AN EMPIRICAL ANALYSIS OF THE RELATIONSHIP BETWEEN EXCHANGE RATES AND INFLATION IN KENYA (1973-2014)

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DECLARATION

This thesis is my original work and has not been presented for an award of a degree in any other university.

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This thesis has been submitted with my approval as the university supervisor

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Dr. Benedicto O. Ongeri

DEDICATION

To my dear mother, Jemima Were and husband, Okoth Origa, who supported and encouraged me throughout the process.

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LIST OF ABBREVIATIONS AND ACRONYMS

AD	Aggregate Demand
ADF	Augmented Dickey – Fuller
AIC	Akaike Information Criterion
ARCH	Autoregressive Conditional Heteroskedastic
AS	Aggregate Supply
ASEAN +3	Association of Southeast Asian and three East Asian Nations of China, Japan and South Korea
BIC	Bayesian Information Criterion
BOP	Balance of Payments
CPI	Consumer Price Index
ECM	Error Correction Model
ERPT	Exchange Rate Pass-through
EU	European Union
FPE	Final Prediction Error
GARCH	Generalized Autoregressive Conditional Heteroskedastic
GDP	Gross Domestic Product
HQ	Hannan-Quinn
IMF	International Monetary Fund
IT	Inflation Targeting
LR	Likelihood Ratio
OECD	Organization for Economic Cooperation and Developments
OLS	Ordinary Least Squares
OPEC	Oil Producing and Exporting Countries
PPI	Producer Price Index
PPP	Purchasing Power Parity
SBC	Schwartz Bayesian criterion
SDR	Special Drawing Rights
VAR	Vector Autoregression
VEC	Vector Error Correction

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ABSTRACT

This study examined the relationship between exchange rates and inflation in Kenya from an empirical perspective using time series data from the year 1973 to 2014. A VAR model was used and data analysis conducted using ADF unit root test, cointegration tests, VECM test as well as Granger causality test. The results of the data analysis revealed a positive unidirectional causality from exchange rate to inflation.

CHAPTER ONE
INTRODUCTION

1.0 Background

Basic macroeconomic indicators are usually used to measure the economic situation of a country. In order to measure the price stability of a country or economic system, inflation rate is normally used as an economic indicator. It is divided conceptually into two sides known as demand side inflation (demand pull inflation) and supply side (cost push inflation).

Kenya being an open economy country has its sources of inflation being both from domestic factors (internal pressure) and overseas factors (external pressure). Exchange rate fluctuations and international commodity prices are the main sources of the external pressure.

The impact of exchange rate on inflation rate depends on a country's choice of exchange rate regime. The system of exchange rate plays a critical role in curtailing the risk of exchange rate fluctuations, which will in turn have an effect on the economy. The economy is adversely affected by changes in exchange rates. Exchange rate fluctuations are likely to have a strong effect on the price level in a situation where there is floating exchange rates; this occurs via the aggregate demand (AD) and aggregate supply (AS). In a situation where a country is an international price taker, depreciation of local currency do affect the level of price directly through imports that consumers buy. This is on the aggregate supply. Indirectly, currency depreciation (devaluation) against a country's price level emanates from the cost of imported in terms of capital or intermediate goods. Therefore input prices will be more expensive following exchange rate weakening, and thereby increasing the production cost. This cost will be passed on to the consumers through goods prices thereby increasing the aggregate price level of a country and if it continues will cause inflation.

1.1 Economic Indicators

These are general trends in the economy as shown by statistical data. Some of the economic indicators include unemployment, Gross Domestic Product, Gross National Product, money supply changes, exchange rate, inflationary trends, and interest rate spread among others. This study will focus mainly on two economic indicators namely Inflation and Exchange Rates, as they are the ones concerning the subject of study.

1.1.1 Inflationary Trends

Inflation measures the rate at which prices are rising in an economy (Frisch, 1984). It is measured using Consumer Price Index, Producer price Index and Average Hourly Earnings. CPI measures the average price level for a basket of goods and services that are purchased by consumers, while PPI measures the average price level for a fixed basket of inputs that a producer requires to manufacture consumer goods. On the other hand, Average Hourly Earnings measures the change in a worker's wages; it sheds light on a consumer's disposable income and the cost to firms for their labour.

In order to understand inflation in Kenya, it is appropriate to discuss the movement of inflation over time from the year 1973 to 2014. This is also illustrated in table one and figure one.

The year beginning 1973 to 1975 inflation rates kept rising from a rate of 8.9% to 17.8% in 1975 caused by escalation of food prices due to dry weather, introduction of sales tax on non-essential manufactured goods in 1973, increased transportation costs and huge rises in the price of imports in 1974 and 1975.The coffee boom of 1976 however, eased the pressure on inflation. From 1977 to 1980 the inflation rate kept fluctuating mainly because of the increase in import prices, increase in rent, increase in the prices of crude oil by most OPEC countries. The oil shock nevertheless caught then president Moi government paralyzed by power struggle with the Jomo Kenyatta 'elite' (after his death) and this manifested itself in a near collapse of fiscal discipline.

In the year beginning 1980, there was an increase in the inflation rate all the way to 1982. This was as a result of the increase in sales tax in 1982, a sharp increase in food prices caused by high transportation costs and the increase in fuel prices coupled with an attempted coup on the government of the then president Moi. In response to this, the government introduced a deflationary monetary policy in 1983 which saw the inflation decline steadily up to 1984 after which the inflation did not fluctuate much through to the year 1989 as seen in figure one.

The high fuel prices caused by the gulf crisis saw inflation begin to rise in 1990 through the years following and reaching its peak in 1993 with a record of 46%, the highest inflation rate the country has experienced. Additionally, the donor embargo of November 1991 led to the government printing more money and increasing Treasury bill discount rate, pushing the rate further. The Goldenberg monetary overhang (excess money) of 1991 to 1993 also contributed to the rise in inflation during this period. The year 1992 political transition from single party to multiparty system destabilized the economy by creating uncertainties. In the year 1993, the Kenya shilling was devalued by the central bank, thereby making imports very expensive, there was bad weather hence crop production did not do well and food prices were pushed up, there were also high fuel prices as well as the widening of the value added tax in that year.

There was a sharp decline in inflation from 46% in 1993 to 28.8% in 1994 a hitting the lowest level of 1.6% in 1995 as can be seen from table1. This was attributed to the fact that there was an appreciation of the Kenya shilling, high levels of investment, good weather, a reduction of import duty, and increase in the inflow of foreign exchange emanating from massive private capital inflows.

In the year 1996, there was an increase in the rate of inflation to 8.86% then 11.36% in 1997 due to the El~Nino rains of 1997 which affected food production, erosion of business confidence precipitated by resurgence of political violence in the run up to 1997 elections. The rates continued to fluctuate until 2002 when elections were conducted and the then president Kibaki came into power. This year there was a big decline reaching 2%

and this was caused by the decline in food prices and prudent monetary policy, specifically by the central bank continuously ensuring that growth in money supply remained in tandem with economic trends. This decline in inflation was also partly due to the stability of the shilling exchange rate that restrained the increase in the price of imports.

However the drought and subsequent floods in 2003 saw the inflation rate rise to 14.5% in 2006, coupled with high oil prices. The favorable weather and the appreciation of the Kenya shillings that followed in 2007 saw the rate decline to 9.8%, but this was only short-lived as the post-election violence and the global economic turmoil that followed in 2008 made the inflation rate to go up again to 26.2% in 2008.

From year 2009 to 2010, the country recovered slowly from post-election crisis and this also brought down the rates of inflation to 10.5% in 2009, then 4.1% in 2010. In the year 2011, there was an increase to 14% caused by the increases in both oil and food prices, bad weather and the depreciation of the Kenya shillings.

The year 2012 Kenya went into elections again and president Uhuru Kenyatta came into power in 2013. Inflation had declined from 14% to 9.7% in 2012 and 5.7% in 2013 because of favorable weather conditions, decrease in electricity and fuel costs, and tightening of monetary policy by Central Bank of Kenya. The weakening in the agricultural sector especially tea and coffee, terror threats together with increase in cost of food and non-food items outweighed the decrease in electricity and fuel prices in 2014 causing a modest increase in the rate of inflation to 6.9% in 2014.

1.1.2 Exchange Rates

Exchange rate is the price of a country's currency in terms of another currency (Cassel, 1921). Exchange rate is a key macroeconomic variable in economic policy making, it allows direct comparison of prices among those who trade in goods and services, which occurs through the role it plays in connection of price systems in various countries thst trade with each other. This research will use the rate of exchange of the Kenya shilling versus the US dollar to establish if there is a relationship between Inflation and Exchange rates.

In the year 1973 Kenya was operating under a fixed exchange rate regime from post-independence under the presidential regime of Mzee Jomo Kenyatta. In this year, the Kenya shilling was devalued following the devaluation of the US dollar under the Smithsonian arrangements. It was during this time that the Kenya shilling was pegged to the US dollar. Devaluation and revaluation continued, albeit slightly all the way to the year 1975 when the Kenya shilling was tied to the SDR (weighted average of the exchange rate of the leading industrial countries).

There was depreciation in 1976, but it was short lived as the 'coffee boom' eased some of the economic difficulties and postponed the pressure for adjustment, this commodity boom led to an appreciation of the exchange rate up to 1978.

The depreciation continued from 1978 to 1980 with a new presidential regime of Moi coming into play, causing political uncertainty and a reduction to the coffee and tea prices. The 1979 oil shock also contributed to this

The decade beginning 1981 to 1991 had the Kenyan currency persistently and rapidly lose its value against the US$ giving an average annual rate of 27% to the US $ during this decade. In the year between 1981 and 1982, the Kenya Shilling depreciation accelerated with discrete devaluation. The attempted coup on Moi's government in 1982 also destabilized the economy with a depreciation of 19.3% occurring. By the end of 1982, the exchange rate regime was changed to a crawling peg in real terms. In the fourth quarter of 1984 the shilling depreciated by 6% and in the second quarter of 1988 it depreciated by 27%.The crawling peg regime lasted until 1990 when dual exchange rate system was adopted. This meant that there was an official exchange rate and a market rate which was operated on the basis of Foreign Exchange Bearer Certificates, but which was later relaxed in 1992 by allowing commercial banks to operate foreign exchange retention accounts.

