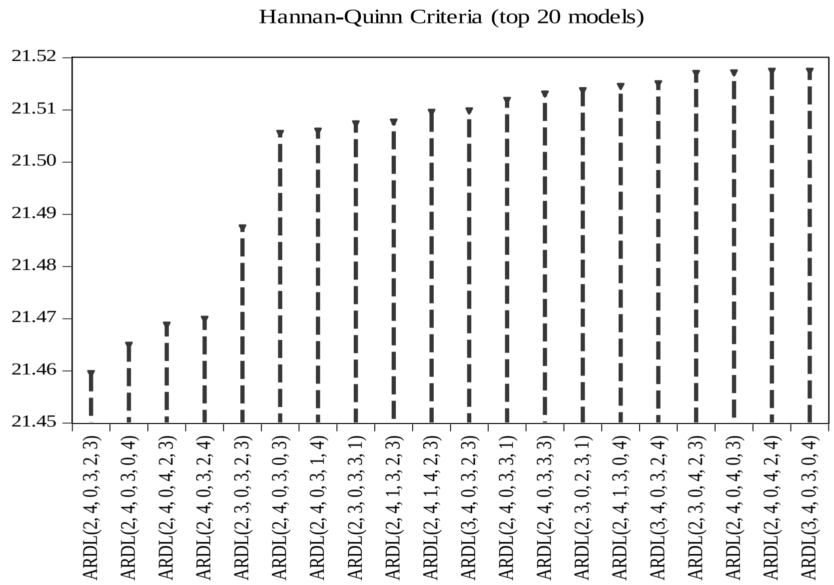
Normality test:



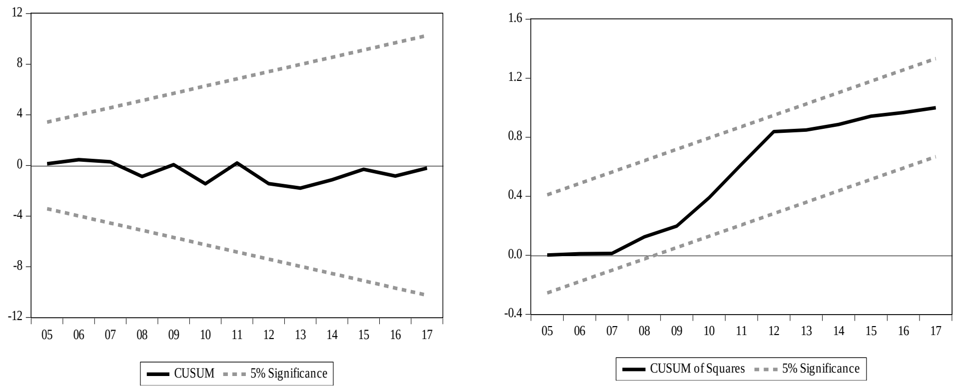
ARDL - Error Correction Regression for RNGDP, OMIS and controls

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RNGDP(-1))	0.300461	0.078556	3.824828	0.0005
D(OPEN)	358.7963	97.93617	3.663573	0.0008
D(OPEN(-1))	-658.9870	125.2906	-5.259668	0.0000
D(OPEN(-2))	-547.4359	128.9235	-4.246207	0.0001
D(OMIS)	-770.7579	197.3243	-3.906046	0.0004
D(OMIS(-1))	633.5738	213.9011	2.961994	0.0053
D(D02)	-22699.75	11703.34	-1.939596	0.0601
D(D02(-1))	59277.70	12648.11	4.686685	0.0000
D(D02(-2))	46597.86	12515.48	3.723218	0.0007
CointEq(-1)	-0.898769	0.095126	-9.448159	0.0000
R-squared	0.790795	Mean dependent var		-1593.805
Adjusted R-squared	0.745966	S.D. dependent var		20616.53
S.E. of regression	10391.10	Akaike info criterion		21.50633
Sum squared resid	4.53E+09	Schwarz criterion		21.88157
Log likelihood	-549.1646	Hannan-Quinn criter.		21.65019
Durbin-Watson stat	2.096476			

Appendix D. ARDL- RNGDP, MIS, OMIS and control variables

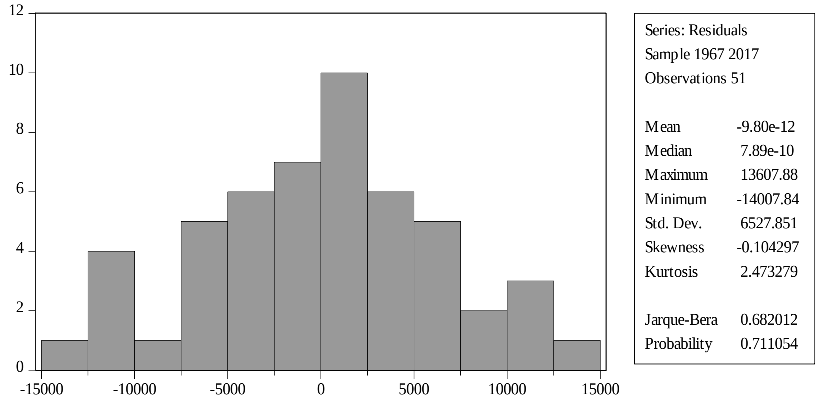


Plot of Cumulative Sum of Recursive Residual & Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

