# EFFECTS OF EXCHANGE RATES VOLATILITY ON IMPORTS AND EXPORTS IN KENYA

University of Nairobi

## SCHOOL OF ECONOMICS

### BY

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# DECLARATION

I hereby declare that this is my work. It has not been presented anywhere for academic award. Secondary sources used in the study have been acknowledged for the ideas borrowed from other scholars and authors in its compilation.


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## DEDICATION

I devote this work to all who continuously gave me support towards achieving this noble goal. May the Lord bless you abundantly.

# ACKNOWLEDGEMENTS

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# LIST OF ACRONYMS

ADF            Augmented Dickey-Fuller

BOP            Balance of Payments

ERS            Economic Recovery Strategy

EAC            East Africa Community

ECM            Error Correction Mechanism

EPAs           Economic   Partnership Agreements

EU             European Union

FDI            Foreign Direct Investment

GDP            Gross Domestic Product

IMF            International Monetary Fund

KNBS           Kenya National Bureau of Statistics

MASD           Moving Average Standard Deviation

MDGs           Millennium Development Goals

ML             Marshall-Lerner

NARC           National Rainbow Coalition

NER            Nominal Exchange Rate

NEER           Nominal Effective Exchange Rate

RBM   Results Based Management

REER   Real Effective Exchange Rate

RER   Real Exchange Rate

SBIC   Schwarz-Bayesian Information Criteria

SDR   Special Drawing Rights

UK   United Kingdom

US   United States

**ABSTRACT**

In some market economies, exchange rate may fluctuate significantly relative to major world currencies. This will have a big impact on a country's trade. This study evaluates the effect of exchange rate volatility on Kenya's imports and exports during the period 1980 – 2015 through estimation of two structural equations; an import function and an export function for the economy whose specification follows standard economic theory. Results indicate that, real exchange rate volatility significantly affect imports and exports. At 5 percent level of significance, result of the cointegration analysis using Johansen test found the trace statistic for both models to be smaller than the critical, with a maximum rank of two (2). This implied that cointegration was present and that there existed at least two (2) co-integrated equations, in and independent variables move closely to achieve equilibrium in the long-run among the variables of imports and exports models. Results further show that increased exchange rate uncertainty has substantial adverse effects in the long-run on export function but not on import function. The results further show that, long-run parameter estimates of the models are consistent with economic theory. The study recommends that imports and exports activities can be improved if macroeconomic policies aimed at keeping stable real exchange rate are implemented.

# CHAPTER ONE: INTRODUCTION

Developing countries face economic challenges ranging from unfavourable balance of payments, increased foreign debt, high inflation levels, and declining growth rates, among others. This has resulted in declining standard of living and underutilization of economic resources found within their boundaries.

During the 1970s, Africa experienced slow growth relative to other parts of the world particularly Asia. Africa recorded lower growth rates than South East Asian countries due to both political and economic factors. This led to Africa lagging behind while South East Asia improved its economic performance.

Transition to sustained economic growth in South East Asia reveals that development has been associated with policies targeting macroeconomic stabilization; improving the rural areas by ensuring that there is ample food supply; liberalizing the economy and ensuring economic freedom for the people. In Africa, these policies were never associated with poverty reduction (Jan Kees et al, 2012)

However, according to the United Nations Conference on Trade and Development's *World Investment Report, 2013*, Africa continues to record impressive growth in Foreign Direct Investment (FDI) as reflected by increasing rate into the continent. Over time, the role of exchange rate in stimulating economic growth has been increasing. However different exchange rate regimes have had different impacts on trade. Wolf (2002:39) notes that a country's economic past, size, sophistication, easy of doing trade, its major trading allies, and political environment all assist in determining which of the available exchange rate regimes it adopts.

The fixed exchange rate dictates that the domestic currency is dependent on other currency/currencies, while the floating exchange rate relies on the market that deals with demand and supply of currencies. However between these two, there are intermediate regimes with various types of currency pegs. These regimes range from single currency, to crawling currencies, to free-floating currencies.

The objective of this research paper was to formulate a model that would explain how exchange rate volatility among other variables affects imports and exports. The model was estimated by separating the two variables – imports and exports - and estimating how exchange rate volatility affects them. Data on the variables is used for Kenya from 1980 to 2015. The estimates of the parameters provide a quantitative perspective of the roles of exchange rate among other variables on imports and exports in Kenya.

## 1.1 Overview of Kenya's economic performance

Kenya, like most developing countries of Africa, relies heavily on primary exports which are subject to external shocks, environmental and internal challenges that the economy has to adjust to.

After independence in 1963, the country made significant gains, however in 1980s the country recorded downward trend in performance of the economy, this worsened further in late 1990s due to poor governance, mismanagement of resources and poor implementation of economic policies. 1980s and 1990s reforms which were meant to stimulate economic growth and eliminate structural problems appeared to have had low impact in jump-starting the economy due to minimal efforts targeting improvement in economic governance (ERS, 2003).

Despite recording an impressive growth rate averaging 5% annually in 1980s, in 1990s, Kenya's GDP experienced great inconsistency in growth rate due to liberalization and declining donor inflows.

The country recorded improved growth rates with the coming of National Rainbow Coalition (NARC) in 2002 peaking at 7% in 2007. However the global financial crisis, drought and the post-election violence of 2008 after the aftermath of 2007 disputed general election reversed the gains made. Kenya returned to higher economic growth in 2010 of 5% from 2.6% in 2009 after recovering from the multiple shocks experienced in 2008.

Kenya's real GDP growth rate has over the years continued on an upward trend from 0.5% in 2002 reaching 7.0% in 2007 and then a drop to 1.6% in 2008. However the economy recorded a recovery and an upward trend recording real GDP growth rate of 4.4% in 2011. According to the Economic Survey 2014, Kenya recorded in 2013 an expanded GDP growth rate of 4.7% compared to a 4.6% growth rate recorded in 2012. In 2014 and 2015, the country continued to record an expanded growth rate of 5.3% and 5.6% respectively with a projected growth rate of 6.8% in 2016 (Economic Survey, 2016)

Overall macroeconomic environment remained stable and inflation rate eased from an average of 9.4% in 2012 to 5.7% in 2013. However in 2014, the country recorded inflation rate of 6.9%, 6.6% in 2015, 6.3% in 2016 with a projected rate of 7.6% in 2017 (Economic Survey, 2016).

Over time, the Kenyan government has continued to embrace reforms in various sectors aimed at improving efficiency in provision of service delivery. Such reforms include: performance contracts, anti-corruption initiatives, Results Based

Management (RBM) system, introduction of e-procurement and review of macroeconomic policies aimed at securing a declining inflation and improving fiscal intermediation (Central Bank of Kenya Annual Report, 2013).

## 1.2 General performance of exchange rate in Kenya.

The macroeconomic performance of Kenya economy can be understood in the context of external and internal shocks that have affected the economy. Such shocks include variability in international oil prices, periods of stabilization and structural adjustments in the 1980s, droughts, food shortage, increased food prices, depressed investments, political environment, declining donor inflows in the 1990s, among others.

Kenya exchange rate over time has seen mixed performance. The underlying economic conditions affecting the exchange rate over the years include low domestic interest rates, drought impacts and market forces that affect the exchange rate determination. (See Figure 1.1)

**Figure 1.1: Kenya exchange rate, KES per USD**



Source: The GlobalEconomy.com, the IMF
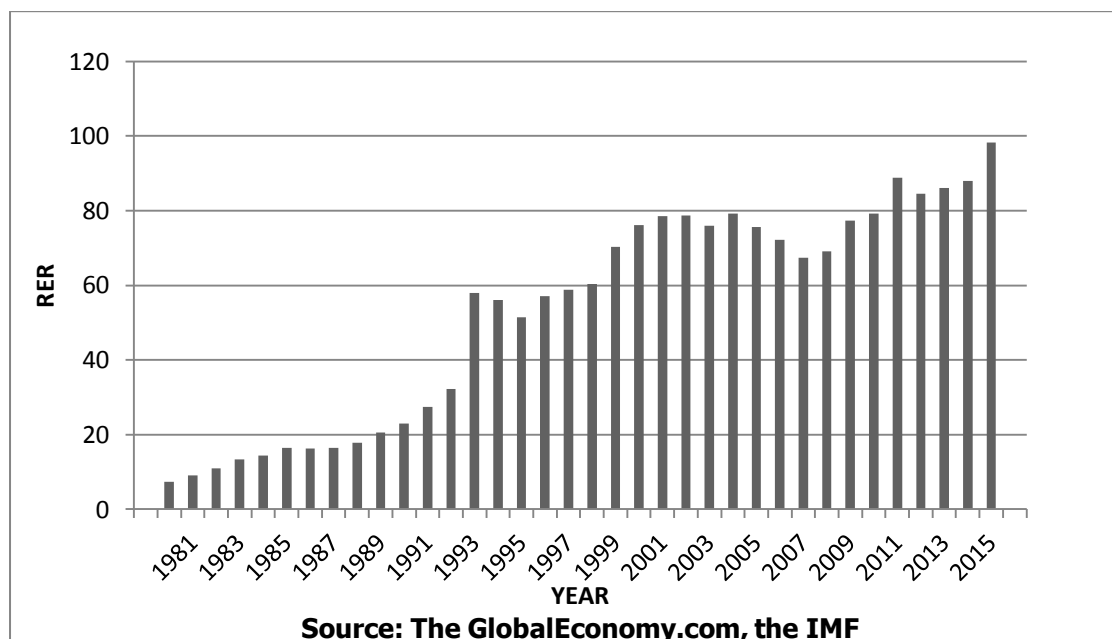
From Figure 1.1, the Kenyan shilling exchange rate per US dollar continued to decline/weaken against the U.S. dollar.

## 1.2.1 Exchange rate Regimes

The rate of exchange of one currency for another currency is known as the exchange rate; the relationship between a country's currency and other foreign currencies is overseen using an exchange rate. According to Wolf (2002), a country's economic conditions, size and sophistication, ease of doing business, major trading partners, and democratic environment define the exchange rate regimes it adopts.

Exchange rate regime at a particular time is linked to the monetary policy in place. The fixed exchange rate dictates that the local currency is dependent on other currency/currencies, while the floating exchange rate relies on forces of demand and supply. In this case the role of the monetary authority can range from full control, to minimal control, and finally to no control of the exchange rate.

Adoption of floating exchange rate in Kenya in 1970s produced significant uncertainty in exchange rates. Researchers and Policy makers started extensive debate focusing on the impact of exchange rate uncertainty on international trade. However conflicting results were recorded from both theoretical and empirical research. Research shows that the effect could be positive, negative or ambiguous.

Exchange rate uncertainty hinders trade flows due to increased uncertainty, however, other studies suggest otherwise. In addition, most studies examine the relationship for developed countries but few investigate for developing countries due to the insufficient time series data. Thus the aim of this research is to close the gap through empirical examination of exchange rate uncertainty on Kenya's imports and exports.

Volatility of exchange rate affects trade in a number of ways. First, for risk averse traders, exchange rate volatility reduces their activities in order to avoid any losses. Second, volatility affects trade volumes by making return on investment and prices uncertain particularly in emerging economies which do not have forward markets. In other developed economies where forward markets exist, research shows that they have not been able to eliminate exchange rate volatility completely.

Third, persistence of exchange rate volatility encourages local manufacturers to buy from the local market, reducing trade volumes particularly on traded inputs. Finally, exchange rate volatility reduces international trade through reduced foreign direct investment.

## 1.2.2 Fixed Regime

In fixed exchange regime, currency is maintained within the same range for the entire year (Klein and Shambaugh, 2008). A fixed exchange rate mitigates against inflation; and it is thus seen as a means of gaining credibility in providing stability for both nominal and real exchange rates (Theis and Arce, 2009). However fixed exchange rates limit flexibility to engage in countercyclical monetary policy. Fixed exchange rates causes overvaluation of real exchange when inflation persists in the economy thus becoming unmanageable in the medium term leaving the economy susceptible to speculative attack (Coudert and Dubert, 2005). However this might not be true if there is government intervention meant to stabilize the exchange rate.

## 1.2.3 Intermediate Regimes

Most developing countries' financial markets and institutions are not fully developed; as a result, the exchange rate regime fluctuates among various alternative intermediate

regimes, depending on the target of the macro-economic policy in place. However, most developing economies have adopted a wide range of options some of which do meet the conventional fixed or flexible regimes (Von Hagen et al, 2007).

Flexible exchange rate has proven more attractive to emerging economies such as Asian economies for it has promoted economic integration. Hochreiter and Wagner (2002) point out that pegged exchange rates encouraged growth in unhedged foreign-currency debt, and a currency mismatch of balance sheets. On the other hand, Hochreiter et al. (2002) notes that, in controlling inflation in the economy and financial stability in future, pegged exchange rate regime can be a beneficial strategy.