The donor embargo of November 1991 however accelerated the depreciation in 1992 coupled with the political transition from single to multiparty systems which caused uncertainty. These factors led to the exchange rate hitting the 68.16 mark (88%

depreciation) in 1993 as seen in table 1. In October 1993, after a series of devaluations the official exchange rate was abolished. The official exchange rate was merged with the market rate and the shilling was put into complete float. This was followed by massive private capital inflows in 1994 leading to a buildup of foreign exchange reserves and the exchange rate appreciating by 34%.

In the period between January 1995 and October 1999, there occurred a currency depreciation of 21%, after which it became stable relatively up till the year 2001 as seen in figure 1.

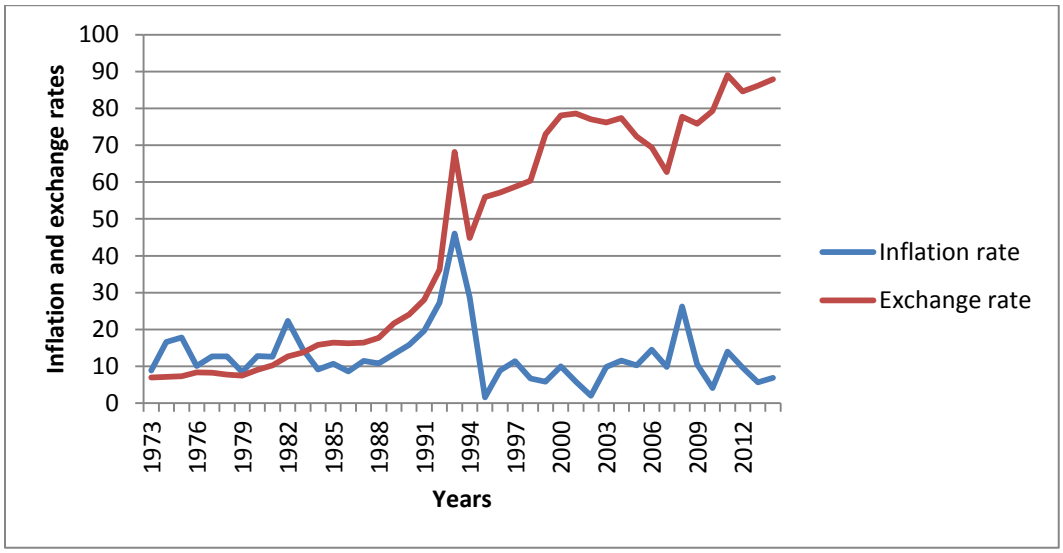
In early 2003, the time which Kenya ushered in a new presidential regime under Mwai Kibaki the currency appreciated strongly from 2002 December to December 2007. This was attributed to the surge in foreign exchange inflows, mainly remittances from Kenyans in the Diaspora, tourist receipts and short-term capital inflows.

The year beginning 2008 saw a depreciation of the Kenya shilling due to the post-election violence that rocked the country during that period. The Kenya shilling continued to depreciate in the following years from the year 2009 reaching an all-time high in the year 2011. This was triggered by the 'twin crises' which comprised of ripple effects of the global financial crisis and the euro- zone crisis that was associated with the Greek debt default. High international oil prices also contributed to the shilling depreciation, along with the decrease in capital inflows into Kenya.

The year running 2012 to 2014 saw a presidential regime change from that of Mwai Kibaki to Uhuru Kenyatta. These years were marked with depreciation caused by security concerns particularly terror threats and activities coupled with the weakening of the tourism sector.

From the above discussion it can be concluded that whenever depreciation occurred it was followed by an increase in the rate of inflation

Fig. 1: Inflation and Exchange Rate Trends, 1973-2014.



Source: Kenya Economic Surveys and Statistical Abstracts from the year 1981-2012

Table 1: Inflation and Exchange Rates, 1973-2014

Years	Inflation rate	Exchange rate
1973	8.9	7
1974	16.6	7.14
1975	17.8	7.34
1976	10.1	8.37
1977	12.7	8.28
1978	12.7	7.73
1979	8.4	7.48
1980	12.8	9.05
1981	12.6	10.3
1982	22.3	12.73
1983	14.6	13.76
1984	9.1	15.78
1985	10.7	16.43
1986	8.6	16.23
1987	11.5	16.45

1988	10.8	17.75
1989	13.3	21.6
1990	15.8	24.08
1991	19.6	28.07
1992	27.3	36.22
1993	46	68.16
1994	28.8	44.84
1995	1.6	55.94
1996	8.9	57.11
1997	11.4	58.73
1998	6.7	60.37
1999	5.8	72.93
2000	10	78.04
2001	5.8	78.6
2002	2	77.07
2003	9.8	76.14
2004	11.6	77.34
2005	10.3	72.37
2006	14.5	69.4
2007	9.8	62.68
2008	26.2	77.71
2009	10.5	75.82
2010	4.1	79.26
2011	14	89.06
2012	9.7	84.6
2013	5.7	86.12
2014	6.9	87.92

Source: Kenya Economic Surveys and Statistical Abstracts from the year 1981-2012

1.2 Problem Statement

Kenya had the prices of its goods and services continually rise since the mid 1970s until early 1980s, caused by the policy it operated of fixed exchange rate at that was introduced in the mid 1980s, the continuous rise in prices worseneds. Kenyan Government liberalized the foreign exchange market gradually, whereby the fixed exchange rate regime lasted till 1982 after which a crawling peg was introduced in 1983 and operated to 1993. In that year of 1993, a floating exchange rate regime was introduced.

Kenya achieved the independence to control inflation using monetary policy after the foreign exchange market was liberalized but at the same time the its nominal anchor to tie down domestic price was lost. This meant that the effects of globalization were now being directly transmitted into the economy (Kiptui and Kipyegon, 2008). This further implies shocks to inflation rate, pushing the inflation rates higher and depreciating the shilling. Understanding this situation calls for an investigation to establish the link between these variables.

This study is therefore meant to establish the exact relationship that exists between exchange rates and inflation. There is also need to investigate whether there is indeed a causal relationship among the variables and if there is, whether it is positive or negative and in that way ascertain the effect that exchange rate has on inflation.

1.3 Objective of the Study

The main objective of this paper is to examine the impact of changes in exchange rates on inflation in Kenya. This general objective will be achieved through the following specific objectives:

1) To examine the existence and direction of any causal relationship between exchange rates and inflation in Kenya in the long run
2) To investigate the existence and direction of any causal relationship between exchange rates and inflation in Kenya in the short run.
3) To develop suitable recommendations that can be used in making policy in the future in Kenya especially when it comes to curbing the high rates of inflation.

1.4 Research Questions

In order to accomplish the objectives of the research, the main research question that will guide the research process is: Does exchange rate affect inflation in Kenya?

The above main research question is extended to the following sub- questions:

1) Is there any connection between exchange rates and inflation in Kenya?
2) To what extent does an exchange rate depreciation or appreciation cause a rise or fall in the rate of inflation in Kenya?
3) What is the direction of the causal link between exchange rates and inflation in Kenya?

1.5 Justification of Study

Kenya as a country has been experiencing fluctuations in inflation rates as well as exchange rates over time. It is therefore necessary to establish the true basal link between exchange rate and inflation and progression made on the issue once and for all for the benefit of the economy.

Additionally, it is in every economy's objective to be competitive in the international market by maintaining a relatively low level of inflation rate and concurrently having a manageable exchange rate. This has been difficult in practice, in this view, this paper will add to policy in matters of exchange rate and inflation alike.

The study will also contribute to existing empirical literature on the subject matter.

CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction

This chapter presents a review of literature first, on real exchange rate, second on the rate of inflation, and finally on the link that exists between the two variables, exchange rates and inflation. It will also lay focus on various researches done by other scholars on the subject both in Kenya and in other countries. This chapter is organized into Theoretical Literature and Empirical Literature reviews.

2.1 Theoretical Literature

2.1.1Exchange Rate

Exchange rate is defined as the price of the currency of a country in terms of another country's currency. Being a price, it is be determined by demand and supply.

According to Mankiw (1998), exchange rate is divided into: Spot exchange rate which is the present rate in any the market at a given specific period, Forward exchange rate which is the speculated exchange rate at a future time. Its existence creates the potential for speculation and Effective exchange rate also known as Sterling Index or Sterling trade-weighted index which is an average exchange rate derived from a basket of currencies.

There also exists Free or Pegged Exchange rate in which if a currency is free floating, its rate is allowed to vary over other currencies and is determined by the market force of demand and supply. On the other hand, a movable or an adjustable peg system is one of fixed exchange rates but with provision for devaluation and revaluation of the currency.

Nominal and Real Exchange rates- the nominal exchange rate e is the domestic currency of one unit of a foreign currency. The Real exchange rate is defined as RER= e (P*/P) where P is the domestic price level and P* is the foreign price level. P and P* must have the same arbitrary value in some chosen base year. Hence in the base year, RER= e.