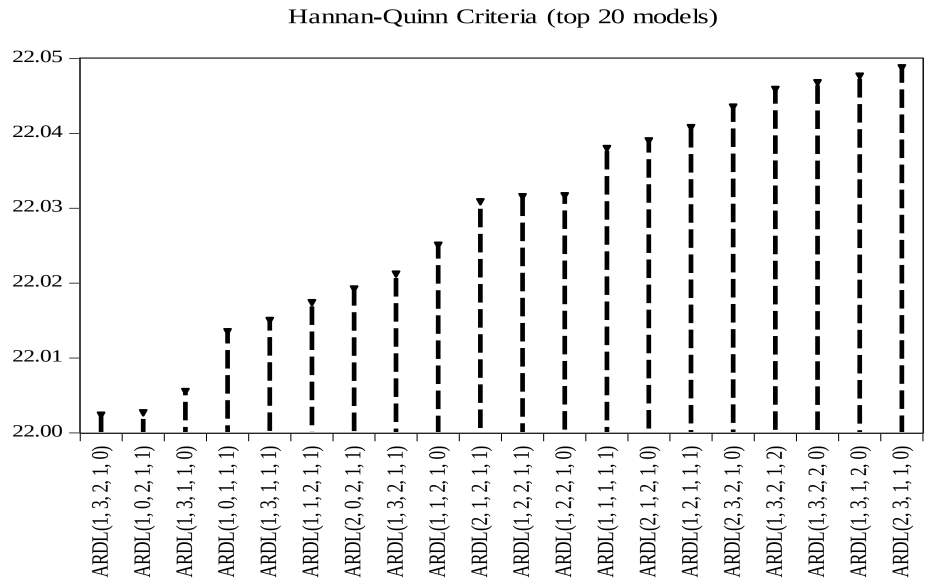
Normality test:



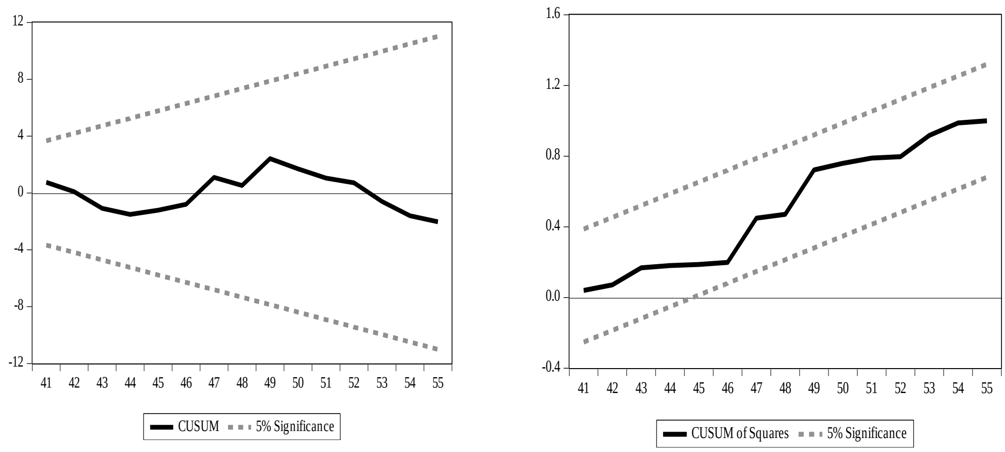
ARDL-Error correction regression for RNGDP, MIS and OMIS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RNGDP(-1))	0.456423	0.079501	5.741085	0.0000
D(OPEN)	219.0346	81.57479	2.685077	0.0115
D(OPEN(-1))	-492.1347	104.9150	-4.690795	0.0001
D(OPEN(-2))	-442.0673	100.5041	-4.398502	0.0001
D(OPEN(-3))	281.6146	108.8355	2.587526	0.0146
D(MIS)	-1522.043	251.2174	-6.058667	0.0000
D(MIS(-1))	197.7624	329.9148	0.599435	0.5532
D(MIS(-2))	-690.7763	170.9489	-4.040834	0.0003
D(OMIS)	445.4193	298.0102	1.494644	0.1451
D(OMIS(-1))	1300.185	387.9714	3.351240	0.0021
D(OMIS(-2))	1088.943	247.0446	4.407881	0.0001
D(D02)	-85727.06	14857.83	-5.769825	0.0000
D(D02(-1))	50689.34	17598.53	2.880316	0.0071
CointEq(-1)*	-0.812434	0.082294	-9.872366	0.0000
R-squared	0.901652	Mean dependent var		-1663.389
Adjusted R-squared	0.867097	S.D. dependent var		20815.51
S.E. of regression	7588.472	Akaike info criterion		20.93476
Sum squared resid	2.13E+09	Schwarz criterion		21.46507
Log likelihood	-519.8364	Hannan-Quinn criter.		21.13741
Durbin-Watson stat	2.205599			

