EFFECT OF SELECTED MACROECONOMIC VARIABLES ON THE VOLATILITY OF FOREIGN EXCHANGE IN KENYA

BY

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DECLARATION

Declaration by Candidate

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ABSTRACT

The volatility in the real exchange rate often results in major changes within the global economy and other macro-economic factors within an economy. The Kenyan shilling enjoyed a period of relative stability between October 1999 to December 2005 but later, the shilling experienced some fluctuation in the real exchange rate appreciating by 30 % to the US Dollar in the period between 2006 and 2013. The study established the effect of selected macroeconomic variables on the volatility of foreign exchange in Kenya from 1999 to 2018. The study had four-fold objectives; to establish the effect of interest rate on foreign exchange volatility in Kenya; to examine the influence of foreign direct investments on foreign exchange volatility in Kenya; to establish the effect of inflation rate on foreign exchange volatility in Kenya; and to determine the effect of the balance of payments on foreign exchange volatility in Kenya. The study was underpinned by the theories of comparative advantage and purchasing power parity. The theory of comparative advantage hypothesis that nations stand to benefit from comparative production cost advantages drawn from specialization and are transformed into absolute money price advantages. Money is a neutral and function as a means of exchange in facilitating international trade. The study adopted an explanatory research design and used documentary analysis to collect secondary data from the published annual reports from the Kenya National Bureau of Statistics (KNBS) and the Central Bank of Kenya spanning twenty years from 1999 to 2018. The data collected included the monthly data on the real exchange rate, interest rates, core inflation rates, inflows and outflows of the balance of payments and foreign direct investments. Once the data had been collected, the data were organized and analysed using descriptive and inferential statistics. The study used a graphical presentation to present the elementary information on the trends of the study variable. The results from the GARCH models indicated that volatility is associated with the balance of payments, interest rate and inflation rates while the foreign direct investments had no influence. The long-run models from the VECM models show that volatility in the foreign exchange rate responds faster to previous period volatility at 35.22%($\chi2 = 38.249$, $p<0.05$), inflation rate at 29.55%($\chi2 = 29.355$, $p<0.05$), interest rate at 27.37%($\chi2 = 26.373$, $p<0.05$) and balance of payment at 22.53%($\chi2 = 20.255$, $p<0.05$) but not the FDI at 9.16% ($\chi2 = 7.059$, $p>0.05$). Based on the findings, the study rejected the null hypotheses that inflation rate, interest rate and balance of payment have no influence on the volatility of the foreign exchange in Kenya and concluded that the selected macro-economic variables (the interest rate, the inflation rate and balance of payments) significantly influenced the foreign exchange rate in Kenya. The findings showed that the selected macroeconomic variables impacted on the stability of the exchange rate in Kenya. The study recommends that the government seeks way to stabilize the local currency against fluctuations by pursuing initiatives that will attract foreign exchange inflows such as encouraging exports and import substitution aimed at reducing trade deficits while pursuing monetary policy regimes that stabilize inflation and interest rates.

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OPERATIONAL DEFINITION OF TERMS

Balance of trade: This is the surplus/deficit of trade and capital flows between Kenya and other nations.

Exchange rate: The price of United State Dollar quoted in terms of Kenya Shilling.

Foreign exchange volatility: The short-term movements or fluctuations in the price of United State Dollar as quoted against the Kenya Shilling.

Foreign direct investments: These are capital investments made by foreign entities into the territory of Kenya.

Inflation rate: This a measure of the pricing index in the economy.

Interest rate: The cost at which government borrows funds through Treasur Bills.

Macroeconomic variables: Inflation rate, interest rate, balance of payment and foreign direct investment

ABBREVIATIONS AND ACRONYMS

BOP: Balance of Payments

CBK: Central Bank of Kenya

EU: European Union

EUR: Euro

FDI: Foreign Direct Investment

GARCH: General Autoregressive Conditional Heteroscedasticity

GDP: Gross Domestic Product

IMF: International Monetary Fund

KNBS: Kenya National Bureau of Statistics

MENA: Middle East and Northern Africa

NER: Nominal Exchange Rate

PPP: Purchasing Power Parity

RER: Real Exchange rate

SSA: Sub-Saharan Africa

SPSS: Statistical Package for Social Sciences

TARCH: Time AutoRegressive Conditional Heteroscedasticity

U.K: United Kingdom

UNCTAD: United Nations Conference on Trade and Development

U.S: United States

USD: United States Dollar

VAR: Vector Autoregressive

VECM: Vector Error Correction Models

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter presents the background of the study and elaborates on the relationship between macroeconomic variables and volatility in foreign exchange. Further, it presents the problem statement, the objectives of the study, the hypotheses, limitations and scope of the study.

1.2 Background to the Study

Most economies have at any one-time experienced volatility in the real exchange rate an aspect which introduces uncertainty in the realisation of major macro-economic and monetary policy objectives of stability in prices and growth in economic output (Ajao & Igbekoyi, 2013). Due to this, the central banks in most emerging economies have noted that excessive volatility in the exchange rate is counterproductive for the economy (Mohanty, 2013) and in particular, the large shifts in the exchange rate is an ongoing concern in the stability of financial and economic conditions.

The stability in the exchange rate with its corresponding alignment is crucially important for economic development (Drine & Rault, 2011). The excessive volatility in the exchange rate in small foreign exchange markets contributes to disorder and illiquidity in the financial and capital markets (Ho & McCauley, 2013). It also tends to adversely affect the economy by creating uncertainty in the macroeconomic environment (Iqbal *et al.,* 2011). However, volatility in the exchange rate in many developing economies is coupled with uncertainty in prices and output growth (Al Samara, 2009) and the destabilization of the country's fiscal and monetary policy (Ajao & Igbekoyi, 2013).

Furthermore, the integration of the Sub-Saharan Africa (SSA) economies into the global financial markets introduces volatility in their business cycles as larger capital inflows worsen the fluctuation in the exchange rate (Kasekende & Brownbridge, 2011). For instance, the volatility of the exchange rate has been identified to negatively impact on European Union (EU) intra-trade trade (Baldwin, Skudelny & Taglioni, 2005) and trade flows while negatively influencing the import demand (Anderton & Skudelny, 2011). Importantly, the effect of the exchange rate on inflation has been identified as the exchange rate pass-through effects on import prices (Heintz & Ndikumana, 2011).

And as indicated by the circumstances in most emerging market economies, volatility in the real exchange rate reduces output (Mohanty, 2013) and as shown by panel data the volatility in EU extra-area exchange rates decreased the extra-European area imports by around 10% (Anderton & Skudelny, 2011). Tarr and Shatz (2010) noted that the management of the exchange rate in many countries has resulted in an overvaluation of the real exchange rate to the tune of 10% in roughly 2% per cent of the countries.

Prosperous and developed economies have favourable appreciation in the exchange rate coupled with improved standards of living. For instance, eliminating volatility of the exchange rate among Eastern European countries through the adoption of the Euro within trading blocs resulted in three-fold increases in the trading between countries (Anderton & Skudelny, 2011). On the converse, volatility in the exchange rate leads to a decrease in all levels of trade with consequent depreciation in the national currency and slowed economic growth (Drine & Rault, 2011). Evidence indicates that emerging market economies face greater vulnerability to the fluctuations in the exchange rate than the industrialized economies due to several factors including consumption patterns

associated with relatively low incomes and histories of higher inflation (Ho & McCauley, 2013).

Empirical evidence deduced from a study on Group Seven(G-7) countries indicated that the relationship between macroeconomic variables and exchange rate volatility is bi-directional, but it is much stronger from the macro-economic variable volatility to the exchange rate volatility than the other way round (Morana, 2009). Empirical evidence suggests that volatility in the exchange rate is associated with macroeconomic fundamentals in the long-run (Della Corte, Sarno, & Tsiakas,2009) but several other factors are important determinants of volatility in the short to medium-term. According to Drine and Rault, (2011), the long-term real exchange rate depends exclusively on the following variables: public expenditures, the openness of the economy, the terms of trade, capital flows and technical progress.

These elements cause volatility in the real exchange; gross domestic product (GDP) growth rate, the balance of trade, fiscal policy, trade openness, and foreign direct investments (Al Samara, 2009). Stancik (2007) observed that other factors include; economic growth, inflation, economic openness, interest rates, the exchange rate regime, domestic money supply, foreign exchange reserves, the independence of the central bank and other random events and occurrences. However, the degree of the impact of each of these factors varies and depends on a particular country's economic condition.

Empirical evidence from G-7 countries (USA, France, UK, Canada, Germany, Japan and Italy) indicated linkages and trade-off between volatility in the exchange rate and fluctuations in macroeconomic conditions (Morana, 2009). Stancık (2006) identified the following main factors contributing to volatility in the exchange rate in the countries

joining the EU trading bloc; the exchange rate regime, the openness of an economy, and policy communication. The movements on the real exchange rate associated with the balance of trade, government fiscal policies, the openness of the economy as measured by the liberalization (Ricci, Lee & Milesi-Ferretti, 2008).

In Eastern EU countries of Slovakia, Poland, Latvia and Slovenia, economic openness has a negative effect while the exchange rate regime, foreign and domestic money supplies, interest rates, gross domestic product (GDP) output, income, inflation have a positive effect on exchange rate volatility and accompanied by country-specific effects (Stancik, 2006). Zettelmeyer, Nagy & Jeffrey (2010) observed that currency volatility in Hungary and Ukraine always induced highly contractionary macroeconomic policies in countries.

Lane & Shambaugh (2010) used panel data to analyse the volatility of the foreign currency and observed that trade openness and levels of economic development explain the cross-sectional variation in foreign currency. Richer and more open economies take long positions in foreign currency and therefore they stand to gain when their currencies depreciate and losses when it appreciates. In a study on South Korea, Ree, Yoon and Park (2012) noted that the high volatility of the currency is often related to capital market openness and liberal foreign exchange regulations.

The emerging market economies of Asia and Latin America are relatively more exposed to exchange rate fluctuations due to various historical and structural reasons (Ho & McCauley, 2013). Whereas volatility in the exchange rate regime is associated with unpredictability in prices (Al Samara, 2009), there is higher volatility under inflation targeting frameworks than the non-inflation targeting regime in those economies (Berganza & Broto, 2012). As indicated by a study in Brazil economy the

inflation targeting policy regime led to a fluctuation in the real exchange rate (Barbosa-Filho, 2008).

In the developing economies of Asia, (Jongwanich, 2009) indicated that GDP, economy openness, terms of trade, foreign direct investments and fiscal policy determine the stability of the real exchange rate. In India, (Dua & Sen, 2006) examined the causes of the volatility in the exchange rate and ranked them from foreign direct investments, government fiscal policy, current account surplus and money supply (Bhattacharya & Patnaik, 2014). Based on a study in Pakistan, (Raja & Ullah, 2014) observed that the following determinants: interest rate, trade balance, terms of trade and net capital flows influence exchange rate. Empirical results from Bangladesh indicate that a strong relationship exists between the exchange rate and the exchange reserves, interest rate, money supply, GDP and balance of trade (Chowdhury, Uddin & Islam, 2014).

In developing economies of Asia, Jongwanich (2009), (Dua & Sen 2006) ranked foreign direct investments, government fiscal policy, current account surplus and money supply, while Ullah (2014) identified the following factors; interest rate, trade balance, terms of trade and net capital flows and Al Samara, (2009) listed the independence of central bank, lower inflation rate, price stability and exchange rate regime as the main determinants of the volatility. (Drine & Rault 2011) also attributed volatility to several macroeconomic factors.

Findings from a co-integration test on the Middle East and North Africa (MENA) countries indicated that output per capita, fiscal policies, the openness of the economy and interest rate differentials influence the real exchange rate (Drine & Rault, 2011). In Syria, the volatility in the exchange rate is determined by several factors including independence of the central bank, lower inflation rate, price stability and exchange rate

regime (Al Samara, 2009). The empirical evidence indicated that the volatility of the Syrian Pound was determined by foreign direct investments, government fiscal policy, terms of trade and economic output. Whereas economic output, investments and terms of trade had a positive effect, the government fiscal policy had a negative effect.

The major themes in the study on the determinants of the exchange rate have been centred on macroeconomic factors which include economic openness, money supply, foreign currency reserves, interest rate, inflation rate, output and growth. For instance in developed countries including the G-7 countries, Morana (2009) indicated the strong linkages and trade-off between macro-economic factors and volatility, Stancık (2006) listed economy openness and communication while Ricci *et al.*,(2008) identified balance of trade, government fiscal policies, the openness of the economy as the most significant factors. Lane & Shambaugh (2010) linked volatility to trade openness and levels of economic development.

In emerging economies of Africa, Alagidede & Ibrahim, (2017) attributed government fiscal policy, terms of trade, money supply and Foreign Direct Investment (FDI) portfolio. Ajao (2013) and Ajao & Igbekoyi (2013) identified economy openness, GDP growth, terms of trade, foreign direct investments and fiscal policy as determinants of the stability of the real exchange rate. Aliyu, (2010) identified interest rate, inflation, and money supply as the main determinants. Based on past studies, the study selectively chose the most prevalent themes that have been identified and from which data could be easily accessed.

Ajao (2013) and Ajao and Igbekoyi(2013) examined the volatility of the Nigeria Currency Naira using Vector Error Correction Model(VECM) and General Auto-Regressive Conditional Heteroscedastic (GARCH) Models and managed to identify the

following economic variables as the main determinants influencing its volatility; economy openness, fiscal policy and interest rates. Other studies in Nigeria have linked the volatility of the Nigerian Naira to adverse monetary policy, interest rate, inflation rate and money supply (Aliyu, 2010). In Ghana, Alagidede & Ibrahim, (2017) used the error correction model and revealed that government fiscal policy, money supply, terms of trade and FDI portfolio contribute to the volatility in the exchange rate.

As indicated by Heintz & Ndikumana (2011), exchange rates are important components in the analysis of inflationary dynamics in sub-Saharan African economies with studies indicating that prolonged and substantial volatility in the exchange rate creates severe disequilibria in the macroeconomic conditions (Ajao, 2015). For instance, Kinyua, (2013) indicated that the economic growth and development of Kenya's financial system has always lagged because of the monetary policy aggregates which tend to destabilize the currency. Further, O'Connell *et al.,* (2010) indicated that capital flows tend to impact the conduct of monetary policy in Kenya.

Since the liberalization policy of 1993, the Kenya shilling has gone through several phases. The shilling depreciated by as much as 21% between January 1995 and October 1999 followed by a period of relative stability until December 2004. Later, the shilling experienced several fluctuations, for instance, the exchange rate moved from a low of 76.41 to the USD in May 2005, to a high of 110 to the USD in 2012, and back to a low of Kshs. 85 in April 2013. In between 1998 and 2018, the shilling fluctuated wildly from Kshs. 61.164/USD in January 1998 to Kshs. 73.605/USD in June 1999, Kshs. 79.018/USD in July 2001, Kshs. 71.804/USD in February 2006, Kshs. 63.303/USD in December 2007, Kshs. 80.261/USD in March 2009, Kshs. 76.947/USD in March 2010, Kshs. 101.27/USD in November 2011, Kshs. 82.897/USD in March 2012, Kshs.

105.275/USD in September 2015 and Kshs. 100.663/USD in May 2018(CBK, reports, 2018).

The depreciation/appreciation of the shilling attract attention from exporters who argue that the strengthening of the shilling erodes the country's competitiveness (CBK, 2013). In particular, from 2003 to 2007, the domestic monetary policy reforms in Kenya were able to stabilize commodity prices while limiting short-run volatility in the exchange rate, however, after the 2007 electoral cycle, the monetary policy was influenced by capital mobility (O'Connell *et al.,* 2010). All these aspects listed point out the potentially deleterious effects of volatility in the exchange rate on the country's economic growth (CBK, 2012). The main factors arising due to the appreciation of the shilling are the weakness in exports, lower tourism numbers and foreign direct inflows.

1.3 Statement of the Problem

Since the liberalization policy, the Kenya shilling has gone through volatility which has seen it depreciate by 21% in 1998/1999, appreciate by 12% in 2006/2007, depreciate by 27% in 2007/2008, depreciate by 31% in 2010/2011, appreciate by 18% 2011/2012. These fluctuations are significant with a profound effect on the economy (CBK, 2018). However, the studies on the foreign exchange rate in Kenya have taken differing perspectives. In particular, Kemboi, and Kosgei (2018) used regression and established that interest rate and inflation rate differentials significantly affected the foreign exchange rate in Kenya. Mwangi and Ochieng (2018) used regression analysis to study selected macroeconomic variables (inflation rate, interest rate and balance of trade) and found that these variables explained some deviations in the exchange rate in Kenya.

Kiptui (2009) used a generalized Phillips curve to examine the effect of the exchange rate and oil prices while Misati *et al.,* (2012) used the VAR model and identified the

following factors: economic growth rate, fiscal policy, interest rate, and money supply influencing the exchange rate. Mungami (2012) examined the effects of exchange rate liberalization on the balance of payments using the case of Kenya. These studies used a variety of methodologies including the regression model (Muchiri, 2017; Kemboi & Kosgei, 2018; Mwangi & Ochieng, 2018; Misati *et al.,* 2012).

Other several factors affecting the exchange rate include the investor perceptions of the stability of the government (O'Connell *et al.,* 2010). In Kenya, studies have identified the following variables as determinants that influence the exchange rate; interest rate differential, inflation rate (Kemboi & Kosgei, 2018), FDI Muchiri, 2017), the balance of trade (Mwangi & Ochieng, 2018), GDP growth rate, money supply and fiscal expenditure (Misati *et al.,* 2012). The studies were short on the appropriate model that could determine volatility in the exchange rate. These studies on the effect of the exchange rate in Kenya have not examined its volatility nor have they established the macroeconomic determinants influencing the volatility in the exchange rate, therefore informed by this knowledge gap, this study sought to examine the volatility in the exchange rate and determine the effect of macroeconomic variables on foreign exchange volatility in Kenya from 1999 to 2018.

1.4 Research Objectives

1.4.1 General Objective

The general objective of the study was to examine the effects of selected macroeconomic variables on foreign exchange volatility in Kenya.

1.4.2 Specific Objectives

The study was guided by the following specific objectives;

i. To establish the effect of interest rate on foreign exchange volatility in Kenya.
ii. To examine the influence of foreign direct investments on foreign exchange volatility in Kenya.
iii. To establish the effect of inflation rate on foreign exchange volatility in Kenya.
iv. To determine the effect of the balance of payments on foreign exchange volatility in Kenya.

1.5 Research Hypotheses

H_{01}: Interest rate does not affect the volatility of the foreign exchange in Kenya.

H_{02}: Foreign direct investments do not influence the volatility of foreign exchange in Kenya.

H_{03}: Inflation rate does not affect the volatility of the foreign exchange in Kenya.

H_{04}. Balance of payments does not affect the volatility of the foreign exchange in Kenya.

1.6 Significance of the Study

The findings of the study are important to the policymakers in the development of the necessary regulations to guide the Central Bank of Kenya in drafting the requisite framework guiding the operations of the monetary policy. The main reason for the policy dilemma is that intervention in the foreign exchange market has direct implications for the stance of monetary policy.

The study conceptually contributes to policy development by advancing and testing knowledge on the volatility of the exchange rate in Kenya. The study sought to understand Kenya's competitiveness and how this component can be used to improve the fortunes in the development of Kenya.

The findings add to the existing literature on the subject. It will assist future scholars and researchers to carry out further studies in the area of macroeconomic variables and foreign exchange volatility as it forms a basis for future research.

1.7 Scope of the Study

The study was confined to establishing the effects of selected macroeconomic variables on foreign exchange volatility in Kenya. Specifically, the study focused on establishing the effects of Interest rates, Foreign Direct Investments, Inflation Rates and Balance of Payments on foreign exchange volatility in Kenya. The study drew economic data indicators from January 1999 to December 2018 because the fluctuations can be considered to be non-random as they do not fall within the confines of the randomness (5% on moving average) therefore, the study viewed the fluctuations as being caused by extraneous factors. This lends support to the inquisition that the fluctuations are driven by several extraneous macroeconomic factors and thus the study set the scope of the study (1999 – 2018).

During this period, the shilling fluctuated wildly from Kshs. 61.164/USD in January 1998, Kshs. 73.605/USD in June 1999, Kshs. 79.018/USD in July 2001, Kshs. 71.804/USD in February 2006, Kshs. 63.303/USD in December 2007, Kshs. 80.261/USD in March 2009, Kshs. 76.947/USD in March 2010, Kshs. 101.27/USD in November 2011, Kshs. 82.897/USD in March 2012, Kshs. 105.275/USD in September 2015 and Kshs. 100.663/USD in May 2018(CBK, reports, 2018). The fluctuations are

somehow related to the macroeconomic foundation of the economy (balance of payment and foreign direct investment) and have a profound effect on the exchange rate and the policymakers use these variables (inflation and interest rate) to realign the exchange rate.

1.8 Assumptions of the Study

The study assumed that selected macroeconomic variables (inflation and interest rate, balance of payment and foreign direct investment) have a significant effect on foreign exchange volatility in Kenya from 1999 to 2018.

Further, both the balance of payment and foreign direct investment can be considered to have direct reciprocal causation on the exchange rate, while the interest and inflation rate has a mutual contrasting effect on the exchange rate.

The study assumed that these selected macroeconomic effects have profound effects on the exchange rate when compared to other macroeconomic variables (GDP, economic growth rate and policy statements). Thus, the application of these study variables drew the desired results when compared to the other macroeconomic variables.

The study assumed the completeness in the secondary data used to generate results.

1.9 Limitations of the Study

The study was limited to the selected macroeconomic variables (interest and inflation rates, balance of payments and foreign direct investments) which were considered to have profound effects on the exchange rate.

The study was limited to the 1999–2018 periods because, during this period, there were wild fluctuations in the exchange rate which at most times could be considered to be non-random and this warranted examination into the phenomenon.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This section introduces the study concepts before reviewing empirical literature based on the study variables, the theoretical underpinning of the study, and the conceptual framework of the study.

2.1 Review of Study Concepts

2.1.1 Exchange Rates

The exchange rate is defined as the price of one currency quoted in terms of another currency or the value of one country's currency in terms of another currency (Madura, 1989). In particular, the exchange rate is a function of international financial relative price (Allayannis, Ihrig, & Weston, 2001). However, the currencies of many countries are not quoted against each other but instead, cross-rate is an exchange rate between two currencies that are not quoted against each other but are quoted against one common currency which is usually the United States US Dollar (Pandey, 2005).