2.1.1.0 Appreciation and Depreciation/ Exchange Rate Fluctuations

Each time either of the two component currencies changes in value, a market based exchange rate will change as well. (Maurizio *et al*, 2007). Any time the demand for a currency is greater than the available supply, the currency will appreciate or tend to

become more valuable. However if the available supply is more than the demand, then the currency will face depreciation (become less valuable), and this implies that people prefer holding wealth in other forms, possibly other currencies, it does also not mean that they people no longer want money. An increase in speculative and transaction demand money both cause an increase in demand for a currency. The transaction demand for money corresponds highly to the country's business activity level, gross domestic product (GDP), and employment levels. High unemployment rates imply less expenditure on goods and services by the public. The transaction demand for money is easy to manage by central banks because all they need to do is to adjust the available money supply to accommodate changes in the demand for money. On the other hand, by adjusting the interest rate, the speculative demand for money is managed albeit with difficulty by a central bank. A higher interest rate leads to increased demand for a currency by investors, hence an investor is more likely to buy that currency in such a scenario. It is an agreed fact that speculation of currency can slow down economic growth especially when those investors who speculate in large currency quantities deliberately create a decrease on a currency to make the government to sell it in order to maintain stability. After this the speculator can buy the currency from the bank at a profit.

In order for a country to pursue an independent economic policy, it is appropriate to operate with a system of free rate as is the opinion of the advocates of flexible exchange rates. Its monetary policy has to deflate its currency and hinge the country into depression and unemployment. A country should allow the exchange rate to vary freely while at the same time focusing on internal stability of unemployment, output and prices, since internal stability is a better objective for a country to pursue as it would do away with economic interference from external sources.

In order to curtail the invasion of inflationary and deflationary forces, it is necessary to let exchange rates vary. Fixing exchange rates rigidly causes the transmission of shocks of inflation and deflation from abroad into the economy. This is because fixed exchange rates act as shock absorber.

2.1.1.1 Theories of Exchange Rates

Purchasing Power Parity and Quantity theory of Exchange rates

According to PPP theory, in order to balance deviating movements in national price, exchange rates must move over time. This theory put forward by Cassel (1921) states that exchange rate between two countries should be equal to the ratio of the price levels of the two countries. This implies that over time the exchange rates between two countries would move to a level whereby it enables exactly the same basket of goods would be purchased in the two countries. A summary of the empirical content of this theory is expressed in equation 1 below:

$$k = (1 - a_1)\bar{k} + a_1 k_{-1} + a_2 z \; ; 0 < a_1 < 1, a_2 > 0 \qquad (1)$$

Where $\bar{k}$ is the equilibrium real price level that perhaps has a time trend k_{-1} and k are the lagged and current and lagged deviations from PPP, and z measures current account imbalance on the deviation from PPP or the systematic effect of borrowing.

On the other hand, according to Mankiw (1998), the Quantity Theory of Exchange Rate is the monetary approach to exchange rate. The approach uses the quantity theory of money and strict PPP to arrive at the theory of exchange rate, and is formulated by combining the theory of monetary equilibrium and exchange rate determination. The condition for monetary equilibrium is written in the equation 2 below:

$$\frac{M}{P} V(r, Y) = Y \qquad (2)$$

Where, M, Y, P, V, and r are the nominal quantity of money, Real Income, Price level, Velocity, nd Interest Rates respectively.

Solving for price level yields equation 3:

$$P = V\frac{M}{Y} (3)$$

On the other hand, a strict PPP indicate that domestic price level is equal to foreign prices, P* multiplied by exchange rates, E in equation 4: P=P*E (4)

Substituting equation 4 in to 3 yields equilibrium exchange rate as shown in equation 5 below:

$$E = (1/P^*)\, V\frac{M}{Y} \qquad (5)$$

From the above equation the theory therefore maintains that it is PPP that links international prices in a situation of full flexibility of prices. Therefore any change in money demand must be compensated in price level changes in conjunction with exchange rates, given the nominal quantity of money.

Balance of Payments Theory of Exchange Rates

This theory argues that the balance receipts and payments emanating from international trade in goods, assets and services are the basis on which exchange rate adjusts. The effect of exchange rates on the capital account occurs changes relative prices, and competitiveness. The extent of the effect on the capital account is such that expectational considerations are important. The theory can be formulated in the equation 6 below:

$BOP=0=C(EP^*/P, Y, Y^*) + k(r, r^*, s)$ (6)

Where: BOP is the Balance of Payments, EP^*/P is the measure of relative price of foreign goods, hence the measure of competitiveness, C is the Capital account and k is the rate of capital inflow and s the speculative variable.

Mundell- Fleming Model

This model of Mundell and Fleming (1960) stipulates that since exchange rate changes affect competitiveness, it enters the macroeconomic framework of interest rate and output determination.

In this framework, assuming a small open economy operating with capital being perfectly mobile and given a world interest rate, monetary policy operates by causing a depreciation and followed by a surplus in the current account surplus. It also operates via the Net Exports component of demand.

This theory has an equilibrium exchange rate that is obtained from either a condition of the goods market equilibrium in equation 7, or as a reduced form equation of the full system in equation 8 below:

$E= E(r, Y, Y^*, P^*/P)$ (7)

$E= (M, Y^* \ldots)$ (8)

Where …denotes fiscal policy variables and other exogenous determinants of goods and money demand.

Portfolio Balance Model

According to Kouri (1976) this model is based on the concept of substitution ability of foreign assets with domestic assets. These two assets are however not perfect substitutes and their relative supplies determine, alongside nominal stock of money, equilibrium exchange and interest rates. A connection to capital accounts is established by the fact that external assets are acquired over time through capital accounts surplus. Therefore an appreciation of exchange rate is caused by surplus of the capital account and accumulation of the net external net assets.

2.1.2 Inflation

Inflation is defined as a general and continuous rise in the price level in an area over a certain period of time (Frisch, 1984). Indices such as Consumer Price Index and by the Implicit Price deflator for Gross National Product are used to measure inflation. The most commonly used measure of this is the Consumer Price Index, which considers how much the prices of goods have increased after weighing the prices of different goods according to importance in a typical budget.

2.1.2.1Theories of Inflation

Inflation theories explain the causes of inflation and vary according to different school of thoughts by different economists. For the purposes of this paper, inflation theories are divided into two basic categories namely: the excess demand theories explained by expectation-augmented Phillips curve, which includes the Keynesian and monetarist theories of inflation; and the cost-push theories which are also known as structuralisms/institutional theories of inflation.

The Classical theory: The money supply

According to the early classical economists led by Friedman (1968), one way of defeating inflation is to reduce the money supply. This is under the assumption that there is always equilibrium in the economy's operations. This implies that an increase in money supply will see the same amount of goods being chased by more money (Ghatak, 1995). The level of price will thereby increase back to equilibrium, either fast or immediately due to

the excess demand and there will be no change in the 'real' sector of the economy except a price level increase. This model clearly has some problems, the main one being that the rigidities in the economy are ignored. For instance the different speeds at which the process of adjustment might work and failure to account for the real effects of changes in the monetary sector to the goods sector.

Keynesian Inflation Theory

This theory was developed by Keynes as a response to the shortcomings of the Classical theory. The theory stipulates that, an increase in demand and or increase in cost can cause inflation. It emphasized on rigidities in the economy, with focus on the labour market. These rigidities came from the fact that firms always opted to increase output instead of changing their prices in response to demand changes, and that workers were on the other hand unwilling to reduce their nominal wages. This led to a model known as a fixed- price model which has many ways of curbing inflation. The most effective way of curing inflation is the reduction of aggregate demand since it is the main cause of inflation. This can be done using policy instruments such as cutting public spending or increasing taxes. Alternatively, rigidities could be reduced in the model. When the economy is near or at full employment and aggregate supply is persistently exceeded by aggregate demand, then demand-pull inflation occurs. The causes of a rise in aggregate demand could be as a result of: An interest rate reduction also causes a rise in investment as well as lead to greater consumer spending on consumer durables. A reduction in personal income tax which would cause a rise in disposable income and lead to an increase in consumer expenditure. A rise in foreigners' income may lead to an increase in exports of a country. An increase in government spending financed by borrowing from the banking system under conditions of full employment is another cause of inflation.

In a case where resources are not fully employed, a demand rise can be met initially and yet demand and supply increases will have little or no effect on the general price level at this point. Inflationary pressures occur in the economy when a continued rise in total

demand of goods and services leads to a full employment of resources condition, making it impossible to increase output further.

Excess demand causes demand-pull inflation, this excess demand is in turn caused by factors such as high level of exports, government borrowing to finance its expenditure or increase in money supply and high investment level. Firms that are well off will experience an increase in their demand for factors of production and may decide to increase wages in order to attract workers from other firms. An increase in the prices of inputs will however occur if there already exists full employment in the factor market, and any increase in productivity will be exceeded by the wage increase leading to higher costs.

The increased costs will be passed to consumers in the form of higher prices by firms, and workers will demand that their wages be increased hence fuelling aggregate demand, which increases once again. The process continues as the product and factor market prices are being pulled upwards. According to the Keynesian theory of cost-push inflation the main cause of inflation is attributed to supply side factors. This implies that accordingly, inflation is caused by increasing costs of production. Cost-push inflation is normally considered to be a process of wage inflation since wages usually constitute a big part of total costs.

Structural Theory of Inflation

This theory generally focuses on the structures of the economy instead of the monetary phenomenon (Frisch, 1984), whereby over time these structures may result into commodities lags and not keep pace with the economy.

Structuralisms consider the major causes of inflation to be conflicts over the distribution of income among three groups namely: landowners and peasants, between different producers in different sectors and between capital and labour. This is due to the fact that demand for higher income by one of the following groups (labour, landowners and different producers in different sectors) in excess of their productivity can only be achieved by each of the other groups(firms, peasants and different producers in different sectors) via increases in prices of their products.

Depreciation of the currency is also considered by the theory as important in explaining inflationary situations, being that capital input has more emphasis in the production process of the structuralisms. This means that depreciation of an exchange rate is a major issue whether foreign exchange control exists or not in a country that does not have foreign reserves. The depreciation of currency makes the cost of raw materials imports for production to be high, which will eventually be reflected in the increased prices for goods and services.