Appendix E. ARDL- RNGDP, UMIS and control variables

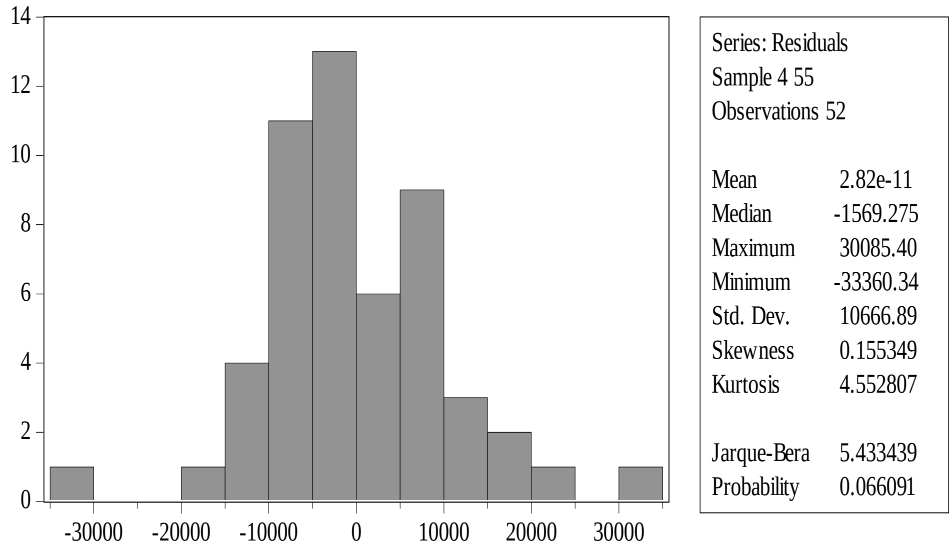


Plot of Cumulative Sum of Recursive Residual & Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

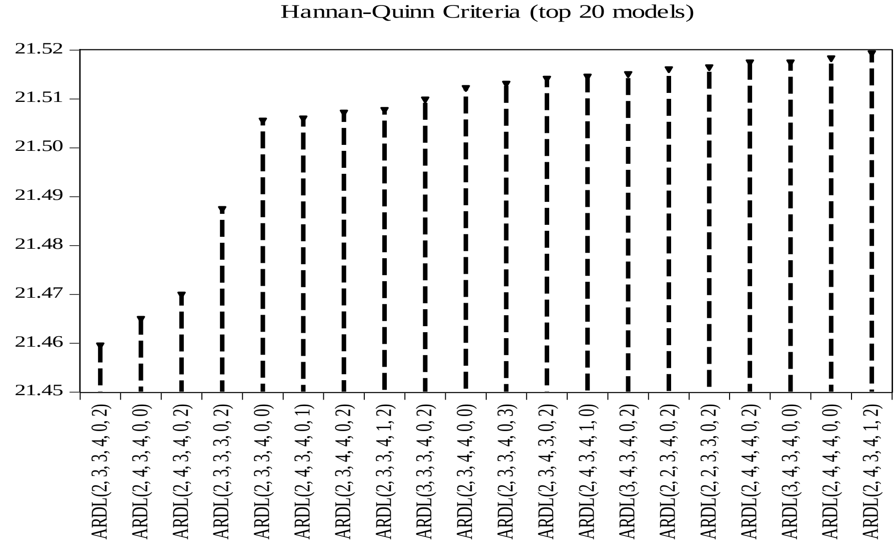
Normality test:



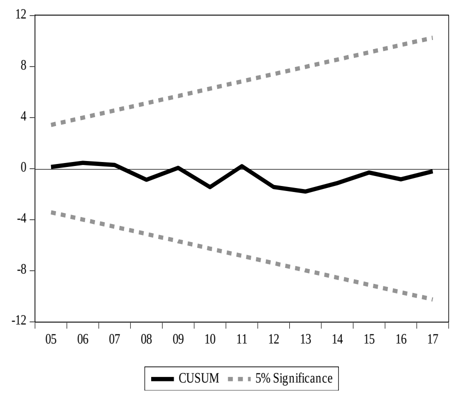
ARDL-Error correction regression for RNGDP, UMIS and controls

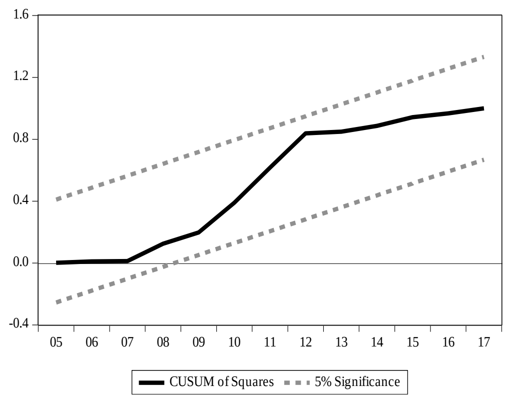
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OPEN)	273.4073	109.3052	2.501322	0.0166
D(OPEN(-1))	-280.0665	125.9059	-2.224412	0.0318
D(OPEN(-2))	-261.9732	122.1172	-2.145261	0.0381
D(ROGDP)	0.929052	0.099337	9.352550	0.0000
D(ROGDP(-1))	0.179648	0.101286	1.773666	0.0837
D(UNDER MIS)	-990.9962	227.5712	-4.354665	0.0001
CointEq(-1)*	-0.517955	0.095108	-5.445975	0.0000
R-squared	0.732303	Mean dependent var		-1593.805
Adjusted R-squared	0.696610	S.D. dependent var		20616.53
S.E. of regression	11355.77	Akaike info criterion		21.63749
Sum squared resid	5.80E+09	Schwarz criterion		21.90016
		Hannan-Quinn criter		
Log likelihood	-555.5747.			21.73819
Durbin-Watson stat	2.086014			

Appendix F. ARDL- RNGDP, MIS, UMIS and control variables



Plot of Cumulative Sum of Recursive Residual & Cumulative Sum of Squares of Recursive Residuals