### 1.2.4 Floating Regime

In the early 1950s, Milton Friedman favored flexible regimes of exchange rate, based on the fact that, nominal exchange rate could be used to protect the economy against shocks during sticky prices. He noted that countries that could change relative prices more would have smoother adjustment of output (Broda 2004).

Policy-makers' changing preferences are seen, through transitions between regimes, as a populist government may endeavor to stimulate output at the expense of exchange rate stability. This can only be achieved by a more conservative and stability-oriented administration.

Under floating regimes, governments do not assume a commitment to follow a certain exchange rate rule, the exchange rate moves freely. A flexible exchange rate has an equilibrating role in trade balances; however a floating exchange rate can be prone to volatility and speculation.

### 1.2.5 Exchange Rate Policy in Kenya

Kenya's major policy objective has been to have an exchange rate that promotes competitiveness, low levels of inflation, positive real interest rates and strict momentary position in the economy. However this has been difficult to achieve in practice over time.

Kenya's exchange policy has recorded progress over time. According to the International Monetary Fund (IMF), the country shilling was pegged to the British pound, then to the US dollar and IMF Special Drawing Rights (SDR), crawling peg based between 1992 and 1997, and independent float and after 1998 managed float.

Until 1990s, Kenya maintained exchange controls; this was in response to crisis on the balance of payments in 1971 /72. These were meant to control pressure on BOP and conserve foreign exchange. However these controls created distortions in the economy. The floating exchange rate in 1993 led to increase in inflation and interest rates (Ndung'u 1999; Kinyua 2000).

The exchange rate policy in Kenya can be summarized as in the Table 1.1

**Table 1.1: The Evolution of Exchange Rate Policy in Kenya since Independence**

| Period Interval | Exchange rate regime pursued |
| --- | --- |
| 1964-1974 | Pegged to the Sterling pound then U.S. dollar |
| 1975-1982 | Pegged to the SDR |
| 1983-1990 | Crawling peg |

| | | |
|---|---|---|
| 1991-1993 | Dual exchange rate system | |
| 1994-1997 | Independent float | |
| 1998-2010 | Managed float | |

Source: Central Bank of Kenya (CBK)

### 1.2.6 Exchange rate equilibrium

The price at which one currency is converted to another is called exchange rate. It is referred to nominal when effects of inflation are embodied in the rate (NER) and when inflation is not factored, real exchange rate (RER).

In an attempt to reduce effect of misalignment of RER in the economy during the fixed exchange era in the country, Kenya constantly devalued its currency. However in 1993, the country adopted floating regime and RER which led the country aligning itself to market determined equilibrium and thus eliminating RER misalignment.

After liberation of foreign market in 1993, Were et. al. (2001), analysed exchange rate movement and factors that influenced it. Ndung'u (1999) also assessed the effect of monetary policy on exchange rate and whether these effects were permanent or temporary. Kiptoo (2007) on the other hand focused on the real exchange rate, misalignment, and its impact on the Kenya's international trade, and investment and found out that, exchange rate misalignment affects trade.

### 1.2.7 Importance of exchange rates to a country

Most of the world assets are owned and traded by non-residents. This is done through trade in the financial markets where the exchange rate plays a crucial role. Foreign

exchange market forms an essential part of the financial system making it important for financial stability. Understanding exchange rates requires an understanding of the different exchange rate systems.

Kenya pursues a flexible exchange rate policy regime where market forces and economic fundamentals play a major role in determining movements in exchange rate where sound fiscal and monetary policy are expected to support a stable exchange rate.

In 1960s and 70s, Kenya operated within the regime of pegged currencies (Musyoki et al, 2012). This was of importance because it gave businesses and government a certain sense of stability and a sense of lower uncertainty in budgeting and cost of imports and exports. Over time such pegs were changed or currencies were allowed to head toward a managed float because market forces were giving a different value to the currency than the pegged rate.

According to the theory of balance of payments, exchange rate of a country depends on market forces of foreign exchange. Foreign currency prices will be higher if the demand is lesser than its supply. However when the BOP is favorable, exchange rate will rise above equilibrium rate resulting in reduction of exports.

To support market-based, liberalized order, flexible exchange rate provides continuous advantage for continuous response in price adjustments. It also acts as an absorbing shock by using price changes to facilitate changes in the market. In achieving economic efficiency, monetary policy aimed at price stability should be pursued alongside exchange rate policy.

For example, David Dodge, Governor to Financial Market Association, 2001-2008, cited why Canada decided to break with the Bretton Woods system in 1950. He noted that in late 1940s, Canada experienced a large inflow of foreign capital and post-war investments. This was due to revaluation of its dollar which influenced heavy capital flows into the country amid speculation. This raised concern on inflation and worries on capital inflow which they believed might lead to increased foreign debt. This meant a shift in policy to focus on exchange rate stability than stabilizing domestic prices (Bank of Canada Review, Winter 2005-2006).

In protecting domestic purchasing power of a country's currency, managing inflation through monetary policy is used. This promotes strong and sustainable economic growth in the economy but a floating currency helps the economy deal with economic shocks.

Over the years, many economists have raised concern over the profitability of devaluing exchange rates. During recession and periods when the economy is stuck and uncompetitive, a falling exchange rate is beneficial. Devaluation increases demand for exports which in turn creates employment. On the other hand it can lead to inflation and reduced standard of living as imports become expensive (Dornbusch, 1973). Appreciation of exchange rate becomes beneficial when the economy becomes more productive but if the appreciation is due to speculation, then it becomes harmful to exporters since exports will be un-competitive in the world market. Exports and imports are determined by exchange rate. Appreciation of domestic currency relatively makes imports cheaper in the domestic market and domestic enterprises find it difficult to compete with their counterparts. On the other hand a strong currency makes goods un attractive to foreign investors, thus loss of competitiveness.

Maintaining fixed exchange rate conflicts with other macroeconomic objectives making the government to intervene particularly when the currency is falling below its band thus prompting the government to increase interest rates so as to increase the value of the currency. An increase in interest rate increases hot money inflows and increases inflationary pressures. However, high interest rates may cause slower economic growth which might end up in recession and rising unemployment.

## 1.3 Import and export trends in Kenya

Trade imbalance causes macroeconomic volatility in any country. Kenya has continuously recorded negative balance of payment in the last 50 years except in 1964 and 1977 when it recorded a surplus of US$ 5.7m and US$ 18.1m respectively. In 1963, Kenya recorded trade deficit of US$ 8.1m which increased to US$ 5649m, US$ 6303m, in 2008 and 2010 respectively reaching a peak of US$ 1019m in May of 2012. However in 2013 February, the country recorded a trade deficit of US$ 808.5 m from US$ 682.9m recorded the previous year, this was because imports rose faster than exports. However in 2015, the balance of trade improved from a deficit of US$ 1,081m recorded in 2014 to a deficit of US$ 997m. Total exports grew faster than total imports, as a result, increasing the total volume of trade marginally from US$ 2156m in 2014 to US$ 2158m in 2015 (Economic Survey, 2016)

Import value increased due to the increase in petroleum prices; oil lubricants, farm inputs, food prices, among others. The huge deficit was as a result of faster growth on imports and low exports growth in the economy. Main exports are agricultural products which are constantly affected by volatility of international prices.

Figure 1.2 and 1.3 summarize Kenya's imports and exports trend over the study period.

**Figure 1. 2: Import of goods and services, billion USD**



Source: The GlobalEconomy.com, IMF
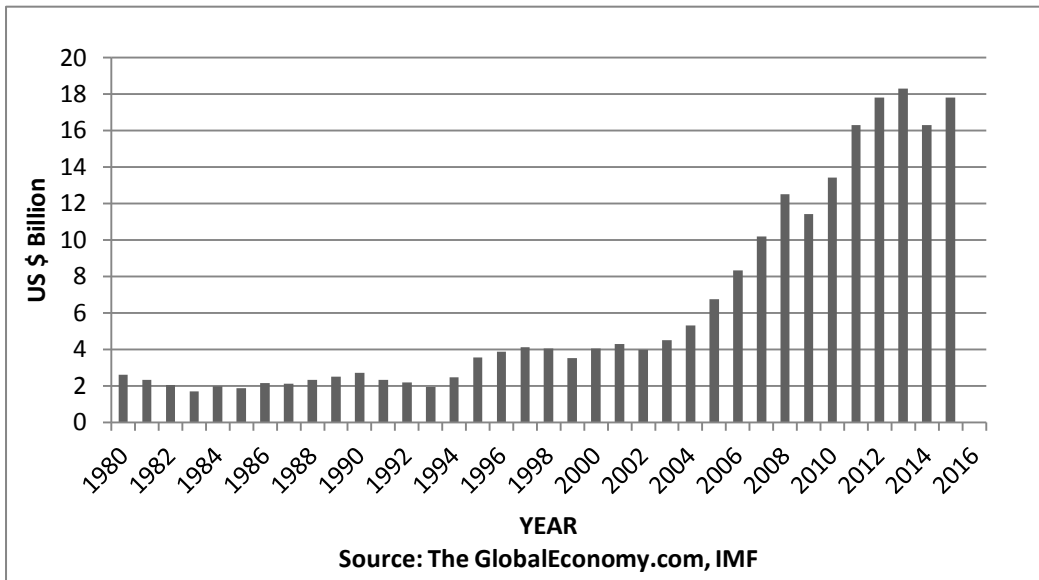
**Figure 1. 3 : Export of goods and services, billion USD**



Source: The GlobalEconomy.com, IMF
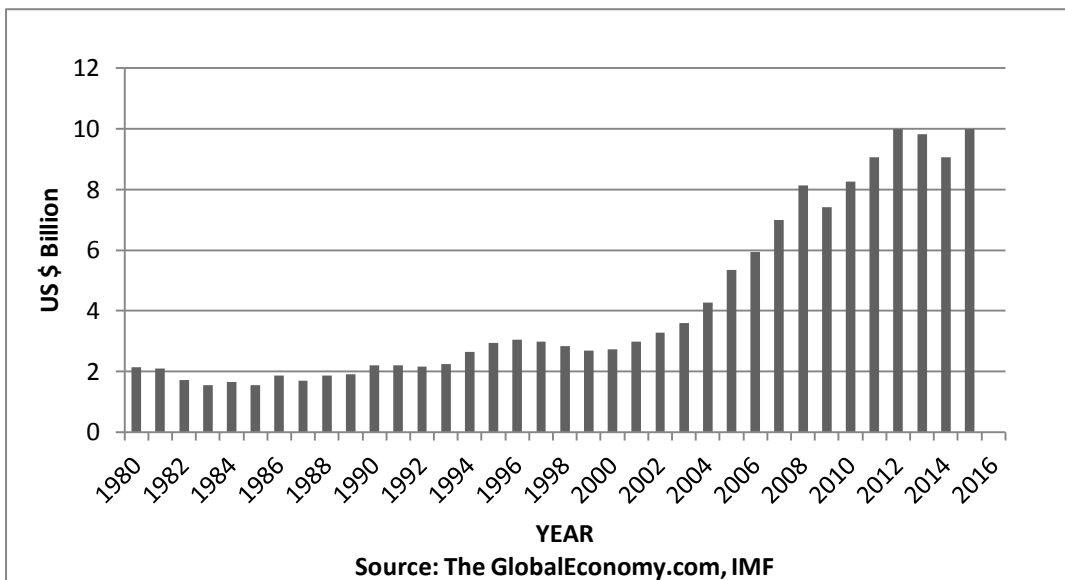
Imports/export of goods and services represent the total value of goods and services received/provided from other parts of the world excluding compensation of employees, investment income and transfer payments.

## 1.3.1 Importance of imports and exports to a country

### 1.3.1.1 A Competitive edge

Countries trading internationally experience comparative advantage and at times absolute advantage over other competitors. For example, when the local market is full of similar goods, foreign market can be the answer for profitability. Trade through competition improves quality, labor, exchange of best practices among trading partners and builds capacity of industry and industry products.

### 1.3.1.2 Economies of scale in production

Companies engaging in foreign trade experience efficiency due to economies of scale in production leading to comparative advantage. This brings significant gains in trade due to the reallocation of resources thus reducing productive inefficiency.

### 1.3.1.3 New markets

Global trade gives opportunities to understand various markets. International trade maximizes gainful opportunities for a country. Further, it contributes cutting of spending by the government through expanded supply of good and services thus strengthening competition for government opportunities.

### 1.3.1.4 Insulation from seasonal domestic sales

International trade introduces companies to new markets by offering products that are seasonal and expanding operations of companies thus making them stay busy and productive all the time.

### 1.3.1.5 Improved return on investments

This refers to spreading a country's risks in foreign markets and companies instead of subjecting the economy to the problems of the domestic economy. This diversification shields a country's trade returns from risks associated with investment in one sector of the economy.