They also pointed out that inflation is caused by inertia, which is a process in which the past history of inflation influences current inflation. Inflation inertia occurs as a result of adjustment of relative prices, expectations on inflation, financial contracts, policy frameworks both for monetary and exchange rates and adjusting of wage indexations by institutions.

The inflation concept was further grouped into two by structuralisms:

1) Demand being more than supply in certain markets, e.g. agricultural, public and industrial sectors.
2) Application of initial price increase to what they call the propagation mechanism. They were of the idea that income and population growth cause demand growth in an economy and that concept of inflation is based on this.

Since there is shortage in supply, inelastic supply exists and price rises on its own in the first concept. The propagation mechanism is presented in the second concept which has conflicts over distortion in the income distribution due to inflation. In situation where budget receipts are based on the past period's level of prices, and expense are based on current prices, resources are reallocated from public to private sector.

The structuralisms projected some measures to increase the elasticity of supply in the lagging sector such as land reform, export diversification and tax reform. Demand pressure could be directed to other sectors with more elastic supply especially through import substitution.

2.1.3 Exchange Rate - Inflation Framework

Economic theory suggests that in the long run inflation and exchange rates can actually affect each other, as well as in the short run.

As stated in the purchasing power parity (PPP) theory put forward by Cassel (1918, 1921), exchange rate is determined by inflation. This theory posits that given two countries, when the domestic purchasing powers are the same in them, then their exchange rates are considered to be at equilibrium with each other. Thus an offsetting factor to changes in relative prices is represented by the nominal exchange rate. It means that in order to get back to PPP, an increase in inflation in a given country should be coupled with a depreciation of its exchange rate. The Absolute PPP and Relative PPP give the PPP equation, whereby in absolute PPP the ratio of domestic price level to the foreign price level equals the nominal exchange making real exchange rate one. In the former, the domestic inflation minus the foreign inflation rate represents the rate of change in nominal exchange rate, hence the real exchange rate remains constant (Taylor, 2002).

PPP is based on the law of one price. In cases where transaction costs do not exist, and the price is in the same currency, competitive markets will equalize the price of identical goods in two countries, but under the following conditions:

i. Transaction costs such as barriers to trade and transportation costs are significant in the economy
ii. Both countries have competitive goods and services markets.
iii. It only applicable in a case of tradable goods.

Christal and Lipsey (1999) argued that domestic and foreign producers' competitiveness can be affected by changes in exchange rate through relative prices. A significant appreciation of the domestic currency causes domestic goods to become expensive as compared to foreign goods causing in a shift of demand away from domestic to foreign goods. This shift reduces demand pull inflation in the economy. On the other hand, a country's currency depreciation leads to an increase in the prices of the import of necessary productive equipment, making prices of goods and services escalate due to high production costs.

Iyoha (2000) was of the opinion that demand pull and cost push factors are both drivers of current inflation. According to him, inflationary pressures are caused by demand pull factors which include expansionary fiscal policy, rapid monetary growth resulting from high fiscal spending alongside huge wage and salary rises. Cost push factors are also a cause of inflation and include increase in the price of fuels plus its scarcity thereby making transportation expensive, poor and insufficient infrastructure services; and supply holdups emanating from congestions in the ports congestion. The author also highlighted that the lack of equilibrium between supply and demand was of essence in the inflationary process as well as increase in wage and monetization policy which puts more money into circulation. Accordingly, his study had noticed that the factors that cause inflation are multidimensional and dynamic and need to be properly established and policies made that will help in containing inflationary pressures. Specifically he advocated for the increase in production of agricultural products and manufactured goods domestically.

Okhiria and Saliu (2008) in their examination of the impact of exchange rate on inflation rate and the relationship that exist among government expenditure, money supply, oil revenue and inflation in Nigeria, found out that the Nigerian government had tried to employ various fiscal and monetary policies to meet its macroeconomic objectives to no avail. Researches done in the past and experience in Nigeria show that the inflationary pressures had been caused by structural adjustment programs and any policy used was not able to work effectively. The study further showed that the effect of each variable on the inflation rate could not be separated in the economy since there is correlation among most of the variables. Furthermore, all the variables exhibited a long run relationship that is strong except the relationship between exchange rate and inflation. Policy measures taken by the government to reduce money supply, exchange rates and government expenditure led to low productivity level of the country. Even though there seems to be no long term relationship between exchange rate and inflation, a short run relationship do exist and this led them to making a recommendation that the policy makers should always curb inflation whenever need arises so that in the short run the exchange rates do not end up having adverse effects on inflation.

Hyder and Shah (2004) argued that it is through aggregate supply and demand that domestic prices are affected by movements in exchange rate. A direct effect is seen on the supply side when domestic consumers purchase imported goods. For a small open economy which is an international price taker, currency depreciation will make the price of imported goods to be lower. An indirect effect of exchange rate variations sometimes occurs on domestic prices. This occurs when currency depreciation occurs thereby increasing the cost of imported inputs used in various firms in the economy, the increase in marginal costs of these goods will later on be passed to the consumers. Also, firms that depend on imported inputs may increase prices of goods if their foreign counterparts do so that they can increase their profit margins. The level to which these prices are increased by domestic firms will be dependent on such factors as market structure, nature of government exchange rate policy, or product substitutability. But the expectation would be that with currency depreciation, domestic prices of imported goods would rise and domestic supply would be stimulated accordingly.

The inflationary effect of currency devaluation redistributes income from workers to producers. Since workers are said to have a high marginal propensity to consume compared to producers, total consumption declines as a result of currency depreciation. Additionally, an increase in nominal wages may also increase prices. This occurs when an economy is experiencing an increased domestic demand and an expansion of Gross National Product which in turn makes the input prices to rise as well as workers demanding higher pay.

Engel (2002) developed open economy general equilibrium models to show the responsiveness of consumer prices to exchange rate variations. The first model was a sticky price model, where the producer's currency was used to set prices. This meant that the prices of a foreign good moved one to tone with the exchange rate in that country. The second model assumes that firms set prices differently based on the segmentation of the international and local markets, whereby the prices are set in local currency for local consumers and in foreign currency for foreign consumers. For this model, there is no short run relationship between prices and nominal exchange rates and this means that

local goods do not compete with foreign goods. The third model incorporates imported goods sold to the consumers by a sector known as the distribution. In this model, the currency of the consumer is utilized when setting the final prices and exchange rate changes affect the relative demand for home and foreign goods of the rather than the consumers' demand.

Dornbusch (1987) developed equilibrium pricing models that explain price movements as being caused by fluctuations in exchange rate. For instance, a dollar appreciation lowers the foreign unit labor costs of a dollar. As a result, market equilibrium is distributed in each industry and price and output adjustment must occur. The nature of the adjustment depends on three factors which are integration of the market and separation, substitution between domestic and foreign variants of a product and organization of market. The study developed three models namely the Dixit-Stiglitz model, the Cournot model, and the extended Dixit- Stiglitz model. These models explain how appreciation causes a decline in import prices. In the case of homogenous goods, the decline in price fully matches appreciation. In the case of product differentiation, the relative price of imported goods declines in response to appreciation while the price of exportable goods will be increased. The level of the increase or decrease depends upon the measurement of the competition level and on the relative number firms both at home and in another country.

2.2 Empirical Literature

Empirical literature focuses on empirical studies that have been done for Kenya and elsewhere. For this study, they include the following studies.

Black and Benzing (1991) in their study recognized that the theoretical effects of currency depreciation and appreciation on domestic prices had been realized for specific industries and for the aggregate economy. The various exchange-rate hypotheses are based on underlying assumptions about the imports demand elasticity and about the market structures of the various import-competing industries. For a particular industry, the theoretical effect of an exogenous depreciation in the local currency would be to raise the dollar price of imports. Given a non-zero import demand elasticity, the demand for domestic goods would increase, allowing domestic producers to also raise prices. These

effects also rely on the degree of homogeneity of imported and domestic goods and thus on the level of competition. Hence the exchange-rate hypothesis asserts that a significant depreciation (or appreciation) would raise (or lower) market prices of imported goods and import-competing products. These price increases would be reflected in the aggregate price level and in an increase in the measured inflation rate. The conclusion they made was that the overall effect of a depreciation would raise inflation temporarily.

Canetti and Greene (2000) studied ten African countries namely, Ghana, The Gambia, Kenya, Nigeria, Sierra Leone, Somalia, Tanzania, Uganda, Zaire and Zambia. Their study tested the existence of a causal relationship between growth of money supply or exchange rate depreciation and inflation.

They used both VAR and the Granger causality tests. The appropriate lag length of four was set based on the Schwarz Criteria; the minimum value of the criteria was found at lag four after an experimental exercise. In the VAR method, they established that in four countries, changes in money supply majorly influenced levels of inflation, in three countries, rates of inflation were dominantly influenced by depreciation of exchange rates, while in the other three countries, the effect on one another were equal. These results were consistent upon conducting granger causality tests using a lag length of four and eight, this meant that there exists feedback causality between M3 growth and CPI, and the causality from supply of money to exchange rate and from exchange rate to CPI were unidirectional. They further indicated that in as much as they used large lag lengths, this could cause a spurious equation.

Kiptui and Kipyegon (2008) in their analysis of the impact of external shocks on the real exchange rate in Kenya conducted cointergration analysis and from this and error correction estimates and found out from the results that, the real exchange rates are affected significantly by oil prices and openness. Specifically, increase in oil prices and openness both cause depreciation of real exchange rate in the short and long run. Their results also showed that domestic shocks are also important in determining the exchange rate. Specifically, interest rate differential has significant negative effects on the real

exchange rate in the long and short and long run, while government spending has significant positive effects on the exchange rate in the short and long run and GDP has positive effects in the short run and negative effects in the long run on exchange rate.