Mishkin (2004) explains that there two kinds of exchange rate transactions; spot transactions which involve the immediate (two-day) exchange of bank deposits and forward transactions which involve the exchange of bank deposits at some specified date in future. Spot exchange rates are the rates of exchange used in the spot transactions while forward exchange rates are used at some future specified date (Mishkin & Eakins, 2009).

Foreign exchange rates can either be nominal or real. The nominal exchange rate is determined by differences between domestic and global interest rates, as well as between the domestic and global prices. The real exchange rate (RER) is the rate of

exchange of goods and services produced at home as compared to those produced in another country or group of countries abroad. The nominal exchange rate (NER) includes the inflation effects in the rate, while the Real Exchange Rate(RER) excludes inflation effects (Copeland, 1989; Lothian, and Taylor, 1997). The real exchange rate follows by definition (i.e., from the nominal exchange rate, the foreign price and the domestic price level) (Were *et al.*, 2013).

There are several exchange rate arrangements which are classified into two major categories of fixed and flexible regimes respectively but with some variants (Ebeke & Fouejieu, 2015). The exchange rates are fixed when the real exchange rates are held constant, more of a political decision and flexible when allowed to fluctuate based on market dynamics (Abdalla, 2012; Madura & Fox, 2011). The trends on the exchange rate regimes point towards the adoption of flexible exchange rate regime as opposed to managed/fixed rate regimes (Tarr & Shatz, 2010) with many emerging market economies operating independently floating or managed exchange rate regimes (Osawa, 2006).

Flexible exchange rates allow for an easier adjustment in response to asymmetric country-specific real shocks The downsides of (softly) fixed exchange rates which are suspected to encourage speculative capital inflows, moral hazard, and overinvestment have become visible (Schnabl, 2018). Proponents of flexible exchange rates have also emphasized the need for macroeconomic flexibility in the face of real asymmetric shocks. In contrast, proponents of fixed exchange rates have stressed the (microeconomic) benefits of low transaction costs for international trade as well as the impact of trade integration on the probability of asymmetric economic developments (Kočenda & Valachy, 2016).

Thus, most developed and successful economies have developed a favourable appreciation in the exchange rate which is coupled with improved standards of living. On the converse, any failure in the economic growth and development results in depreciation in the national currency (Drine & Rault, 2011). According to Durevall & Sjö (2012), the foreign currency regime in Kenya is more of a managed floating than a fully floating regime which was adopted in early 1993. Kenya is classified by the IMF as operating a flexible regime between 1992 and 1997 and a managed float from 1998 onwards (O'Connell *et al.,* 2010; Durevall & Sjö,2012).

2.1.2 Exchange Rate Volatility

Equilibrium real exchange rate is the relative price of traded and non-traded goods which ensures simultaneously the internal and external balances of the economy (Drine & Rault, 2011). The equilibrium exchange rate continually changes and evolves following a trajectory determined by the changes in the fundamentals (Drine & Rault, 2011). The fluctuations in the country's exchange rate regime can either deviate positively from the equilibrium resulting in overvaluation or negatively from the equilibrium leading to undervaluation (Ajao & Igbekoyi, 2013).

A relatively flexible exchange rate regime appears to be more appropriate in dealing with the high capital flows, productivity improvements and the appreciation of exchange rates also in nominal terms (Égert & Lommatzsch, 2004). At the same time, the exchange rate peg was replaced by monetary policies, putting more emphasis on inflation stabilization (Fidrmuc & Horváth, 2018). Égert & Lommatzsch, (2014) stresses the role of exchange rate expectations and argues that the existence of a credible fluctuation band influences the exchange rate behavior not only at the edge of the band but also inside the band.

Volatility in the exchange rate refers to a situation where the country's actual exchange rate deviates from unobservable equilibrium. Exchange rate volatility is defined as the risk associated with unexpected movements in the exchange rate and represents the degree to which a variable change over time. Volatility in the exchange rate can adversely affect the investment by creating uncertainty in the environment thus leading to suboptimal resource allocation (Iqbal *et al.,* 2011).

The fluctuation of the exchange rate between currencies is often a result of changes in the major global economy and other instances, the country's fiscal and/or monetary policies (Olowe, 2011). The exchange rate volatility generally increased with the introduction of more flexible exchange rate arrangements. Furthermore, a decrease of interest rates differential decreases exchange rate volatility, while high interest rates differential has the opposite effect (Kočenda & Valachy, 2016).

Devereux & Engel (2012) stressed the presence of all three factors: local currency pricing, heterogeneous international distribution of commodities, and speculation in the foreign exchange markets as the most important factors influencing the volatility in the foreign exchange rate. Furthermore, expectations may be, in principle, formed differently in the appreciation and depreciation parts of the target zones (either de jure or de facto), which may cause systematic asymmetric effects (Fidrmuc & Horváth, 2018). From an initial trade deficit position, currency depreciation has a consequent effect on aggregate demand and rise in exports which have a strong exchange pass-through inflation pressure leading to fluctuations in the exchange rate (Ebeke & Fouejieu, 2015).

2.1.3 Interest Rates

Interest is considered as the price paid for the use of credit or money (Bomin, 2019). Interest rates are either real or nominal. The real interest rate is the rate quoted by banks and the press, while the real rate adjusts the nominal rate for the influence of inflation. Changes in the nominal interest rates rise due to the changes in the underlying real rate of interest or changes in the expected inflation (Hakkio, 1986). In the US, the interest rate is usually based on 10 - year treasury bond rate and as a common standard, the interest rate is based on the county's treasury bill or bond.

Several factors can cause variation in the underlying real rate or expected rate of inflation. The real rate of interest is determined by market dynamics and tends to rise or fall as the demand for funds grows faster or slower than the supply of funds. Thus, an increase in demand amplifies the upward pressure on the real interest rate. The supply of funds in an economy comes from savings of individuals and firms plus funds provided by the banking system, while the demand for funds comes from firms making investment decisions, consumers borrowing above current income and government financing a budget deficit (Hakkio, 1986).

Since the nominal interest rate depends on future inflation expectation while the nominal exchange rate relies on rate differences between foreign and domestic inflation rates, then inflation affects both nominal interest and exchange rate. Inflation has a negative correlation between nominal interest rates and exchange rates, and thus any changes in the real interest rate will directly translate into changes in nominal interest rates. Besides, changes in real interest rates through the alteration of the relative investment opportunities of domestic and foreign investment opportunities cause movements in nominal and real exchange rates (Hakkio, 1986).

For investment opportunities between two countries, market forces should equalize the real returns to investment and if one country has comparatively higher interest rates, then the market must expect that country's real exchange rate to depreciate and vice versa. Viewed differently, the expected appreciation or depreciation of the country's currency is directly related to the real interest rate differential in the two countries (Hakkio, 1986). In this manner, the rate of interest can be equated to the opportunity cost of using money (Madura, 2008). Therefore, any increase in a country's real interest rate leads to an increase in the real and nominal exchange rate.

There are significant correlations between inflation, interest and exchange rates (Al Samara, 2009) such that higher interest rate differentials could increase the premium of a currency of a country with a higher interest, because of higher capital inflows (Jongwanich, 2009). This would then portend that any variations in interest rates differentials would lead to the variations of inflation rates and exchange rates. Higher interest rate differential attracts direct foreign capital inflows and leads to the appreciation of the local currency, lower interest rate differential reduces the direct foreign investments thereby leading to a depreciation of the local currency (Al Samara, 2009).

All these impacts depend on the magnitude of the foreign direct capital inflows with a consequent effect on the output (Were *et al.*, 2013). When the central bank raises the interest rate, capital flows into the country, and this, in turn, leads to an appreciation of the exchange rate (Osawa, 2006). Interest rate is one of the most important determinants of the long-term variability in the foreign exchange markets (Mińska-Struzik, 2012).

2.1.4 Foreign Direct Investments

Foreign direct investment (FDI) is a crucial channel through which capital flows between the industrial and developing nations. Its composition also changes remarkably as it takes different forms such as portfolio investment, direct foreign investment (FDI), external commercial borrowings, non-resident deposits and social deposit schemes (Dua & Sen, 2006). Thus, private capital flows (foreign direct investments) acts as a source of stability by promoting credit and risk-sharing across borders (O'Connell *et al.,* 2010). FDI flows increases consumption demands for both traded and non-traded goods resulting in rise in the prices of non-traded goods and the consequent attainment of equilibrium in the market conditions. These increases in the consumption of traded goods lead to a deterioration in the balance of trade without any accompanying changes in the price of traded goods (Al Samara, 2009).

Capital moves in slowly and therefore the target currencies tend to appreciate gradually, thus attracting momentum trading, which in turn fuels further appreciation (Hassan, 2015). Foreign direct capital investment follows the liberalization of the economy and the development of the financial market (Drine & Rault, 2011). Surges in the capital inflows tend to stimulate excessive credit growth (Hassan, 2015). For instance, capital inflows into developing economies lead to an appreciation of the real exchange rate. However, any volatility in the real exchange rate has a direct, deleterious effect on FDI inflows (Kiyota and Urata, 2004; and Ruiz, 2005).

The appreciation effect of the exchange rate on FDI inflows is indeed diminished by active large financial and capital markets (Al Samara, 2009). Any increases in the FDI lead to an appreciation of the real exchange rate followed by a rise in domestic demand and an increase in non-tradable prices. Consistent with other studies, Ricci, Lee and

Milesi-Ferretti, (2008) indicated that increases in the net foreign assets tend to lead to the appreciation in the real exchange rate. When capital mobility increases, the relationship between exchange market pressures and domestic short-term interest rates exists through monetary policy tools (O'Connell *et al.,* 2010).

Kenya relies heavily on FDI for capital and employment, as is evidenced by the fact that a third of Kenyan banks are foreign-owned, controlling 51% of total banking assets in the country (CBK, 2015). Further, the FDI inflows primarily go into telecommunications, media, technology, retail and consumer products, oil, natural gas and mineral sectors. These FDI are mainly drawn from the UK, US and India. In 2013, FDI inflows in Kenya stood at USD 514 million (KES 45.18 billion), up from USD 259 million (KES 22.7 billion) a year earlier which is ninety-eight per cent (98%) increase. In 2018, the total FDI inflows into Kenya was 1.6 billion US Dollars (UNCTAD, 2014).

2.1.5 Inflation Rate

The inflation rate is a measure of the stability of prices in an economy and it conceptually describes the rise of average prices in an economy (Edwards, 2002). The inflation rate is categorized into either core or headline inflation which is simply known as consumer price index (CPI). While core inflation excludes specific items such as food and fuel, overall headline inflation is inclusive of all the total price movements. In Kenya, as in other emerging countries, non-core items account for a larger share of headline or consumer price (CPI). This combined food and fuel share are between 60% of Kenya's CPI basket while energy accounts for a further 18% (Adam *et al.,* 2010).

The inflation rate has taken a new meaning in becoming a monetary policy instrument referred to as inflation targeting. The inflation targeting (IT) regime is an institutional arrangement in which the central bank defines a medium-term inflation rate that is compatible with macroeconomic stability (Schnabl, 2018). Inflation targeting involves the addition or shifting of inflation pressure as a monetary anchor. In the inflation targeting regime, price stability remains the primary objective, while other monetary tool targets are subordinated. The inflation target is set and reset each year by the central bank in agreement with the government (Gemayel, Jahan & Peter, 2011). Bassey and Essien (2014) observed that inflation targeting as a monetary tool began in New Zealand in 1990, Canada, Israel in 1991, the United Kingdom in 1992, Brazil in 1997, South Africa in 2000 among other countries (Gemayel *et al.,* 2011).

Inflation targeting as a monetary tool has a stronger footing with regard to macro-economic stability (Heintz & Ndikumana, 2011). The objective of this monetary policy tool is to establish a nominal and credible anchor for domestic prices and the essence is that the policy actions and pronouncements will credibly influence the evolution of the inflation expectations of the private sector (Adam *et al.*, 2010). Theoretically, a low inflation rate scenario will lead to an appreciation of the exchange rate (Duarte, & Stockman, 2002).

2.1.6 Balance of Payments

Balance of payments (BOP) accounts is an accounting record of all monetary transactions between a country and the rest of the world and include payments for the country's exports and imports of goods, services, financial capital, and financial transfers (Aziza, 2010). In the short run, however, an import-dependent economy has a low elasticity regarding the exchange rate regime. As the domestic value of the trade

balance increases, the currency depreciates, thus lowering export prices, and raising import prices simultaneously. Due to the low elasticity of the currency to imports, an increase in the nominal value of imports into value exceeding the nominal value of exports leads to depreciation of the exchange rate and a worsening of the trade balance (Kandil, 2009).

The balance of payments (BOP) serves as a bookkeeping system that records all payments on the movement of funds between a nation (private sector and government) and foreign countries (Danby, 2009). A surplus in the balance of payment indicates that inflows exceed outflows, thus the positive balance of trade. In other words, the total current flow is positive. During the surplus period, the demand for domestic currency will exceed the supply leading to the appreciation of the exchange rate (Arize, 1994). The consequent effect of the surplus in trade is a decrease in net exports as a form of correcting the payment surplus. When the total current flow equal zero, the net change in the reserves is marginal.

In case of deficits in the balance of trade, that is, when the imports exceed the exports, there is a surge in the demand for foreign currencies to fuel the consumption of the imports and in such a case there is the downward pressure for the currency to depreciate. For a current account surplus, the value of the local currency goes up (Cavallo, 2004). In the case of deficits in the current account, the immediate subsequent depreciation of the local currency makes export relatively cheaper and imports relatively more expensive. This should automatically eliminate the deficits. When the imports as a share of GDP is higher, there are stronger pass-through inflationary effects. As a consequence, there is less flexibility in the exchange rate regime of such countries (Ebeke & Fouejieu, 2015).

2.2 Theoretical Literature Review

The study was guided by the following theories on foreign exchange volatility; the theory of comparative advantage and the purchasing power parity theory.

2.2.1 Theory on Comparative Advantage

The theory of comparative advantage allows the consideration of both sources of comparative advantage; that is the technology and factor endowment, within a unifying, yet highly tractable framework. This is important not only for generalizing results from the previous literature but also because factor endowment in practice coexists with technology and institutional differences (Costinot, 2009). The theory rests on the assumptions that labour and capital do not move between nations, that there are no trade imbalances, that all resources are always fully employed and that international trade can be described by a comparative-static model (Schumacher, 2013).

Ricardo was the first economist who distinguish international trade from domestic trade. He showed that international trade follows different rules from domestic trade. This distinction is based on the assumption that labour and capital do not move between nations as they do inside a nation (Schumacher, 2013). The reasons for the immobility of capital are that these sources (labour and capital) when not under the immediate control of its owner, together with the natural disinclination which every man has to quit the country of his birth and connections, and entrust himself with all his habits, to a strange government and new laws. The immobility of labour also originates from the latter reason. Therefore, free international trade is determined, unlike free domestic trade, by comparative production advantages (Ricardo 2004).

The theory shows that it would be advantageous for both nations to specialize according to their respective comparative advantage and start trading with each other.

Due to the more efficient employment of labour and capital, the amount and variety of the objects on which revenue may be expended and the sum of enjoyments increase (Ricardo 2004). As there are no other economic gains from international trade, the whole population, as consumers, would benefit from international trade because goods become cheaper and available in larger quantities. The theory does not integrate dynamic developments like economic growth (Schumacher, 2013). Ricardo shows not only that free trade is advantageous for nations, but also that nation will benefit automatically because free international trade leads inevitably and even unintentionally to a specialization according to comparative advantages.

Ricardo draws on the price-specie-flow mechanism, which is a simple version of the quantity theory of money. Money is seen as neutral and has only one function in international trade, namely as a means of exchange to facilitate trade. As a corollary, trade must be balanced. This is an important presumption of the price-specie-flow mechanism. According to this mechanism, changes in the quantity of gold (and silver), which was the means of payment at the time, have no real effect, only a price effect. Thus, absolute (gold) prices, wages, etc. depend on the quantity of gold that is available inside a nation (Kowalski, 2011).

Comparative production cost advantages are thus transformed into absolute money price advantages for the consumer. This transformation is significant and necessary: the cost of production, though it may be, and generally is, the ultimate condition governing international exchange, is never, in any case, the proximate or immediate cause. That proximate or immediate cause is not the cost, but the price. Since consumers buy a good from whoever sells it the cheapest, comparative production cost advantages must be

transformed into absolute price advantages. This mechanism prevents trade from being unbalanced Kowalski, 2011).

A perpetual trade surplus or deficit is thus theoretically impossible under free trade conditions. The volume of trade may change but international trade will always be balanced at least after some time of adjustment (Kowalski, 2011). Ricardo has this mechanism in mind when he says that, in a free trade system, each country naturally devotes its capital and labour to such employments as are most beneficial to each and the exchanges could be no otherwise in every country than at par. Although each nation seeks to maximize its advantage, it brings about the best possible outcome because labour is distributed "most effectively and most economically (Ricardo, 2004).

Comparative advantages are determined by comparing national opportunity costs at the respective optima. If each nation specializes according to its comparative advantage, the overall production increases and through trade the available quantity of commodities in both nations is higher than in the state of autarky. This means national consumption increases beyond the respective production possibility frontier and each nation can reach a higher social indifference curve. Hence, the consumers' needs are satisfied to a higher degree and in this way, free international trade is beneficial for each nation (Kowalski, 2011).

There are several explanations for why national opportunity costs differ. The two most common are the Ricardian models with one factor, two goods, and two countries and the Heckscher-Ohlin model with two factors, two goods, and two countries. In these simple models, differences in either technology or factor endowments have strong implications for the pattern of international specialization (Costinot, 2009). The most

famous model, the Heckscher-Ohlin model, assumes that it is the effect of different endowments of factors of production.

In this model, each nation has a comparative advantage in the production of commodities into which enter considerable amounts of factors abundant and cheap and thus each nation will specialize accordingly (Ohlin, 1933). There are no further gains from trade. Any possible dynamic changes and gains are completely disregarded (Heckscher, 1949). Consumption and production are at an overall maximum. If opportunity costs are equal in both nations and thus no comparative production advantages exist, international trade will not take place, as in the classical theory.

The neoclassical formulation of the theory of comparative advantage contains an automatic adjustment mechanism. It has the same function, namely, to transform comparative production advantages into absolute price advantages, because, ultimately, absolute price differences determine the international flow of commodities. Neoclassical economists assert the assumption of balanced trade and see money as neutral. In today's world national paper money forms the international means of payment. In the case of floating exchange rates, the exchange rate adjustment mechanism is responsible for such a transformation. According to this mechanism, trade imbalances cause a shift in exchange rates (Aldrich, 2004).

The exchange rate is solely determined by trade flows. The absolute level of money prices is internationally determined by the exchange rate of a nation's currency. Trade imbalances affect the demand for currencies and result in a change in the exchange rate (Felipe & Vernengo, 2002). The currency of the nation that experiences a trade deficit – and thus an outflow of money – will be depreciated and the currency of the nation that has a trade surplus will be appreciated. Thus, the commodities that are produced in

the deficit nation will become cheaper internationally while those from the surplus nation will become more expensive. When exports become equal to imports in money value, the exchange rate will stop moving and equilibrium will exist (Eicher *et al.*, 2009).

Unsurprisingly, balanced trade is only an exception in practice. Even strong defenders of the theory of comparative advantage have admitted that in reality, a country's foreign trade is exactly balanced only rarely, thus, internationally, trade imbalances that can be large and persistent are common (Felipe & Vernengo, 2002). Anytime a trade imbalance exists, the equilibrium state will be restored through this exchange rate adjustment mechanism. Changes in the exchange rate do not change relative prices or long-run allocation of resources. As a result, each nation will automatically specialize in the production of those goods, in which it has a comparative advantage, and each nation will be able to successfully compete in world markets (Salvatore, 2011).

2.2.2 Purchasing Power Parity Theory

The purchasing power parity theory was developed by Gustav Cassel in 1918 and holds that the nominal exchange rate between two currencies should be equal to the ratio of aggregate price levels between the two countries and thus unit of currency of one country has the same purchasing power in a foreign country (Taylor & Taylor, 2004). The theory has been used in the determination of the exchange rate and asserts that the exchange rate change between two currencies over any period is determined by the change in the two countries' relative price levels (Rogoff, 1996). The assumptions to the theory are that the importers and exporters are motivated by cross-country price differences and thus seek to induce changes in the spot exchange rate. Another perspective to the theory is that the transactions on a country’s current account tend to

affect the value of the exchange rate on the foreign (Forex) markets (Devereux & Engel, 2003).

The theory holds based on the international goods arbitrage which is related to the Law of One Price. The law of one price holds that the price of an internationally traded good should be the same anywhere in the world when that price is expressed in a common unit of currency. Thus, individuals would under this circumstance make a pure economic profit by pursuing arbitraging behaviours. The Law of One Price would imply that a PPP exchange rate should hold between the countries concerned (Taylor & Taylor, 2004). The theory is based on an extension and variation of the ―law of one price as applied to the aggregate economy (Devereux & Engel, 2003).

As proposed by the PPP theory, inflation rate differentials between two countries would result in differences in purchasing power of the two currencies (Cassel, 1922). The hypothesis postulates an underlying tendency for changes in the nominal exchange rate to be fully offset by changes in the ratio of foreign to domestic price levels (Gelbard & Nagayasu, 2004). Purchasing power parity is also a tool used for making a comparison of data between countries by international organizations such as the World Bank. The theory holds for periods of less than six years in that the speed of convergence of the actual exchange rate to its PPP level is very low (Macdonald, 1995; Phylaktis & Kassimatis, 1994).

In the flow model approach to the balance of payment, PPP lays down the fact that the exchange rate has to compensate for the difference in the inflation rate. As the inflation rate differences between countries are eliminated, the PPP will tend to equalize the price levels in different countries. This scenario will occur as the currency of the country with a higher rate of inflation will depreciate against the other country's currency. However,

it is finally the market dynamics that will drive the eventual price of a commodity. Further, not all trade goods between countries with the weight attached to perfectly substitute goods in aggregate price indices will differ across countries. Also, since PPP is based on traded goods, it might be more usefully tested with producer price indices (Taylor & Taylor, 2004).

Though scholars consider the theory as sufficient in determining the exchange rates, it has two shortcomings. Firstly, not all goods are traded internationally (for example, capital intensive infrastructure such as roads, buildings) and secondly, the transportation cost is considered negligent under the theory but in a real-life context, it represents a small amount of the good's worth. Lastly, PPP is not a very reliable determinant because of the influence of the changes in commercial policies, labour force technology, and tastes and preference, which in turn changes the real exchange rate (Cochran & Defina, 1995).