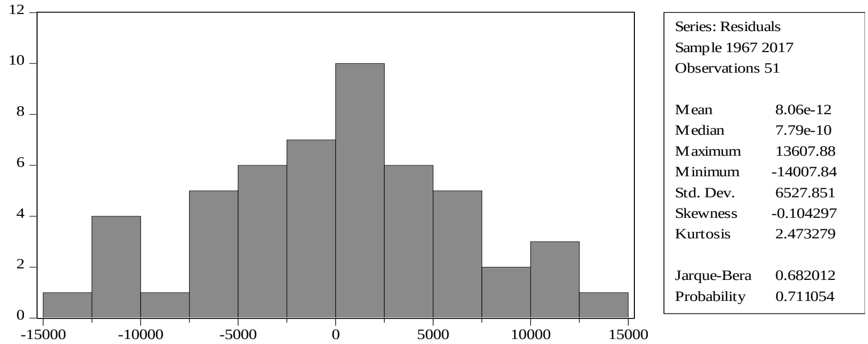




The straight lines represent critical bounds at 5% significance level

Normality test:

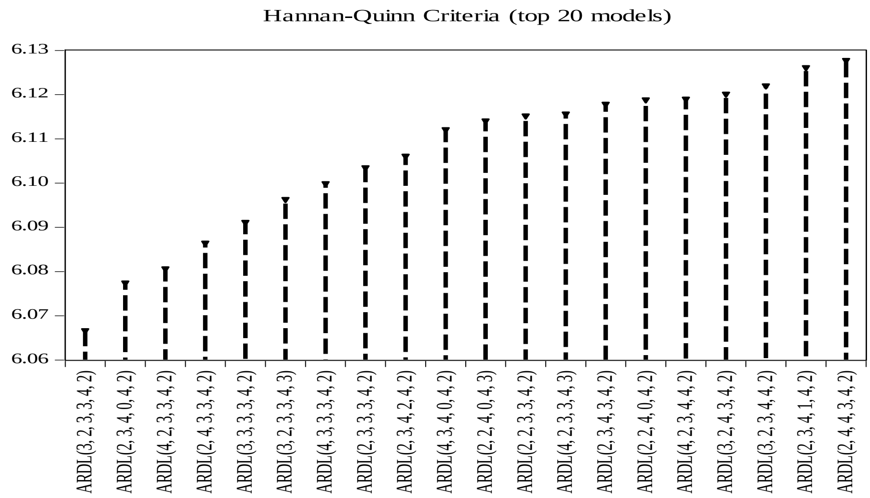
The straight lines represent critical bounds at 5% significance level



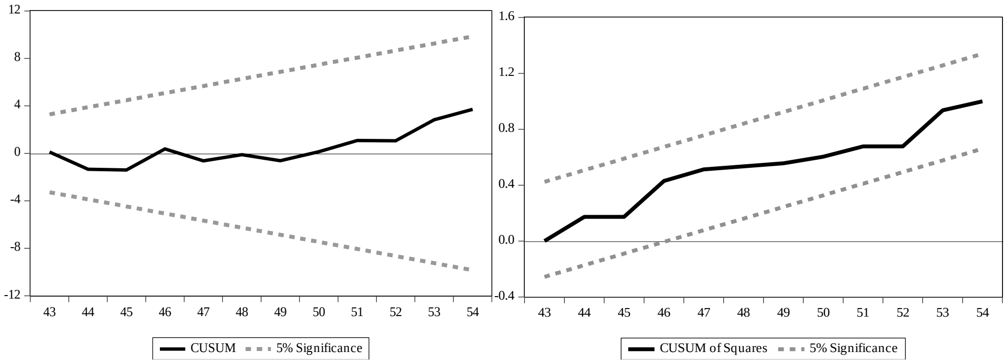
ARDL-Error correction regressions RNGDP, MIS, UMIS and controls

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REAL_REAL_NON_O _M_GDP_LIB_$(-1))	0.456423	0.079501	5.741085	0.0000
D(MIS_)	-1076.623	149.0818	-7.221698	0.0000
D(MIS_(-1))	1497.948	191.9477	7.803938	0.0000
D(MIS_(-2))	398.1670	158.6802	2.509243	0.0175
D(D_UNDER__MIS_)	-445.4193	298.0102	-1.494644	0.1451
D(D_UNDER__MIS_(-1))	-1300.185	387.9714	-3.351240	0.0021
D(D_UNDER__MIS_(-2))	-1088.943	247.0446	-4.407881	0.0001
D(OPEN)	219.0346	81.57479	2.685077	0.0115
D(OPEN(-1))	-492.1347	104.9150	-4.690795	0.0001
D(OPEN(-2))	-442.0673	100.5041	-4.398502	0.0001
D(OPEN(-3))	281.6146	108.8355	2.587526	0.0146
D(D02)	-85727.06	14857.83	-5.769825	0.0000
D(D02(-1))	50689.34	17598.53	2.880316	0.0071
CointEq(-1)*	-0.812434	0.082294	-9.872366	0.0000
R-squared	0.901652	Mean dependent var		-1663.389
Adjusted R-squared	0.867097	S.D. dependent var		20815.51
S.E. of regression	7588.472	Akaike info criterion		20.93476
Sum squared resid	2.13E+09	Schwarz criterion		21.46507
Log likelihood	-519.8364	Hannan-Quinn criter.		21.13741
Durbin-Watson stat	2.205599			