Achsani *et al* (2010) in their analysis of the link between real exchange rates and inflation level in Asia (ASEAN +3) and Non-Asia (EU and North America) countries adopted the model of Kamin and Klau (2003). Using the model they found out that in Asian countries there is a strong link that exists between real exchange rates and inflation, but there is no such relation in the EU and North America. Additionally, Asian countries seemed to feel the impact of the Asian financial crisis locally, contrary to what was being experienced in the EU and North America where there was no significant impact felt.

Flood and Rose (1995) in their study of fixing exchange rates, investigated nine industrial countries from 1960 to 1991 using monthly data of the said countries. They concluded that the regime of exchange rates do not change macroeconomic variables. The authors did not find a tradeoff between the level of inflation and the volatility of exchange rate. Corroboration of the results by a sticky price level was done, with price variations being a function of the output gap, expected inflation and the output- a function of exchange rate, external prices and of ex-ante real interest rates.

Rogoff (2001) in his study of exchange rate volatility, pointed out that it was perceived that inflation would stabilize if exchange rate became calm in the macroeconomic crisis of 1970s. This is because exchange rate stability and instability of price are not compatible in the weak PPP version. The author further pointed out that since the differences in effects may be due to microeconomic distortions in the models the empirical issue was not solved.

Campa and Goldberg (2002), in their analysis of exchange rate and inflation linkages in twenty five OECD countries used an OLS model with domestic price index, exchange rate and international prices as the variables. The results obtained from the model

indicated that the transmission of exchange rate to import prices in the short run was high and differs from country to countryin the euro- zone.

Ndungu (1997) in his study of price and exchange rate dynamics in Kenya using a six variable VAR model of money supply, domestic price level, exchange rate index, foreign price index, real output and interest rate, concluded that exchange rate changes and inflation drive each other. That the foreign rate of inflation and the real effective exchange rate drives the nominal effective exchange rate. He further concluded that the pass-through effects are large, which explains why the domestic rate of inflation had followed the developments in the external sector. In his dynamic analysis, results showed that inflation is driven by exchange rate movements and changes in foreign reserves with strong revenue effects. He also noted that exchange rate, money supply, foreign exchange reserves and the rate of inflation form a causal structure that is consistent with loss of a nominal anchor in the system.

Smith (1999) conducted a regression analysis test on changes in real domestic price of good i, defined as

$P_i = eP_i^c/\pi$

where e is the nominal exchange rate, P_i^c is the external price of good i and π is inflation, against exchange rate. From the developed model, the results indicated that if exchange rate volatility rose, there would occur a 31% reduction in inflation volatility in response.

In the assessment of exchange rate volatility and inflation, Bobai *et al* (2013) demonstrated that the two variables were both potentially endogenous. This called for use the VAR modeling, since the OLS modeling does not capture the dynamism that exists in the inter-relationship between inflation and exchange rate, however the VAR model captures this. In order to capture the volatility of inflation and exchange rate, they used additional models namely, the ARCH and GARCH models. The results obtained by them from the above models suggested that inflation and exchange rate are negatively related. The results also showed that interest rate and inflation are significantly related, inflation in the previous year also increases money supply, and that GDP and current inflation

have a negative relationship which is significant as well. There was also evidence of volatility, though the volatility was not persistent.

Sek *et al* (2012) conducted an analysis on the relationship between exchange rate flexibility and monetary policy of inflation targeting using GARCH model. Their results showed significant correlation between exchange rate movements and inflation and output movements. They also concluded that inflation targeting (IT) has significant impacts on the movements of inflation, output and exchange rate. Comparing the performance of IT across countries, they observed that volatility in exchange rate increases and is higher in Asia compared to developed countries.

2.3 Literature Overview

In the light of the above literature review conducted, it can be concluded that procedurally sound studies directly and indirectly concerning the relationship between exchange rate and inflation exist. Studies regarding the effects of exchange rate on inflation and other variables suggest that the relation exists, although the researchers did not come to a consensus about the characteristics of this relation. The literature on exchange rate pass-through suggests that foreign price level and exchange rate both affect domestic price level.

Furthermore, studies concerning specifically the relationship that exists between the variables, exchange rate and inflation are scanty, with most studies focusing on the relationship across developed countries or pursuing different objectives, whereby the result concerning inflation comes in as a side issue. Few studies refer to the subject matter directly. It is therefore necessary to verify specifically the relationship that exists between exchange rate and inflation in Kenya, which is a developing country, by conducting and empirical study.

CHAPTER THREE
METHODOLOGY

3.0 Introduction

This chapter will provide the methodological framework used to estimate the variables in an attempt to meet the set objectives. It also gives the sources of data that are used in the study.

3.1 Data Source

This research will be carried out using secondary data from various Central Bank of Kenya publications (Annual Report), statistical abstracts, and government of Kenya Economic reviews from the financial years 1973 to 2014.

3.2 Econometric Model

This study adopts a VAR model (Sims, 1980) approach to study the relationship that exists between exchange rate and inflation.

A VAR is an n-equation, n-variable linear model in which each variable is explained by its own lagged values, plus current and past values of the remaining variables. This model is appropriate for this study because in a VAR it is hypothesized that the variables are contemporaneous related and therefore using a single equation framework is not appropriate because of the problem of endogeneity.

The VAR model used in this study takes the form of the equation (1) expressed as follows:

$$x_t = \hat{a}_i + \sum_{i=1}^{k} A_i x_{t-1} + \varepsilon_t \qquad (1)$$

Where x_t is an (n x 1) vector of five variables at time t namely: log of consumer price index (LOGCPI), log of nominal exchange rate (LOGER), log of GDP (LOGGDP), log of interest rate (LOGIR), and log of foreign prices (LOGFP); A_i is the matrix of coefficients; $\hat{a}_i$is a vector of coefficients and ε_t is a white noise error term.

The choice of variable foreign prices is based on the PPP theory which stipulates that price differentials between two countries should determine the exchange rate between

these two countries. GDP, representing real output and interest rate is included in the model in line with the Mundell- Fleming model as discussed in the literature review in the preceding chapter.

The VAR analysis is useful in describing the dynamic behavior of economic series, forecasting systems of interrelated time series and analyzing the dynamic impact of random disturbances on the system of variables

It is important to determine the lag length to be used in the VAR. this is done using the Akaike Information Criterion (AIC), Schwartz Bayesian Criterion (SBC) and Lag Likelihood Ratio (LR) function.

Since the level of persistence in time series data is high, it is necessary to determine the order of integration using ADF unit root test. This test includes extra lagged terms of the dependent variable as additional explanatory variables so that the possible autocorrelation in the error process is eliminated. The regression equation used to analyze the unit root test is given in equation (2) below:

$$\Delta y = \ddot{a} y_{t-1} + \sum_{i=1}^{k} \hat{a}_i \, \Delta y_{t-i} + \varepsilon_t \qquad (2)$$

Where k is the number of lags for Δy_{t-i}. The test procedure involves the examination of the student t ratio for δ. If the value of the t-statistic is larger than the critical value, the null hypothesis of δ=0 cannot be rejected. This would imply that the series contain a unit root and therefore is not stationary.

In order to determine cointegration of non-stationarity variables in the model, the following model specified in equation (3) and (4) is used:

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_{0i} \, \Delta X_{t-i} + V_{0t} \qquad (3)$$

$$X_{t-k} = \sum_{i=1}^{k-1} \Gamma_{1i} \, \Delta X_{t-i} + V_{1t} \qquad (4)$$

The Johansen's cointegration test is used to determine the number of cointegrating equations in the system in order to resolve the unit root hypothesis. If the series are integrated of the same order, then there is a possibility of cointergration. In this case the

VAR model may be written as a Vector Error Correction (VEC) Model. This model specification restricts the long run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for a wide range of short run dynamics.

Using the residual vectors V_0 and V_1 in equation (3) and (4), likelihood ratio statistics are constructed to establish the number of unique cointegrating vectors, which is determined by the use of λ_{trace} LR statistic. The trace statistic is given by equation (5) below:

$$ë_{trace}(r) = -T \sum_{i=r+1}^{r} \ln(1 - \hat{o}_i) \qquad (5)$$

Where T is the number of usable observations, $\tau_{r+1} \ldots \tau_p$ denotes p-r smallest squared canonical corrections of V_{0t} with respect to V_{1t}. The trace tests test the null hypothesis that the number of cointegrating vectors in X_t is less than or equal to r, where $r \leq N-1$ with r being the number of cointegrating vectors and N being the number of variables in the system. If r = N, then the vector process X_t is said to be stationary, that is, the variables in X_t are not cointegrated.

CHAPTER FOUR

EMPIRICAL RESULTS AND INTERPRETATION

4.0 INTRODUCTION

This chapter gives results of the data analysis as well as their interpretation. The analysis of data is conducted using the statistical package Eviews. It begins by looking at univariate analysis, followed by the multivariate analyses and finally the diagnostic tests.

4.1Univariate Analyses

4.1.1Stationarity Tests

The ADF test is used in the series in their levels and first differences to determine the stationarity of the series. The optimal lag length for the ADF is determined using the AIC, SC, LR and HQ criteria which is auto generated by the Eviews program. Table 2 below gives a summary of unit root test in both levels and first difference.

Table 2: Unit root tests*

Variable	**ADF TESTS****				
	T	MacKinnon p value	Coefficient	Std error	p>|t|
LOGER	-1.024	0.9408	-0.0758953	0.0741001	0.313
LOGDP	-2.839	0.1831	-.183028	0.0644731	0.008
LOGIR	-1.744	0.7312	-.286812	0.1644683	0.090
LOGP	-1.643	0.7753	-.1315525	.0800919	0.110
LOGFP	-2.869	0.1726	-.0633766	.0220863	0.007

Where t is the test statistic

*the regression included a constant, trend and two lags

**The critical values at 1%, 5%, and 10% are -4.251, -3.544 and -3.206 respectively.

The analysis tables are represented in the Appendix section.