2.3 Empirical Literature Review

2.3.1 Interest Rate and Foreign Exchange Volatility

At the onset of the 1997 Asian financial crisis, Osawa (2006) studied the exchange rate volatility of the three Asian countries of Korea, the Philippines and Thailand and was able to show the strong correlations between the interest rate and the exchange rate. Asari *et al.,* (2011) used error correction models and observed a long–term relationship between interest rates and the volatility in exchange rates in Malaysia. Thus, they reported that interest rates influence the stability of the real exchange rates. Further away in South America, Barbosa-Filho, (2008) also observed that the situation was remedied by a rise in the interest rates to attract short-term capital inflows leading to appreciation in the real exchange rate. However, in the sub-Saharan African economies

where capital markets are underdeveloped, these risks have not yet been noticed (Heintz & Ndikumana, 2011).

Al Samara (2009) studied the effect of interest and inflations rates using error correction models to estimate the effect of the macro-economic variables on the volatility of the exchange rate. The study found a significant correlation between interest rates, inflation and exchange rate, such that any variations in interest rates lead to the variations of inflation rates and exchange rates. Thus, higher interest rates attract direct foreign capital inflows and lead to the appreciation of the local currency, lower interest rates reduce the direct foreign investments thereby leading to a depreciation of the local currency (Al Samara, 2009).

The East Asian currency crisis and the failure of high-interest rates policy to stabilize the exchange rate have challenged the credibility of raising interest rates to defend the exchange rate. Critics argue that the high interest rates imperil the ability of the domestic firms and banks to pay back the external debt and thereby reduce the probability of repayment. Thus, a high-interest rate regime leads to capital outflows with consequent depreciation of the currency (Mohanty & Klau, 2004). The study by Sifunjo (2011) examined chaos and nonlinear dynamical approaches to predicting exchange rates in Kenya using GARCH models. The results suggest the presence of nonlinearity in the returns, high volatility in the market with a maximum duration of six months.

2.3.2 Foreign Direct Investments and Foreign Exchange Volatility

Empirical studies on the volatility of the exchange rate in East Asian countries found a negative relationship between FDI flows and exchange rate (Dhakal *et al.,* 2010). They continued to say that if both the real demand and exchange rate shocks are assumed,

exchange rate volatility tends to increase the FDI share even with identical costs of production across countries. A study by Ricci, Lee & Milesi-Ferretti, (2008) observed that an increase in net foreign assets and government consumption tend to be associated with appreciating real exchange rates.

Foreign direct capital investment follows the liberalization of the economy and the development of the financial market with a consequent appreciation of the real exchange rate (Drine & Rault, 2011). This FDI inflow increases consumption demands for both traded and non-traded goods leading to a rise in the price of non-traded goods leading to market equilibrium. The increase in traded consumptions causes the trade balance to deteriorate without any changes in the price of traded goods (Al Samara, 2009).

Chiira (2009) in a study of the South African investment in the Southern and Eastern African region, identified the exchange rate as one of the major barriers to FDI in Zimbabwe, Botswana and Mozambique. Similarly, in a survey of the southern African countries, Jenkins & Thomas (2002) found that about 25 per cent of the total firms surveyed identified exchange rate risk as an important determinant of FDI in the sub-region. However, these studies did not analyse the relationship and the extent to which exchange rate volatility constrains FDI in these countries.

Ajayi (2004) did a study aimed at determining the magnitude and direction of the effects of exchange rate movement and its volatility on FDI flows to the agriculture and manufacturing sectors in Nigeria. Employing the GARCH measure of volatility, the error correction methodology was used for the empirical investigation in testing the effects of both the official and parallel market exchange rates on FDI flows to agriculture and manufacturing. While the results show that the official market exchange

rate movement significantly reduces FDI inflows to agriculture, the same is, however, insignificant for the manufacturing FDI. For the volatility coefficients, official market exchange rate volatility was not found to be significant for FDI inflows.

As observed by O'Connell *et al.,* (2010) the foreign capital flows respond to interest rate differentials, exchange rate expectations, and uncertainties about the domestic political process in Kenya. These effects may well be nonlinear, allowing the central bank to achieve considerable short-term smoothing of the exchange rate during normal times but proving illusory in the presence of large shocks. Mwega and Rose (2005) noted that uncertainty reduces investment in the presence of adjustment costs. The investment also has a negative impact due to the irreversible nature of investment (Ruiz, 2005).

2.3.3 Inflation Rate and Foreign Exchange Volatility

Inflation correlates with the choice of foreign exchange regime (Durevall & Sjö, 2012) and is higher in emerging markets that tend to intervene to stem currency appreciation (De Gregorio & Tokman, 2005). In emerging economies that have adopted inflation targeting as a nominal anchor, an analysis by Ebeke & Fouejieu (2015) showed that IT positively correlated with a flexible exchange rate regime when compared to non – inflation targeting (IT) countries. As indicated by the authors, the adoption of the inflation targeting regime tends to increase the exchange rate flexibility as the period for adoption lengthens.

Pattnaik & Mitra (2001) observed the existence of a high correlation between interest rates, inflation rates and exchange rates and therefore, the manipulating of interest rates, influences both inflation and exchange rates. For instance, a study on inflation targeting as a policy regime in emerging market economies indicated that inflation-targeting

countries achieve a dual-pronged objective of responding to both inflation rates and real exchange rates (Aizenman, Hutchison & Noy, 2008). Further, the same policy regime tends to respond more strongly to the fluctuations in the real exchange rate. This is supported by a study that indicated that after the Asian crisis, most central banks adopted the inflation-targeting regimes to stabilize the volatility in their exchange rates. This is illustrated by South Korea which replaced headline inflation with core CPI at a range of about 2–4% to stabilize the Korean Won (Osawa, 2006).

Bassey & Essien (2014) reported that in the developing countries where their reserve/central banks have adopted an inflation-targeting regime, the post-inflation targeting regime in all those countries have shown that there is a general tendency of currency to appreciate in the aftermath of the adoption of inflation targeting. This significantly reduced the volatility in the exchange rate. According to Adam *et al.,* (2010), the use of inflation targeting as a monetary policy tool in Kenya is not sufficient because of the strong pass-through effects of the exchange rate on the domestic prices and output. Heintz & Ndikumana(2011) observed that in developed economies with relatively developed financial capital markets, inflation targeting mechanisms would always attract inflows of short–term portfolio investment which always lead to the appreciation of the real exchange rates. Studies on the inflation targeting regimes in emerging markets indicate that inflation targeting is a mixed strategy that responds to both inflation rates and real exchange rates (Aizenman *et al.,* 2008).

The relationship between the inflation targeting regime and exchange rate regime has led some analysts to conclude that the costs of inflation targeting regime are the increase in the volatility of the exchange rate (Leve-Yeyati & Sturzenegger, 2002). Low inflation rates in the economy always signify higher real interest rates and/or

appreciated real exchange rates. Any price changes directly impact investment decisions and, as a consequence, long-run growth (Heintz & Ndikumana, 2011). A study on the inflation rate targeting in Brazil indicated that the policy shift leads to over-valuing of the exchange rate of the Brazil Real (Barbosa-Filho, 2008). The authors continued to say that IT is more prevalent in middle-income countries (emerging markets) and low-income (developing) countries as opposed to advanced economies. Thus, these countries using IT as an inflation anchor exhibit more flexibility in exchange rate regimes.

And as indicated by Heintz & Ndikumana, (2011) emerging economies without an inflation targeting regime tend to respond more strongly to the fluctuations in the real exchange rate. As the rate of inflation exceeds the rate of the crawl of the exchange rate, the domestic relative price of non-traded goods rises relative to the prices of traded goods leading to a fall in exports with a significant increase in the imports. Consequently, the trade balance worsens, and external liabilities accumulate (O'Connell *et al.*, 2010). Inflation targeting serves as a nominal anchor which provides a framework for making economic decisions (Berganza & Broto, 2012). For instance, empirical studies from 127 countries showed that GDP growth rates tend to decline only when inflation rates have moved beyond 20-25 per cent and that economic growth increases when inflation rates range between 15-20 per cent range (Heintz & Ndikumana, 2011).

The use of inflation targeting regimes as a monetary policy tool is more prevalent in both industrialized and emerging market economies because of its long-run effect on price stability and output (Kasekende & Brownbridge, 2011). A panel data analysis on 37 emerging economies indicated that the use of inflation targeting regimes leads to

instability in the exchange rate than the non-inflation targeting regimes (Berganza & Broto, 2012). The indication is that some countries can effectively reduce the volatility in the exchange rate through the use of an inflation-targeting policy. Bassey and Essien (2014) observed that there was a general tendency of the naira to appreciate after the adoption of the inflation targeting regime.

The use of inflation targeting as monetary policy has a significant effect on the economy through real exchange rate and financial volatility (Cordero, 2008). In economies with relatively unrestricted capital mobility and reasonably developed capital markets like Kenya, high-interest rates associated with inflation targeting often attract inflows of short-term portfolio investment. Such foreign capital flows lead to an appreciation of the real exchange rate, hurting exports and facilitating import penetration (Heintz & Ndikumana, 2011).

Adam *et al.*, (2010) indicated that the use of inflation targeting as a monetary policy tool in Kenya is driven by the inability of the former monetary policy regimes in maintaining price stability in a deepening and open financial market. Thus, they say that inflation targeting is unavoidable in responding to the movements in the real exchange rates because of the strong pass-through effects of the exchange rate on the domestic prices and output. It is a well-documented fact that emerging market economies tend to experience higher pass-through. In particular, several studies have found that exchange rate pass-through has tended to be stronger in Latin America than in Asia (Ho & McCauley, 2013).

2.3.4 Balance of Payments and Foreign Exchange Volatility

Research show that international trade has the greatest impact on exchange rate levels for countries that export mainly low-processed goods (such as Brazil, Australia). The

growing demand for raw materials contributes to a rise in their prices on world markets. It leads to an increase in exports and to the appreciation of the national currency value (Chisholm, 2013). Studies on the Nigerian economy indicate that an unfavourable balance of trade has a destabilizing effect on the exchange rates (Aliyu, 2007).

To a great extent, this is because the optimal degree of exchange rate flexibility is quite idiosyncratic and depends on several country-specific characteristics that might include the degree of openness, the degree of price and wage stickiness, the degree of short- and medium-term exchange rate pass-through to prices, the degree of substitutability between domestic and imported goods, the state of the banking system and the amount and nature of financial dollarization (De Gregorio & Tokman, 2005).

Empirical evidence by Ricci *et al.*, (2008) indicated a strong positive relation between the CPI-based real exchange rate and commodity terms of trade. While a time-series analysis indicated that uncertainties in the electoral cycles in Kenya determine the volatility in the balance of payments (O'Connell *et al.*, 2010). Chen & Rogoff (2004) observed that in those countries with favourable terms of trade, the doubling in the value of commodities exported lead to a single unit appreciation in the exchange rate. Finding the optimal degree of exchange rate flexibility is difficult.

A study on Nigerian currency volatility indicated the existence of a stable long-run equilibrium relationship between non-oil exports and the exchange rate (Aliyu, 2010). Importantly is the balance of payments resulting from the export of non-oil products reduced when the volatility of the local currency was high and increased when volatility approached zero.

2.4 Summary of Literature Gaps

Several empirical studies in Asia (Osawa, 2006; Asari *et al.*, 2011), in South America (Barbosa-Filho, 2008), in Middle East (Al Samara, 2009) have reported of significant correlation between inflation and exchange rate, such that any variations in interest rates lead to the variations of inflation rates and exchange rates. However, in the sub-Saharan African economies where capital markets are underdeveloped, these risks have not yet been noticed (Heintz & Ndikumana, 2011).

Studies in East Asian countries (Dhakal *et al.*, 2010) found a negative relationship between FDI flows and exchange rate. Ricci, Lee & Milesi-Ferretti, (2008); Drine & Rault, 2011). observed that an increase in net foreign assets is associated with appreciating real exchange rates. In Nigeria, Ajayi (2004) observed that the volatility on FDI flows showed that the official market exchange rate movement significantly reduces FDI inflows. In Kenya, O'Connell *et al.*, (2010) reported that foreign capital flows respond to interest rate differentials and exchange rate expectations. Lucas' assertion of Mwega & Rose (2005) is not the only theoretical framework explaining the negative relationship between exchange rate volatility and foreign direct investment.

Past empirical studies have reported that inflation correlates with the choice of foreign exchange regime (Durevall & Sjö, 2012; De Gregorio & Tokman, 2005). For instance, the use of inflation targeting in emerging economies is positive with a flexible exchange rate regime (Ebeke & Fouejieu, 2015). Authors have reported of association between interest rates, inflation rates and exchange rates (Pattnaik & Mitra, 2001), thus, the use of inflation targeting as a policy regime leads to the stabilization of the real exchange rates (Aizenman *et al.*, 2008; Osawa, 2006). However, the use of inflation targeting in

Brazil led to over-valuing of the exchange rate of the Brazil real (Barbosa-Filho, 2008; Berganza & Broto, 2012).

The relationship between the inflation targeting regime and the exchange rate regime has led some analysts to conclude that one of the costs of inflation targeting adoption is the increase in exchange rate volatility (Leve-Yeyati & Sturzenegger, 2002). Studies on the inflation targeting regimes in emerging markets indicate that inflation targeting is a mixed strategy that responds to both inflation rates and real exchange rates (Aizenman *et al.*, 2008). In Kenya, Adam *et al.,* (2010) and in Asia (Ho & McCauley, 2013) noted that the use of inflation targeting has strong pass-through effects on the exchange rate and long-run effect on price stability and output (Kasekende & Brownbridge, 2011).

Research has shown that international trade impacts on exchange rate levels for countries that export mainly low-processed goods (Chisholm, 2013; Aliyu, 2007). Empirical evidence by Ricci, Lee & Milesi-Ferretti, (2008) indicated a strong positive relation between the CPI-based real exchange rate and commodity terms of trade. Net importing countries tend to exhibit strong exchange rate pass-through inflation pressure (Ebeke & Fouejieu, 2015), while oil–exporting countries have high volatility in exchange arising from the oil exports (Aliyu, 2010). O'Connell *et al.*, (2010) observed that uncertainty in the governance regimes influences the stability of the exchange rate through the unfavourable balance of payments.

2.5 Conceptual Framework

A conceptual framework is the diagrammatic presentation of the relationship between the variables as shown in Figure 2.1. In this study, the independent variables were; interest rate, foreign direct investments, inflation rate and balance of payments. The

study sought to investigate how the macroeconomic variables influenced foreign exchange volatility in Kenya from 1999 to 2018.

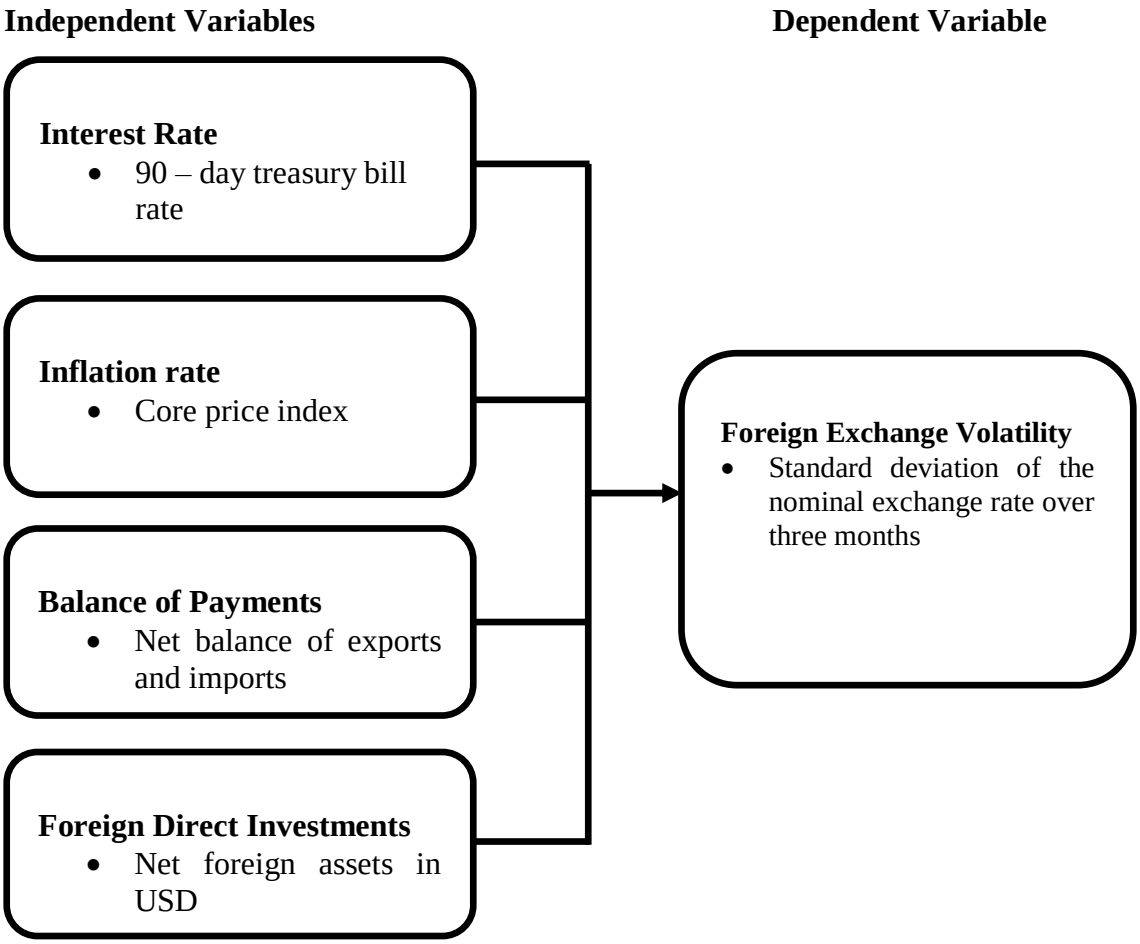


Figure 1.1: Conceptual Framework

Source: Author (2019)

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter presents the methods of data collection and analysis. The chapter is composed of the research design, study population, sampling design, data collection, validity, reliability, data analysis and ethical considerations.

3.1 Research Design

The study employed an explanatory research design with a time-series dimension. The study is explanatory as it seeks to establish causal relationships between variables by emphasizing studying a situation to explain the relationship (Saunders, Lewis & Thornhill, 2009). Explanatory research seeks to identify the extent and nature of cause-and-effect relationships and is conducted to assess impacts of specific changes on existing norms, various processes etc and focuses on an analysis of a situation or a specific problem to explain the patterns of relationship between variables (Wooldridge, 2009; Hair *et al.*, 2010).

3.2 Data Collection

The study used data from the Kenya National Bureau of Statistics (KNBS) and the Central Bank of Kenya from 1999 to 2018. The researcher used secondary data that was obtained from the published monthly reports spanning twenty years from 1999 to 2018.

First, the study converted monthly data values for the inflation, exchange, and interest rate into quarterly data values using the simple moving averages method where the average of the two previous periods summed up with the current period data values and then divided by two. This was done continuously like a chain from the first data values of January 1999 till December 2018. The monthly data values for the balance of trade

were converted into quarterly data values by summing up the three months of data values. For the foreign direct investments, there were quarterly data values that were captured as they were.

3.3 Data Analysis

The study used descriptive analysis to perform the elementary transformation of data to describe the basic characteristics of the data. Descriptive statistics are procedures used to describe the basic characteristics of the variable and summarizes the variable data in a simple and understandable way. Since most of the information was on a ratio scale, the data were analysed through the use of means, skewness, and standard deviation statistics. The mean as a measure represents the central figure in the data set, with the standard deviation estimating the variability around the central figure (Zikmund *et al.,* 2010; Depoy & Gitlin 2011). Once the descriptive analysis had been done, the information was presented in various ways such as tabular and pictorial format.

The study had time-series data that have been collected over a period of time on one or more variables. Time series data are associated with a particular frequency of observation or frequency of collection of data points (Brooks, 2014). The time-series data that cointegrate is best analyzed by an error correction model (ECM) which is a time series regression model based on the behavioural assumption that two or more time-series exhibit an equilibrium relationship that determines both short-run and long-run behaviour. An error correction model (ECM) belongs to a category of multiple time series models most commonly used for data where the underlying variables have a long-run common stochastic trend. ECMs are a theoretically driven approach useful for estimating both short-term and long-term effects of time series data (Brooks, 2014;

Wooldridge, 2009). The results were considered significant at $\alpha=0.05$ levels of significance.

3.3.1 ARCH Models

The study examined the volatility in the exchange rate using Autoregressive Conditional Heteroscedasticity (ARCH) models. There are several ARCH models with the most common being the Exponential General Autoregressive Conditional Heteroscedasticity (E-GARCH) or simply General Autoregressive Conditional Heteroscedasticity (GARCH) and Time Autoregressive Conditional Heteroscedasticity (TARCH) models. ARCH models are suitable in determining the volatility because the technique models conditional variance or volatility of the variable as opposed to a conditional mean of the variable which most statistical tools are designed to. In ARCH models, the variance of the dependent variable is modelled as a function of past values of the dependent variable and independent (exogenous) variables.

E-GARCH or GARCH models are used to model and forecast conditional volatility by estimating the path of time-varying variance and are also used to describe the autoregressive process of exchange rate volatility if the interest is in the stochastic process of short-term volatility (Nowak *et al.*, 2004). The GARCH models are generally applied for the estimations of the conditional volatility of high-frequency (daily) exchange rate changes. This pattern of exchange rate behavior can be estimated by generalized autoregressive conditional heteroskedasticity (GARCH) models terms (Égert & Lommatzsch, 2004).

Empirical evidence indicates that exchange rates like other financial time series exhibit non-linear behaviour (Brooks, 2001; Bauwens & Sucarrat, 2006), therefore GARCH

models have been used to examine the volatility of the exchange rate in studies in Nigeria (Aliyu, 2010), Latin America (Domaç & Mendoza, 2004) with Sekantsi (2009) using GARCH models to examine the effect of real exchange rate volatility on South African exports while Stancik (2006) employed TARCH to model volatility.

The study used the GARCH (1, 1) model which imposes symmetric behaviour and allows for the inclusion of negative variables affecting volatility (Domaç & Mendoza, 2004). Further, it is the most common specification largely used in empirical studies for being parsimonious, thus avoids over-fitting of the model and violation of non-negativity constraint and sufficiently characterizing the behaviour of the exchange rate.

The GARCH model takes the following format.

$$\sigma_t^2 = \sigma_0 + \boldsymbol{\alpha_1} \sum_{\boldsymbol{t-1}}^{\boldsymbol{2}} + \beta\sigma_{t-1}^2 + \mu \quad \text{.....(3.1)}$$

σ^2 depends not only on the square error term in the previous period (as in GARCH (1) but also its conditional variance in the previous time.