Appendix G. ARDL- INF, MIS and control variables

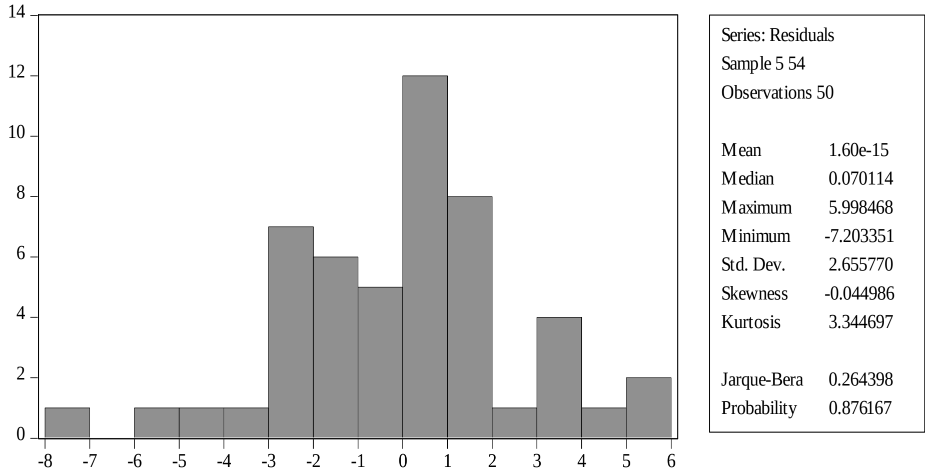


Plot of Cumulative Sum of Recursive Residual & Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Normality test:



ARDL- Error correction regression for INF, MIS and controls

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INF(-1))	0.459887	0.112761	4.078436	0.0004
D(INF(-2))	0.158528	0.071605	2.213916	0.0355
D(MIS)	0.640192	0.058052	11.02784	0.0000
D(MIS(-1))	-0.311888	0.082503	-3.780309	0.0008
D(OGDP)	0.000138	6.48E-05	2.129644	0.0425
D(OGDP(-1))	0.000401	8.10E-05	4.952065	0.0000
D(OGDP(-2))	0.000251	8.18E-05	3.063965	0.0049
D(GIM)	-0.134775	0.021015	-6.413281	0.0000
D(GIM(-1))	0.127460	0.029309	4.348887	0.0002
D(GIM(-2))	0.076662	0.023782	3.223502	0.0033
D(GMS)	-0.045089	0.026254	-1.717413	0.0974
D(GMS(-1))	-0.262518	0.044106	-5.951988	0.0000
D(GMS(-2))	-0.224303	0.041196	-5.444769	0.0000
D(GMS(-3))	-0.108878	0.028937	-3.762544	0.0008
D(D2)	17.59496	4.494661	3.914636	0.0006
D(D2(-1))	-20.17237	5.135568	-3.927973	0.0005
CointEq(-1)*	-1.262832	0.143018	-8.829886	0.0000
R-squared	0.961310	Mean dependent var		0.302735
Adjusted R-squared	0.942552	S.D. dependent var		13.50183
S.E. of regression	3.236172	Akaike info criterion		5.451144
Sum squared resid	345.6027	Schwarz criterion		6.101232
Log likelihood	-119.2786	Hannan-Quinn criter.		5.698701
Durbin-Watson stat	1.922485			

Appendix H. VAR- NOX, MIS and control variables

Impulse responses table

Response of NOX

Period	NOX	MIS	NFII	OPEN
1	384.2586	0.000000	0.000000	0.000000
2	179.0932	-47.99261	68.27311	16.81432
3	98.68447	-75.08263	70.97988	18.35900
4	60.29071	-88.92434	56.54522	12.82030
5	36.74019	-93.78366	39.92259	4.050707
6	19.21426	-92.40246	25.26936	-5.880260
7	4.909924	-86.71725	13.37888	-15.75147
8	-7.041880	-78.16887	4.081134	-24.81489
9	-16.91968	-67.85663	-3.006684	-32.62235
10	-24.84723	-56.62680	-8.263205	-38.93121

Response of NOX

Period	NOX	MIS	NFII	OPEN
1	1.137293	12.43572	0.000000	0.000000
2	1.433178	10.62512	1.026636	1.644183
3	2.209983	8.873586	1.547543	2.930686
4	2.994739	7.192312	1.852265	3.912009
5	3.640510	5.602427	2.037732	4.622647
6	4.110630	4.124892	2.138984	5.092133
7	4.406478	2.777023	2.171901	5.348965
8	4.542949	1.571415	2.146872	5.421479
9	4.539810	0.515799	2.072926	5.337729
10	4.418388	-0.386684	1.958789	5.125073

Response of NOX

Period	NOX	MIS	NFII	OPEN
1	354.4509	-40.41368	454.8356	0.000000
2	247.4521	-155.3024	346.2675	20.38523
3	176.0730	-222.9545	250.6705	16.95929
4	118.7829	-256.6836	173.5164	-0.041784
5	69.20396	-266.0885	113.1819	-23.91352
6	25.71984	-258.3114	66.64398	-50.15437
7	-11.92487	-238.7611	31.08483	-75.75738
8	-43.71250	-211.5724	4.224402	-98.77734
9	-69.67815	-179.9172	-15.70941	-118.0395
10	-89.98739	-146.2235	-30.08813	-132.9317