The test statistic is greater than the critical value at all levels hence the null hypothesis of a unit root in all cases cannot be rejected. It is therefore prudent to conclude that all the series are integrated of order I (1). This calls for a Cointegration analysis.

4.2 Multivariate Analyses

4.2.1 Lag Length Determination

The table 3 below represents some statistical criterions used in the selection of the lag length used in the VAR model. It can be observed that all the criterion presented recommend a lag length of 2.

Table 3: Lag Length Determination for VAR

Lag	LogL	LR	FPE	AIC	SC	HQ
0	11.49293	NA	4.97e-07	-0.324647	-0.113537	-0.248316
1	287.9726	470.0154	1.74e-12	-12.89863	-11.63197	-12.44064
2	334.4731	67.42578*	6.32e-13*	-13.97365*	-11.65145*	-13.13402*

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

4.2.2 Cointegration Analysis

Since it has already been known that a unit root exists in the variables, we investigate whether these variables are cointegrated. In this study, the Johansen procedure (Johansen, 1988) is used.

Table 4: Cointegration Test Results

λ_{trace}			
Max rank	Eigenvalue	Trace statistic	5%critical value
0	.	68.7103	68.52
1	0.50978	40.1939*	47.21
2	0.34032	23.5537	29.68

3	0.27297	10.5260	15.41
4	0.21356	0.9163	3.76
5	0.02265		

*denotes rejection of null hypothesis at 0.05 level

From the above table, the null hypothesis is rejected at 0.05 level and it can therefore be concluded that there is one cointegrating relation among the variables in the system.

4.2.3 Stationarity test for the VAR

Assuming two basic conditions of stationarity and stability regarding the data X and its associated VAR model, a stochastic process X is weakly stationary if its first and second moments do not change with time. On the other hand, a VAR process is considered stable if its reverse characteristics polynomial has no roots in or on the complex unit circle. Equivalently, x_t is stable if all eigenvalues of A have modulus less than 1(Lutkepohl, 2006). Stability implies stationarity.

Table 5: Eigenvalue Stability Condition

Lag specification: 1 2

Root	Modulus
1.024112	1.024112
0.951672	0.951672
0.844998 - 0.204068i	0.869290
0.844998 + 0.204068i	0.869290
0.468181 - 0.500226i	0.685142
0.468181 + 0.500226i	0.685142
0.411352 - 0.337406i	0.532028
0.411352 + 0.337406i	0.532028
-0.477068	0.477068
-0.261087	0.261087

Warning: At least one root outside the unit circle.

VAR does not satisfy the stability condition.

From the above table, one eigenvalue is more than 1 hence it can be concluded that the model is not stable and is also non stationary. This can also be seen from the inverse roots graph in the appendix section.

4.2.4 Lag Exclusion Test

This test determines whether any of the lag periods can be excluded from the analysis.

Table 6: VAR Lag Exclusion Wald Tests

Chi-squared test statistics for lag exclusion:
Numbers in [ ] are p-values

	LOGER	LOGGDP	LOGIR	LOGP	LOGFP	Joint
Lag 1	52.31343	93.96669	8.364480	59.30723	121.0164	420.6524
	[4.65e-10]	[0.000000]	[0.137260]	[1.69e-11]	[0.000000]	[0.000000]
Lag 2	16.03182	14.31533	9.190217	12.32607	23.76596	107.9511
	[0.006754]	[0.013726]	[0.101713]	[0.030583]	[0.000241]	[2.78e-12]
Df	5	5	5	5	5	25

The results in table 6 show that the p-value of lag 2 is greater than the 5% error level. This there implies that we exclude lag length 2.

The long run equilibrium relationships can now be estimated. In order to obtain the vector cointegration for LOGGDP, LOGER, LOGP, LOGFP and LOGIR, the Johansen (1995) reduced rank maximum likelihood (ML) method is used. Following the existence of one cointegrating vector, normalization of the cointegrating vectors is done in order to obtain an economic interpretation of the results. Normalization of the long run coefficients involves expressing the relationship in terms of one of the variables as a dependent variable as shown in table 7 below:

Table 7: Normalized Cointegrating Coefficients

Normalized cointegrating coefficients (standard error in parentheses)				
LOGER	LOGGDP	LOGIR	LOGP	LOGFP
1.000000	-2.837468	-0.448520	0.553568	-1.187601
	(1.57750)	(0.19268)	(0.37986)	(1.27396)

The results from the table above indicate that movements in exchange rate have a positive effect on price level. Further, the long run effect of elasticity of exchange rates on price level has a magnitude of 0.553568. A currency depreciation therefore has a significant inflationary impact on prices. Additionally, the exchange rate movements have a negative long run effect on output (GDP), interest rates and foreign prices with a magnitude of -2.837468, -0.448520 and -1.187601 respectively.

4.2.5 Vector Error Correction Estimates

The results of error correction mechanism of VECM is estimated and presented in the table 8. It gives the short-run dynamics adjustment coefficients

Table 8: Vector Error Correction Estimates

Standard errors in ( ) & t-statistics in [ ]

Error Correction:	D(LOG(ER), 2)	D(LOG(GDP),2)	D(LOG(IR), 2)	D(LOG(P),2)	D(LOG(FP), 2)
CointEq1	0.194544	-0.005188	2.916318	0.190952	0.014966
	(0.12837)	(0.02276)	(0.52120)	(0.06810)	(0.01360)
	[1.51552]	[-0.22800]	[5.59543]	[2.80404]	[1.10028]

The short-run formulation of the error correction models show that the error correction terms for all equations except the interest rate (LOGIR) equation are very small indicating a longer period is required to restore equilibrium in these markets once there is a shock. From The appendix, the equation of ECM is specified as:

ΔLOGER=0.003817-0.428740ΔLOGER(-1)-3.643975ΔLOGGDP(-1)+0.0047625ΔLOGIR(-1)-0.389468ΔLOGP(-1)+1.367829ΔLOGFP(-1)…eqn 1

ΔLOGP=-0.000319+0.209181ΔLOGER(-1)-1.649957ΔLOGGDP(-1)+0.036042ΔLOGIR(-1)-0.628085ΔLOGP(-1)+1.240551ΔLOGFP(-1)…eqn 2

ΔLOGGDP=0.000246-0.014594ΔLOGER(-1)-0.0743130ΔLOGGDP(-1)-0.002362ΔLOGIR(-1)+0.29315ΔLOGP(-1)-0.385513ΔLOGFP(-1)…eqn 3

ΔLOGIR=0.034395-1.648140ΔLOGER(-1)+0.313519ΔLOGGDP(-1)+0.197619ΔLOGIR(-1)+1.477833ΔLOGP(-1)+11.74031ΔLOGFP(-1)…eqn 4

ΔLOGFP=-0.001452-0.0069280ΔLOGER(-1)+0.120410ΔLOGGDP(-1)+0.007217ΔLOGIR(-1)-0.120410ΔLOGP(-1)+0.007217ΔLOGFP(-1)…eqn 5

From the results in table 8, it can be deduced that the error correction terms were well defined in all equations and indicate a feedback of approximately 19.45%, 0.52%, 291.3%, 19.1% and 1.5% from exchange rate, GDP, interest rates, price and foreign price equations respectively of previous year's disequilibrium. They are also all significant in all variables except GDP which has its Fstatistic<tabulated statistic as shown in appendix. This implies that about 19.45% of inconsistencies in the short run were being corrected and incorporated into the long run relationship among the variables and their past value in the exchange rate equation 1. On the other hand, 19.1%of short run inconsistencies were being corrected and incorporated into the long run relationship among the variables and their past value in the price equation 2.

Further, from the adjusted R^2 results in appendix, adjusted R^2 for the exchange rate equation(0.197228) indicates that 19.72% of exchange rate growth variations were being explained by the variables in the model jointly. Adjusted R^2 for price equation(0.315172) indicates that 31.52% of price growth variations were being explained by the variables in the model jointly.

4.2.6 Granger Causality Test Results

Under Granger causality, the null hypothesis that A does not granger cause B is tested. If p value is less than 0.05($p<0.05$), the null hypothesis is rejected meaning A granger cause B. on the other hand, if $p>0.05$, the null hypothesis cannot be rejected implying that A does not granger cause B. the test is based on the Wald tests' χ^2 - statistics. The results are presented in table 9 where A is represented by the row variables and B represented by the column variables.

Table 9: VEC Granger Causality Wald Tests

	Dependent				
Independent	D(LOG(ER))	D(LOG(GDP))	D(LOG(IR))	D(LOG(P))	D(LOG(FP))
D(LOG(GDP))	0.0085		0.9555	0.0247	0.4119
D(LOG(IR))	0.2539	0.7496		0.1036	0.1028
D(LOG(P))	0.2266	0.6077	0.2585		0.0221
D(LOG(FP))	0.3290	0.1207	0.0399	0.0952	
D(LOG(ER))		0.6332	0.0186	0.0223	0.7047
ALL	0.1022	0.6133	0.0104	0.0069	0.0046

From the multivariate granger causality analysis table 9 above, it can be seen that lags in exchange rate explain changes in price level and interest rate but not the other way round, similarly lags in output(GDP) cause changes in exchange rate and price level.

It can also be seen that lags of following variables do not cause each other: exchange rate and foreign prices, GDP and interest rates, GDP and foreign prices, as well as interest rates and prices.

In order to explain the degree of causality, R^2 is used. From appendix the R^2 for exchange rate and price is 0.323981 and 0.423303 respectively. This implies that the degree of causality from exchange rate to price is about 42.33% and the degree of causality from price to exchange rate is 32.4%. It can be concluded that the degree of causality from

exchange rate to price is high and significant and that from price to exchange rate is low and insignificant.