Where,

σ^2 = conditional variance of the $\sum$ at time,

σ_0 = constant

t = time t,

$\boldsymbol{\alpha_1} \sum_{\boldsymbol{t-1}}^{\boldsymbol{2}}$ = Sum of conditional variances for period t = 1

$\beta\sigma_{t-1}^2$ = conditional variance for the previous time, t -1

μ = error term

The model for calculating the volatility of the foreign exchange takes the following format;

$$\epsilon_t^2 = \omega + (\boldsymbol{\alpha} - \boldsymbol{\beta})\epsilon_{t-1}^2 + \vartheta_t - \beta\vartheta_{t-1} \quad \text{.....(3.2)}$$

Where,

ϵ_t^2 = the conditional variance of the exchange rate,

ω = the constant term,

α and β = constants

ϵ_{t-1}^2 = the volatility of the previous period (ARCH)

ϑ_{t-1} = component of the last period's forecast variance (σ_{t-1}^2) (GARCH).

Hence, the GARCH (1,1) model can be written as

$$\sigma_t^2 = \gamma_0 + \gamma_1\mu_{t-1}^2 + \gamma_2\mu_{t-2}^2 + \cdots + \mu \quad \text{.....(3.3)}$$

which is a restricted infinite order ARCH model. Thus, the GARCH (1,1) model, containing only three parameters in the conditional variance equation, is a very parsimonious model, that allows an infinite number of past squared errors to influence the current conditional variance (Brooks, 2012). The squared errors follow the heteroscedastic ARMA (1, 1) processes with the autoregressive root which governs the persistence of volatility shocks in the sum of (**α**+**β**). In many applied settings, the root is close to unity, so that the shocks die out. Aliyu, (2010) used the generalized autoregressive conditional heteroskedasticity (GARCH) models to measure the volatility of the exchange rate in Nigeria.

3.3.2 VECM Models

Secondly, the study utilized the VECM (Vector Error Correction Models) to examine the effect of macroeconomic variables on the exchange rate. Empirical studies indicate that trend characteristics of the co-integration analysis of the time series is clear cut (Baldwin, Skudelny & Taglioni, 2005). The VECM model variables express the difference in the short run while describing the real exchange rate dynamics in the long run (Drine & Rault, 2011). Vector error correction models have been applied in analysing the determinants of exchange rate volatility in Nigeria (Aliyu, 2010), Syria (Al Samara, 2009).

The overall function for determining the volatility takes the following format;

$$FXR = \int(INT^{-}, BOP^{-}, INF^{+}, FDI^{-}) \quad \text{.....(3.4)}$$

Where FXR is the volatility in the foreign exchange rate, INT is the interest rate, BOP is the balance of the payment, INF is the inflation rate and FDI is the foreign direct investment. It is expected that volatility in the foreign exchange rate is increased by the reduction in the interest rate (INT^{-}), the drop in balance of payments (BOP^{-}), increase in the inflation rate (INF^{+}) and the drop in the net foreign direct investment (FDI^{-}).

The VECM is a subset of Vector Auto Regression (VAR) models which allows for the prediction of the effect of interventions. VECM also provide a framework in which the results obtained from the impulse response function (IRF) have economic meaning. Contrary to SVAR/VAR models, VECM models are suitable for identifying economic shocks when a co-integration relationship exists between variables in the model. This model has advantages because in systems with co-integration the estimators of impulse

responses from SVAR are more precise. Thus, possible short-run restrictions are placed to identify shocks (Enders 2004).

In simple terms, a VECM can be expressed as Johansen and Juselius (1990)

$$\Delta \boldsymbol{y_t} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} \Delta x_t + \boldsymbol{\beta_2} (\Delta y_{t-1} - \boldsymbol{\gamma_1} x_{t-1}) + \mu_t \quad \text{.....(3.5)}$$

for one independent variable

$$\Delta \boldsymbol{y_t} = \boldsymbol{\beta_1} \Delta x_t + \boldsymbol{\beta_2} \Delta w_t + \boldsymbol{\beta_3} \Delta v_t + \boldsymbol{\beta_4} \Delta z_t + \boldsymbol{\beta_5} (\Delta y_{t-1} - \boldsymbol{\gamma_1} x_{t-1} - \boldsymbol{\gamma_2} w_{t-1} - \boldsymbol{\gamma_3} v_{t-1} - \boldsymbol{\gamma_4} z_{t-1}) + \mu_t \quad \text{.....(3.6)}$$

for several cointegrating variables

Where Δy_t represents the volatility in the exchange rate, ΔX_t represents a change in interest rate, Δz_t represents the inflation rate while Δw_t represents the balance of payment and Δv_t representing foreign direct investments.

While γ is purported to change between t - 1and t as a result of changes in the values of the explanatory variable(s), x, v, w and z between t - 1 and t, and also in part to correct for any disequilibrium that existed during the previous period. The error correction term ($\gamma_{t-1} - \gamma_{xt-1}$ appears with a lag.

$\Delta \boldsymbol{y_t}$, is a vector of endogenous variables and t is the time,

$$FXR = \beta_0 + \beta_1(INT^-) + \beta_2(BOP^-) + \beta_3(INF^+) + \beta_4(FDI^-) \quad \text{.....(3.7)}$$

3.3.3 VECM Diagnostic Tests

There are two main tests: pre-estimation and post–estimation tests. The pre-estimation test is mainly made up of the test for the selection order criteria, while the post-estimation tests include; Lagrange Multiplier (LM) test for serial correlation, Jarque-

Bera normality test for normalisation of errors, Augmented Dicker Full tests for Stationarity and Unit Root Testing and Johansen test for Co-integration.

Tests for Selection Order Criteria

It is often important to include lagged values of the dependent variable as independent variables. Since the variable in question is persistent, if values in the far past still affect today's values, then more lags will be necessary. The selection criteria are used to determine how many lags to be applied in the analysis, with the most common being the Akaike Information Criterion (AIC) and the Schwarz' Bayesian Information Criterion (SIC/BIC/SBIC), Hanna – Quinn Information Criteria.

Test for Normality

The Jarque-Bera test is used to check for the assumption that a given sample x_S is a sample of a normal random variable with an unknown mean and dispersion. The test is applied and requires that the distribution is normal. This test is based on the fact that skewness and kurtosis of normal distribution equal to zero. The test uses the sample Jarque-Bera statistic which is calculated:

$$JB = \frac{n}{6}\left((Skew\ x_S)^2 + \frac{(Kurt\ x_S)^2}{4} \right) \quad \text{……...……..(3.8)}$$

H_0: Normal distribution is platykurtic or mesokurtic.

The test statistic can be compared with a χ^2 (chi-square) distribution with 2 degrees of freedom.

The null hypothesis of normality is rejected if the calculated test statistic exceeds a critical value from the **(2)** distribution.

The decision criteria for large samples is = 0.50, critical value = 5.99 and = 0.01, critical value = 9.21, while for small samples the decision rule can be viewed as approximate.

Stationarity and Unit Root Testing

The analysis first step is simply to look at the data univariate properties and to determine their integratedness degree. Theoretically, a process is either I(0), I(1) or I(2). Nevertheless, in practice, many variables or variable combinations are borderline cases so that distinguishing between a strongly autoregressive I(0) or I(1) process (interest rates are a typical example), between a strongly autoregressive I(1) or I(2) process (nominal prices are a typical example) is far from being easy(Drine & Rault, 2011).

The tests examine whether the stochastic or deterministic result in spurious regression results, un-interpretable student t-values and other statistics have too high a goodness of fit which make results difficult to evaluate. The stationarity or otherwise of a series can strongly influence its behaviour and properties - e.g., the persistence of shocks infinite for non-stationary series. This will result in spurious regressions, a situation where two variables trend over time, with regression of one on the other having a high R^2 even if the two are unrelated or if the variables in the regression model are not stationary, then it can be proved that the standard assumptions for asymptotic analysis will not be valid.

The basic objective of the test is to test the null hypothesis that $\psi = 1$ in $y_t = \psi y_{t-1} + u_t$ against the one-sided alternative $\psi < 1$.

The test is as follows;

H_0: series contains a unit root.

H_1: series is stationary.

The regression takes the form of $\Delta y_t = \psi y_{t-1} + u_t$ so that a test of $\psi = 1$ is equivalent to a test of $\psi = 0$ (since ψ-1= ψ).

The test was carried using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. In both the ADF and the PP test, the unit root is the null hypothesis. If tests with stationarity as the null as well as tests with unit root as the null both fail to reject the respective nulls or both reject the respective nulls, there is no confirmation of stationarity or non-stationarity.

Test for Co-integration

Unit-root tests have limited power to distinguish between a unit-root and a close alternative since the pure unit-root assumption is based on convenience rather than on strong theoretical or empirical facts. This has led many economists and econometricians to believe near-integrated processes, which explicitly allow for a small (unknown) deviation from the pure unit-root assumption to be a more appropriate way to describe much economic time series. Near-integrated and integrated time series have implications for estimation and inference that are similar in many respects., However, the strict unit-root assumption that these methods typically rely upon is often not easy to justify on economic or theoretical grounds. More generally, if there are *n* variables that have unit roots there are at most $n - 1$ co-integrating vector. The Johansen test provides estimates of all co-integrating vectors.

The testing for the order of integration is crucial in setting up an econometric model and making inference and the economic theory suggests that certain variables should be integrated. The best way of testing for co-integration restrictions is through the

Johansen estimator (1991). This estimator also gives an asymptotically efficient estimate of the co-integrating vectors (the β's) and the adjustment parameters (the α's). Johansen's methodology takes its starting point in the vector autoregression (VAR) of order p given by

$$yt = \mu + A1yt{-}1 + \ldots + Apyt - p + \varepsilon t,$$

Where y_t is an *n*x1 vector of variables that are integrated of order one – commonly denoted as I (1) – and ε_t is an *n*x1 vector of innovations.

After ascertaining that the variables are integrated of the same order, the order of the VAR is selected using the likelihood ratio test that suggests an optimal lag length of 3(Dua & Sen, 2006)

Test for Autocorrelation

Changes in many macro-variables are gradual and therefore their values in the current period depend on what happened in the previous one. Thus, time-series data show successive observations that tend to correlate. Economic variables usually autocorrelate and if such a relevant variable effect is included in the stochastic term, then the stochastic term will, to that extent, become autocorrelated. Autoregression can be the result of misspecification of the model and not genuine autocorrelation due to the behavioural characteristics of the residuals.

The most popular test of autocorrelation in the linear regression model is the Lagrange Multiplier test. It checks the null or no autocorrelation up to lag order *k*. The algorithm of conducting the test is as follows. First, one has to calculate the residuals of the original regression:

$\mathbf{e_t = y_t - \alpha`xt.}$

Then, for the auxiliary regression:

$\boldsymbol{e_t = \gamma x_t + \rho_1 e_{t-1} + \rho_2 e_{t-2} + \ldots \rho_k e_{t-k} + v_t.}$

The null of no autocorrelation can be tested as:

$H_0: \rho_1 = 0 \wedge \rho_2 = 0 \wedge \ldots \wedge \rho_k = 0$

$H_1: \rho_1 \neq 0 \wedge \rho_2 \neq 0 \wedge \ldots \wedge \rho_{k \neq} 0$

To this end, we can use the standard tests of significance for models with multiple variables (F –test or LM-test). The null hypothesis is rejected if $TR^2 > {}^2h$ critical value.

3.4.4 Co-Integration and Error Correction Mechanisms

The remedy to stationarize the data is by differencing. Differencing, however, leads to loss of long-run properties as the model indifference has no long-run solution. This will be remedied by measuring variables in the level form while maintaining stationarity with short-run (impact effect) and long-run properties simultaneously incorporated by the use of the error correction mechanism (ECM) or feedback mechanism in the co-integration analysis. Co-integration solves the problem associated with the loss of information associated with detrending or by the attempts to address the stationarity through differencing as in the growth rate models such as used by (Odedokun 1993). It rejects spurious regression results but at the same time accepts the correlation between non-stationary series where correlation is structural rather than spurious. This co-integration analysis was developed by among others Granger (1986) and (Granger & Engle 1987).

Non-stationary variables are said to be co-integrated if they have a long-run relationship amongst themselves in which deviations from their long-run path are stationary; that is two or more variables could be non-stationary but have their differences (or their linear combination) stationary. By definition, therefore, variables are said to be co-integrated if a linear combination of these variables assumed lower order of co-integration. The variables are themselves non-stationary but must be of the same order of integration individually. It is their linear combination that is integrated of a lower order. Where co-integration is rejected, then there will be no long-run relationship between the non-stationary series and thus there will be no information in the α coefficient in equation 3.7. The imposition of ECM will be rejected by the data and the solution will be to specify the model in another form in which no long-run relationship appears.

If $Y_t \sim I(a)$ and $X_t \sim I(b)$ and their linear combination are

$\varepsilon_t = Y_t - \alpha X_t I(a-b)$ then Y_t and X_t are co-integrated. This can be specified as;

$$Y_t = \alpha X_t + \varepsilon_t \quad (3.9)$$

Where,

Y_t is the regress and X_t is the regressor, α is the parameter to be estimated and ε is the mean-zero error term.

If Y_t and X_t are non –stationary but their differences (ΔY *and* ΔXt) are stationary, then only the short-run effect will be captured by running a regression on the following equation.

$$\Delta Y_t = \alpha \Delta X_t + \varepsilon_t \quad (3.10)$$

But if in (3.7), $Y_t - \alpha X_t$ is stationary, then their lag ($Y_{t-1} - \alpha X_{t-1}$) can be augmented into (3.8) as an explanatory variable such that we have an ECM_t represented by

$$\Delta Y = \alpha \Delta X_t + \text{ø} (Y_{t-1} - \alpha X_{t-1}) + \varepsilon_t \quad \text{(3.11)}$$

Equation (3.9) simultaneously incorporates both the short run and the long-run solution and has an error correlation mechanism when ø is negative.

3.5 Measurement of the Variables

Table 3.1: Measurement of variables

Variable	Explanation		Data source
Forex volatility	The standard deviation of the nominal exchange rate change over three months	σ Σ NER	KNBS/CBK
Inflation (%)	Core inflation (CPI index) reflects the headline inflation	%	KNBS/CBK
Interest rate (%)	The 90 – day treasury bill rate	%	CBK
Balance of payment	The log of the balance of exports and imports	Log_{10}	KNBS/CBK
FDI	The log of net foreign assets	Log_{10}	CBK/World Bank

3.6 Ethical Considerations

Generally, ethics conforms to the notion of right with the consequent ethical behaviour being considered fair, just, and acceptable to the research participants. Ethical values can be highly influenced by one's moral standards and are based more on the social or cultural acceptability of behaviour. The researcher approached the ethical issues from an idealist point of view where one bases their morality on moral standards (Zikmund *et al.,* 2010).

The study considered the major ethical considerations that include accessibility and reliability of the secondary data. The researcher first obtained permission from Moi

University, School of Business and Economics and then sought clearance from the National Commission for Science, Technology and Innovation.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents the research findings, hypothesis testing and discussion on the findings. The section begins with the description of the respondents and firm characteristics followed by the presentation of the descriptive statistics of the study variables and inferential statistics respectively. Accordingly, hypotheses testing was done and the explanations of the findings were subsequently presented. Ultimately, the conclusion of the hypotheses was supported by a discussion.

4.1 Trends on Macroeconomic Variables

4.1.1 Trends on Foreign Exchange in Kenya

Graph 1 in appendix III shows the trending behaviour of the exchange rate of the Kenyan shilling to the US dollar. As seen, the shilling started at exchanging at 63/08 rate to the dollar in the first quarter of the year 1999 before losing over 10% value to close at 70/10 in the second quarter and progressively losing value to a rate of 78/65 at the fourth quarter of 2000. It fluctuates between a rate of 78/10 in the first quarter of the year 2001 and 80/39 in the fourth quarter of 2004 before gradually firming to its lowest level of 63/49 in the second quarter of 2008. It then drastically weakens to 79/48 in the first quarter of 2009 before slightly gaining ground to 75/34 in the fourth quarter of the year 2009.

The shilling maintained caps at 80/57 in the fourth quarter of 2010 and then weakened to 93/45 to the dollar in the third quarter of the year 2011 and appreciated slightly to a rate of 84/42 in the first quarter of 2012 and depreciates gradually close at a rate of 91/39 in the first quarter of the year 2015. It oscillates between 102.90 and 101.97 from

early 2016 to the last quarter of 2018. The fluctuations in the exchange rate could be attributed to several factors among them electoral violence of 2008 where the shilling lost over 25% in the first quarter 2008, the interventionism policies of the Central Bank when the shillings lost 16% of its value between first and last quarter of the year 2011 and first and third quarter of the year 2015. Other significant factors influencing it include the world macro-economic conditions. All these events are indicated by sharp rises followed by smoothening bearish curves. For instance, during the first quarter of 2007, the gains made by the shilling could have been due to the high rates of return for the US dollar in the international markets as the US economic meltdown started. This resulted in both emerging and advancing market economies gaining from the trade openness which increased their financial flows. Further, corrections in the first quarter of the year 2012 could also be attributed to the zero-bound rate of the US interest rates which persisted till the last quarter of the year 2014(Rey, 2012). Increased dollarization of economies tends to disrupt asset markets and financial intermediation. These global financial cycles are associated with surges and retrenchments in capital flows, booms and busts in asset prices and are not aligned with countries' specific macroeconomic condition (Rey, 2012). Durevall & Sjö, (2012) observed that the Kenyan shilling depreciated in its value from about 80/00 to the US dollar to over 100/00 to the US dollar in the 2011 financial year.

4.1.2 Trends on 91 – Day Treasury Bill in Kenya

Graph 2 in appendix III shows that the 90-day Treasury Bill was approximately 9% in the first quarter of the year 1999 before drastically rising and peaks at over 18% in the fourth quarter of the year 1999 and easing back to 10% in the first quarter of the year 2002 and then gradually rises to over 14% in the first quarter of the year 2003. It then gradually eases and drops to the lowest of less than 2% in the first quarter of the year

2004 and creeps back to 6% by the end of that year. It then see-saws between 6% and 8% between the first quarter of the year 2005 and first quarter of the year 2010 and drastically falls to 4% and then 2% in the third quarter of 2010. After which it climbs back to7% in the second quarter of the year 2011 and rises to a high of 18% in the first quarter of 2012 and eases to 16% in the second quarter before dropping to less than 10% in the third quarter of the year 2012 and maintaining the momentum of between 8% and 9% until the second quarter of the year 2015. By the third quarter, it rises to 12% and slightly drops to 10% in the second quarter of the year 2016. It then gradually eases to a level of between 7% and 9% until the fourth quarter of the year 2018.

The notable statistics on the trends are in the first quarter of the year 1999 and third quarter of the year 2001 which could be attributable to the government fiscal policy which focused on the short-term bills which were then followed by changes in government that saw a reduction in the T-bill rates as a result of the shift in the focus to the longer-term bonds by the new government. Other periods showing a significant upward trend is between second quarters of years 2011 and 2012 which saw a significant jump in the rates. Noteworthy is the correction of the bearish trends in the third quarter of the year 2004 and the first quarter of the year 2011 which was followed by drastic rises in the rates. As from the third quarter of the year 2015, the rates seem to stabilize towards a mean of between 7% and a maximum of 10%. All these depend on the government fiscal policies on the amount of borrowing.

4.1.3 Trends on Inflation Rate in Kenya

Graph 4 in Appendix III shows the average quarter inflation figures as measured by the consumer price index or headline inflation rates. The figure shows that the average inflation rate figures were erratic quarterly, starting at 2% in the first quarter of the year

1999 and rising to 12% in the first quarter of the year 2000. It gradually eased to less than 2% in the first quarter of 2002, dramatically rose to 13% in the first quarter of 2003, before easing back to figures of 6% in the second quarter of 2004. It then hits a high of 17% in the fourth quarter of 2004 and gradually eases back to 3% by the second quarter of 2007 and drastically rises again to reach figures of 18% in the fourth quarter of 2008. It gradually drops to a low of 3% in the third quarter of 2010 and drastically rises to a new high of 19% in the fourth quarter of 2011 and gradually eases to 4% in the fourth quarter of 2012. It then maintains a stable range of between 6% and 9% from the third quarter of 2013 till the fourth quarter of 2018.

These rapid swings in the inflationary pressure result from the economic cycle at a fundamental level and monetary policy at the macro-economic level and sometimes random events such as the 2008 post-election violence. In other instances, several countries experienced high inflationary pressure in late 2006 and early 2007 when commodity prices(oil) skyrocketed partially due to the global crisis during this period (De Gregorio, 2012). Durevall & Sjö, (2012) noted that the inflation rate in Kenya is at times influenced by electoral cycles with the most recent being the post-election violence after the 2007 elections which drove the inflation rate to over 30%. Due to the inflation pressure after the 2008 electoral violence, the central bank of Kenya initiated a monetary policy response which involved the commensurate reduction in the interest rate to stimulate growth (Durevall & Sjö, 2012).

4.1.4 Trends on the Balance of Payments in Kenya

Graph 6 in appendix III shows that the imports have progressively grown from less than 50 billion Kenya shillings in the first quarter of 1999 to over 400 billion shillings in the fourth quarter of 2018. The average growth in imports is approximately 3% quarterly

with an exception in some quarters where there was a slowdown in the overall import trade. Regarding the export trade, the amount of exports has increased from 17 billion shillings in the first quarter of 1999 to 142 billion shillings in the fourth quarter of 2018. Generally, the growth in export trade is averaging 2% quarterly while the balance of trade has widened from –ve17 billion shillings to –ve284 billion shillings representing an average growth of 6.5% quarterly.

4.1.5 Trends on Foreign Direct Investments in Kenya

Graph 7 in appendix III shows the amounts of FDI inflows into Kenya and it indicates that the amounts of FDI inflows progressively grew from over 10 million US dollars in the first quarter of 1999 to close at over 40 million US dollars in the last quarter of 2000 after which it significantly dropped to an average of less than USD 2 million per quarter until the last quarter of 2002. In the first quarter of 2003 it grew to an average of 16 million US Dollars for the next four quarters before dropping to less than 10 million US dollars per quarter. It averaged 175 million US dollars per quarter in 2007 before dropping to less than 25 million Dollars per quarter in 2008. There was sustained growth in the investments from the second quarter of 2008 averaging 25 million US dollars to reach a new average of 40 million US dollars in 2010 and a significant increase to over 350 million US dollars per quarter in the year 2011 and 2012 before oscillating back to less than 200 million US dollars per quarter in the year 2014, 150 million US dollars per quarter in 2015, 100 million US dollars in 2016. In 2017 it rose dramatically to an average of 175 million US dollars per quarter and peaking at over 400 million US dollars in all the quarters of 2018.