### 1.3.1.6 Promotes peaceful coexistence of trading partners

Trade strengthens peaceful coexistence of nations by bringing people together. These contribute to increased trade and stability and hence reduce the probability of escalating conflicts for nations that trade with one another. Trade also helps in boosting development and reducing poverty through increased opportunities and investments.

### 1.4 Statement of the problem.

A stable and sustainable macroeconomic environment creates investor confidence and encourages investment. Over time many countries across the world have been pursuing policies that will allow them enter the new era of globalization so as to earn benefits associated with such developments in the new economic order. A good exchange rate policy promotes exports and provides import-competing and export-oriented industries incentives (Kemal and Usman, 2005).

Adoption of floating exchange rate in Kenya has been the subject for research to determine the effect of volatility of exchange rate on imports and exports.

During the era of fixed exchange rate regime (1966-1982), Kenya like many other emerging economies of the world increasingly devalued their currency in order to

minimize adverse effects of real exchange rate (RER) posed on the economy (Musyoki et al. 2012). Between 1982 and 1993, the country had a crawling peg regime. However in 1993, Kenya adopted the market determined exchange rate regime. Since then, volatilities of exchange rate have characterized the Kenyan financial market (Kiptoo, 2007).

The Kenya government, through the Economic Recovery Strategy and Wealth Creation, committed itself to improving economic performance, creating employment and fighting corruption so as to jumpstart the economy from stagnation. This played a great role in the stability and economic recovery during 2003-2007 and ushered in Kenya's new development agenda, Vision 2030.

To realize economic growth and development, the Kenya Vision 2030 places high premium on steady macroeconomic environment for renewed growth. This is envisaged in a growth rate target of 10% per annum as reflected in the economic pillar of the vision. Achieving this growth rate requires implementation of prudent fiscal, monetary and exchange rate policies.

In the recent past Kenya has recorded greater movement of the Kenya shilling exchange rate against major world currencies which has raised interest by the public and investors on the success of the exchange rate policies in promoting stability and economic growth in the country.

According to the Kenya Economic Report 2011, Kenya exchange rate remained stable against the US dollar for the greater part of 2003-2007 with some tendency to appreciate. In 2010, exchange rate averaged Ksh. 81.0 per US $ while in 2011 it depreciation against major currencies hitting a record low of Ksh. 107.0per US $ in October 2011. In 2013, the country recorded an annual average of Ksh 86.12 per US$

which continued to depreciate in 2014 and 2015 recording an annual average of Ksh 87.92 and Ksh 98.18 per US$ respectively.

Businesses and investors requires stable environment to thrive. However in the recent past, exchange rate volatility has left investors and the public with questions as to whether exchange rate policies can promote stability and economic growth. The study therefore, seeks to investigate the effect of exchange rate volatility on imports and exports in Kenya.

## 1.5 Broad objective of the study

The overall objective of the study was to investigate the effect of exchange rate volatility on imports and exports in Kenya for the period 1980 to 2015.

The specific objectives were;

i.   To find out whether exchange rate volatility affect imports and exports in Kenya.

ii.  To investigate the effect of real exchange level on imports and exports in Kenya.

iii. Based on the findings from the above analysis, discuss policy effects with a view to enhancing the formulation and implementation of monetary policy and exchange rate policy to achieve stability in imports and exports.

**1.6 Research questions**

The research was guided by the following questions:

i.  Does exchange rate volatility affect imports and exports in Kenya? If so, how do they relate?

ii. Does real exchange rate level affect imports and exports in Kenya? If so, how do they relate?

**1.7 Motivation and justification of the study**

Kenya like most other developing countries is committed to national and international development agenda as well as international commitment such as the Sustainable Development Goals (SGDs) which sets targets countries aspire to achieve by 2030. Of importance to this study, Goal 17 on strengthening the means of implementation and revitalization of the global partnership for sustainable development recognizes partnerships from different stakeholders as being key in supporting SDGs in various countries particularly in developing countries.

Kenya is a member and signatory of various trading blocs. Regional integration schemes like the East Africa Community (EAC) greatly affect trade, and therefore there is need to know how trade will respond to exchange rates.

According to the Kenya Millennium Development Goal (MDG) Final Status Report 2016, the volume of trade between Kenya and the world has improved over the years with imports increasing more rapidly than exports thus widening the current account deficit.

According to the Economic Survey 2014, the shilling appreciated against major currencies of the major trading partners and remained relatively stable.

Therefore, a combination of several factors inspired a research in this subject of exchange rate with special focus to the principle objective. Effectively the research findings are expected to help policy makers make informed decisions on policy direction and focus on interventions that benefit all Kenyans. It will also make good reference material in the academic circles.

## 1.8 Organization of the study

The study is divided into five chapters. Chapter One introduces the study by giving an overview of economic performance in Kenya, general performance of exchange rate, problem statement, study objectives and research questions. Chapter Two reviews the theoretical and empirical literature while Chapter Three discusses methodology; model specification; model estimation as well as data collection techniques and analysis. Chapter Four looks at empirical results and interpretation while Chapter Five presents the summary, conclusions and policy recommendations for the study.

**CHAPTER TWO: LITERATURE REVIEW**

There has been a growing concern on the role of macroeconomic policies, to provide incentives to firms engaged in international trade. Countries across the globe, regardless of their level of development are now pursuing policies that will allow them enter the new era of globalization, and Kenya is no exception. Trade is being promoted as a necessary catalyst for fostering economic growth and over the past decades policy-makers have used foreign trade policy and exchange rate policy to influence trade flows. This chapter therefore, presents an analysis of both theoretical and empirical literature on exchange rate volatility.

## 2.1 Theoretical literature

### 2.1.1 Introduction

Exchange rates play a central role in global trade by providing an avenue where prices can be compared in different countries. There are two forms of exchange rate; the spot exchange rate and forward rate. For spot exchange rate, it is the immediate price within a short period say two days (Reuvid, 2001), while forward rate is futuristic. Flood and Garber (2000) notes that, global trade creates demand and supply that may result in volatility based on exchange rate regime adopted by a country. They further classify exchange rate volatility as unobservable, deterministic or stochastic. Lindert and Pugel (1996) also note that exchange rate uncertainty can represent both positive and negative risks for firms trading in the international market.

Different schools of thought have tried to explain the effect of exchange rate volatility on trade. They include; the traditional school of thought, risk portfolio school of thought and the political economy theory. The traditional school of thought holds that

volatility depresses trade and increases risks (Cote, 1994), risk-portfolio school of thought holds that, higher risk presents an opportunity for profit and thus increased trade while political-economy theory proposes that trade will be reduced with increased volatility due to protectionist legislation (De Grauwe, 1988).

## 2.1.2 The traditional school of thought

Proponents of this theory concentrated more on the behavior of firms and assumed that volatility of exchange rate reduces returns of contracts done using foreign currency and thus reduces trade to points that otherwise would not exist if they were not present. For risk-neutral and risk-averse individuals, uncertainty of returns on investment leads to redirecting their activities to domestic markets where the risks are lower. Cote (1994), the traditional school of thought examines both the presence and degree of risk which also depends on other factors of production such as; ability of firms to edge, contract currency and imported factors of production. According to Hooper and Kohlhagen (1978), the volume of exports and trade in general are affected by exchange rate volatility through increased risks making traders to react differently depending on whether they are risk-averse, risk-neutral or risk-loving with exchange rate volatility. For risk-neutral, volatility does not affect their decision to export.

Hooper and Kohlhagen examined volatility and bilateral trade on U.S demand for certain steel products from Canada and Mexico by deriving supply and demand schedules for different firms. They used currency of contracts, firms's degree of risk aversion and degree of hedging as explanatory variables in the forward market and found out that volatility only affect the amount of risk that remains unhedged. They made a number of assumptions including; importer being price taker with known demand curve and that exporters sell their goods in a market free of competition

abroad. Their findings indicated that, with increase in exchange rate volatility both demand and supply curves shifts downwards declining both price and quantities when the importer faces risk in exchange rate while prices and quantities increases when the risks and born by the exporter.

Baron (1976) also focuses on bilateral trade and the effect of currency on exporting firm decisions on prices production in a volatile market which is competitive. He concluded that exporting companies face both price risk and quantity demand risk when transactions are in foreign currency and when home currency is used respectively. With increased uncertainty, profit maximizing companies which are risk-averse increases their prices when goods are bought using foreign currency. Baron notes that reducing a firms risk will depend on the demand curve a firm faces.

Clark (1973) on the other hand examined the behavior of risk-averse companies in support of traditional school of thought. He notes that increase in variance of exchange rate increases profit uncertainty. However he highlighted a number of limitations. These include; firms produce only for exports, contracts are done in foreign currencies, and existence of perfect competitive markets.

According to him, utility function is given by quadratic function of profits:

$U(\pi) = a\pi + b\pi^2$, where b is risk aversion and less than zero while $\pi$ represents utility . With increased uncertainty, risk averse firms reduce their supply of goods to a level where marginal cost is less than marginal revenue so as to compensate for the additional risks.

In summary, traditional school of thought holds that international trade falls with increased uncertainty of profits due to higher exchange rate volatility leading to

redirection of activities of risk-averse and risk-neutral to domestic markets with lower risks. The major setback to the school of though is that it does not model on how risks are managed by the firms in order to increase profitability.

### 2.1.3 Risk-Portfolio School of thought

According to Risk-Portfolio school of thought, higher risks present an opportunity for profit and thus increased trade. De Grauwe (1988) notes that risk-neutral persons are attracted by higher profits and are not affected by the adverse exchange rates and reduced outputs. For exporters, returns from exchange rate which are favorable will always outstrip the reduced returns. De Grauwe analyzes exchange rate risk in view of diversification of portfolio in the modern world by holding that economic agents will maximize their returns through diversification of their investment and engaging in risk environments that corresponds well with their returns. He further notes that, high risks due to higher rates of volatility discourages risk neutral traders from trade but presents opportunities for diversification and hence increase profits.

The major drawback to this school of thought is that, it fails to model firms' response to risks. For the high risk averse, increased exchange rate volatility would increase the utility of export revenue and encourage exports from exporters to avoid reduced revenues. For the low risk averse, exchange rate volatility presents greater risks by reducing exports and switching of resources within sectors. Thus exports will increase with increase in exchange rate volatility with higher income effect and reduce if the substitution effect is more than the income effect.

### 2.1.4 Political-economy theory

The Political-economy theory holds that, trade will be reduced with increased volatility due to protectionist legislation. According to De Grauwe (1988), countries that have market determined exchange systems but experience misalignments in exchange rate are vulnerable to politicization and increase of protection on trade making trade flows to fall due to protectionist regulation on falling businesses.

### 2.2 Empirical literature review

### 2.2.1 Introduction

Exchange rate behavior varies depending on the period under study. Volatility is high in the short run due to such events such as political environment, change in expectation both current and future as well as monetary policies (Krugman and Obstfeld, 2003). While in the long-run, they are determined by the relative prices of goods in various countries (Samuelson and Nordhaus, 2001). Blackman on the other hand notes that, macroeconomic variables such as supply and demand of goods, investments, economic growth and inflation rates, rate of return, among others affect volatility of exchange rate.

### 2.2.2 Positive effects of exchange rate volatility on trade

Arize et al. (2000) investigated real exchange rate volatility on the exports of thirteen less developed countries with quarterly data series for the period 1973-1996  using Johansen's multivariate procedure for long-run and error correlation model to analyze short-run dynamics and found that increased exchange rate volatility induces exporters to increase their exports thus increasing their revenues. They note that exports activities responds faster to activities in the foreign market than to relative

prices. They further notes that exchange rate volatility has effect on trade depending on the period of time and may have greater effect on resource allocation in the market as traders try to minimize the effect of the risks associated with exchange rate.

Osoro (2013) investigated long-run and short-run determinants of trade balance in Kenya using annual data for the periods 1963 – 2012 using Johansen Cointegration approach and error correlation coefficients of trade balance and found a positive correlation between exchange rates and trade balance in Kenya in the long-run. His study revealed that in the long-run, elasticities of exchange rate have positive sign indicating that devaluation leads to improvement in trade. Results further showed that Foreign Direct Investment (FDI) positively affect trade suggesting that FDI flows motivates investors to increase import substitutes in order to improve trade balances.

Ariz (1998), Samanta (1998), Alam and Ahmed (2010) also confirmed there being positive relationship between trade and volatility of exchange rate for developed countries.

### 2.2.3 Negative effects of exchange rate volatility on trade

Kamal and Qadir (2005), using Engel-Granger approach and the Johansen Cointegration technique studied long-run and short-run relationship between real exchange rate, imports and exports using monthly data from December 1981 to January 2003 on Pakistan imports and exports and found out that a country's trade can be strongly influenced by a country's exchange rate with a strong correlation. They concluded that, in determining a country's competitiveness in global trade, exchange rate plays a major role. Overvaluation of exchange rate leads to unfavourable balance of payment (BOP), fall in reserves and thus prompting use of exchange controls and trade barriers to protect the economy and vice versa.