4.3 Diagnostic Tests

4.3.1 Variance Decomposition Results

In order to find the forecast error variance percentage for each variable that is explained by own shocks of that variable and those explained by shocks of other variables in the system, variance decomposition tests are conducted. These results are presented in table 10.

It can be concluded from the results that for all variables except interest rates, the predominant sources of variations are own shocks. Most of the shock in price level can be attributed to its own shocks at 45%, the exchange rate at 35% and foreign prices at 14%. Exchange rate explains 65.5% of its own innovations and to a small extent, 12% of the forecast error variance is attributed to output level. Foreign prices on the other hand, explains 87.4% of its own variations. It can also be seen that the output level explains most of its own variance at 80%. Interest rates however has most of its shocks explained by exchange rate at 41% and explaining its own shocks by 34%.

Table 10: Variance Decomposition

Variance Decomposition of LOG(ER):

Period	S.E.	LOG(ER)	LOG(FP)	LOG(GDP)	LOG(IR)	LOG(P)
1	0.095372	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.140482	89.79609	0.100460	10.01706	0.079924	0.006464
3	0.182677	86.26734	0.692426	10.87765	2.044069	0.118518
4	0.210530	84.39511	3.192004	8.553399	3.747408	0.112074
5	0.236825	80.00790	6.778300	7.420181	5.699462	0.094154
6	0.263638	72.94356	10.72372	9.303909	6.946433	0.082382
7	0.292073	65.31480	13.87828	13.02919	7.685592	0.092145
8	0.320393	58.59011	16.13560	17.13765	8.013165	0.123477
9	0.347421	53.31105	17.61890	20.73988	8.169212	0.160958

10	0.372510	49.33265	18.59709	23.62150	8.249919	0.198842

Variance Decomposition of LOG(FP):

Period	S.E.	LOG(ER)	LOG(FP)	LOG(GDP)	LOG(IR)	LOG(P)
1	0.013567	0.757708	99.24229	0.000000	0.000000	0.000000
2	0.029505	0.191984	94.30796	5.251767	0.084884	0.163407
3	0.046920	0.200530	89.65851	9.575701	0.340703	0.224557
4	0.063958	0.335918	86.60986	12.07173	0.717789	0.264709
5	0.079520	0.442417	85.11499	12.89373	1.245577	0.303279
6	0.093157	0.472812	84.74217	12.55101	1.872822	0.361187
7	0.105019	0.451737	84.98335	11.55478	2.568815	0.441311
8	0.115472	0.404619	85.45855	10.30738	3.285000	0.544446
9	0.124922	0.353076	85.92603	9.071096	3.983951	0.665847
10	0.133688	0.308514	86.27565	7.980357	4.636343	0.799138

Variance Decomposition of LOG(GDP):

Period	S.E.	LOG(ER)	LOG(FP)	LOG(GDP)	LOG(IR)	LOG(P)
1	0.020771	11.71939	6.308612	81.97200	0.000000	0.000000
2	0.037683	12.94882	5.095894	81.50978	0.268165	0.177349
3	0.050809	13.18928	3.987184	81.84107	0.659690	0.322773
4	0.060186	13.56511	3.151138	81.65710	1.190053	0.436599
5	0.066614	13.90658	2.597390	81.24087	1.749617	0.505541
6	0.071140	14.23289	2.287068	80.62329	2.310926	0.545824
7	0.074521	14.51613	2.144316	79.94737	2.826558	0.565631
8	0.077273	14.76729	2.088916	79.28704	3.282799	0.573953
9	0.079697	14.99005	2.064800	78.69565	3.673654	0.575845
10	0.081972	15.19090	2.041880	78.18707	4.005470	0.574683

Variance Decomposition of LOG(IR):

Period	S.E.	LOG(ER)	LOG(FP)	LOG(GDP)	LOG(IR)	LOG(P)
1	0.567766	44.52837	3.452018	2.283278	49.73634	0.000000

2	0.668089	38.81430	4.202716	9.652543	42.10536	5.225081
3	0.800618	38.92164	3.650493	12.96609	38.80695	5.654826
4	0.897688	36.60541	4.272225	16.83854	35.30598	6.977844
5	0.990896	36.12652	4.451056	18.74395	33.30522	7.373262
6	1.069305	35.66259	4.749881	20.07793	31.64405	7.865546
7	1.141321	35.82019	4.907626	20.63326	30.50812	8.130800
8	1.205824	36.10509	5.063805	20.85934	29.59504	8.376729
9	1.265909	36.57278	5.177780	20.81438	28.89288	8.542174
10	1.321933	37.07077	5.287170	20.65364	28.30912	8.679296

Variance Decomposition of LOG(P):

Period	S.E.	LOG(ER)	LOG(FP)	LOG(GDP)	LOG(IR)	LOG(P)
1	0.069150	35.49840	1.695688	2.909847	0.316914	59.57915
2	0.114055	39.64036	4.401032	1.853699	1.399966	52.70494
3	0.149143	42.47134	6.318378	2.546681	1.034816	47.62878
4	0.177941	42.82540	9.236681	2.194513	0.767919	44.97549
5	0.203362	41.82297	12.66416	1.681346	0.590819	43.24071
6	0.227158	39.87523	16.06993	1.671180	0.474108	41.90955
7	0.249934	37.68366	18.99037	2.162855	0.392610	40.77050
8	0.271615	35.65302	21.30311	2.863868	0.335920	39.84408
9	0.292009	33.98763	23.05979	3.524272	0.297799	39.13051
10	0.311058	32.70345	24.38536	4.033770	0.273457	38.60396

Cholesky Ordering: LOG(ER) LOG(FP) LOG(GDP) LOG(IR) LOG(P)

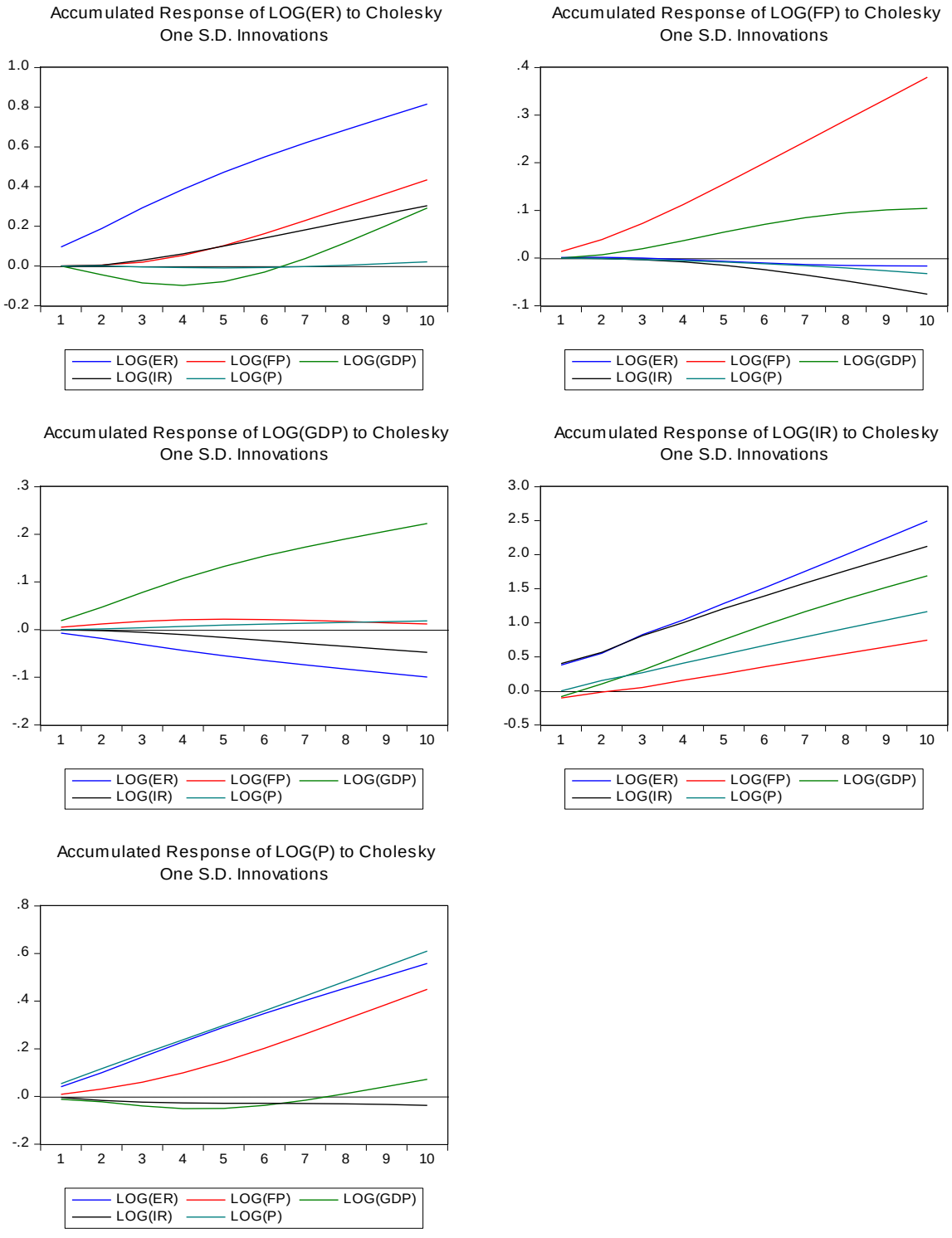
4.3.2 Impulse Response Analysis

The dynamic effects of the shocks on the variables in the system have a direction which is indicated by conducting impulse response tests, which in turn yields an impulse response function. This function indicates the impact that an exogenous variable has on other variables in the system; this is however not shown by variance decompositions. The results are presented in figure 2.