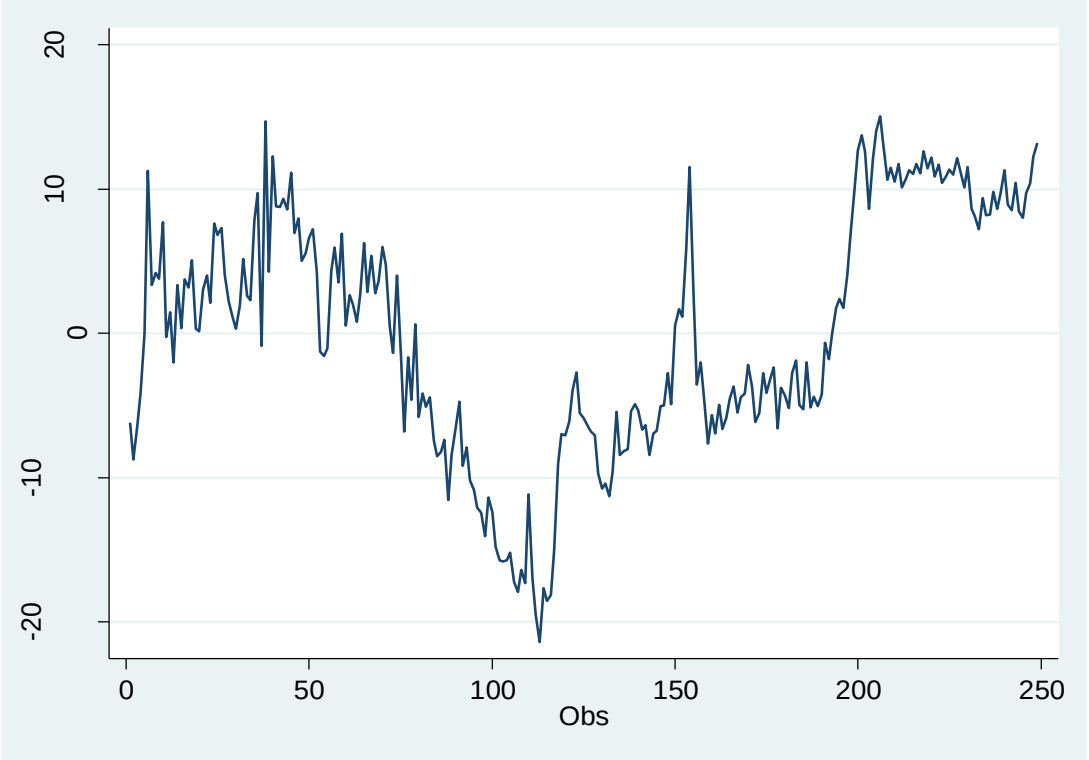
4.2 Diagnostic Statistics for GARCH Models

The diagnostic statistics for the overall GARCH models were based on clustering volatility and testing for ARCH effects.

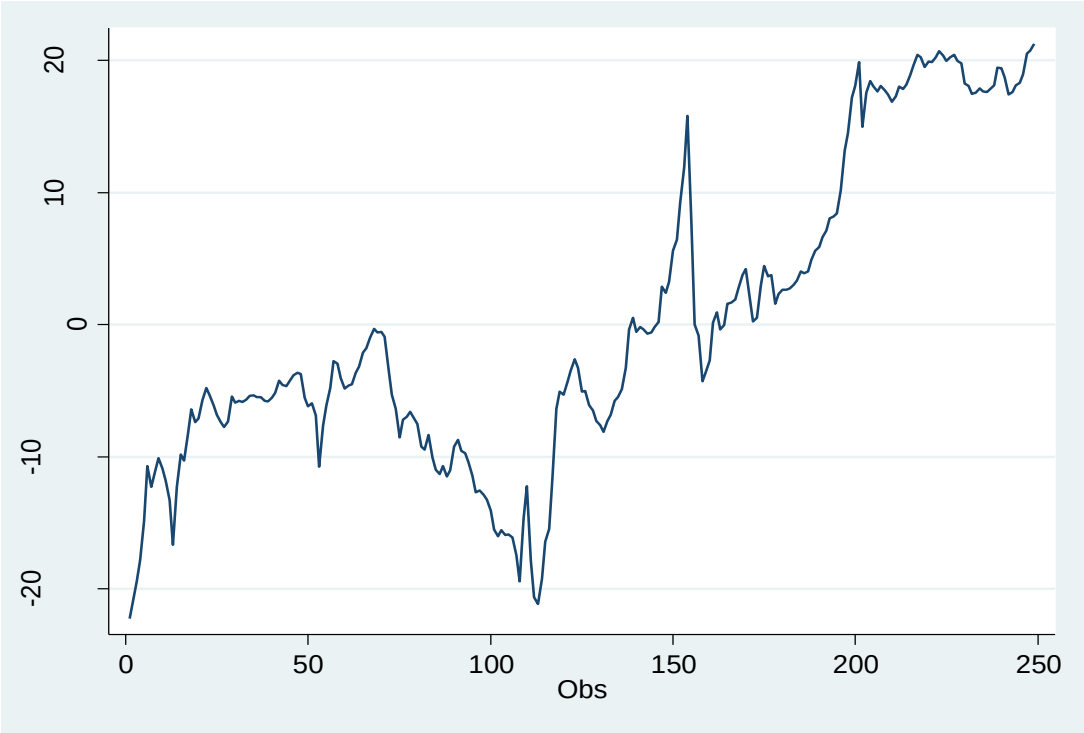
4.2.1 Tests for clustering volatility

The test for clustering volatility is based on the identification of the clusters of volatility from graph based on the residuals. The situation is observed from the graph when the movement in the graph sequentially hits lows or highs which are then followed by further lows or highs respectively.

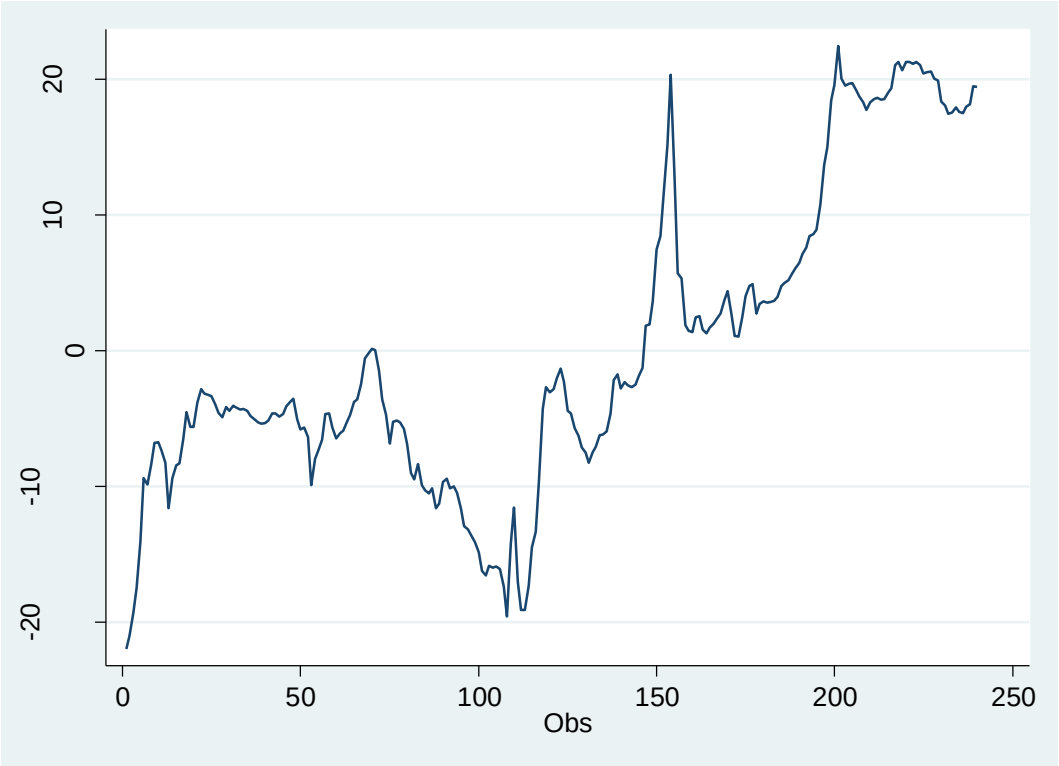
The physical examination of graphs 4.1, 4.2, 4.3 and 4.4 indicate the presence of clustering volatility in some periods and thus the data can be said to have clustering volatility.



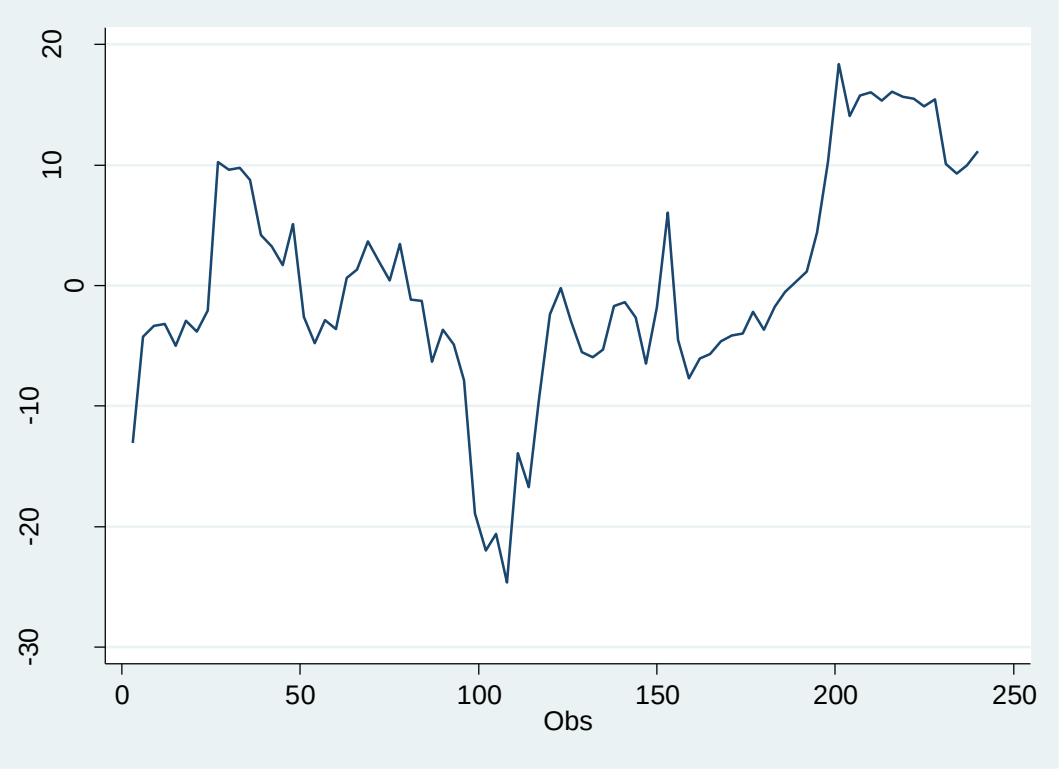
Graph 4.1: Volatility associated with BOP



Graph 4.2: Volatility associated with T-bill Rate



Graph 4.3: Volatility associated with Inflation Rate



Graph 4.4: Volatility associated with FDI

The second test for GARCH models is based on the test for ARCH effects with the H_0 stating that there are no ARCH effects while the H_1 is stated as there is ARCH(p) disturbance. The test results in Table 4.1 shows that all the p-values for the residuals of the independent variables are greater than 0.05(p>0.05) and therefore the null hypothesis that there are no ARCH effects is rejected. Based on the conclusion of the results, the conclusion is that the ARCH effects are present in the residuals.

The test was carried out as follows: H_0: no ARCH effects vs H_1: ARCH(p) disturbance.

Table 4.1: LM test for autoregressive conditional heteroskedasticity (ARCH)

Variable	Lags	χ^2	df	p-value	Interpretation
Balance of Payments	1	0.846	1	0.3577	Volatility is present
T-Bill rates	1	0.578	1	0.4471	Volatility is present
Inflation Rate	1	0.679	1	0.4101	Volatility is present
FDI	1	0.505	1	0.4774	Volatility is present

4.2 GARCH Modelling

GARCH models are used to explain the effect of the independent variable on the volatility of the dependent variable. In this case, the GARCH (1,1) models were run to establish whether the selected macroeconomic variables generate the volatility in the exchange rate. The test for the GARCH modelling was carried based on ARCH (1) and GARCH (1) to test for volatility and this implies that there is one ARCH term and one GARCH term.

4.2.1 GARCH Modelling

The results of the test are shown in tables 4.2, 4.3, 4.4 and 4.5 and are interpreted based on the two outcomes. A test of significance in the upper columns illustrate the significance of the variable in explaining the variance while the lower part shows the significance of the GARCH (1,1) models.

Table 4.2: Volatility associated with BOP

Sample: 1999 Q1 - 2018 Q4	**Number of observations = 80**
Distribution: Gaussian	**Wald χ^2 (1) = 4.50**
Log likelihood = -97.53026	**P – value = 0.0339**

Volex					OPG		
		Coef.	Std. Err.	t	p	[95% Conf.	Interval]
Volex	BOP	.4405721	.2076483	2.12	0.034	.033589	.8475553
	Constant	4.734143	1.881432	2.52	0.012	1.046604	8.421683
ARCH	Arch L1.	.7860864	.2337387	3.36	0.001	.327967	1.244206
	Garch L1.	.2358675	.1046615	2.25	0.024	.0307348	.4410002
	Constant	.1720135	.105412	1.63	0.103	-.034590	.3786172

The statistics in Table 4.2 shows that χ^2 (1) = 4.5, p< 0.05 thus the balance of payment is statistically significant in explaining the volatility of Kenya shilling. Further, the GARCH (0,1) model is statistically significant in indicating the presence of conditional heteroscedasticity. The overall model for the volatility of the Kenya shilling (VOLEX);

VOLEX = 4.7341 + 0.4405(Balance of Payment)

Therefore, a unit increase on the balance of payment explains 0.4405-unit changes in the volatility of the Kenyan Shilling.

Table 4.3: Volatility associated with Inflation

Sample: 1999 Q1 - 2018 Q4	**Number of observations = 80**
Distribution: Gaussian	**Wald χ^2 (1) = 8.12**
Log likelihood = -93.96028	**P – value = 0.0000**

Volex		OPG					
		Coef.	Std. Err.	t	p	[95% Conf.	Interval]
Volex	Inflation	.0484851	.0170149	2.85	0.004	.0151364	.0818338
	Constant	.2812444	.1286658	2.19	0.029	.029064	.5334248
ARCH	Arch L1.	1.014568	.2756905	3.68	0.000	.4742244	1.554912
	Garch L1.	.1391173	.0985191	1.41	0.158	-.053976	.3322112
	Constant	.1783324	.082693	2.16	0.031	.0162571	.3404076

The statistics in Table 4.3 shows that χ^2 (1) = 24.76, p< 0.05 thus inflation is statistically significant in explaining the volatility of Kenya shilling. Further, the GARCH (1,0) model is statistically significant in indicating the presence of conditional heteroscedasticity. The overall model for the volatility of the Kenya shilling (VOLEX);

VOLEX = 0.0654(inflation)

Therefore, a unit increase in inflation explains 0.0654-unit changes in the volatility of the Kenyan Shilling.

Table 4.4: Volatility associated with 90-day T-Bill

Sample: 1999 Q1 - 2018 Q4	**Number of observations = 80**
Distribution: Gaussian	**Wald χ^2 (1) = 4.42**
Log likelihood = -95.70994	**P – value = 0.0355**

Volex		OPG					
		Coef.	Std. Err.	t	p	[95% Conf.	Interval]
Volex	T-bill rate	-.0571275	.0271746	-2.10	0.036	-.11039	-.003866
	Constant	1.085211	.2320395	4.68	0.000	.63042	1.54
ARCH	Arch L1.	1.219874	.3658658	3.33	0.001	.50279	1.936957
	Garch L1.	.1214644	.0986228	1.23	0.218	-.07183	.3147614
	Constant	.154395	.0923486	1.67	0.095	-.02660	.3353949

The statistics in Table 4.4 shows that χ^2 (1) = 4.42, p< 0.05 thus 90-day T-bill is statistically significant in determining the volatility of Kenya shilling. Further, the GARCH (1,0) model is statistically significant in indicating the presence of conditional heteroscedasticity. The overall model for the volatility of the Kenya shilling (VOLEX);

VOLEX = - 0.0571 (90-day treasury bill)

Therefore, a unit increase on 90 day – treasury bill explains -0.0571-unit changes in the volatility of the Kenyan Shilling.

Table 4.5: Volatility associated with FDI

Sample: 1999 Q1 - 2018 Q4	**Number of observations = 80**
Distribution: Gaussian	**Wald χ^2 (1) = 0.47**
Log likelihood = -98.08201	**P – value = 0.4931**

Volex		OPG					
		Coef.	Std. Err.	t	p	[95% Conf.	Interval]
Volex	FDI	-.0686515	.1001551	-0.69	0.493	-.264952	.127649
	Constant	1.204639	.7663449	1.57	0.116	-.297369	2.706648
ARCH	Arch L1.	.8911074	.2876926	3.10	0.002	.3272403	1.454975
	Garch L1.	.1988139	.1084262	1.83	0.067	-.013697	.4113254
	Constant	.1841876	.1021254	1.80	0.071	-.015975	.3843497

The statistics in Table 4.5 shows that χ^2 (1) = 0.47, p> 0.05 thus FDI is not statistically significant in determining the volatility of Kenya shilling. Further, the GARCH (1,0)

model is statistically significant in indicating the presence of conditional heteroscedasticity.

The statistics in the Tables 4.2, 4.3, 4.4 and 4.5 show the presence of conditional heteroscedasticity in all the model equations as indicated by the GARCH (1,0), GARCH (0,1) and GARCH (1,1) models. However, only three selected macroeconomic variables are statistically significant in explaining the volatility of the Kenyan Shilling to the US dollar. The variables having a significant effect on the volatility of the exchange rate include the balance of payment, the 90-day treasury bill rate and inflation while FDI does not explain the volatility. While inflation and balance of payment have a positive effect on the volatility of the exchange rate in Kenya, the 90-day treasury bill has a negative effect.

In South Korea, Ree, Yoon & Park (2012) observed that currency volatility is accompanied by swings in capital flows with an effect on the economic and financial systems. In Nigeria, Ajao & Igbekoyi(2013) observed that about 80% of the volatility in the Naira was explained by several macroeconomic variables. According to O'Connell *et al.,* (2010), the Kenyan Shilling was limited to a short–run volatility between the period 2003 and 2007 due to the favourable conditions that included a combination of FDI inflows, growth in exports and the flexibility of the monetary policy tools to respond to the volatility. Kasekende & Brownbridge (2011) observed that the SSA economies are developing and becoming more integrated into global financial markets, thus they acquire the characteristics of emerging market economies that include among other things larger capital account flows which may intensify the volatility of the exchange rate.

Most of the central banks in emerging-market and low-income countries routinely intervene to limit exchange rate volatility that is attributable to extreme short-run appreciations or depreciation caused by speculation, high capital mobility and exposure to uncertainties in international financial markets (O'Connell *et al.*, 2010). On the converse, the widespread use of foreign currency and foreign currency deposits in private portfolios increases the sensitivity of domestic money demand to interest rates and inflation (Adam *et al.*, 2010). However, De Gregorio & Tokman (2005) observed that some economies are becoming more resilient to exchange rate fluctuations with improved macroeconomic policies and policy credibility reducing the short-term pass-through of exchange rate changes to inflation.

4.3 Error Correction Modelling

4.3.1 Diagnostic Statistics

The diagnostic testing for the VECM models includes the following tests; pre-selection of lag order, autocorrelation, normality, co-integration and unit root and stationarity. The tests were carried based on the specific tests to ensure that the assumption of lags differences, autocorrelation between independent variables, data were drawn from a normally distributed population and stationarity.

Table 4.6: Selection Order Criteria

Lag	LL	LR	Df	p	FPE	AIC	HQIC	SBIC
0	-553.031				1.64157	14.685	14.7463	14.8384
1	-334.172	437.72	25	0.000	.010009	9.58346	9.95115	10.5035*
2	-294.424	79.495	25	0.000	.006848*	9.19537*	9.86947*	10.8821
3	-275.315	38.218	25	0.044	.008172	9.3504	10.3309	11.8038
4	-256.126	38.377*	25	0.042	.009929	9.50333	10.7902	12.7234

The statistics in Table 4.6 shows that the selection order criteria were examined through the three-information criteria test, the Akaike (AIC), Schwarz – Bayesian (SBIC) and Hannan-Quinn information criteria (SBIC). The choice of appropriate lags is based on

the information criteria which ensures independence in the residual series. The choice of the lag difference is based on two of the three information criteria having similar value as indicated by the asterisk. Based on Table 4.6, the AIC = 9.19537, HQIC = 9.8695 and SBIC = 10.5035, and this indicates that the number of the lags to be applied in the overall VECM are two (2) as opposed to one (1).

The statistics in Table 4.7 and 4.8 reports the test for the presence of stationarity which was carried through the test for unit root and stationarity based on two comparative tests of Augmented Dickey-Fuller and Philip Peron test.