They also found that imports and exports are closely related. Increased exports without surplus stock require increased production with increased capital and supplies. However most developing countries are agro-based and luck sufficient capital, thus prompting importation of capital from developed countries to promote their production.

According to Baron (1976), analyzed incomplete capital markets by looking at the capital and foreign markets, individual firms, investors, investor equilibrium and arbitrage between spot and forward markets and concluded that increased volatility of exchange rate reduces internal trade. Hooper and Kohlhagen (1978), analyzing theoretical risk of exchange rate on equilibrium prices and quantities of US and German trade between 1965 and 1975 using differential risk bearing import and export sides of market for goods argue that increased exchange risk, lowers revenue and incentives from the exports. They also argue that exchange rate poses greater risk for decision making individual. Economic agents experience greater uncertainty with international trade when they cannot predict the value of foreign transaction thus becoming difficult for firms to project their trade activities. Clark (1973) further explains that volatility reduces international trade transactions and causes profit to change.

Caporale and Doroodian (1994) adopt a generalized autoregressive conditional heteroskedastic (GARCH) model to generate exchange rate volatility to examine US imports from Canada during 1974 – 1992 and found out that volatility has negative effect on imports results which were consistent with Arize (1998) and Doroodian (1999) who also reported negative effect on US imports and negative effects for trade for Malaysia, India, and South Korea.

According to Baum et el (2004), allocating resources optimally does not prevent firms from being affected by exchange rate volatility since exporting firm cannot predict the effect volatility would have on their sales. They empirically studied the impact of exchange rate volatility on real international trade flow using 13-country dataset of monthly bilateral real exports for 1980 – 1988 and their findings indicates that for forward markets which are not well developed, firms become uncertain on the value of exchange it would want to cover. However for perfect markets, volatility of exchange rate can be reduced.

Ethier (1973) similarly notes that exchange rate volatility adversely affect trade even when forward market exists due to the fact that, forward markets cannot neutralize all the risks completely. This is because volatility of exchange rate exposes firms through different channels thus lowering their profits. Boron (1976) also argues that, despite negative effect of exchange rate volatility, firms can reduce its impact if they can hedge using the forward contracts.

Akpolodje and Omjimite (2009) studied the effect of exchange rate volatility on imports of ECOWAS countries over the period1986 – 2006 when the countries operated flexible exchange rate system through estimation of import model with exchange rate volatility as one of the independent variables and found that exchange rate volatility poses negative effect on imports. Coric and Pugh (2010) using applied meta-regression analysis (MRA) to the empirical literature studied US trade flows between 1978 and 2003 and found similar results of negative impact on trade flows which were consistent with Alam (2012) on his study on Pakistan imports in the long run where he estimated import function using quarterly time series data between 1979

and 2005 using autoregressive distribution lag approach and found that exchange rate volatility adversely affect imports.

## 2.2.4 Ambiguous effect of exchange rate volatility

A number of researches have been done aiming to establish the challenge presented by exchange rate volatility on volumes of trade. However results show that there is no consistence in the findings and conclusions arrived at.

Sercu and Uppal (2003) notes that, while firms can diversify their risks associated with uncertainty of exchange rate, they sometimes fail to adjust their production in response to exchange rate. They overlook the economy and any changes that can increase the risks of a firm. Sercu and Uppal holds that, variations in international trade depend on the source of uncertainty and may affect equilibrium in the volume of trade in the international market.

Backman (2006) also agrees that the results of the impact may be ambiguous depending on the assumptions used such as the time period of analysis since exchange rates are believed to be responsive to time, whether long term or short term. Other assumptions include economic growth rate, rate of inflation, demand and supply for goods and services.

Koray and Lastrapes (1989) used vector autoregressive (VAR) models to examine exchange rate volatility and its effects on the volume of trade from United Kingdom, Germany, France, Japan and Canada using monthly data from 1959 to 1985 and concluded that permanent shocks to exchange rate volatility has negative impact on trade particularly over the flexible rate period but week effect on imports.

Hooper and Kohlhagen (1978), affirms that increase in exchange rate volatility

increases the risk of firms. They further noted that prices of goods are affected depending on who is taking the risk. For example, for an importing firm, if it takes the risks, prices will fall with fall in demand for imports. On the other hand, there will be price increase if the exporter takes the risk by charging an increasingly higher risk premium. They also examined the impact of exchange rate volatility on imports of six advanced countries (Japan, Canada, Germany, UK, US and France) during 1965 – 1975 and found out that exchange rate volatility measured by the standard error of movements in nominal exchange rate positively affects imports of Japan, UK, the US and Canada but negatively affecting imports of France and Germany.

**CHAPTER THREE: METHODOLOGY**

This chapter presents an analysis of the underlying theoretical and empirical models. It also describes the variables by giving explanation of the variables. The study undertook to test the applicability of Cote's analysis that volatility depresses trade and increases risks (Cote, 1994). The study analysed which of the independent variables are significant to imports and exports by use of structural models. The justification was to answer the questions on what would be the behaviour of dependent variable to the independent variables, whether the relationship is significant, and which of the independent variables can actually affect the dependent variables. McKenzie (1999) notes that analysis of imports and exports using standard model requires adequate variables. This study followed Olimov and Sirajiddinov (2008) in explaining the model by specifying the following trade functions:

$$M=g\ (RERVOL, Y_{domestic}, P_m, TOT_m) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \ (1)$$

$$X=f\ (RERVOL, Y_{foreign}, P_x, TOT_x) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \ (2)$$

where *M, X* represents real aggregate imports and exports respectively; *RERVOL* is real exchange rate volatility, $Y_{domestic}$ is domestic income, $P_m$ is relative price of imports *(proxied by the real exchange rate)*, $Y_{foreign}$ accounts for foreign income of Kenya's major trading partners (USA, UK, and China), $P_x$ is relative price of exports *(proxied by the real exchange rate)*, $TOT_m$ and $TOT_x$ are terms of trade for import and export function respectively.

Theoretical literature on imports suggests that, desired real imports are functionally related to real exchange rate volatility *(RERVOL)*, income ($Y_{domestic}$) and import prices ($P_m$), proxied by real exchange rate *(RER)*. Theory indicates that the derivative of

demand for imports with respect to income ($Y_{domestic}$) is positive, the effect of real exchange rate on the demand for imports is negative implying that a depreciation of real exchange rate will raise the cost of imports, while an appreciation of real exchange rate will reflect in a lower cost of imports leading to an increase in volume demanded. Higher exchange rate volatility leads to increased cost of imports and overall reduction in trade.

On the other hand, economic theory on exports suggests that increase in foreign income affects domestic exports – an increase in real foreign income ($Y_{foreign}$) increases domestic exports. A reduction in relative export prices ($P_x$) will cause the domestic goods to be more attractive than foreign goods, thus increasing exports. However exchange rate volatility may result in increasing overall trade for risk-averse traders, while exports will be less attractive for risk-neutral traders thus declining trade.

## 3.1 Model specification

In order to understand the determinants of Kenyan imports and exports, I estimated two structural models/equations; an import function and an export function for the economy. The specifications of these functions followed standard economic theory. The imports function is given by:

$$M_t = \beta_o + \beta_1 M_{t-1} + \beta_2 RERVOL_t + \beta_3 Y_{domestict} + \beta_4 RER_t + \beta_5 TOT_t + \omega_t \dots\dots\dots\dots\dots (3)$$

where *RERVOL* is real exchange rate volatility, $Y_{domestic}$ is domestic national income, *RER* represents the real exchange, TOT is terms of trade, and ω is a stochastic error term for the import function. Kenya's gross domestic product is used to indicate domestic national income. The export function is:

$$X_t = \alpha_o + \alpha_1 X_{t-1} + \alpha_2 RERVOL_t + \alpha_3 Y_{foreign\,t} + \alpha_4 RER_t + \alpha_5 TOT_{t+} \mu_t \ldots\ldots\ldots\ldots\ldots (4)$$

where $Y_{foreign}$ represents foreign income and $\mu$ represents the stochastic error term for the export function. To study this relationship, the models will be transformed to log-linear equations:

$$logM_t = \beta_o + + \beta_1 logRERVOL_t + \beta_2 logY_{domestic} + \beta_3 logRER_t + \beta_4 logTOT_{t+}$$

$$\omega_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$logX_t = \alpha_o + \alpha_1 logRERVOL_t + \alpha_2 logY_{foreign\,t} + \alpha_3 logRER_t + \alpha_4 logTOT_{t+}$$

$$\mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where $logM_t$ is the logarithm of real imports, $logM_{t-1}$ is logarithm of imports at time t-1, $logRERVOL_t$ logarithm of real exchange rate volatility, $logY_{domestic}$, logarithm of real domestic income, $logTOT_t$, logarithm of terms of trade, $logX_t$ logarithm of real exports, $logX_{t-1,}$ logarithm of exports at time t-1, $logY_{foreign,}$ logarithm of real foreign income, and $\omega_t, \mu_t$ are error terms for import and export functions respectively.

Theoretical studies determine that total imports to a domestic economy increases with improvement of the domestic economy; this implies that $\beta_2 > 0$. Implying that, a rise of import prices or depreciation of real exchange rate will make foreign goods more expensive making imports to fall i.e. $\beta_4 < 0$. Better terms of trade will increase both imports and exports i.e. $\beta_5, \alpha_5 > 0$. Export volume increases with increase in income of foreign countries thus $\alpha_2 > 0$. Rise in the price of exports causes local products to be uncompetitive in the international market. Exports will be adversely affected while the volume of imports will increase. Thus $\beta_3$ and $\alpha_3$ can be either positive or negative or non-significant.

## 3.2 Definition of the variables and the expected signs

**Table 3. 1: Definition of the variables and the expected signs**

| Variable | Description | Expected sign |
|---|---|---|
| Imports (M) | Total value of imports in US dollars | |
| Exports (X) | Total value of exports in US dollars | |
| Real Exchange Rate (RER) | RER=e*($P_f$/$P_d$), where e = local currency units per US \$, $P_f$ is foreign prices and $P_d$ is domestic prices. | +/- |
| Terms of trade (TOT) | Is the ratio of export price to import price (TOT= $P_x$/$P_m$) | + |
| $Y_{domestic}$ | domestic national income in billions of U.S. dollars | + |
| $Y_{foreign}$ | foreign income of major trading partners or countries (USA, UK and China) in billions of U.S. dollars | + |
| Real exchange rate volatility (RERVOL) | | +/- |

*Source: Generated by the author from literature review*

Form literature review, it is estimated that, increase in domestic income has positive effect on imports; depreciation of real exchange rate will have negative impact on imports and positive impact on exports while exchange rate volatility will either have positive or negative effect on imports and exports.

## 3.3 Real exchange rate volatility

Exchange rate volatility is indirectly observable. Various methods have been used to determine it. In estimating volatility, the study followed Sauer and Bohara (2001) using the conditional variance of a first-order ARCH model with the exchange rate. The equation is of the form:

$$\log(RER_t) = \alpha_0 + \alpha_1 \log(RER_{t-1}) + u_t, \text{ whereas, } u_t \sim N(0, \delta_t) \dots\dots\dots\dots\dots(7)$$

$$\text{Volatility, } \delta_t = \beta_0 + \beta_1 u^2_{t-1} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (8)$$

Estimating equation (8) gave the following results (standard errors are in parenthesis).

$$\textbf{Volatility, } \boldsymbol{\delta_t = 0.3265939 + 0.93191u^2_{t-1}}$$

$$\textbf{(0.0913447)} \quad \textbf{(0.240871)}$$

The result is interpreted as current prediction of real exchange rate variance which is a measure of the weighted average of long term average and the ARCH term. The predicted values of $\delta_t$ provides a measure of volatility of the Kenya's exchange rate against the US dollar.