The impulse response graphs in figure 2 show that the accumulated response of exchange rate to one standard deviation shocks in foreign prices, interest rates, price level and output level is weak and exchange rate responds to its own shocks by increasing.
Accumulated responses of output level to exchange rate, foreign prices, interest rates, and price level is negligible. Output level responds only to its standard deviation shock by increasing.

Cumulatively, foreign prices is irresponsive to shocks emanating from exchange rate, interest rates, price level and output level. This implies that the dynamic effects of exchange rate, interest rates, price level and output level on foreign prices observed from the coefficient estimates are very weak. The response of foreign prices to its own shocks is to increase.
The cumulative response of price level to one percent standard deviation shock on itself, exchange rate, and foreign prices is to increase. On the other hand, the response of price level to shocks in interest rates, and output level are very weak.
The accumulated response of interest rate to one standard deviation innovations on itself, exchange rate, foreign prices, price level and output level is to increase.

Figure 2: Impulse Responses to Innovations



CHAPTER FIVE

CONCLUSION AND POLICY RECOMMENDATIONS

5.0 Conclusion

This study set out to empirically analyze the relationship between exchange rates and inflation in Kenya during the period from 1973 to 2014. A multivariate Vector Autoregression analysis was used to analyze this relationship. The study also incorporated three more variables that are theoretically known to relate closely with the two, namely; foreign prices, interest rates and output level (GDP).

Empirical evidence from this research indicates that there is a positive relationship between exchange rate and inflation in Kenya in the long run.

The results further show that there is a unidirectional causality between exchange rate and inflation, and the degree of causality from exchange rate to inflation is much higher and significant. This indicates that indeed a causal relationship exists from exchange rate to inflation in the short run. However, the degree of causality from inflation to exchange rate is very low and insignificant.

Short run inconsistencies are corrected and incorporated into the long run relationship among the variables and their past values in the equations.

5.1 Policy Recommendations

From the conclusion above, it is recommended that the Central Bank of Kenya should carefully monitor the movement of market determined exchange rate so that it does not become counterproductive through price distortions in the economy. In order to achieve control of inflationary pressures, it would be prudent for the government or central bank to do this by formulating policies geared towards lowering the exchange rate level.

Additionally, the government should consider the encouragement of local production in order to minimize importation of goods. This is because mostly the exchange rate is passed through inflation via import prices.

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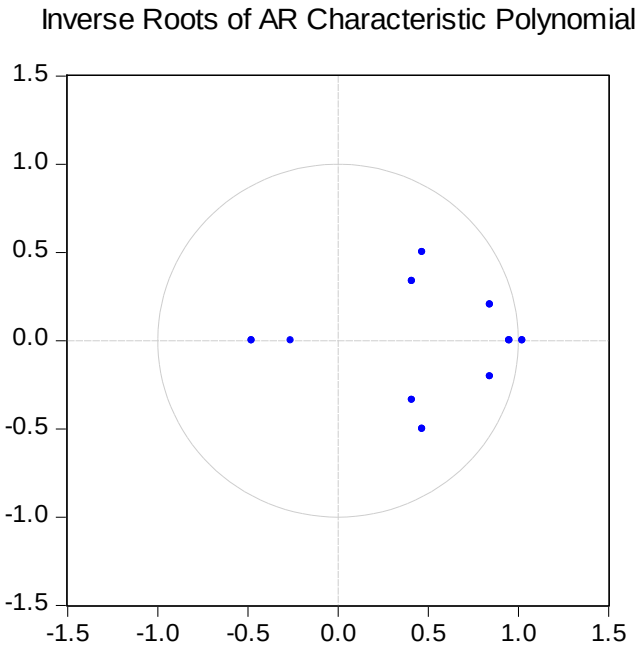
APPENDICES

Appendix 1: The Inverse Roots Graph



Appendix 2: Cointegration Coefficients

1 CointegratingLog

Equation(s): likelihood 314.3761

Normalized cointegrating coefficients (standard error in parentheses)

LOG(ER)	LOG(GDP)	LOG(IR)	LOG(P)	LOG(P_)
1.000000	-2.837468	-0.448520	0.553568	-1.187601
	(1.57750)	(0.19268)	(0.37986)	(1.27396)

Adjustment coefficients (standard error in parentheses)

D(LOG(ER))	-0.121360
	(0.03275)
D(LOG(GDP))	0.008899
	(0.00713)

D(LOG(IR))	-0.032097
	(0.19497)
D(LOG(P))	-0.015622
	(0.02375)
D(LOG(P_))	0.007269
	(0.00466)

Appendix 3: Vector Error Correction Estimates

Standard errors in ( ) & t-statistics in [ ]

Error Correction:	D(LOG(ER),2)	D(LOG(GDP),2)	D(LOG(IR),2)	D(LOG(P),2)	D(LOG(FP),2)
CointEq1	0.194544	-0.005188	2.916318	0.190952	0.014966
	(0.12837)	(0.02276)	(0.52120)	(0.06810)	(0.01360)
	[1.51552]	[-0.22800]	[5.59543]	[2.80404]	[1.10028]
D(LOG(ER(-1)),2)	-0.428740	-0.014594	-1.648140	0.209181	-0.006928
	(0.17253)	(0.03058)	(0.70050)	(0.09153)	(0.01828)
	[-2.48504]	[-0.47719]	[-2.35281]	[2.28547]	[-0.37894]
D(LOG(GDP(-1)),2)	-3.643975	-0.074130	0.313519	-1.649957	0.120410
	(1.38481)	(0.24548)	(5.62261)	(0.73464)	(0.14674)
	[-2.63138]	[-0.30198]	[0.05576]	[-2.24592]	[0.82058]
D(LOG(IR(-1)),2)	0.047625	-0.002362	0.197619	0.036042	0.007217
	(0.04174)	(0.00740)	(0.16949)	(0.02215)	(0.00442)
	[1.14089]	[-0.31918]	[1.16597]	[1.62750]	[1.63162]
D(LOG(P(-1)),2)	-0.389468	0.029315	1.477833	-0.628085	-0.078124
	(0.32213)	(0.05710)	(1.30790)	(0.17089)	(0.03413)
	[-1.20905]	[0.51337]	[1.12993]	[-3.67540]	[-2.28878]

D(LOG(FP(-1)),2)	1.367829	-0.385513	11.74031	1.240551	0.168612
	(1.40133)	(0.24841)	(5.68968)	(0.74341)	(0.14849)
	[0.97609]	[-1.55193]	[2.06344]	[1.66874]	[1.13552]
C	0.003817	0.000246	0.034395	-0.000319	-0.001452
	(0.02174)	(0.00385)	(0.08828)	(0.01153)	(0.00230)
	[0.17553]	[0.06373]	[0.38960]	[-0.02764]	[-0.63011]
R-squared	0.323981	0.096131	0.839458	0.423303	0.345824
Adj. R-squared	0.197228	-0.073344	0.809357	0.315172	0.223166
Sum sq. resids	0.576831	0.018126	9.509153	0.162338	0.006477
S.E. equation	0.134261	0.023800	0.545125	0.071225	0.014227
F-statistic	2.555993	0.567226	27.88756	3.914737	2.819415
Log likelihood	26.82987	94.30390	-27.81812	51.55332	114.3721
Akaike AIC	-1.016917	-4.477123	1.785545	-2.284785	-5.506262
Schwarz SC	-0.718329	-4.178535	2.084133	-1.986198	-5.207674
Mean dependent	-0.000179	0.001118	-0.002693	-0.002767	-0.001827
S.D. dependent	0.149849	0.022972	1.248491	0.086069	0.016141

Determinant resid covariance (dof adj.)	7.68E-13
Determinant resid covariance	2.86E-13
Log likelihood	286.5497
Akaike information criterion	-12.64357
Schwarz criterion	-10.93736

Appendix 4: VEC Granger Causality/ Block Exogeneity Wald Tests

VEC Granger Causality/Block Exogeneity Wald Tests

Date: 09/23/15 Time: 23:11

Sample: 1973 2014

Included observations: 39

Dependent variable: D(LOG(ER),2)

Excluded	Chi-sq	df	Prob.
D(LOG(GDP),2)	6.924171	1	0.0085
D(LOG(IR),2)	1.301624	1	0.2539
D(LOG(P),2)	1.461796	1	0.2266
D(LOG(P_),2)	0.952754	1	0.3290
All	7.724588	4	0.1022

Dependent variable: D(LOG(GDP),2)

Excluded	Chi-sq	df	Prob.
D(LOG(ER),2)	0.227711	1	0.6332
D(LOG(IR),2)	0.101875	1	0.7496
D(LOG(P),2)	0.263550	1	0.6077
D(LOG(P_),2)	2.408479	1	0.1207
All	2.676946	4	0.6133

Dependent variable: D(LOG(IR),2)

Excluded	Chi-sq	df	Prob.
D(LOG(ER),2)	5.535710	1	0.0186
D(LOG(GDP),2)	0.003109	1	0.9555
D(LOG(P),2)	1.276735	1	0.2585
D(LOG(P_),2)	4.257775	1	0.0391
All	13.19506	4	0.0104

Dependent variable: D(LOG(P),2)

Excluded	Chi-sq	df	Prob.
D(LOG(ER),2)	5.223394	1	0.0223
D(LOG(GDP),2)	5.044177	1	0.0247
D(LOG(IR),2)	2.648762	1	0.1036
D(LOG(P_),2)	2.784679	1	0.0952
All	14.13818	4	0.0069

Dependent variable: D(LOG(P_),2)

Excluded	Chi-sq	df	Prob.
D(LOG(ER), 2)	0.143596	1	0.7047
D(LOG(GDP),2)	0.673351	1	0.4119
D(LOG(IR), 2)	2.662184	1	0.1028
D(LOG(P),2)	5.238514	1	0.0221
All	15.03642	4	0.0046