Table 4.7: Augmented Dickey-Fuller Tests for Unit Root

Variable	Test Statistic Z(t)	Lags	Interpolated Dickey-Fuller 1% Critical value	5% Critical value	10% Critical Value	MacKinnon p-value
BOP	-3.466	0	-4.086	-3.471	-3.163	0.0431
	-2.289	1	-4.088	-3.472	-3.163	0.4399
	-1.452	2	-4.091	-3.473	-3.163	0.8450
Inflation	-2.921	0	-4.086	-3.471	-3.163	0.1556
	-4.212	1	-4.088	-3.472	-3.163	0.0043
	-4.236	2	-4.091	-3.473	-3.164	0.0039
Treasury Bill rate	-3.505	0	-4.086	-3.471	-3.163	0.3118
	-3.924	1	-4.088	-3.472	-3.163	0.0112
	-3.453	2	-4.091	-3.473	-3.164	0.0447
FDI	-3.420	0	-4.086	-3.471	-3.163	0.0488
	-3.345	1	-4.088	-3.472	-3.163	0.0592
	-3.622	2	-4.091	-3.473	-3.164	0.0280
	-3.521	3	-4.093	-3.474	-3.164	0.0372

Table 4.8: Philip – Peron Test for Unit Root

Variable	Test Statistic		Lags	Interpolated Dickey-Fuller			MacKinnon p-value
				1% Critical value	5% Critical value	10% Critical Value	
BOP	Z(rho)	-22.762	0	-26.686	-20.322	-17.206	0.0431
	Z(t)	-3.466	0	-4.086	-3.471	-3.163	0.0431
Inflation	Z(rho)	-17.338	0	-26.686	-20.322	-17.206	0.0897
	Z(t)	-3.174	0	-4.086	-3.471	-3.163	0.0897
	Z(rho)	-22.870	1	-26.686	-20.322	-17.206	0.0321
	Z(t)	-3.574	1	-4.086	-3.471	-3.163	0.0321
	Z(rho)	-25.452	2	-26.686	-20.322	-17.206	0.0194
	Z(t)	-3.747	2	-4.086	-3.471	-3.163	0.0194
Treasury bill rate	Z(rho)	-12.243	0	-26.686	-20.322	-17.206	0.1056
	Z(t)	-2.542	0	-4.086	-3.471	-3.163	0.1056
	Z(rho)	-16.531	1	-26.686	-20.322	-17.206	0.0417
	Z(t)	-2.932	1	-4.086	-3.471	-3.163	0.0417
FDI	Z(rho)	-20.753	0	-26.686	-20.322	-17.206	0.0488
	Z(t)	-3.420	0	-4.086	-3.471	-3.163	0.0488
	Z(rho)	-21.302	1	-26.686	-20.322	-17.206	0.0440
	Z(t)	-3.459	1	-4.086	-3.471	-3.163	0.0440

Both the augmented Dickey-Fuller test (ADF), and the Phillips-Perron test (PP) are carried on the basis that the null hypothesis that the series possesses a unit root and hence is not stationary. The interpretation of the test is that a result of significance indicates that the null hypothesis that the series has unit root is not rejected and thus the series is considered stationary.

The test statistic for variable BOP indicates that $p< 0.05$ at (0) lags for both the ADF and PP test, thus the null hypothesis that the series has unit root is rejected, therefore the series was considered to be stationary.

The test statistic for variable inflation rate indicates that $p< 0.05$ at (1) lags for both the ADF and PP test, thus the null hypothesis that the series has unit root is rejected therefore the series was considered to be stationary.

The test statistic for variable rate differential indicates that p< 0.05 at (0) lags for both the ADF and PP test, thus the null hypothesis that the series has unit root is rejected therefore the series was considered to be stationary.

The test statistic for variable FDI indicates that p< 0.05 at (0) lags for both the ADF and PP test, thus the null hypothesis that the series has unit root is rejected therefore the series was considered to be stationary.

Table 4.9: Lagrange-multiplier test for Autocorrelation

Lag	χ2	df	p-value
1	21.8991	25	0.64156
2	18.7420	25	0.80932
3	33.5948	25	0.11686
4	38.9478	25	0.03729

H0: no autocorrelation at lag order

The statistics in Table 4.9 illustrates the test for autocorrelation between the independent variables which was carried with the aid of the Lagrange test with the null hypothesis indicating that there is no autocorrelation between the variables at any lag order. The test statistic indicates that the p< 0.05 at lag 4 indicating that the null hypothesis that data autocorrelated was rejected.

Table 4.10: Jarque – Bera Test for Normality

Equation	**χ2**	**Df**	**p-value**
D_BOP	14.313	2	0.95201
D_T Bill rate	2.214	2	0.24513
D_inflation rates	35.426	2	0.72430
D_FDI	57.239	2	0.86304
ALL	547.898	10	0.00000

Table 4.11: Skewness and Kurtosis test

	Skewness test				Kurtosis test			
Equation	**Skewness**	**χ2**	**df**	**p**	**Kurtosis**	**χ2**	**df**	**p**
D_Volex	2.1588	60.584	1	0.0000	13.786	378.12	1	0.0000
D_BOP	0.5866	4.473	1	0.0344	4.74	9.839	1	0.0017
D_T Bill rate	0.2829	1.041	1	0.3076	3.6009	1.173	1	0.2787
D_inflation rates	0.8695	9.830	1	0.0017	5.8064	25.596	1	0.0000
D_FDI	-0.6805	6.021	1	0.0141	6.9698	51.218	1	0.0000
ALL		81.950	5	0.0000		465.95	5	0.0000

The statistics in Tables 4.10 and 4.11 show the test for normality which was examined through the use of Jacque – Bera test with a test of non - significance indicating that the null hypothesis that data comes from the normally distributed population is rejected. The results show that the p> 0.05 therefore the null hypothesis that data comes from a normally distributed population is not rejected. Therefore, the assumption that data comes from a normally distributed population is upheld.

Table 4.12: Johansen Test for Cointegration

Trend: rtrend				**Number of observations = 78**	
Sample: 1999Q1 – 2018Q4				**Number of lags = 2**	
maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	5	-403.970	.	117.0169	87.31
1	15	-373.430	0.53844	55.9378*	62.99
2	23	-363.124	0.22965	35.3260	42.44
3	29	-353.681	0.21263	16.4400	25.32
4	33	-349.268	0.10571	7.6136	12.25
5	35	-345.462	0.09188		

The statistics in Table 4.12 testing for co-integration was examined through the use of Johansen co-integrating rank. The test statistic indicates that the VECM model co-integrates at lag 1.

Table 4.13: Stability Mechanism for the VECM Estimates

Eigenvalue		**Modulus**
1		1
1		1
1		1
0.6198959	+ 0.4658098i	0.775403
0.6198959	- 0.4658098i	0.775403
-0.00267614	+ 0.3377218i	0.337732
-0.00267614	- 0.3377218i	0.337732
-0.2763688	+ 0.08402024i	0.288858
-0.2763688	- 0.08402024i	0.288858
0.1656375		0.165637

The VECM specification imposes 3 unit moduli.

4.3.2 VECM Models

The results in Table 4.14 show the long-run models. This models indicate that volatility responds faster to its own volatility at 35.22%($\chi2 = 38.249$, $p<0.05$), than the inflation rates at 29.55%($\chi2 = 29.355$, $p<0.05$), T-bill rate at 27.37%($\chi2 = 26.373$, $p<0.05$) and balance of payments at 22.53%($\chi2 = 20.255$, $p<0.05$). However, the volatility does not respond to the FDI at 9.16%($\chi2 = 7.059$, $p>0.05$).

Table 4.14: Long–run VECM Model

Sample: 1991Q1 – 2018Q4			**Number of observations = 78**		
			AIC = 9.651793		
Log likelihood = -336.4199			**HQIC = 10.13561**		
Det(Sigma_ml) = 0.0038364			**SBIC = 10.86036**		
Equation	Parms	RMSE	R-sq	$\chi2$	p-value
D_Volex	7	0.94886	0.3533	38.24915	0.0000
D_T-bill rate	7	1.71316	0.2737	26.37531	0.0004
D_Inflation rate	7	1.96366	0.2955	29.35506	0.0001
D_BOP	7	0.088272	0.2253	20.35527	0.0049
D_FDI	7	0.309386	0.0916	7.059626	0.4227

The implication is that volatility in the exchange rate responds more to its volatility more than the other variables with the effect being 0.3522 implying that 35.22 per cent of volatility is determined by volatility in the exchange rate. To the same extent, the volatility in the exchange rate responds to the inflation rate more than the remaining variables with the effect being 0.2955 implying that 29.55% of volatility is determined by the inflation rate, T-bill rate at 27.37% and balance of payment at 22.53%.

Table 4.15: Short–Run Model

		Coef.	Std. Err.	t	p	[95% Conf. Interval]	
D_Volex	ce1L1.	-0.7666	0.153883	-4.98	0.000	-1.06827	-0.46506
	Volex LD.	0.09396	0.124514	0.75	0.450	-0.15008	0.33800
	T-Bill rate LD.	0.08006	0.063373	1.26	0.206	-0.04414	0.20427
	BOP LD.	0.97642	1.130194	0.86	0.388	-1.23871	3.19157
	Inflation LD.	0.04699	0.051012	0.92	0.357	-0.05298	0.14698
	FDI LD.	0.24472	0.356453	0.69	0.492	-0.45391	0.94336
	Constant	-0.04086	0.109358	-0.37	0.709	-0.25519	0.17348

Table 4.16: Co-integrating Equation

Equation	Parms	$\chi 2$	p-value
_ce	4	30.86046	0.0000

Identification: beta is exactly identified

The statistics shown in Table 4.15, shows that there is a long-run relationship between the macroeconomic variables that co-integrated at the first difference and second lag. This is supported by the statistics in Table 4.16 which illustrates that $\chi 2 = 30.86$, $p < 0.05$ thereby indicating that the co-integration long-run equation model is significant.

Table 4.17: Johansen normalization restrictions imposed

beta	**Coef.**	**Std. Err.**	**z**	**p**	**[95% Conf. Interval]**	
_ce1						
Volex	1	.	.	.	.	.
tbillrate	-0.01038	0.02937	-0.35	0.724	-0.06797	0.047189
inflation	-0.08855	0.02763	-3.21	0.001	-0.14269	-0.034400
bop	1.365244	0.79264	1.72	0.085	-0.18831	2.918796
fdi	-0.69609	0.25669	-2.71	0.007	-1.19918	-0.192989
_trend	0.038628	0.01279	3.02	0.003	0.01355	0.0637105
_cons	16.03984	.	.	.	.	.

This result affirmed the proposition that volatility in the exchange rate in Kenya is influence by the selected macroeconomic variables; interest rates, inflation rates and balance of payments. The results are also supported by studies done in Nigeria which indicated that there was a long-run equilibrium relationship among the variables which

was validated by the error correction model coefficients from the estimated short-run dynamic model with a reasonable speed of adjustment towards the long-run equilibrium (Ajao & Igbekoyi, 2013). Volatility is also revealed by shifts in the estimated densities of rolling daily standard deviations during years of relative tranquillity (De Gregorio & Tokman, 2005). Overall, the evidence of volatility in the exchange rate is consistent with the evidence of movement in the macroeconomic variables. The results point to the relevance of both global and regional factors in explaining common macroeconomic dynamics in the G-7 area (Morana, 2009).

4.4 Hypothesis Testing

4.4.1 Hypothesis One

This hypothesis sought to determine the effect of the interest rate on the volatility of the foreign exchange in Kenya. The null hypothesis was stated as follows:

H_{01}: Interest rate does not affect the volatility of the foreign exchange in Kenya.

The results from long-run error correction models showed that the interest rate has a significant influence on the volatility of the foreign exchange in Kenya with the volatility responding to the treasury bill rate at 27.37% levels. Based on the findings the study rejected the null hypothesis that interest rate has no effect on the volatility of the foreign exchange rate in Kenya and concludes that interest rate has a significant effect on the volatility of the foreign exchange in Kenya.

The hypothesis is explained by empirical studies which illustrate how interest rate influences the stability of the real exchange rate. Bhattacharya & Patnaik (2014) noted that a reduction in the interest rates will always lead to a significant depreciation of the nominal exchange rate while Drine & Rault(2011) observed that in the economies of

Egypt, Kuwait and Tunisia, an increase in the rate differential tends to lead to real exchange rate depreciation. This scenario was illustrated by Osawa(2006) who observed a strong correlation between interest rate and the exchange rate during the 1997 Asian financial crisis.

On the converse, the relationship between the exchange rate and the interest rate has been reported. Adam *et al.,* (2010) reported that the widespread use of foreign currency and foreign currency deposits in private portfolios increases the sensitivity of domestic money demand to interest rates and inflation. O'Connell *et al.,* (2010) also observed a statistically significant short-run response of the interest rate and the foreign exchange volatility in Kenya. Heintz & Ndikumana (2011) also reported that a low inflation rates regime always signify higher real interest rates and/or appreciation of the real exchange rate.

4.4.2 Hypothesis Two

This hypothesis sought to determine the influence of foreign direct investments on the volatility of the foreign exchange in Kenya. The null hypothesis was stated as follows:

H_{02}: Foreign direct investments do not influence the volatility of foreign exchange in Kenya.

The results from long-run error correction models showed that the foreign direct investments do not have a significant influence ($\chi 2 = 7.059$, $p>0.05$) on the volatility of the foreign exchange in Kenya. Based on the findings the study does not reject the null hypothesis that foreign direct investments do not influence the volatility of the foreign exchange rate in Kenya and concludes that foreign direct investments have no significant influence on the volatility of the foreign exchange in Kenya.

The hypothesis is explained by empirical studies which illustrate how foreign direct investment influences the stability of the real exchange rate. The conclusion of the study differs from other studies which have shown evidence that the FDI flows into a country tend to stabilize that currency while reducing its volatility. For instance, Bassey and Essien (2014) observed the stability in currency in Ghana arose from the increased inflow in foreign capital. This phenomenon is prevalent in countries with open and large capital markets and therefore exposed to foreign exchange volatility due to FDI inflows which are driven by the global markets (Ree *et al.,* 2012).

Consistent with other studies, Ricci, Lee & Milesi-Ferretti, (2008) indicated that increases in the net foreign assets tend to lead to the appreciation in the real exchange rate. In developing economies, FDI inflows lead to the appreciation of the real exchange rate (Al Samara, 2009). For instance, in Kenya, the foreign capital inflows in the period 2003 to 2007 exerted a significant impact by limiting short-run volatility in the exchange rate while stabilizing commodity prices (O'Connell *et al.,* 2010). However, the appreciation effect of the exchange rate on FDI inflows is indeed diminished by active and large financial and capital markets (Al Samara, 2009).

Private capital flows (foreign direct investments) are a source of stability, by promoting credit and risk-sharing across borders. They can also undermine macroeconomic stability, however, by exposing domestic markets to external volatility (O'Connell *et al.,* 2010). This FDI inflow increases consumption demand for both traded and non-traded goods leading to a rise in the price of non-traded goods and market equilibrium. The increase in traded consumption consequently leads to the deterioration in the trade balance without any changes in the price of traded goods (Al Samara, 2009).

4.4.3 Hypothesis Three

This hypothesis sought to determine the effect of the inflation rate on the volatility of the foreign exchange volatility in Kenya. The null hypothesis was stated as follows:

H_{03}: Inflation rate does not affect the volatility of the foreign exchange in Kenya.

The results from long-run error correction models showed that the inflation rate has significant influence ($\chi 2 = 29.355$, $p<0.05$) on the volatility of the foreign exchange in Kenya with the volatility responding to the inflation rate at 29.55% levels. Based on the findings the study rejects the null hypothesis that the inflation rate has no effect on the volatility of the foreign exchange rate in Kenya and concludes that the inflation rate has a significant effect on the volatility of the foreign exchange in Kenya.

The hypothesis is explained by empirical studies which illustrate how the inflation rate influences the stability of the real exchange rate. The use of the inflation targeting regime is based on balancing the stability in the exchange rate regime and the near-term inflation and the anchoring inflation expectations. Further, the use of Inflation targeting as a monetary policy regime is also important in reducing the volatility of a nation's currency by reducing and/or limiting the exchange rate variations and thus limit the size of the exchange rate pass-through effects (Ebeke & Fouejieu, 2015).

Heintz & Ndikumana (2011) also observed that the use of inflation targeting policy significantly affects real exchange rate and financial volatility (Cordero, 2008). Further, inflation targeting is a mixed strategy that responds to both inflation rates and real exchange rates (Aizenman *et al.,* 2008). Inflation targeting mechanisms in developing economies always attract inflows of short-term portfolio investment leading to the appreciation of the real exchange rates (Bassey & Essien, 2014; Heintz & Ndikumana,

2011). But in emerging markets like Brazil, the inflation targeting policy regime led to a fluctuation in the real exchange rate (Barbosa-Filho, 2008). Thus, there is the widespread use of inflation targeting regimes in both industrialized and emerging market economies because of its long-run effect on price stability and output (Kasekende & Brownbridge, 2011).

In emerging economies, the adoption of inflation targeting leads to a relatively more flexible exchange rate regime (Ebeke & Fouejieu, 2015), but then exchange rates are more volatile under IT than under other regimes in emerging market economies (EME) (Berganza & Broto, 2012). In some instances, the global inflationary pressure in 2007–08 was a reflection of the global food and fuel price shocks, strong domestic demand (Gemayel *et al.,* 2011). This global phenomenon resulted in the pass-through effects seen through currency depreciation.

4.4.4 Hypothesis Four

This hypothesis sought to determine the effect of the balance of payments on the volatility of the foreign exchange in Kenya. The null hypothesis was stated as follows:

H_{04}. Balance of payments does not affect the volatility of the foreign exchange in Kenya.

The results from long-run error correction models showed that the balance of payments has significant influence ($\chi 2 = 20.255$, $p<0.05$) on the volatility of the foreign exchange in Kenya with the volatility responding to the variable at 22.53% levels. Based on the findings the study rejects the null hypothesis that balance of payments has no effect on the volatility of the foreign exchange in Kenya and concludes that balance of payment has a significant effect on the volatility of the foreign exchange in Kenya.

The hypothesis is explained by empirical studies which illustrate how the balance of payment influences the stability of the real exchange rate. Other studies have pointed to the effect of commodity terms of trade in influencing the equilibrium in the exchange rate. Countries who are net importers have a strong exchange pass-through inflation pressure leading to fluctuations in the exchange rate (Ebeke & Fouejieu, 2015). Studies on the Nigerian economy indicate that an unfavourable balance of trade has a destabilizing effect on the stability of macroeconomic conditions that include the exchange rates (Aliyu, 2007).

Chen & Rogoff (2004) observed that in those countries with favourable terms of trade, the doubling in the value of commodities exported lead to a single unit appreciation in the exchange. Finding the optimal degree of exchange rate flexibility is difficult.

To a great extent, this is because the optimal degree of exchange rate flexibility is quite idiosyncratic and depends on several country-specific characteristics (De Gregorio & Tokman, 2005).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

The study was based on the effect of selected macro-economic variables of interest rate, inflation rate, the balance of payments and foreign direct investment portfolio on the volatility of the foreign exchange in Kenya. The findings showed that the Kenyan shilling exhibits a period of volatility randomly and within specific periods that are linked to monetary and fiscal policies. Specifically, there was less volatility in the years 2006 to 2008 followed by high volatility between 2008 and 2011 which were attributable to the global factors of movements of foreign-denominated currency investments. For instance, between 2005 and 2008, the low volatility could be traced to movements in foreign-denominated investments into the economy from developing countries while the high volatility between 2009 was traced to international commodity prices. Beyond 2012, the shilling experienced lower volatility and maintained the momentum until 2015 when the currency experienced volatility which is attributable to the domestic macroeconomic factors. This volatility essentially even out in 2018.

The graphical presentation on the selected macroeconomic factors shows that the inflation rate has been showing significant fluctuation with periods of low, sustained and higher inflationary pressures at different periods. However, the trend from 2013 indicated a sustained momentum and a downward stable trend. The interest rates have a more or less similar trend when compared to inflation in that the lows and highs in inflation are indicated by lagged lows and highs of the interest rate which is also evening out as from 2013 like the inflation rate. The amounts of foreign direct investments are considerable with a significant increase from 2016 where it has new

levels of over 1.5 billion USD in 2018. Kenya is considered a net importer in that the imports outweigh the exports in the ratio of 2:1 as of 2018.

The findings showed that the inflation rate and balance of payment has a significant positive effect on volatility while the interest rate has a significant negative effect. This implies that increases in inflation and imports tend to increase the volatility of the shilling while increases in the interest rate tend to reduce the volatility. The foreign direct investment does not impact volatility due to significantly low amounts that are outweighed by the large imports denominated by the US dollar. The findings from the error correction models showed that interest rate, inflation rate and balance of payment contributed to volatility while foreign capital inflows do not.

5.2 Conclusion

First, the interest rate has a significant influence on the volatility of the exchange rate in Kenya. The conclusion is based on the hypothesis testing from the long-run error correction models showing that the interest rate has a significant influence on the volatility of the foreign exchange in Kenya with the volatility responding to the treasury bill rate at 27.37% levels.

Second, foreign direct investment does not have a statistically significant effect on the volatility of the exchange rate in Kenya. The conclusion is based on the hypothesis testing which from the long-run error correction models showed that the foreign direct investments do not have a significant influence ($\chi 2 = 7.059$, $p>0.05$) on the volatility of the foreign exchange in Kenya.

Third, the inflation rate has a significant influence on the volatility of the exchange rate in Kenya. The conclusion is based on the hypothesis testing from the long-run error

correction models showing that the inflation rate has a significant influence on the volatility of the foreign exchange in Kenya with the volatility responding to the inflation rate at 29.55% levels.

Lastly, the balance of payments has a significant influence on the volatility of the exchange rate in Kenya. The conclusion is based on the hypothesis testing from the long-run error correction models showing that the balance of payments has a significant influence on the volatility of the foreign exchange in Kenya with the volatility responding to the variable at 22.53% levels.

5.3 Recommendations

Based on the findings the study recommends the following;

The government should pursue initiatives that will encourage foreign exchange inflows such as encouraging exports. This mechanism will be geared towards improving the current balance of trade and by extension bring foreign currency inflows associated with exports and thus stabilize the exchange rate.

This study forms a basis for future studies and research, especially to determine the effect of Foreign Direct Investments (FDI) on the volatility of the foreign exchange in Kenya.

The policymakers at the central bank of Kenya should sustain the momentum of stable policy-making processes which have seen the inflation and interest rates maintain a stable outlook since 2014. This should reduce the volatility of the shilling going forward.