**Figure 3. 1: Real Exchange Rate Volatility Measure, 1980-2015**
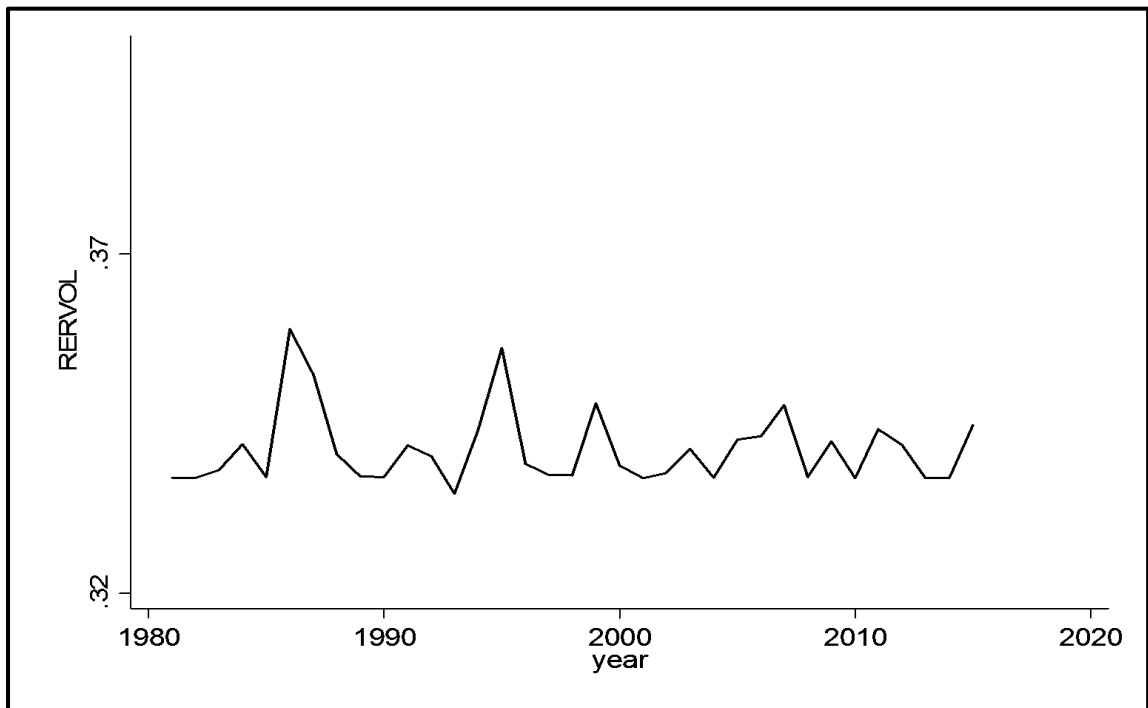


*Source: Generated by the author from the data set*

The vertical axis represent real values for volatility while horizontal axis time in years for period under study. In this case, volatility is given by the graph of conditional variance of ARCH.

## 3.4 Lag Length

The model was tested for serial correlation to determine the relationship between variables over time to see whether past variables can predict the future variables. The test was done on the assumption that the error terms may be serially correlated and involves adding the lagged values of the dependent variables so as to eliminate serial correlation. This was done using Schwartz-Bayesian Information Criterion, as the Johansen Maximum Likelihood method is sensitive to the number of lags, and also due to the fact that the data used was time series.

## 3.5 Correlation Analysis

To measure the strength of association and the direction of the relationship, pair-wise correlation analysis was done for the independent variable. The correlation coefficient was used as a measure of the strength and the direction of a linear relation between a pair of variables. The coefficient ranges from -1 to 1, and if close to one (1), the relationship between the pair is strong, and vice versa. When two independent variables are highly correlated, then model coefficients cannot be estimated with precision (Gujarati, 1999). Thus, one of the independent variables will be dropped from model. However, auto correlated variables were corrected using the Paris-Winston command in stata.

## 3.6 Stationarity Analysis

Non-stationarity of time series data may lead to spurious regression problem which distorts results. In light of this challenge, the unit root test was done using Augmented Dicky Fuller (ADF) test so as to ensure that there was no trend or seasonality in the data. The test was done at levels and differences to determine the order of integration. According to Gujarati (1999), ADF test assumes that the error terms are independently and identically distributed.

## 3.7 Cointegration Analysis

Cointegration refers to long-run relationship between a set of economic variables given a particular model (Engle and Granger, 1987). Time series often have trends with non-standard statistical properties, in this model; Short term relationships can be estimated if cointegration is not present, however, if present long-term relationship between the variables will be tested using the Johansen Maximum Likelihood

Cointegration test, given the multivariate nature of the model. An Error Correlation Mechanism will be also be used to determine the speed and direction of adjustment to shocks.

# CHAPTER FOUR: RESULTS AND ANALYSIS

## 4.1 Introduction

The chapter presents analysis and findings of the study as set in the research objectives and methodology. The findings and discussions give details on the time series properties and regression results.

## 4.2 Time Series Properties

### 4.2.1 Lag Length Determination

The two models lag length was determined using Schwartz-Bayesian Information Criterion (SBIC), as the Johansen Maximum Likelihood method for testing for cointegration is sensitive to the number of lags and the fact that data is annual. In the first model (imports model) four lags were selected for the model as shown in appendix A1 while in the second model (exports model) one lag was selected for the model as shown in appendix A2. The lag length with the lowest SBIC was selected.

### 4.2.2 Unit Root Test Results

To avoid admission of spurious results, the data was tested to ensure there was no trend or seasonality. The test was done using Augmented Dickey Fuller (ADF) test. To determine the order of integration, the test was done at levels and differences. The results are presented in the table 4.1.

**Table 4. 1: Stationarity test results**

| Variable | Test Statistic | p-value | Remark |
|---|---|---|---|
| logM | 1.323 | 0.9967 | Not Stationary |
| D. logM | -4.311 | 0.0004 | Stationary |
| logX | 1.268 | 0.9964 | Not Stationary |
| D.logX | -4.423 | 0.0003 | Stationary |
| logRERVOL | -1.608 | 0.7612 | Not Stationary |
| D.logRERVOL | -5.765 | 0.0000 | Stationary |
| logY_domestic | 1.262 | 0.9964 | Not Stationary |
| D.logY_domestic | -4.065 | 0.0011 | Stationary |
| logY_foreign | -1.441 | 0.5625 | Not Stationary |
| D.logY_foreign | -4.656 | 0.0001 | Stationary |
| logRER | -2.828 | 0.0544 | Not Stationary |
| D.logRER | -4.556 | 0.0002 | Stationary |
| logTOT | -1.181 | 0.0611 | Not Stationary |
| D.logTOT | -6.633 | 0.0000 | Stationary |

*Source: Author's computation from the data set*

All the variables, logM, logX, logY_domestic, logY_foreign, logRERVOL and logTOT and logRER were found to be integrated of first order, I(1). This means that all the variables were stationary at first difference.

### 4.2.3 Cointegration Test

Having established that all the variables in the study were I(1), it was important to establish the existence of long-run relationship between the dependent and independent variables. Using the Johansen test for cointegration, the trace statistic for both models was found to be smaller than the critical value at 5 percent level of significance, with a maximum rank of 2. This implied that cointegration was present and that there existed at least two (2) co-integrated equations, in ether bi-directional or uni-directional relationship, as shown in appendix A3 and A4. This meant that the dependent and independent variables move closely to achieve a long-run equilibrium.

### 4.3 Correlation Analysis Results

Pair-wise correlation analysis was done for the independent variables, and results are shown in Appendix A5 and A6. The correlation coefficient was used as a measure of the strength and the direction of a linear relationship between a pair of variables. The coefficient ranges from -1 to 1, and if close to one (1), the relationship between the pair is strong, and vice versa. The results indicated that logM and logY_domestic had a strong positive relationship, in model 1, while logX and logY_foreign, and logRER and logY_foreign had very strong positive relationships, in model 2. A correlation analysis using the Variance Inflation Factors (VIF) indicated that the VIF values were less than 10, hence no evidence of serial collinearity (*appendix A7 and A8*).

## 4.4 Diagnostic Test Results

Table 4.2 shows a summary of the diagnostic tests conducted. These include normality tests, test for omitted variables, and test for homoscedasticity. Several diagnostic tests were performed to ensure soundness of the results as shown in the table 4.2.

**Table 4. 2: Summary of Diagnostic Tests**

| Test | Description | t-statistic | p-value |
|------|-------------|-------------|---------|
| Jarque-Bera | For checking normality | 1.508 | 0.934 |
| Ramsey RESET Test | Test for omitted variables | 3.59 | 0.027 |
| White's Test | Test for homoscedasticity | 18.81 | 0.1725 |

*Source: Author's computation from the data set*

As the study models were multiple regression equation, the error terms were expected to be normally distributed with mean of zero and constant variance. The test was done by predicting residuals and running a density and normal plots as shown in figure A1 and figure A2 in the appendix. The plot showed that, the error terms were not normally distributed before transformation, but were normally distributed after the data was transformed. A Shapiro-Wilk test for normal data supports the result of table 4.2. Hence, the assumption that the residuals followed a normal distribution could not be rejected at 5 percent level of significance.

Further, using the White's test, the error term was found to be homoscedastic with a calculated Chi-square (32) value of 18.81 with probability 0.1725, implying that the null hypothesis of constant variance could not be rejected at 5 percent level of significance, as the probability was greater than 0.05 as shown in table 4.2. The data was also tested for linearity using a graph matrix. The graph matrix showed that the independent variables were not in linear relationship before transformation, but were after the data was transformed (*figure A3 and A4*).

### 4.5 Regression Results

### 4.5.1 Import function (Model 1)

The following table contains the multiple regression results from a model with L.logM as the dependent variable, and logRERVOL, logY_domestic, logRER, and logTOT, as explanatory variables.

**Table 4. 3: Regression Results**

| Variable | Coefficient | p-value |
|---|---|---|
| L._ce1(ECM) | 0.274 | 0.015 |
| LD.logRERVOL | 0.045 | 0.000 |
| LD.logY_domestic | 0.082 | 0.000 |
| LD.logRER | -0.012 | 0.000 |
| LD.logTOT | 0.024 | 0.000 |

R-squared =0.9983, Root Mean Squared Error = .03274; * $p < 0.05$, ** $p < 0.01$; F (4, 28) = 4099.98, p = 0.000

*Source: Author's computation from the data set*

The F-statistic (4099.98) is statistically significant at 5 percent level of significance implying that all the dependent variables as a group explain 99.8 percent of the total variations in imports ($R^2$ = 0.9983). The model has a better fit since its Root Mean Squared Error is 0.03274. The closer the Root Mean Squared Error to zero, the better the model.

From the results (table 4.3), the coefficient for logRERVOL is significant at 5 percent level of significance ($p < 0.05$), meaning that logRERVOL is important. A unit increase in exchange rate volatility increases imports by 0.045 percent. The coefficient for logY_domestic is significant at 5 percent level of significance ($p < 0.05$), meaning that logY_domestic is important. A percent unit increase in domestic national income increases imports by 0.082 percent. The coefficient for logRER is significant at 5 percent level of significance ($p < 0.05$), meaning that logRER is important. A percentage unit increase in real exchange decreases imports by 0.012 percent. The coefficient for logTOT is significant at 5 percent level of significance ($p < 0.05$), meaning that logTOT is important. A percent unit increase Terms of Trade (TOT) increases imports by 0.024 percent.

As shown in appendix 11, the model as an Error Correction Mechanism (ECM) of 0.274 (*speed of adjustment*), which is significant meaning divergence from equilibrium will take place and the system will be unstable. Further, logRERVOL granger causes logRER and logTOT; logRER granger causes logY_domestic, while logM granger causes logRER and logTOT. All these relationships are uni-directional.

The estimated equation shows that the coefficient on the logY_domestic, logRERVOL and logTOT are positive, but the coefficient for the real exchange rate is negatively related to the import function. It is observed that increasing domestic

income positively affects import demand but depreciation of real exchange rate adversely affect the long-run dynamics of the import model.

## 4.4.2 Export Function (Model 2)

Table 4.3 contains the multiple regression results for the export function with logX as the dependent variable, and L.logX, logRERVOL, logY_foreign, logRER, and logTOT, as explanatory variables.

**Table 4. 4: Regression Results**

| Variable | Coefficient | p-value |
|---|---|---|
| L._ce1 (ECM) | -0.072 | 0.013 |
| LD.logRERVOL | -0.046 | 0.000 |
| LD. logY_foreign | 0.019 | 0.000 |
| LD.logRER | -0.083 | 0.000 |
| LD.logTOT | 0.007 | 0.145 |

R-squared = 0.9728, Root Mean Squared Error = .10538; * $p < 0.05$, ** $p < 0.01$; F $(4, 28) = 250.81$, $p = 0.000$

*Source: Author's computation from the data set*

The F-statistic (250.81) is statistically significant at 5 percent level confidence meaning that all the independent variables as a group, explain 97.2 percent of the total variations in exports ($R^2 = 0.9728$). The model has a better fit since its Root Mean

Squared Error is 0.10538. The closer the Root Mean Squared Error to zero, the better the model.

From the results (table 4.4), the coefficient for logRERVOL is significant at 5 percent level of significance ($p < 0.05$), meaning that logRERVOL is important. A percent unit increase in exchange rate volatility decreases exports by 0.046 percent. The coefficient for logY_foreign is significant at 5 percent level of significance ($p < 0.05$), implying that logY_foreign is important. A percent unit increase in foreign (UK, US and China) national income increases exports by 0.019 percent. The coefficient for logRER is significant at 5 percent level of significance ($p < 0.05$), meaning that logRER is important. A percent unit increase in real exchange rate, decreases imports by 0.083 percent. The coefficient for logTOT is not significant at 5 percent level of significance ($p < 0.05$), meaning that logTOT is not that important. A percent unit increase Terms of Trade (TOT) increases exports by 0.007 percent.