`Response of OPEN

Period	NOX	MIS	NFII	OPEN
1	3.476689	-5.365598	-2.640196	14.06068
2	5.680127	-4.426989	-1.886251	12.08809
3	6.222880	-4.045241	-0.889997	10.54230
4	6.146642	-3.972312	-0.088199	9.242775
5	5.809649	-4.053243	0.452330	8.094389
6	5.344159	-4.188867	0.766811	7.045413
7	4.807426	-4.316513	0.909261	6.068466
8	4.231173	-4.398506	0.928917	5.150591
9	3.637589	-4.414618	0.865325	4.287404
10	3.044349	-4.356785	0.748780	3.479392

Cholesky Ordering: NOX MIS NFII OPEN

Variance Decompositions tables

Variance Decomposition of NOX

Period	S.E.	NOX	MIS	NFII	OPEN
1	384.2586	100.0000	0.000000	0.000000	0.000000
2	432.4075	96.12398	1.231863	2.492946	0.151207
3	455.7713	91.20972	3.822648	4.669271	0.298359
4	471.8387	86.73635	7.118586	5.792850	0.352211
5	484.1355	82.96209	10.51406	6.182308	0.341547
6	493.9309	79.85552	13.60091	6.201263	0.342307
7	501.9350	77.33854	16.15539	6.076108	0.429957
8	508.6562	75.32736	18.09294	5.923031	0.656669
9	514.4854	73.73825	19.42483	5.792990	1.043927
10	519.7145	72.49047	20.22309	5.702284	1.584159

Variance Decomposition of MIS

Period	S.E.	NOX	MIS	NFII	OPEN
1	12.48762	0.829440	99.17056	0.000000	0.000000
2	16.57242	1.218822	97.41311	0.383761	0.984302
3	19.21597	2.229216	93.77864	0.934012	3.058132
4	21.18221	3.833398	88.70574	1.533312	5.927547
5	22.77823	5.869397	82.75982	2.126270	9.244512
6	24.15088	8.118185	76.53679	2.675861	12.66916
7	25.37168	10.37211	70.54657	3.157342	15.92398
8	26.47322	12.47175	65.15023	3.557713	18.82031
9	27.46809	14.31629	60.55162	3.874189	21.25790
10	28.35967	15.85759	56.82278	4.111482	23.20815

Variance Decomposition of NFII

Period	S.E.	NOX	MIS	NFII	OPEN
1	578.0520	37.59917	0.488791	61.91204	0.000000
2	734.7192	34.61721	4.770564	60.53524	0.076982
3	826.8289	31.86878	11.03799	56.99037	0.102857
4	890.9264	29.22571	17.80754	52.87816	0.088589
5	939.5340	26.82245	24.03360	48.99951	0.144443
6	978.2981	24.80805	29.13851	45.65738	0.396053
7	1010.407	23.27034	32.89988	42.89635	0.933438
8	1037.964	22.22845	35.33093	40.65046	1.790159
9	1062.439	21.64626	36.58966	38.82107	2.943009
10	1084.818	21.45045	36.91239	37.31276	4.324394

Variance Decomposition of OPEN

Period	S.E.	NOX	MIS	NFII	OPEN
1	15.67005	4.922560	11.72454	2.838779	80.51412
2	21.14456	9.919923	10.82280	2.354900	76.90238
3	24.78130	13.52772	10.54397	1.843419	74.08489
4	27.44285	16.04768	10.69314	1.504223	71.75495
5	29.47905	17.79127	11.15746	1.327142	69.72413
6	31.07003	18.97439	11.86170	1.255616	67.90829
7	32.32249	19.74456	12.74368	1.239329	66.27242
8	33.30743	20.20786	13.74507	1.244897	64.80218
9	34.07691	20.44502	14.80961	1.253792	63.49159
10	34.67207	20.52011	15.88451	1.257756	62.33763

Cholesky Ordering: NOX MIS NFII OPEN

VAR Residual Serial Correlation LM Tests
Sample: 1970- 2016

Null hypothesis: No serial correlation at lag h

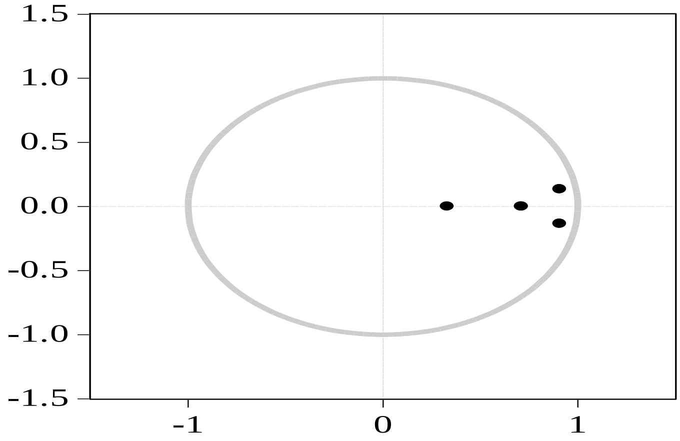
`	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	20.61276	16	0.1939	1.326229	(16, 104.5)	0.1954
2	18.75155	16	0.2818	1.196157	(16, 104.5)	0.2835

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	20.61276	16	0.1939	1.326229	(16, 104.5)	0.1954
2	35.67826	32	0.2995	1.135242	(32, 112.2)	0.3073

*Edgeworth expansion corrected likelihood ratio statistic.