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APPENDICES

Appendix I: Document Analysis

ITEM	1999 to 2018
Exchange rate (Kshs)	
Consumer Price index (%)	
Overall inflation (%)	
Central Bank rate (%)	
Lending rate (%)	
FOREX reserves (USD)	
Exports (Kshs)	
Imports (Kshs)	
Net FDI(USD)	

Appendix II: Figures on Economic Indicators

Table 1: Monthly Economic Indicators

Year	Month	Exchange rate/USD	Imports (Millions Shs)	Exports (Millions Shs)	Balance of trade (Millions Shs)	T-Bill Rate (%)	Lending rate (%)	CPI(%)	Core Inflation (%)	FDI in USD
1999	1	61.802	13,452.90	9,006.75	-4,446.15	10.7	23.67	-0.44	-0.44	
1999	2	62.496	17,321.64	10,614.49	-6,707.15	8.95	22.83	1.52	1.52	
1999	3	64.011	17,985.49	11,911.40	-6,074.09	8.84	21.36	2.97	2.97	10,644,530.00
1999	4	65.651	15,738.90	10,154.31	-5,584.59	9.03	20.9	3.77	3.77	
1999	5	68.819	14,782.75	9,849.65	-4,933.10	9.63	20.86	5.79	5.79	
1999	6	73.605	14,143.45	11,968.29	-2,175.16	11.44	20.7	5.02	5.02	12,988,064.00
1999	7	73.098	15,957.84	10,400.94	-5,556.90	14.47	21.12	5.23	5.23	
1999	8	74.414	15,394.51	9,477.58	-5,916.93	14.84	21.93	6.62	6.62	
1999	9	75.681	17,419.32	10,111.30	-7,308.02	15.78	22.45	8.37	8.37	17,585,630.00
1999	10	75.571	13,978.37	9,589.28	-4,389.09	17.63	23.12	9.41	9.41	
1999	11	74.789	20,781.46	9,860.06	-10,921.40	18.14	24.43	10.7	10.7	
1999	12	73.943	17,514.86	9,633.83	-7,881.03	19.97	25.19	10.5	10.5	10,735,232.00
2000	1	70.681	17,197.20	9,124.26	-8,072.93	20.3	25.14	9.63	9.63	
2000	2	73.219	16,360.15	10,712.92	-5,647.22	14.84	25.39	7.52	7.52	
2000	3	74.431	21,541.46	11,886.71	-9,654.75	11.28	23.76	5.9	5.9	19,456,243.00
2000	4	74.363	15,672.79	9,448.21	-6,224.58	12.44	23.44	7.2	7.2	
2000	5	75.97	20,874.72	12,673.81	-8,200.91	11.22	23.4	8.6	8.6	
2000	6	77.545	19,870.91	11,997.16	-7,873.75	10.47	23.11	11.21	11.21	25,579,374.00
2000	7	76.406	23,352.04	10,910.06	-12,441.98	9.9	22.39	11.46	11.46	
2000	8	76.448	24,510.50	11,722.91	-12,787.59	9.25	21.23	11.31	11.31	
2000	9	78.197	21,245.30	10,186.03	-11,059.28	10.36	20.57	11.59	11.59	38,142,795.00
2000	10	79.257	23,127.67	11,936.74	-11,190.93	10.65	20.22	11.28	11.28	
2000	11	78.857	26,517.15	13,014.90	-13,502.25	11.17	19.79	11.63	11.63	
2000	12	78.733	17,534.00	10,913.36	-6,620.64	12.9	19.6	11.78	11.78	27,726,138.00
2001	1	78.606	20,740.73	13,536.97	-7,203.76	14.76	20.27	11.97	11.97	

2001	2	78.25	20,592.29	14,127.74	-6,464.56	15.3	20.13	10.17	10.17	
2001	3	77.753	23,383.92	14,168.56	-9,215.37	14.97	20.19	9.46	9.46	906,574.00
2001	4	77.499	22,645.84	11,410.62	-11,235.22	12.9	19.56	9.1	9.1	
2001	5	78.54	28,207.31	13,419.03	-14,788.28	10.52	19.2	6.94	6.94	
2001	6	78.62	29,449.49	12,934.28	-16,515.20	12.07	19.26	4.61	4.61	1,325,655.00
2001	7	79.018	28,977.57	14,850.46	-14,127.11	12.87	19.71	4.26	4.26	
2001	8	78.914	21,832.85	12,561.59	-9,271.26	12.84	19.54	4.03	4.03	
2001	9	78.946	23,328.38	10,451.87	-12,876.51	12.39	19.44	3.08	3.08	1,386,652.00
2001	10	78.967	25,048.34	11,671.65	-13,376.69	11.63	19.77	3.21	3.21	
2001	11	78.959	19,245.59	12,601.68	-6,643.91	11.5	19.44	2.15	2.15	
2001	12	78.686	16,008.94	10,977.56	-5,031.38	11.01	19.49	1.6	1.6	1,683,742.00
2002	1	78.597	33,559.57	14,456.64	-19,102.92	10.85	19.3	0.46	0.46	
2002	2	78.25	15,871.69	13,337.53	-2,534.15	10.61	19.18	1.2	1.2	
2002	3	78.057	22,193.73	12,923.72	-9,270.01	10.14	18.86	2.03	2.03	4,657,690.00
2002	4	78.274	18,139.62	14,677.01	-3,462.60	10.01	18.69	0.86	0.86	
2002	5	78.315	21,060.46	15,656.57	-5,403.89	9.04	18.54	1.71	1.71	
2002	6	78.663	21,267.15	15,583.49	-5,683.66	7.34	18.38	2.85	2.85	6,904,612.00
2002	7	78.797	20,915.15	15,561.75	-5,353.41	8.63	18.12	2.12	2.12	
2002	8	78.574	19,143.62	13,409.63	-5,733.99	8.34	18.12	1.81	1.81	
2002	9	78.807	19,458.36	15,178.98	-4,279.38	7.6	18.14	1.78	1.78	10,684,624.00
2002	10	79.324	22,450.86	14,691.68	-7,759.17	8.07	18.34	1.89	1.89	
2002	11	79.565	21,030.96	13,977.38	-7,053.58	8.3	18.05	2.57	2.57	
2002	12	79.534	22,573.61	12,391.73	-10,181.88	8.38	18.34	4.25	4.25	5,371,521.00
2003	1	77.718	24,319.81	16,737.38	-7,582.43	8.38	19.02	6.37	6.37	
2003	2	76.841	23,114.30	17,195.94	-5,918.36	7.77	18.83	7.44	7.44	
2003	3	76.583	21,409.61	16,120.88	-5,288.74	6.24	18.49	10.12	10.12	18,365,290.00
2003	4	75.656	21,780.75	14,890.11	-6,890.63	6.25	18.57	11.64	11.64	
2003	5	71.607	23,094.11	14,806.56	-8,287.56	5.84	18.52	14.92	14.92	
2003	6	73.722	25,871.03	14,591.99	-11,279.04	3	15.73	13.74	13.74	15,320,072.00
2003	7	74.747	26,469.39	14,483.28	-11,986.11	1.54	15.3	10.91	10.91	

2003	8	75.96	20,829.93	13,741.95	-7,087.98	1.18	14.81	8.27	8.27	
2003	9	77.904	22,355.45	15,000.08	-7,355.37	0.83	14.82	7.89	7.89	27,618,320.00
2003	10	77.765	25,241.28	15,378.53	-9,862.75	1	14.75	9.08	9.08	
2003	11	76.738	21,352.80	15,740.76	-5,612.04	1.28	14.07	8.97	8.97	
2003	12	76.019	25,985.36	14,433.59	-11,551.76	1.46	13.47	8.35	8.35	20,434,561.00
2004	1	76.295	25,538.35	16,390.57	-9,147.78	1.58	13.48	9.14	9.14	
2004	2	76.39	25,567.60	15,500.35	-10,067.25	1.57	13.01	9.85	9.85	
2004	3	77.262	29,775.11	16,695.20	-13,079.91	1.59	13.12	8.32	8.32	9,515,946.00
2004	4	77.91	29,385.02	18,170.75	-11,214.27	2.11	12.67	7.57	7.57	
2004	5	79.243	26,308.82	17,922.62	-8,386.20	2.87	12.55	4.65	4.65	
2004	6	79.27	30,702.78	17,722.23	-12,980.55	2.01	12.17	5.94	5.94	13,372,087.00
2004	7	79.991	29,398.25	19,067.21	-10,331.04	1.71	12.31	8.54	8.54	
2004	8	80.826	33,494.30	17,556.35	-15,937.95	2.27	12.19	15.8	15.8	
2004	9	80.721	30,723.33	16,552.26	-14,171.07	2.75	12.27	18.96	18.96	10,506,432.00
2004	10	81.202	28,106.06	16,939.18	-11,166.88	3.95	12.39	18.29	18.29	
2004	11	81.204	33,577.87	20,567.78	-13,010.10	5.06	11.97	17.4	17.4	
2004	12	79.774	38,234.25	19,517.97	-18,716.27	8.04	12.25	17.08	17.08	12,669,466.00
2005	1	77.93	38,505.95	19,840.09	-18,665.86	8.26	12.12	12.27	14.87	
2005	2	76.938	28,879.97	20,532.56	-8,347.40	8.59	12.35	12.6	13.94	
2005	3	74.803	35,879.08	23,126.80	-12,752.28	8.63	12.84	13.07	14.15	5,307,967.00
2005	4	76.146	50,933.05	21,207.05	-29,726.00	8.68	13.12	13.76	16.02	
2005	5	76.397	37,903.25	21,873.08	-16,030.17	8.66	13.11	14.61	14.78	
2005	6	76.681	45,977.18	21,902.73	-24,074.45	8.5	13.09	15.1	11.92	3,922,331.00
2005	7	76.234	31,435.96	19,731.78	-11,704.18	8.59	13.09	15.34	11.76	
2005	8	75.809	45,714.81	20,577.19	-25,137.62	8.66	13.03	14.53	6.87	
2005	9	74.103	36,371.65	19,969.19	-16,402.46	8.58	12.83	13.24	4.27	6,673,523.00
2005	10	73.709	36,200.41	18,642.90	-17,557.51	8.19	12.97	11.99	3.72	
2005	11	74.738	36,567.21	18,140.95	-18,426.26	7.84	12.93	10.89	4.4	
2005	12	73.107	40,126.43	18,187.31	-21,939.12	8.07	13.16	9.87	4.7	5,307,864.00
2006	1	72.214	39,630.49	17,178.20	-22,452.29	8.23	13.2	9.36	8.39	

2006	2	71.804	38,542.39	18,039.72	-20,502.66	8.02	13.27	9.01	9.39	
2006	3	72.281	40,697.62	21,124.14	-19,573.48	7.6	13.33	8.61	8.85	15,638,234.00
2006	4	71.304	47,275.38	17,908.92	-29,366.46	7.02	13.51	7.77	5.44	
2006	5	71.764	42,434.09	21,399.68	-21,034.40	7.01	13.95	6.95	4.47	
2006	6	73.405	42,309.93	21,789.39	-20,520.54	6.6	13.79	6.33	4.28	10,564,290.00
2006	7	73.657	39,876.47	23,207.66	-16,668.81	5.89	13.72	5.73	4.16	
2006	8	72.87	49,881.48	23,308.94	-26,572.54	5.96	13.64	5.57	4.92	
2006	9	72.866	44,168.52	21,555.21	-22,613.31	6.45	13.54	5.7	5.93	12,668,681.00
2006	10	72.289	47,886.88	19,910.04	-27,976.84	6.83	14.01	5.94	6.55	
2006	11	71.127	49,152.49	22,852.36	-26,300.13	6.41	13.93	6.12	6.64	
2006	12	69.627	45,014.00	19,625.99	-25,388.01	5.73	13.74	6.39	7.98	11,803,520.00
2007	1	69.885	48,294.19	20,877.69	-27,416.50	6	13.78	6.08	4.63	
2007	2	69.616	56,917.28	24,216.67	-32,700.61	6.22	13.64	5.55	3.02	
2007	3	69.293	45,827.13	23,512.62	-22,314.51	6.32	13.56	4.99	2.19	185,678,300.00
2007	4	68.577	43,589.49	20,466.74	-23,122.74	6.65	13.33	4.69	1.85	
2007	5	67.191	51,498.55	25,044.47	-26,454.08	6.77	13.38	4.47	1.96	
2007	6	66.575	50,201.13	22,814.03	-27,387.11	6.53	13.14	4.46	4.07	206,317,430.00
2007	7	67.068	53,190.58	23,684.54	-29,506.04	6.52	13.29	4.57	5.48	
2007	8	66.946	52,604.06	23,890.63	-28,713.43	7.3	13.04	4.6	5.3	
2007	9	67.024	48,460.16	21,264.45	-27,195.71	7.35	12.87	4.57	5.53	161,532,410.00
2007	10	66.845	59,049.06	24,684.25	-34,364.81	7.55	13.24	4.48	5.38	
2007	11	65.49	57,731.91	26,073.75	-31,658.16	7.52	13.39	4.45	6.08	
2007	12	63.303	37,757.37	18,066.00	-19,691.37	6.87	13.32	4.27	5.7	175,516,006.00
2008	1	68.081	64,341.01	23,753.53	-40,587.48	6.95	13.78	4.69	9.4	
2008	2	70.624	58,051.43	32,327.17	-25,724.26	7.28	13.84	5.32	10.58	
2008	3	64.924	53,200.79	27,115.46	-26,085.32	6.9	14.06	6.13	11.9	16,745,320.00
2008	4	62.256	54,785.45	29,186.19	-25,599.27	7.35	13.91	7.32	16.12	
2008	5	61.899	56,877.43	25,739.61	-31,137.82	7.76	14.01	8.7	18.61	
2008	6	63.783	49,957.26	25,309.94	-24,647.31	7.73	14.06	9.86	17.87	25,765,230.00
2008	7	66.704	70,300.09	30,338.89	-39,961.20	8.03	13.9	10.83	17.12	

2008	8	67.679	72,644.67	29,753.42	-42,891.24	8.02	13.66	11.92	18.33	
2008	9	71.409	74,773.03	28,487.59	-46,285.45	7.69	13.66	13.02	18.73	27,862,340.00
2008	10	76.657	74,855.83	32,540.21	-42,315.62	7.75	14.12	14.13	18.74	
2008	11	78.176	68,387.90	29,058.65	-39,329.25	8.39	14.33	15.25	19.54	
2008	12	78.04	68,567.90	29,343.83	-39,224.06	8.59	14.87	16.27	17.83	25,212,790.00
2009	1	78.95	66,177.18	27,359.75	-38,817.43	8.46	14.78	16.56	13.22	
2009	2	79.533	60,563.13	28,676.20	-31,886.93	7.55	14.67	16.87	14.69	
2009	3	80.261	61,296.80	31,469.71	-29,827.08	7.31	14.87	17.07	14.6	25,643,082.00
2009	4	79.626	65,799.21	26,348.27	-39,450.94	7.34	14.71	16.72	12.42	
2009	5	77.861	58,699.61	25,778.27	-32,921.34	7.45	14.85	15.93	9.61	
2009	6	77.851	62,910.79	28,166.23	-34,744.55	7.33	15.09	15.11	8.6	28,065,600.00
2009	7	76.751	63,738.10	31,533.06	-32,205.04	7.24	14.79	14.35	8.44	
2009	8	76.372	59,768.18	28,046.40	-31,721.77	7.25	14.76	13.42	7.36	
2009	9	75.605	69,361.44	29,076.80	-40,284.63	7.29	14.74	12.41	6.74	30,167,540.00
2009	10	75.244	72,359.38	28,344.30	-44,015.08	7.26	14.78	11.42	6.62	
2009	11	74.739	69,148.32	29,878.75	-39,269.57	7.22	14.85	10.24	5	
2009	12	75.431	78,274.61	30,270.94	-48,003.67	6.82	14.76	9.24	5.32	32,381,387.00
2010	1	75.786	71,198.89	30,602.58	-40,596.31	6.56	14.98	8.64	5.95	
2010	2	76.73	60,327.58	33,354.84	-26,972.74	6.21	14.98	7.88	5.18	
2010	3	76.947	75,233.43	34,743.93	-40,489.50	5.98	14.8	7.03	3.97	40,465,240.00
2010	4	77.254	72,107.34	31,269.25	-40,838.09	5.17	14.58	6.32	3.66	
2010	5	78.541	80,316.75	33,241.70	-47,075.06	4.21	14.46	5.85	3.88	
2010	6	81.018	79,208.22	33,039.49	-46,168.73	2.98	14.39	5.43	3.49	45,527,421.00
2010	7	81.426	80,566.22	34,835.39	-45,730.83	1.6	14.29	5.03	3.57	
2010	8	80.44	73,016.16	30,309.84	-42,706.32	1.83	14.18	4.69	3.22	
2010	9	80.912	88,640.52	35,043.83	-53,596.69	2.04	13.98	4.4	3.21	40,564,433.00
2010	10	80.714	82,681.88	32,252.42	-50,429.46	2.12	13.85	4.12	3.18	
2010	11	80.46	102,724.91	39,282.14	-63,442.77	2.21	13.95	4.02	3.84	
2010	12	80.568	93,411.69	40,226.51	-53,185.19	2.28	13.87	3.96	4.51	51,507,513.00
2011	1	81.029	90,527.85	35,457.78	-55,070.07	2.46	14.03	3.93	5.42	

2011	2	81.473	85,558.42	38,784.40	-46,774.01	2.59	13.92	4.05	6.54	
2011	3	84.206	109,732.89	43,875.51	-65,857.37	2.77	13.92	4.49	9.19	356,209,848.00
2011	4	83.89	86,987.95	39,417.20	-47,570.75	3.26	13.92	5.2	12.05	
2011	5	85.433	116,829.99	40,774.79	-76,055.20	5.35	13.88	5.96	12.95	
2011	6	89.049	104,304.80	43,814.26	-60,490.54	8.95	13.91	6.88	14.48	369,576,530.00
2011	7	89.898	102,898.39	44,665.99	-58,232.40	8.99	14.14	7.88	15.53	
2011	8	92.786	136,122.68	46,270.57	-89,852.11	9.23	14.32	9	16.67	
2011	9	96.357	123,700.96	46,257.64	-77,443.32	11.93	14.79	10.18	17.32	321,223,131.00
2011	10	101.27	115,737.69	45,269.28	-70,468.41	14.8	15.21	11.49	18.91	
2011	11	93.676	126,316.89	44,529.49	-81,787.40	16.14	18.51	12.82	19.72	
2011	12	86.663	116,937.25	41,919.87	-75,017.37	18.3	20.04	14.02	18.93	403,465,248.00
2012	1	86.343	101,658.50	42,365.12	-59,293.38	19.7	19.54	15.1	18.31	
2012	2	83.176	102,061.54	44,080.50	-57,981.04	20.56	20.28	15.93	16.69	
2012	3	82.897	110,843.84	43,222.81	-67,621.03	17.8	20.34	16.45	15.61	345,043,467.00
2012	4	83.188	121,387.40	43,972.12	-77,415.28	16.01	20.22	16.5	13.06	
2012	5	84.384	128,775.76	42,366.78	-86,408.98	11.18	20.12	16.4	12.22	
2012	6	84.789	112,058.43	41,263.62	-70,794.81	10.09	20.3	15.97	10.05	367,032,318.00
2012	7	84.14	123,414.28	42,901.77	-80,512.50	11.95	20.15	15.27	7.74	
2012	8	84.075	116,102.08	43,883.96	-72,218.12	10.93	20.13	14.33	6.09	
2012	9	84.613	107,467.85	41,826.56	-65,641.29	7.77	19.73	13.29	5.32	320,064,332.00
2012	10	85.112	110,925.04	48,544.04	-62,381.00	8.98	19.04	12.04	4.14	
2012	11	85.629	129,894.85	46,057.64	-83,837.21	9.8	17.78	10.67	3.25	
2012	12	85.994	117,057.91	40,152.34	-76,905.57	8.3	18.15	9.38	3.2	348,033,545.00
2013	1	86.9	130,764.52	47,116.32	-83,648.21	8.08	18.13	8.2	3.67	
2013	2	87.446	116,417.60	46,701.68	-69,715.93	8.38	17.84	7.24	4.45	
2013	3	85.818	108,816.01	40,516.96	-68,299.05	9.88	17.73	6.33	4.11	295,328,640.00
2013	4	84.189	118,664.19	42,587.84	-76,076.35	10.38	17.87	5.61	4.14	
2013	5	84.146	113,701.52	43,638.54	-70,062.98	9.46	17.45	4.96	4.05	
2013	6	85.488	97,060.75	38,644.17	-58,416.58	6.21	16.97	4.56	4.91	260,532,689.00
2013	7	86.859	124,207.24	41,526.51	-82,680.73	5.92	17.02	4.44	6.03	

2013	8	87.493	119,643.75	40,810.59	-78,833.16	10.03	16.96	4.5	6.67	
2013	9	87.413	112,317.66	41,300.52	-71,017.14	9.58	16.86	4.75	8.29	268,956,430.00
2013	10	85.31	132,206.44	39,246.66	-92,959.78	9.72	17	5.05	7.76	
2013	11	86.103	116,025.12	44,301.22	-71,723.90	9.94	16.89	5.39	7.36	
2013	12	86.309	118,982.26	40,308.27	-78,673.99	9.52	16.99	5.72	7.15	294,007,241.00
2014	1	86.214	130,116.45	43,062.47	-87,053.98	9.26	17.03	6.01	7.21	
2014	2	86.278	107,072.27	42,647.83	-64,424.44	9.16	17.06	6.21	6.86	
2014	3	86.489	107,990.37	48,832.81	-59,157.56	8.98	16.91	6.39	6.27	188,002,360.00
2014	4	86.716	139,284.61	48,995.41	-90,289.20	8.8	16.7	6.58	6.41	
2014	5	87.412	150,477.64	47,866.02	-102,611.63	8.82	16.97	6.85	7.3	
2014	6	87.612	113,690.24	44,160.29	-69,529.95	9.81	16.36	7.05	7.39	185,287,940.00
2014	7	87.773	148,739.56	43,001.07	-105,738.50	9.78	16.91	7.19	7.67	
2014	8	88.106	143,962.43	43,961.71	-100,000.72	8.29	16.26	7.33	8.36	
2014	9	88.836	159,936.01	40,473.27	-119,462.74	8.38	16.04	7.19	6.6	202,578,540.00
2014	10	89.227	157,402.05	44,139.98	-113,262.07	8.67	16	7.08	6.43	
2014	11	89.963	121,600.12	42,893.33	-78,706.79	8.64	15.94	6.97	6.09	
2014	12	90.444	138,182.69	41,157.08	-97,025.61	8.58	15.99	6.88	6.02	245,068,758.00
2015	1	91.358	127,647.41	41,162.98	-86,484.43	8.59	15.93	6.74	5.53	
2015	2	91.489	113,143.49	42,645.98	-70,497.51	8.59	15.47	6.63	5.61	
2015	3	91.727	114,862.49	47,706.93	-67,155.56	8.49	15.46	6.63	6.31	148,325,098.00
2015	4	93.438	129,842.15	39,880.86	-89,961.29	8.42	15.4	6.69	7.08	
2015	5	96.389	144,039.06	45,965.67	-98,073.38	8.26	15.26	6.65	6.87	
2015	6	97.705	128,167.64	47,529.52	-80,638.12	8.26	16.06	6.63	7.03	154,964,270.00
2015	7	101.196	144,153.03	59,405.04	-84,747.99	10.57	15.75	6.54	6.62	
2015	8	102.431	125,695.73	55,074.98	-70,620.75	11.54	16.82	6.34	5.84	
2015	9	105.275	138,743.16	49,940.64	-88,802.51	14.61	15.68	6.29	5.97	132,958,530.00
2015	10	102.779	126,644.38	52,131.17	-74,513.20	21.65	16.58	6.31	6.72	
2015	11	102.168	162,941.70	48,658.36	-114,283.34	12.34	17.16	6.42	7.32	
2015	12	102.195	124,450.72	50,898.40	-73,552.32	9.81	18.3	6.58	8.01	183,476,572.00
2016	1	102.313	106,482.96	48,023.38	-58,459.59	11.434	18	6.77	7.78	