As shown in appendix 12, the model as an Error Correction Mechanism (ECM) of -0.072 (*speed of adjustment*), which is negative and significant meaning that there is long-run causality running from logX to logRERVOL, logY_foreign, logRER and logTOT.

In the short term, logRERVOL granger causes logX, and this relationship is uni-directional (*see appendix 12*). The estimated equation shows that the coefficients of Y_foreign and TOT are positive and the coefficients of real exchange rate volatility, real exchange rate are negative and are statistically significant. This implies that increase in real foreign income and improvement in terms of trade (TOT), positively affect export demand while real exchange rate volatility and real exchange rate have negative impact on exports.

**CHAPTER FIVE:SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

This chapter presents summary of the study, conclusions and policy recommendation based on the findings.

**5.1 Summary**

Empirical evidence has shown that imports and exports are affected by several factors. In this study, it was postulated that imports are affected by the exchange rate volatility, domestic income, real exchange rate and terms of trade while exports are affected by the exchange rate volatility, foreign income (US, UK and China), real exchange rate and the terms of trade.

The multiple regression results from the import function (model 1) with logM as the dependent variable, and logRERVOL, logY_domestic, logRER, and logTOT, as explanatory variables established that, the coefficients for logRERVOL, logY_domestic, logRER were all significant at 5 percent level of significance. The model had an Error Correction Mechanism (ECM) of 0.274 which was significant, meaning that divergence from equilibrium would take place and the system would be unstable. Further, logRERVOL granger causes logRER and logTOT; logRER granger causes logY_domestic, while logM granger causes logRER and logTOT and the relationship were uni-directional.

On the other hand, multiple regression results from the export function (model) with logX as the dependent variable, and logRERVOL, logY_foreign, logRER, and logTOT, as explanatory variables established that, the coefficient for logRERVOL, logY_foreign, and logRER were significant at 5 percent level of significance while the coefficient for logTOT was not significant at 5 percent level of significance, the

model had an Error Correction Mechanism (ECM) of -0.072 which was negative and significant meaning that there was long run causality.

## 5.2 Conclusions

The study estimated the impact of real exchange rate volatility on Kenyan imports and exports using annual data for periods from 1980 to 2015. Empirical evidence has shown that imports and exports are affected by several factors. In this study, it was postulated that imports are affected by exchange rate volatility, domestic income, real exchange rate and terms of trade. While exports are affected exchange rate volatility, foreign income (in this case, US, UK and China), real exchange rate and terms of trade.

Results of cointegration analysis using Johansen test found the trace statistic for both models to be smaller than the critical value at 5 percent level of significance, with a maximum rank of two (2). Regression results for the import function shows that the model has significant Error Correction Mechanism (ECM) implying that divergence from equilibrium will take place and the system will be unstable. While the export function model shows that the model has a negative Error Correction Mechanism (ECM) implying that there is long run causality relationship.

## 5.3 Recommendations

From the empirical analysis, results suggest that trade can be improved if macroeconomic policies which aim at keeping stable competitive real exchange rate are adopted. Therefore policy makers should establish coherent policies that will lead to a stable exchange rate system under which stability of the real exchange rate will be achieved and maintained to boost the country's overall trade and economic growth.

The government therefore, needs to commit itself in maintaining the stability and competitiveness of the exchange rate as part of its promotion and diversification strategy and apply appropriate policy management tools as well as embracing structural reforms that contribute to international competitiveness

## 5.4 Limitations of the study

Sources of exchange rate variations has not been explained and therefore an open area for research. There has also been a belief that, strengthening and weakening of the dollar plus the international oil prices and the monetary policy have been the main drivers of these movements. Theoretical literature has focused more on this belief, but, there has been no clear evidence on the role of monetary policy linking monetary policy and exchange rate movement. Researchers need to fully exhaust this gap.

## 5.5 Suggestions for further reading

The researcher suggests study on the effect of current public sector reforms in promoting a stable exchange rate and how devolution affects trade and whether there is any relationship between these variables and real exchange rate.

There are other factors that affect trade such as interest rate, government spending/borrowing among others which the study did not analyze. Therefore there is need for in-depth analysis of these factors to see how they affect imports and exports

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# APPENDICES

## OUTPUT 1: Volatility measurement

```
      Source |       SS           df       MS            Number of obs =        35
-------------+--------------------------------           F( 1,     33) = 1496.85
       Model | 18.1273049         1  18.1273049          Prob > F      =  0.0000
    Residual | .399640464        33  .012110317          R-squared     =  0.9784
-------------+--------------------------------           Adj R-squared =  0.9778
       Total | 18.5269454        34  .544910158          Root MSE      =  .11005

-------------+----------------------------------------------------------------
      logRER |     Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      logRER |
         L1. |    .93191   .0240871    38.69   0.000     .8829043    .9809156

       _cons |   .3265939   .0913447     3.58   0.001     .1407516    .5124361
-------------+----------------------------------------------------------------
```

Appendix A 1: Lag Length Determination (Model 1)

```
varsoc  logM logRERVOL logY_domestic logRER logTOT

   Selection-order criteria
   Sample:  1985 - 2015                        Number of obs      =        31
  +---------------------------------------------------------------------------+
  | lag |    LL      LR     df    p     FPE       AIC      HQIC      SBIC      |
  |-----+---------------------------------------------------------------------|
  |  0  |  78.454                        6.0e-09  -4.73897  -4.66357  -4.50768 |
  |  1  | 221.521  286.13   25  0.000    3.0e-12  -12.3562  -11.9038  -10.9685 |
  |  2  | 252.491   61.94   25  0.000    2.4e-12  -12.7414   -11.912  -10.1972 |
  |  3  | 299.584  94.186   25  0.000    8.4e-13  -14.1667  -12.9604  -10.4661 |
  |  4  | 362.688 126.21*   25  0.000    1.8e-13* -16.625* -15.0417*  -11.768* |
  +---------------------------------------------------------------------------+
   Endogenous:  logM logRERVOL logY_domestic logRER logTOT
    Exogenous:  _cons
```

Appendix A 2: Lag Length Determination (Model 2)

```
varsoc  logX logRERVOL  logY_foreign logRER logTOT

   Selection-order criteria
   Sample:  1985 - 2015                        Number of obs      =        31
  +---------------------------------------------------------------------------+
  | lag |    LL      LR     df    p     FPE       AIC      HQIC      SBIC      |
  |-----+---------------------------------------------------------------------|
  |  0  |  71.3337                       9.5e-09  -4.2796   -4.2042  -4.04831  |
  |  1  | 227.938  313.21   25  0.000    2.0e-12 -12.7702  -12.3179 -11.3825*  |
  |  2  | 252.686  49.495   25  0.002    2.3e-12 -12.7539  -11.9246  -10.2098  |
  |  3  | 283.239  61.106   25  0.000    2.4e-12 -13.1122  -11.9059  -9.41157  |
  |  4  | 327.266  88.055*  25  0.000    1.8e-12* -14.3398* -12.7565* -9.48271 |
  +---------------------------------------------------------------------------+
   Endogenous:  logX logRERVOL logY_foreign logRER logTOT
    Exogenous:  _cons
```

## Appendix A 3: Johansen Cointegration Test (Model 1)

```
                        Johansen tests for cointegration
Trend: constant                                   Number of obs =      33
Sample:  1983 - 2015                                       Lags =       2
────────────────────────────────────────────────────────────────────────
                                                     5%
maximum                                   trace   critical
  rank     parms       LL        eigenvalue  statistic   value
   0        30     222.88215         .        86.4022   68.52
   1        39     241.65121      0.67939     48.8641   47.21
   2        46     254.29302      0.53521     23.5804*  29.68
   3        51     262.79709      0.40274      6.5723   15.41
   4        54     265.46352      0.14922      1.2394    3.76
   5        55     266.08324      0.03686
────────────────────────────────────────────────────────────────────────
```

## Appendix A 4: Johansen Cointegration Test (Model 2)

```
. vecrank  logX  logRERVOL  logY_foreign logRER logTOT, lags(1)

                        Johansen tests for cointegration
Trend: constant                                   Number of obs =      34
Sample:  1982 - 2015                                       Lags =       1
────────────────────────────────────────────────────────────────────────
                                                     5%
maximum                                   trace   critical
  rank     parms       LL        eigenvalue  statistic   value
   0         5     194.58073         .       114.6315   68.52
   1        14     218.0537       0.74861     67.6855   47.21
   2        21     240.43445      0.73193     22.9240*  29.68
   3        26     247.79873      0.35156      8.1955   15.41
   4        29     250.40251      0.14201      2.9879    3.76
   5        30     251.89647      0.08413
────────────────────────────────────────────────────────────────────────
```

## Appendix A 5: Correlation Analysis (Model 1)

```
. corr logM logRERVOL logY_domestic logRER logTOT
(obs=33)

                    logM logRER~L logY_d~c    logRER    logTOT
       ─────────────────────────────────────────────────────────
         logM │    1.0000
    logRERVOL │   -0.1979    1.0000
  logY_domes~c │    0.9913   -0.2405    1.0000
        logRER │    0.7429    0.0669    0.7219    1.0000
        logTOT │   -0.1386    0.4582   -0.2606    0.0137    1.0000
```

Appendix A 6: Correlation Analysis (Model 2)

```
. corr  logX logRERVOL  logY_foreign logRER logTOT
(obs=33)

                      logX logRER~L logY_f~n   logRER   logTOT
             ────────────────────────────────────────────────
        logX │  1.0000
   logRERVOL │ -0.1234    1.0000
logY_foreign │  0.9376   -0.0896    1.0000
      logRER │  0.7715    0.0669    0.9239   1.0000
      logTOT │ -0.0379    0.4582   -0.1279   0.0137   1.0000
```

Appendix A 7: Serial Correlation test (Model 2)

```
. vif

    Variable │      VIF        1/VIF
    ─────────────────────────────────────
logY_foreign │     8.55     0.116994
      logRER │     8.44     0.118511
   logRERVOL │     1.38     0.726524
      logTOT │     1.34     0.748843
    ─────────────────────────────────────
    Mean VIF │     4.92
```

Appendix A 8: Serial Correlation test (Model 1)

```
. vif

    Variable │      VIF        1/VIF
    ─────────────────────────────────────
logY_domes~c │     2.70     0.370947
      logRER │     2.47     0.404104
   logRERVOL │     1.39     0.719183
      logTOT │     1.35     0.741639
    ─────────────────────────────────────
    Mean VIF │     1.98
```

Figure A 1: Normality Test (Model 1)