Stability of VAR – MIS & NOX



Roots of Characteristic Polynomial

Root	Modulus
0.909405 - 0.133979i	0.919221
0.909405 + 0.133979i	0.919221
0.711869	0.711869
0.331920	0.331920

No root lies outside the unit circle.
VAR satisfies the stability condition.

Appendix I. VAR- BME, MIS and control variables

Impulse response table

Response of BME

Period	BME	INF	MIS	RGDP
1	0.104178	0.000000	0.000000	0.000000
2	0.093647	-0.018540	-0.013408	0.005817
3	0.086299	-0.036988	-0.024068	0.006719
4	0.080813	-0.054636	-0.031753	0.005438
5	0.076325	-0.070124	-0.036793	0.003113
6	0.072287	-0.082590	-0.039619	0.000396
7	0.068373	-0.091690	-0.040661	-0.002310
8	0.064411	-0.097451	-0.040313	-0.004757
9	0.060334	-0.100140	-0.038928	-0.006810
10	0.056139	-0.100160	-0.036805	-0.008414

Response of INF

Period	BME	INF	MIS	RGDP
1	-1.257064	5.600235	0.000000	0.000000
2	-0.971980	3.331507	0.169023	0.673337
3	-0.720340	2.296950	0.094498	0.652102
4	-0.515290	1.611614	0.007469	0.528248
5	-0.353217	1.097490	-0.057371	0.406423
6	-0.227871	0.704953	-0.099517	0.303289
7	-0.133039	0.409091	-0.123593	0.219553
8	-0.063089	0.191256	-0.134243	0.153072
9	-0.013085	0.035793	-0.135333	0.101307
10	0.021208	-0.070599	-0.129926	0.061820

Response of MIS

Period	BME	INF	MIS_	RGDP
1	-2.835948	4.843145	8.824555	0.000000
2	-3.676498	10.55844	7.309842	-0.507179
3	-4.116847	12.51430	6.360810	0.161729
4	-4.238529	13.01908	5.507105	0.784678
5	-4.134060	12.73232	4.696919	1.202730
6	-3.880304	11.96156	3.941886	1.437292
7	-3.536687	10.90514	3.256106	1.532598
8	-3.147561	9.704287	2.647549	1.528670
9	-2.744981	8.459872	2.118397	1.457711
10	-2.351231	7.241823	1.666598	1.344617

Response of RGDP

Period	BME	INF	MIS	RGDP
1	1080.238	-2115.314	1147.929	10557.88
2	2057.707	1694.739	-1870.286	4088.767
3	2673.004	-172.6044	-2752.167	2268.942
4	3073.788	-2416.924	-3073.659	1389.479
5	3307.595	-4177.219	-3161.754	780.3113
6	3405.089	-5390.540	-3111.578	313.4774
7	3393.351	-6132.299	-2969.903	-44.05460
8	3297.191	-6494.786	-2768.853	-309.4139
9	3138.786	-6563.857	-2532.735	-497.0577
10	2937.330	-6414.272	-2280.019	-620.4929

Cholesky Ordering: BME INF MIS RGDP

Variance Decompositions table

Variance Decomposition of BME

Period	S.E.	BME	INF	MIS	RGDP
1	0.104178	100.0000	0.000000	0.000000	0.000000
2	0.142057	97.23821	1.703337	0.890791	0.167659
3	0.172105	91.39156	5.779263	2.562527	0.266654
4	0.200434	83.63918	11.69153	4.399090	0.270201
5	0.228649	75.41407	18.38997	5.969800	0.226168
6	0.256704	67.76079	24.94125	7.118288	0.179671
7	0.283967	61.17152	30.80770	7.867338	0.153444
8	0.309727	55.74435	35.79586	8.307222	0.152567
9	0.333408	51.38157	39.91275	8.532292	0.173389
10	0.354640	47.91911	43.25306	8.618289	0.209542

Variance Decomposition of INF

Period	S.E.	BME	INF	MIS	RGDP
1	5.739586	4.796820	95.20318	0.000000	0.000000
2	6.743032	5.553197	93.38684	0.062832	0.997135
3	7.190098	5.887794	92.34013	0.072535	1.699540
4	7.405365	6.034648	91.78586	0.068481	2.111009
5	7.505808	6.095673	91.48374	0.072503	2.348087
6	7.549035	6.117180	91.31108	0.089053	2.482683
7	7.565478	6.121541	91.20698	0.115354	2.556120
8	7.570896	6.119727	91.14030	0.146630	2.593342
9	7.572879	6.116821	91.09481	0.178489	2.609880
10	7.574605	6.114818	91.06200	0.207830	2.615352