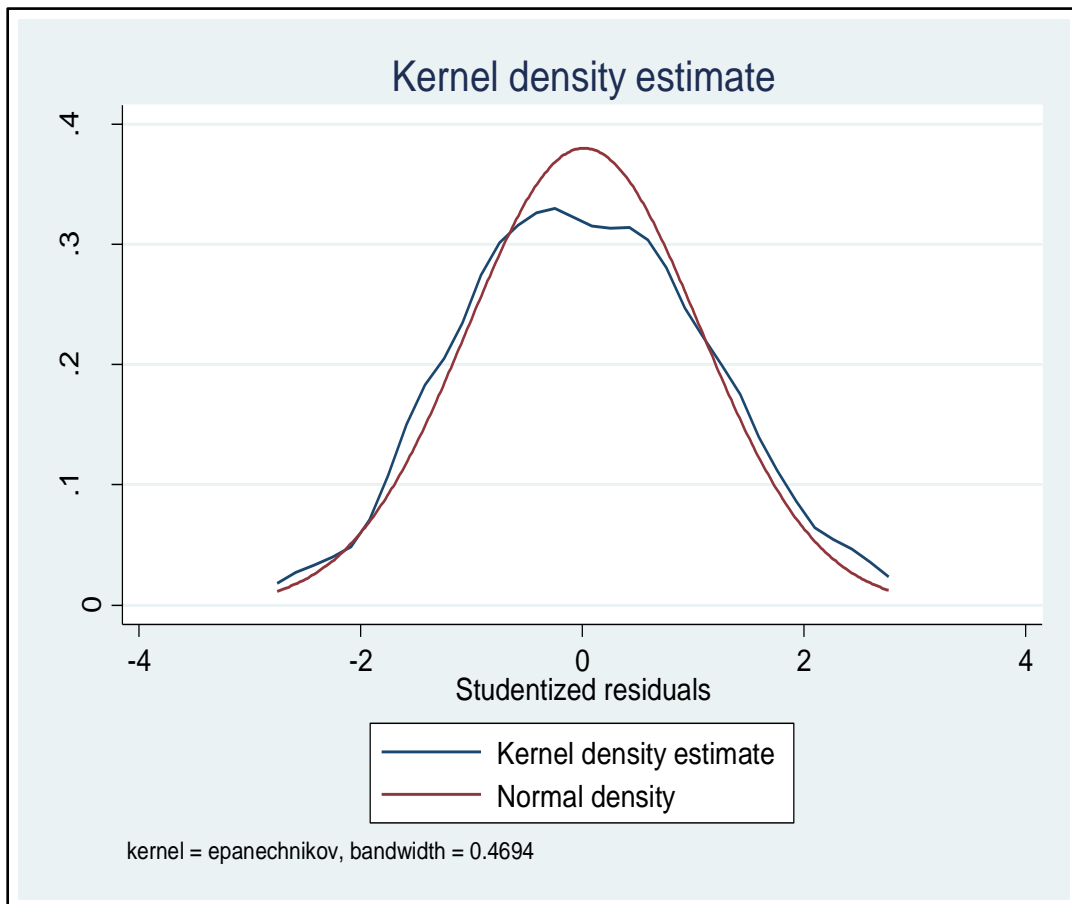Kernel density estimate

kernel = epanechnikov, bandwidth = 0.4694

Figure A2: Normality Test (Model 2)
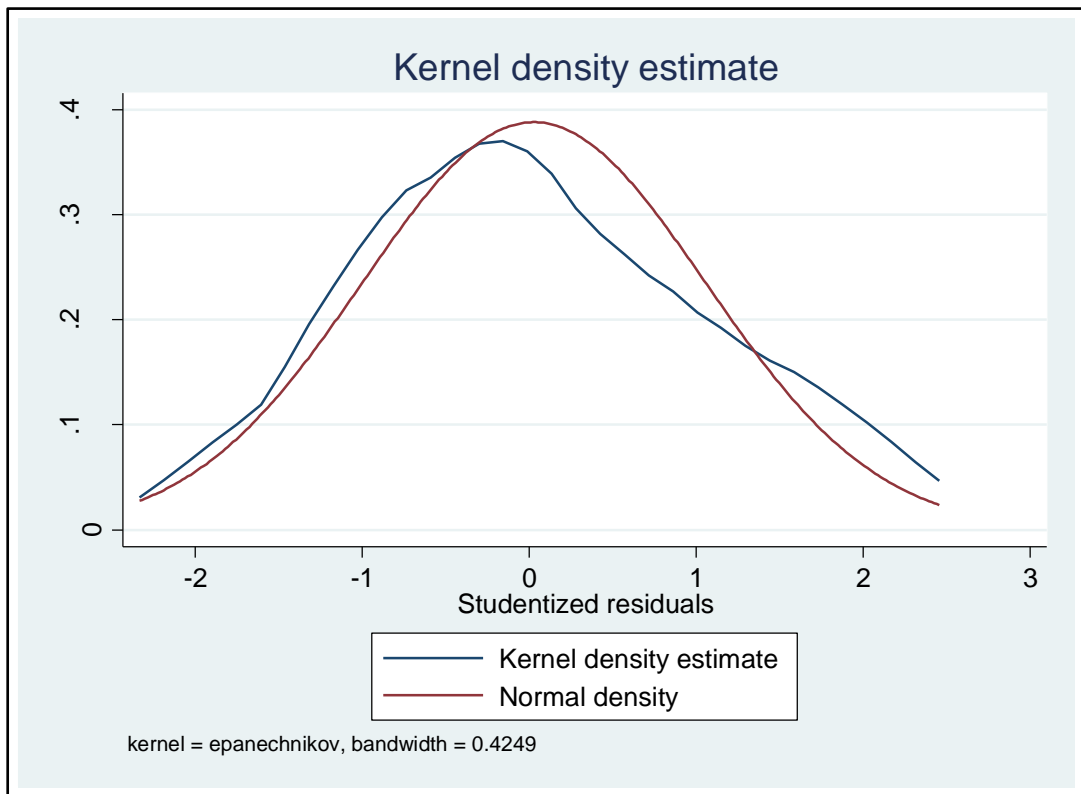


Figure A 3: Linearity Test (Model 1)
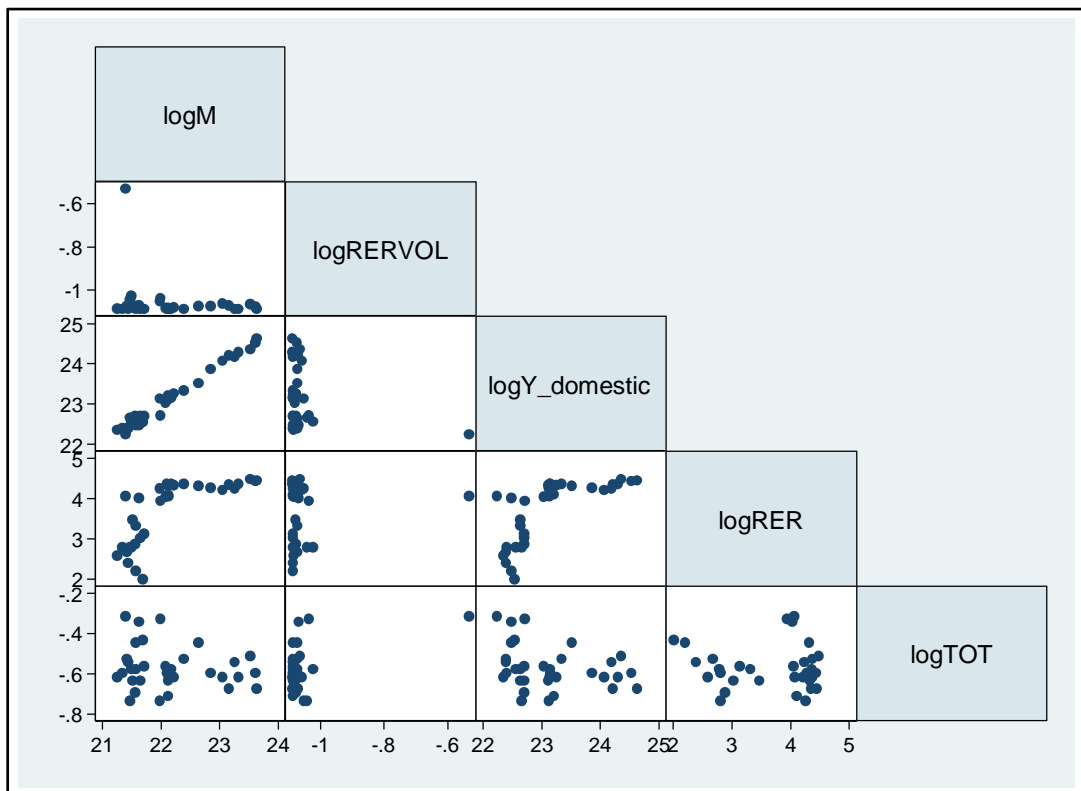
Figure A 4: Linearity Test (Model 2)
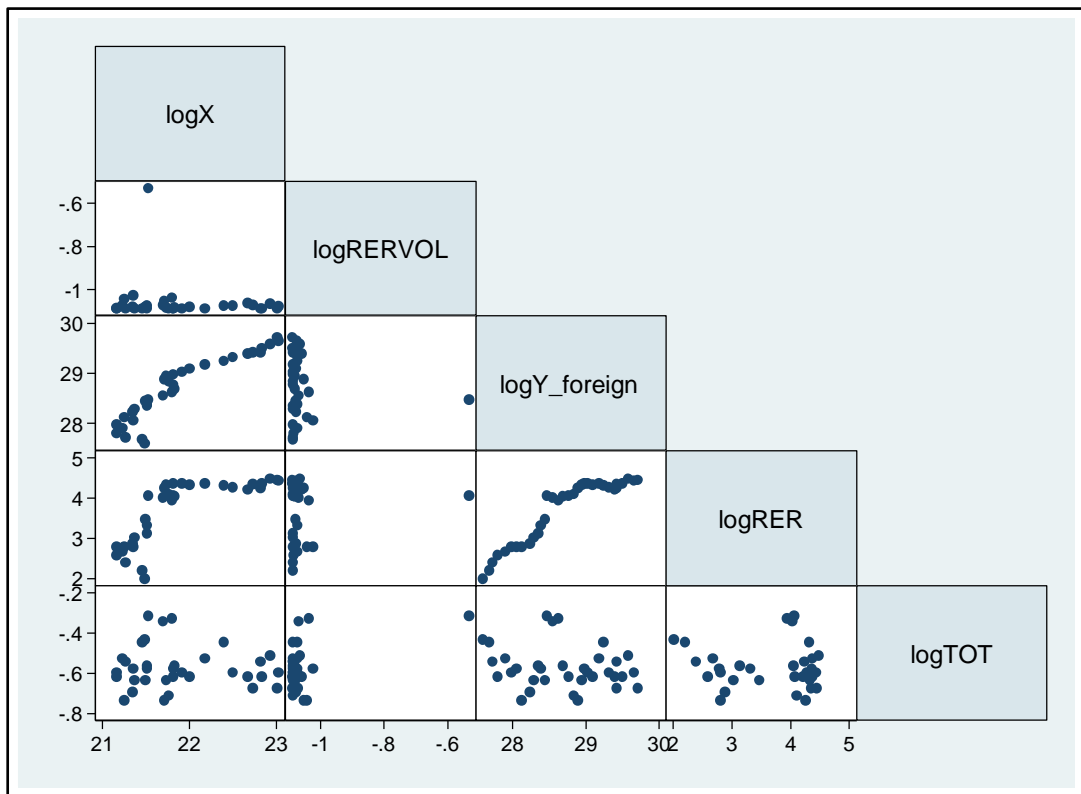
## Appendix A 9: Long Term Results (Model 1)

```
Cointegrating equations

Equation          Parms     chi2     P>chi2

_ce1                4    13935.66    0.0000


Identification:   beta is exactly identified
                  Johansen normalization restriction imposed
```

| beta | Coef. | Std. Err. | z | P>|z| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| _ce1 | | | | | | |
| logM | 1 | . | . | . | . | . |
| logRERVOL | .0516173 | .0029322 | 17.60 | 0.000 | .0458703 | .0573643 |
| logY_domes~c | .0796462 | .0016408 | 48.54 | 0.000 | .0764302 | .0828622 |
| logRER | -.0140361 | .0011093 | -12.65 | 0.000 | -.0162103 | -.0118619 |
| logTOT | .0265455 | .0015817 | 16.78 | 0.000 | .0234453 | .0296456 |
| _cons | 1.081128 | . | . | . | . | . |

## Appendix A 10: Long Term Results (Model 2)

```
Cointegrating equations

Equation          Parms     chi2     P>chi2

_ce1                4    435.4189    0.0000


Identification:   beta is exactly identified
                  Johansen normalization restriction imposed
```

| beta | Coef. | Std. Err. | z | P>|z| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| _ce1 | | | | | | |
| logX | 1 | . | . | . | . | . |
| logRERVOL | -.0350694 | .004225 | -8.30 | 0.000 | -.0433502 | -.0267885 |
| logY_foreign | -1.942738 | .1605115 | -12.10 | 0.000 | -2.257335 | -1.628141 |
| logRER | .0796224 | .0133108 | 5.98 | 0.000 | .0535337 | .1057111 |
| logTOT | .0098806 | .003713 | 2.66 | 0.008 | .0026033 | .0171578 |
| _cons | 26.6647 | . | . | . | . | . |

## Appendix A 11: Short Term Results (Model 1) - Granger Causality Results

|  | D_logM | D_logRERVOL | D_logY_domestic | D.logRER | D.logTOT |
|---|---|---|---|---|---|
| L._ce1 | 0.274 | -0.798 | 3.018 | 4.662 | -38.128 |
|  | (0.015)$^*$ | (0.985) | (0.519) | (0.260) | (0.097) |
| LD.logM | 0.044 | -234.559 | -26.254 | -36.195 | 175.083 |
|  | (0.987) | (0.376) | (0.356) | (0.150) | (0.210) |
| L2D.logM | -0.739 | -307.329 | -29.172 | -49.874$^*$ | 325.112$^{**}$ |
|  | (0.766) | (0.197) | (0.254) | (0.027) | (0.010) |
| L3D.logM | -1.069 | -244.991 | -19.139 | -31.012 | 320.897$^{***}$ |
|  | (0.558) | (0.162) | (0.308) | (0.062) | (0.001) |
| LD.logRERVOL | -0.010 | -1.265 | -0.185 | -0.282 | 2.092$^*$ |
|  | (0.611) | (0.484) | (0.340) | (0.100) | (0.028) |
| L2D.logRERVOL | 0.002 | -1.923 | -0.229 | -0.337$^*$ | 1.900$^*$ |
|  | (0.934) | (0.285) | (0.234) | (0.048) | (0.045) |
| L3D.logRERVOL | 0.000 | -0.559 | -0.098 | -0.142 | 0.943$^*$ |
|  | (0.978) | (0.522) | (0.294) | (0.087) | (0.041) |
| LD.logY_domestic | -0.027 | -26.856 | -2.363 | -3.806 | 14.848 |
|  | (0.934) | (0.383) | (0.474) | (0.193) | (0.361) |
| L2D.logY_domestic | -0.118 | -33.518 | -2.967 | -5.748$^*$ | 37.552$^*$ |
|  | (0.714) | (0.276) | (0.369) | (0.049) | (0.021) |
| L3D.logY_domestic | -0.038 | -25.206 | -2.131 | -3.479$^*$ | 28.432$^{**}$ |
|  | (0.831) | (0.139) | (0.244) | (0.032) | (0.002) |
| LD.logRER | 0.033 | 3.087 | 0.003 | 0.412 | -1.045 |
|  | (0.605) | (0.616) | (0.996) | (0.480) | (0.747) |
| L2D.logRER | -0.016 | 9.423 | 0.853 | 1.412 | -8.009 |
|  | (0.876) | (0.329) | (0.410) | (0.123) | (0.115) |
| L3D.logRER | -0.070 | -5.877 | -0.242 | -0.129 | 9.254$^{**}$ |
|  | (0.225) | (0.290) | (0.685) | (0.806) | (0.002) |
| LD.logTOT | -0.003 | -2.082 | -0.247 | -0.409 | 1.769 |
|  | (0.926) | (0.507) | (0.463) | (0.170) | (0.286) |
| L2D.logTOT | -0.010 | -2.947 | -0.251 | -0.492$^*$ | 3.089$^*$ |
|  | (0.727) | (0.262) | (0.374) | (0.049) | (0.026) |
| L3D.logTOT | -0.013 | -2.135 | -0.155 | -0.291$^*$ | 3.042$^{***}$ |
|  | (0.423) | (0.164) | (0.347) | (0.046) | (0.000) |
| _cons | 0.088 | -6.139 | -1.183 | -1.465 | -0.144 |

|  | D_logM | D_logRERVOL | D_logY_domestic | D.logRER | D.logTOT |
|---|---|---|---|---|---|
|  | (0.500) | (0.625) | (0.380) | (0.219) | (0.983) |

*p*-values in parentheses; $^*$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Appendix A 12: Short Term Results (Model 2) – Granger Causality Results

|  | logX |
|---|---|
| **D_logX** |  |
| L._ce1 | -0.072 |
|  | (0.013)$^*$ |
| _cons | 0.048$^{**}$ |
|  | (0.005) |
| **D_logRERVOL** |  |
| L._ce1 | 21.933$^{***}$ |
|  | (0.000) |
| _cons | 0.192 |
|  | (0.917) |
| **D_logY_foreign** |  |
| L._ce1 | 0.687 |
|  | (0.470) |
| _cons | -6.344$^{***}$ |
|  | (0.000) |
| **D_logRER** |  |
| L._ce1 | -0.441 |
|  | (0.397) |
| _cons | -0.708$^{**}$ |
|  | (0.001) |
| **D_logTOT** |  |
| L._ce1 | -0.221 |
|  | (0.960) |
| _cons | 0.708 |
|  | (0.705) |

*p*-values in parentheses; $^*$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Appendix A 13: Data used for analysis

| year | X | M | Y_domestic | GDP | TOT_adjusted | RER | TOT | Y_china | Y_UK | Y_US | Y_foreign | RERVOL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1980 | 2.14E+09 | 2.61E+09 | 6.14E+09 | 7.27E+09 | -2.9E+10 | 7.42 | 0.65 | 1.43E+11 | 4.47E+11 | 2.30E+12 | 9.63E+11 | 0.342013 |
| 1981 | 2.09E+09 | 2.32E+09 | 5.81E+09 | 6.85E+09 | -4.3E+10 | 9.05 | 0.64 | 1.44E+11 | 4.19E+11 | 2.60E+12 | 1.05E+12 | 0.337053 |
| 1982 | 1.71E+09 | 2.03E+09 | 5.3E+09 | 6.43E+09 | -8.1E+10 | 10.92 | 0.58 | 1.54E+11 | 3.98E+11 | 2.73E+12 | 1.09E+12 | 0.337107 |
| 1983 | 1.55E+09 | 1.69E+09 | 5.09E+09 | 5.98E+09 | -8.9E+10 | 13.31 | 0.54 | 1.84E+11 | 3.82E+11 | 2.97E+12 | 1.18E+12 | 0.338144 |
| 1984 | 1.66E+09 | 1.98E+09 | 5.34E+09 | 6.19E+09 | -8.4E+10 | 14.41 | 0.59 | 2.15E+11 | 3.59E+11 | 3.36E+12 | 1.31E+12 | 0.342013 |
| 1985 | 1.55E+09 | 1.85E+09 | 5.34E+09 | 6.14E+09 | -1.04E+11 | 16.43 | 0.55 | 2.59E+11 | 3.78E+11 | 3.61E+12 | 1.42E+12 | 0.33717 |
| 1986 | 1.87E+09 | 2.16E+09 | 6.29E+09 | 7.24E+09 | -1.03E+11 | 16.23 | 0.56 | 2.59E+11 | 4.83E+11 | 3.81E+12 | 1.52E+12 | 0.358959 |
| 1987 | 1.7E+09 | 2.1E+09 | 6.91E+09 | 7.97E+09 | -9.7E+10 | 16.45 | 0.48 | 2.31E+11 | 5.93E+11 | 4.08E+12 | 1.64E+12 | 0.352202 |
| 1988 | 1.87E+09 | 2.31E+09 | 7.21E+09 | 8.36E+09 | -9.5E+10 | 17.75 | 0.5 | 2.71E+11 | 7.28E+11 | 4.46E+12 | 1.82E+12 | 0.340564 |
| 1989 | 1.91E+09 | 2.5E+09 | 7.19E+09 | 8.28E+09 | -1.12E+11 | 20.57 | 0.53 | 3.00E+11 | 7.32E+11 | 4.75E+12 | 1.93E+12 | 0.33726 |
| 1990 | 2.2E+09 | 2.69E+09 | 7.24E+09 | 8.57E+09 | -1.54E+11 | 22.91 | 0.57 | 3.07E+11 | 8.53E+11 | 4.99E+12 | 2.05E+12 | 0.337149 |
| 1991 | 2.2E+09 | 2.33E+09 | 6.78E+09 | 8.15E+09 | -1.34E+11 | 27.51 | 0.56 | 3.29E+11 | 8.92E+11 | 5.14E+12 | 2.12E+12 | 0.341827 |
| 1992 | 2.16E+09 | 2.19E+09 | 6.79E+09 | 8.21E+09 | -1.28E+11 | 32.22 | 0.53 | 3.71E+11 | 9.39E+11 | 5.46E+12 | 2.26E+12 | 0.340245 |
| 1993 | 2.24E+09 | 1.95E+09 | 4.58E+09 | 5.75E+09 | -1.24E+11 | 58 | 0.73 | 3.83E+11 | 8.47E+11 | 5.72E+12 | 2.32E+12 | 0.334697 |
| 1994 | 2.65E+09 | 2.45E+09 | 5.81E+09 | 7.15E+09 | -9E+10 | 56.05 | 0.71 | 4.88E+11 | 9.33E+11 | 6.11E+12 | 2.51E+12 | 0.344091 |
| 1995 | 2.95E+09 | 3.54E+09 | 7.33E+09 | 9.05E+09 | -8.9E+10 | 51.43 | 0.72 | 6.26E+11 | 1.02E+12 | 6.44E+12 | 2.70E+12 | 0.356155 |
| 1996 | 3.04E+09 | 3.87E+09 | 1.01E+10 | 1.2E+10 | -1.18E+11 | 57.11 | 0.57 | 7.32E+11 | 1.07E+12 | 6.85E+12 | 2.89E+12 | 0.339139 |
| 1997 | 2.98E+09 | 4.11E+09 | 1.12E+10 | 1.31E+10 | -7.1E+10 | 58.73 | 0.54 | 8.19E+11 | 1.21E+12 | 7.34E+12 | 3.12E+12 | 0.337519 |
| 1998 | 2.84E+09 | 4.05E+09 | 1.21E+10 | 1.41E+10 | -5E+10 | 60.37 | 0.49 | 8.72E+11 | 1.33E+12 | 7.84E+12 | 3.34E+12 | 0.337453 |
| 1999 | 2.69E+09 | 3.53E+09 | 1.11E+10 | 1.29E+10 | -6.1E+10 | 70.33 | 0.48 | 9.24E+11 | 1.33E+12 | 8.30E+12 | 3.52E+12 | 0.348072 |
| 2000 | 2.74E+09 | 4.03E+09 | 1.1E+10 | 1.27E+10 | -9.2E+10 | 76.18 | 0.53 | 1.01E+12 | 1.32E+12 | 8.84E+12 | 3.72E+12 | 0.338822 |
| 2001 | 2.98E+09 | 4.29E+09 | 1.12E+10 | 1.3E+10 | -4.5E+10 | 78.56 | 0.56 | 1.11E+12 | 1.31E+12 | 9.12E+12 | 3.85E+12 | 0.336982 |
| 2002 | 3.27E+09 | 3.98E+09 | 1.13E+10 | 1.31E+10 | -5.5E+10 | 78.75 | 0.55 | 1.23E+12 | 1.45E+12 | 9.39E+12 | 4.02E+12 | 0.337713 |
| 2003 | 3.59E+09 | 4.48E+09 | 1.25E+10 | 1.49E+10 | -9.4E+10 | 75.94 | 0.54 | 1.39E+12 | 1.69E+12 | 9.79E+12 | 4.29E+12 | 0.341288 |
| 2004 | 4.28E+09 | 5.29E+09 | 1.38E+10 | 1.61E+10 | -1.03E+11 | 79.17 | 0.59 | 1.60E+12 | 1.99E+12 | 1.04E+13 | 4.68E+12 | 0.337079 |
| 2005 | 5.34E+09 | 6.74E+09 | 1.63E+10 | 1.87E+10 | -1.00E+11 | 75.55 | 0.64 | 1.84E+12 | 2.10E+12 | 1.11E+13 | 5.01E+12 | 0.342717 |
| 2006 | 5.94E+09 | 8.33E+09 | 2.3E+10 | 2.58E+10 | -9.1E+10 | 72.1 | 0.55 | 2.20E+12 | 2.21E+12 | 1.19E+13 | 5.42E+12 | 0.3432 |
| 2007 | 7E+09 | 1.02E+10 | 2.83E+10 | 3.2E+10 | -9.6E+10 | 67.32 | 0.54 | 2.81E+12 | 2.54E+12 | 1.22E+13 | 5.84E+12 | 0.347776 |
| 2008 | 8.14E+09 | 1.25E+10 | 3.2E+10 | 3.59E+10 | -7.6E+10 | 69.18 | 0.58 | 3.51E+12 | 2.37E+12 | 1.22E+13 | 6.02E+12 | 0.337143 |
| 2009 | 7.42E+09 | 1.14E+10 | 3.3E+10 | 3.7E+10 | 0 | 77.35 | 0.51 | 4.07E+12 | 1.97E+12 | 1.20E+13 | 6.02E+12 | 0.342385 |
| 2010 | 8.26E+09 | 1.34E+10 | 3.58E+10 | 4E+10 | -3.6E+10 | 79.23 | 0.54 | 4.72E+12 | 2.08E+12 | 1.26E+13 | 6.48E+12 | 0.337024 |
| 2011 | 9.07E+09 | 1.63E+10 | 3.78E+10 | 4.2E+10 | -7.9E+10 | 88.81 | 0.6 | 5.70E+12 | 2.25E+12 | 1.32E+13 | 7.05E+12 | 0.344251 |
| 2012 | 9.99E+09 | 1.78E+10 | 4.53E+10 | 5.04E+10 | -4.3E+10 | 84.53 | 0.55 | 6.61E+12 | 2.24E+12 | 1.39E+13 | 7.58E+12 | 0.341952 |
| 2013 | 9.83E+09 | 1.83E+10 | 4.95E+10 | 5.49E+10 | -6.4E+10 | 86.12 | 0.51 | 7.42E+12 | 2.28E+12 | 1.44E+13 | 8.04E+12 | 0.337015 |
| 2014 | 9.07E+09 | 1.63E+10 | 3.78E+10 | 4.2E+10 | -7.9E+10 | 87.92 | 0.6 | 5.70E+12 | 2.25E+12 | 1.32E+13 | 7.05E+12 | 0.336988 |
| 2015 | 9.99E+09 | 1.78E+10 | 4.53E+10 | 5.04E+10 | -4.3E+10 | 98.18 | 0.55 | 6.61E+12 | 2.24E+12 | 1.39E+13 | 7.58E+12 | 0.344828 |

Source: The World Bank data bank