Variance Decomposition of MIS

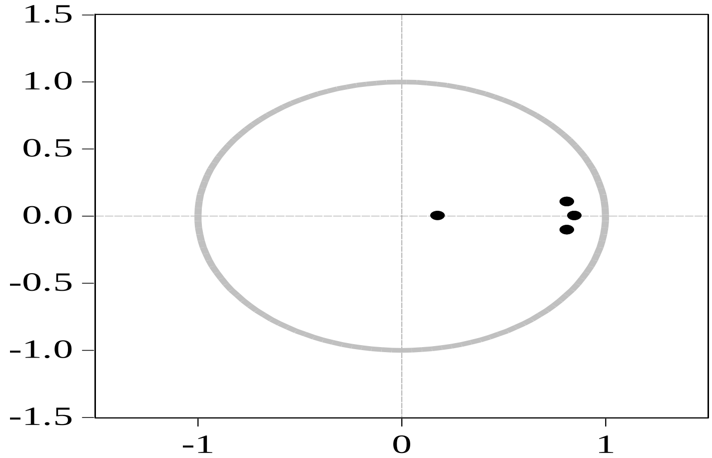
Period	S.E.	BME	INF	MIS	RGDP
1	10.45808	7.353474	21.44624	71.20029	0.000000
2	16.97233	7.484291	46.84332	45.58309	0.089298
3	22.40763	7.669291	58.06479	34.20947	0.056440
4	26.84227	7.837918	63.98837	28.04893	0.124788
5	30.38450	7.968137	67.49795	24.27984	0.254075
6	33.15053	8.064006	69.72352	21.81105	0.401424
7	35.26101	8.133595	71.19169	20.13099	0.543724
8	36.83430	8.183823	72.18102	18.96466	0.670504
9	37.98003	8.219872	72.85334	18.14882	0.777970
10	38.79485	8.245527	73.30971	17.57900	0.865763

Variance Decomposition of RGDP

Period	S.E.	BME	INF	MIS	RGDP
1	10882.46	0.985337	3.778291	1.112695	94.12368
2	12072.71	3.705705	5.040604	3.304085	87.94961
3	12870.41	7.573928	4.453122	7.479819	80.49313
4	13867.78	11.43653	6.873094	11.35506	70.33531
5	15208.88	14.23819	13.25803	13.76256	58.74122
6	16785.20	15.80484	21.19844	14.73546	48.26126
7	18430.55	16.49877	28.65306	14.81856	40.02961
8	20012.52	16.70790	34.83447	14.48261	33.97502
9	21449.92	16.68495	39.68638	14.00084	29.62784
10	22703.60	16.56701	43.40636	13.50582	26.52081

Cholesky Ordering: BME INF MIS RGDP

Inverse Roots of AR Characteristic Polynomial



Roots of Characteristic Polynomial

Root	Modulus
0.852067	0.852067
0.814285 - 0.104367i	0.820946
0.814285 + 0.104367i	0.820946
0.179878	0.179878

No root lies outside the unit circle.
VAR satisfies the stability condition.

(BME & MIS) VAR model
VAR Residual Serial Correlation LM Tests
Sample: 1980-2016

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	11.22372	16	0.7955	0.687376	(16, 74.0)	0.7973
2	16.90911	16	0.3915	1.073666	(16, 74.0)	0.3949

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	11.22372	16	0.7955	0.687376	(16, 74.0)	0.7973
2	27.05748	32	0.7151	0.822137	(32, 75.4)	0.7270

*Edgeworth expansion corrected likelihood ratio statistic.

Appendix J. Markov Switching (over and undervaluation states)

=

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Regime 1				
C	24.77303	4.149210	5.970542	0.0000
LOG(SIGMA)	2.910360	0.157031	18.53366	0.0000
Regime 2				
C	-36.00838	6.044905	-5.956815	0.0000
LOG(SIGMA)	3.188162	0.163617	19.48556	0.0000
Transition Matrix Parameters				
P11-C	2.360286	0.672391	3.510289	0.0004
P21-C	-2.109992	0.697534	-3.024930	0.0025
Mean dependent var	-1.666893	S.D. dependent var		37.14488
S.E. of regression	28.99734	Sum squared resid		42042.30
Durbin-Watson stat	1.039818	Log likelihood		-253.2840
Akaike info criterion	9.603112	Schwarz criterion		9.824110
Hannan-Quinn criter.	9.688342			

Dependent Variable: MIS

Appendix K. Markov Switching (appreciation and depreciation)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Regime 1				
C	2.003897	1.043253	1.920815	0.0548
LOG(SIGMA)	1.633256	0.176027	9.278423	0.0000
Regime 2				
C	-2.183908	6.314302	-0.345867	0.7294
LOG(SIGMA)	3.111846	0.229747	13.54464	0.0000
Transition Matrix Parameters				
P11-C	1.735699	0.676328	2.566358	0.0103
P21-C	-0.484627	0.896618	-0.540506	0.5888
Mean dependent var	0.829767	S.D. dependent var		12.92127
S.E. of regression	13.01497	Sum squared resid		8469.466
Durbin-Watson stat	1.523986	Log likelihood		-199.4490
Akaike info criterion	7.609222	Schwarz criterion		7.830221
Hannan-Quinn criter.	7.694453			

Dependent Variable: Growth rate of RER

Appendix L. DSGE Codes

```
import excel "C:\Users\User\Desktop\dsge try (1).xlsx",sheet ("Sheet1") firstrow
tsset years, yearly
dsge(F.u={rhou}*u, state) (F.g={rhog}*g, state) (p={beta}*E(F.p) + {kappa}*x) (x=E(F.x) - (r - E(F.p) - g), unobserved) (r=(1/{beta})*p + u)
nlcom 1/_b[beta]
estat policy
estat transition
irf set nkirf.irf
irf create model1
irf graph irf, impulse(u) response(x p r u) byopts(yrescale)
irf graph irf, impulse(g) response(x p r g) byopts(yrescale)
estimates store dsge_est
tsappend, add(12)
forecast create dsgemodel
forecast estimates dsge_est
forecast solve, prefix(d1_) begin(2017)
tsline d1_p if tin(1980, 2030), tline(2017)
estat stable
```