2016	2	101.932	100,563.13	51,489.46	-49,073.67	11.301	17.91	6.87	6.84	
2016	3	101.485	114,420.69	54,029.60	-60,391.09	8.807	17.87	6.88	6.45	98,478,340.00
2016	4	101.228	124,916.24	46,597.41	-78,318.83	9.001	18.04	6.72	5.27	
2016	5	100.732	116,150.48	49,861.71	-66,288.77	8.581	18.22	6.59	5	
2016	6	101.145	127,317.35	48,213.04	-79,104.30	11.36	18.18	6.46	5.8	84,782,530.00
2016	7	101.332	117,320.91	48,046.37	-69,274.54	10.63	18.1	6.44	6.4	
2016	8	101.41	133,003.72	47,031.22	-85,972.51	8.72	17.66	6.47	6.26	
2016	9	101.271	124,427.15	46,204.31	-78,222.84	8.92	13.86	6.5	6.34	103,464,370.00
2016	10	101.323	115,177.80	42,089.39	-73,088.41	8.15	13.73	6.48	6.47	
2016	11	101.748	129,493.73	49,651.03	-79,842.69	7.25	13.67	6.43	6.68	
2016	12	102.132	123,150.81	46,680.50	-76,470.31	6.16	13.66	6.3	6.35	106,634,189.00
2017	1	103.747	150,734.13	48,840.44	-101,893.70	8.648	13.66	6.26	6.99	
2017	2	103.644	130,840.52	47,957.27	-82,883.25	8.779	13.69	6.43	9.04	
2017	3	102.853	141,129.27	54,051.79	-87,077.47	8.628	13.61	6.76	10.28	143,675,490.00
2017	4	103.325	129,061.41	44,801.46	-84,259.95	8.773	13.61	7.2	11.48	
2017	5	103.262	151,422.18	52,670.31	-98,751.87	8.759	13.71	7.84	11.7	
2017	6	103.491	143,013.54	51,573.88	-91,439.67	8.325	13.66	8.13	9.21	176,045,642.00
2017	7	103.877	165,573.49	52,921.84	-112,651.65	8.221	13.7	8.21	7.47	
2017	8	103.556	144,290.78	41,666.28	-102,624.50	8.153	13.65	8.36	8.04	
2017	9	103.12	141,786.92	50,375.57	-91,411.34	8.134	13.69	8.4	7.06	189,853,273.00
2017	10	103.388	147,856.57	49,085.37	-98,771.19	8.129	13.71	8.33	5.72	
2017	11	103.571	138,150.71	50,874.65	-87,276.06	8.015	13.68	8.15	4.73	
2017	12	103.095	141,763.03	49,309.40	-92,453.63	8.005	13.64	7.98	4.5	161,913,988.00
2018	1	102.918	157,521.59	53,448.13	-104,073.46	8.08	13.65	7.79	4.83	
2018	2	101.4	128,943.27	57,271.67	-71,671.60	8.005	13.68	7.4	4.46	
2018	3	101.181	152,038.51	50,992.76	-101,045.76	8.005	13.49	6.89	4.18	396,496,850.00
2018	4	100.611	150,095.55	49,997.57	-100,097.97	8	13.24	6.24	3.73	
2018	5	100.663	168,020.10	55,313.87	-112,706.23	7.967	13.25	5.61	3.95	
2018	6	101.003	142,525.14	52,919.25	-89,605.89	7.938	13.22	5.2	4.28	463,021,538.00
2018	7	100.672	152,706.62	52,882.92	-99,823.70	7.656	12.78	4.95	4.35	

2018	8	100.613	149,822.17	50,986.90	-98,835.28	7.664	13.1	4.63	4.04	
2018	9	100.834	129,796.06	46,777.38	-83,018.68	7.649	12.66	4.53	5.7	368,621,464.00
2018	10	101.076	149,324.01	49,959.22	-99,364.79	7.507	12.61	4.53	5.53	
2018	11	102.357	150,501.44	48,315.46	-102,185.98	7.346	12.55	4.59	5.58	
2018	12	102.292	126,686.88	44,012.51	-82,674.37	7.342	12.51	4.69	5.71	397,781,642.00

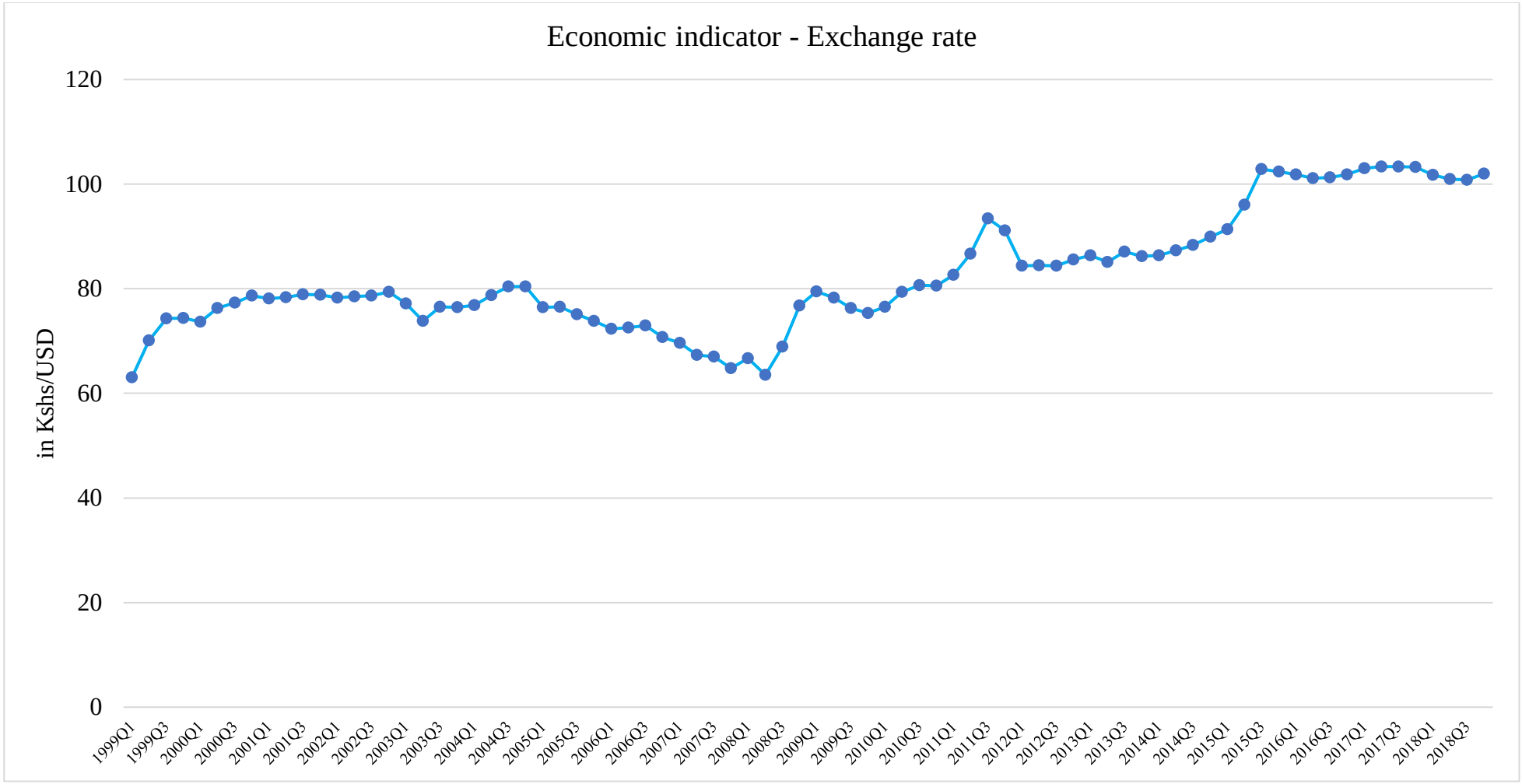
Table 2: Quarterly Economic Indicators

year	Q	Forex rate/USD	3 month SD of Forex	Imports in (MShs)	Exports in (Mshs)	Balance of trade (MShs)	T- Bill rate	Headline Inflation(%)	Balance of Trade(USD)	FDI(USD)
1999	Q1	63.08	1.1296	48,760.03	31,532.64	-17,227.39	9.33	1.76	-273,103,836.398	10,644,530.00
1999	Q2	70.1	4.0043	44,665.10	31,972.25	-12,692.85	10.42	4.65	-181,067,760.342	12,988,064.00
1999	Q3	74.34	1.2916	48,771.67	29,989.82	-18,781.85	14.71	7.07	-252,647,968.792	17,585,630.00
1999	Q4	74.41	0.8142	52,274.69	29,083.17	-23,191.52	18.56	9.99	-311,672,087.085	10,735,232.00
2000	Q1	73.66	1.9137	55,098.81	31,723.89	-23,374.90	14.21	7.28	-317,335,052.946	19,456,243.00
2000	Q2	76.27	1.5910	56,418.42	34,119.18	-22,299.24	11.37	9.57	-292,372,361.348	25,579,374.00
2000	Q3	77.29	1.0221	69,107.84	32,819.00	-36,288.85	10.15	11.25	-469,515,461.250	38,142,795.00
2000	Q4	78.65	0.2738	67,178.82	35,865.00	-31,313.82	11.84	11.61	-398,141,385.887	27,726,138.00
2001	Q1	78.1	0.4284	64,716.94	41,833.27	-22,883.69	14.64	10.22	-293,004,993.598	906,574.00
2001	Q2	78.39	0.6254	80,302.64	37,763.93	-42,538.70	12.11	6.46	-542,654,675.341	1,325,655.00
2001	Q3	78.88	0.0533	74,138.80	37,863.92	-36,274.88	12.53	3.89	-459,874,239.351	1,386,652.00
2001	Q4	78.81	0.1600	60,302.87	35,250.89	-25,051.98	11.4	2.22	-317,878,188.047	1,683,742.00
2002	Q1	78.27	0.2736	71,624.99	40,717.89	-30,907.08	10.5	1.65	-394,877,730.931	4,657,690.00
2002	Q2	78.48	0.2137	60,467.23	45,917.07	-14,550.15	8.49	2.17	-185,399,464.832	6,904,612.00
2002	Q3	78.71	0.1317	59,517.13	44,150.36	-15,366.78	8.03	1.88	-195,232,880.193	10,684,624.00
2002	Q4	79.41	0.1311	66,055.43	41,060.79	-24,994.63	8.28	3.24	-314,754,187.130	5,371,521.00
2003	Q1	77.14	0.5950	68,843.72	50,054.20	-18,789.53	7.14	8.12	-243,577,002.852	18,365,290.00
2003	Q2	73.86	2.0252	70,745.89	44,288.66	-26,457.23	4.63	13.07	-358,207,825.616	15,320,072.00
2003	Q3	76.52	1.5925	69,654.77	43,225.31	-26,429.46	1.48	9.01	-345,392,838.474	27,618,320.00
2003	Q4	76.48	0.8775	72,579.44	45,552.88	-27,026.55	1.36	8.68	-353,380,622.385	20,434,561.00

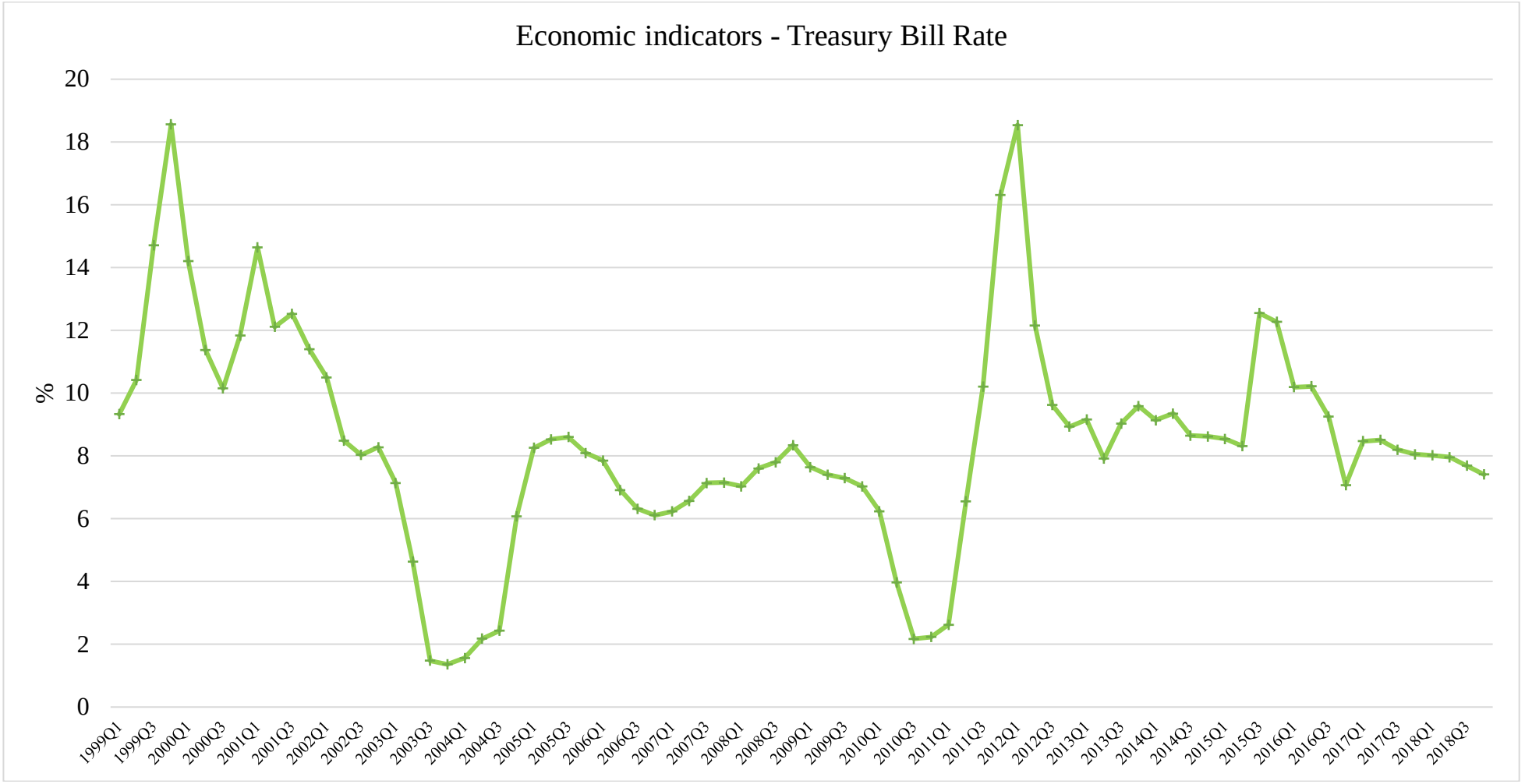
2004	Q1	76.83	0.5330	80,881.06	48,586.12	-32,294.94	1.56	8.85	-420,342,834.830	9,515,946.00
2004	Q2	78.79	0.7775	86,396.62	53,815.60	-32,581.02	2.18	6.18	-413,517,197.614	13,372,087.00
2004	Q3	80.41	0.4548	93,615.88	53,175.82	-40,440.06	2.43	15.27	-502,923,268.250	10,506,432.00
2004	Q4	80.39	0.8250	99,918.18	57,024.93	-42,893.25	6.08	17.09	-533,564,498.072	12,669,466.00
2005	Q1	76.43	1.5979	103,265.00	63,499.45	-39,765.54	8.26	14.55	-520,287,060.055	5,307,967.00
2005	Q2	76.51	0.2677	134,813.48	64,982.86	-69,830.62	8.53	13.48	-912,699,254.999	3,922,331.00
2005	Q3	75.1	1.1278	113,522.42	60,278.16	-53,244.26	8.6	7.01	-708,978,162.450	6,673,523.00
2005	Q4	73.84	0.8248	112,894.05	54,971.16	-57,922.89	8.09	4.79	-784,437,838.570	5,307,864.00
2006	Q1	72.35	0.2582	118,870.50	56,342.06	-62,528.43	7.85	8.42	-864,249,205.252	15,638,234.00
2006	Q2	72.6	1.1044	132,019.40	61,097.99	-70,921.40	6.91	4.99	-976,878,787.879	10,564,290.00
2006	Q3	72.93	0.4555	133,926.47	68,071.81	-65,854.66	6.32	5.34	-902,984,505.690	12,668,681.00
2006	Q4	70.75	1.3346	142,053.37	62,388.39	-79,664.98	6.11	7.14	-1,126,006,784.452	11,803,520.00
2007	Q1	69.63	0.2964	151,038.60	68,606.98	-82,431.62	6.23	3.32	-1,183,852,075.255	185,678,300.00
2007	Q2	67.36	1.0254	145,289.17	68,325.24	-76,963.93	6.57	3.17	-1,142,576,157.957	206,317,430.00
2007	Q3	67.05	0.0618	154,254.80	68,839.62	-85,415.18	7.14	5.17	-1,273,902,759.135	161,532,410.00
2007	Q4	64.76	1.7872	154,538.34	68,824.00	-85,714.34	7.15	5.69	-1,323,569,178.505	175,516,006.00
2008	Q1	66.72	2.8555	175,593.23	83,196.16	-92,397.06	7.03	10.48	-1,384,848,021.583	16,745,320.00
2008	Q2	63.49	1.0007	161,620.14	80,235.74	-81,384.40	7.6	16.91	-1,281,845,959.994	25,765,230.00
2008	Q3	68.9	2.4833	217,717.79	88,579.90	-129,137.89	7.8	18.2	-1,874,279,970.972	27,862,340.00
2008	Q4	76.76	0.8405	211,811.63	90,942.69	-120,868.93	8.34	18.42	-1,574,634,314.747	25,212,790.00
2009	Q1	79.48	0.6568	188,037.11	87,505.66	-100,531.44	7.64	14.93	-1,264,864,620.030	25,643,082.00
2009	Q2	78.28	1.0219	187,409.61	80,292.77	-107,116.83	7.4	10.12	-1,368,380,556.975	28,065,600.00
2009	Q3	76.27	0.5838	192,867.72	88,656.26	-104,211.44	7.29	7.53	-1,366,349,023.207	30,167,540.00
2009	Q4	75.34	0.3580	219,782.31	88,493.99	-131,288.32	7.03	5.68	-1,742,611,096.363	32,381,387.00
2010	Q1	76.55	0.6173	206,759.90	98,701.35	-108,058.55	6.24	4.73	-1,411,607,446.114	40,465,240.00
2010	Q2	79.37	1.9131	231,632.31	97,550.44	-134,081.88	3.97	3.76	-1,689,326,949.729	45,527,421.00
2010	Q3	80.67	0.4931	242,222.90	100,189.06	-142,033.84	2.17	3.33	-1,760,677,327.383	40,564,433.00
2010	Q4	80.57	0.1275	278,818.48	111,761.07	-167,057.42	2.23	4.03	-2,073,444,458.235	51,507,513.00
2011	Q1	82.67	1.7205	285,819.16	118,117.69	-167,701.45	2.62	7.41	-2,028,564,775.614	356,209,848.00
2011	Q2	86.7	2.6480	308,122.74	124,006.25	-184,116.49	6.55	12.91	-2,123,604,267.589	369,576,530.00

2011	Q3	93.45	3.2355	362,722.03	137,194.20	-225,527.83	10.21	16.38	-2,413,352,915.998	321,223,131.00
2011	Q4	91.09	7.3054	358,991.83	131,718.64	-227,273.18	16.31	18.81	-2,495,039,850.697	403,465,248.00
2012	Q1	84.42	1.9141	314,563.88	129,668.43	-184,895.45	18.54	16.62	-2,190,185,382.611	345,043,467.00
2012	Q2	84.44	0.8324	362,221.59	127,602.52	-234,619.07	12.16	11.79	-2,778,529,962.103	367,032,318.00
2012	Q3	84.4	0.2937	346,984.21	128,612.29	-218,371.91	9.63	6.62	-2,587,344,905.213	320,064,332.00
2012	Q4	85.59	0.4432	357,877.80	134,754.02	-223,123.78	8.93	3.76	-2,606,890,758.266	348,033,545.00
2013	Q1	86.33	0.8286	355,998.13	134,334.96	-221,663.19	9.16	4.1	-2,567,626,433.453	295,328,640.00
2013	Q2	85.1	0.7627	329,426.46	124,870.55	-204,555.91	7.91	4.5	-2,403,712,220.917	260,532,689.00
2013	Q3	87.07	0.3453	356,168.65	123,637.62	-232,531.03	9.03	7.13	-2,670,621,683.703	268,956,430.00
2013	Q4	86.23	0.5275	367,213.82	123,856.15	-243,357.67	9.59	7.28	-2,822,192,624.377	294,007,241.00
2014	Q1	86.37	0.1439	345,179.09	134,543.11	-210,635.98	9.14	6.66	-2,438,763,227.973	188,002,360.00
2014	Q2	87.29	0.4703	403,452.49	141,021.72	-262,430.78	9.35	7.15	-3,006,424,332.684	185,287,940.00
2014	Q3	88.33	0.5437	452,638.00	127,436.05	-325,201.96	8.65	7.24	-3,681,670,553.606	202,578,540.00
2014	Q4	89.91	0.6129	417,184.86	128,190.39	-288,994.47	8.62	6.24	-3,214,263,930.597	245,068,758.00
2015	Q1	91.39	0.1871	355,653.39	131,515.89	-224,137.50	8.54	6.03	-2,452,538,570.960	148,325,098.00
2015	Q2	96.05	2.1851	402,048.85	133,376.05	-268,672.79	8.32	6.87	-2,797,218,011.452	154,964,270.00
2015	Q3	102.9	2.0917	408,591.92	164,420.66	-244,171.25	12.55	6.13	-2,372,898,445.092	132,958,530.00
2015	Q4	102.35	0.3452	414,036.80	151,687.93	-262,348.86	12.27	7.44	-2,563,252,173.913	183,476,572.00
2016	Q1	101.81	0.4144	321,466.78	153,542.44	-167,924.35	10.19	6.84	-1,649,389,549.160	98,478,340.00
2016	Q2	101.14	0.2657	368,384.07	144,672.16	-223,711.90	10.22	5.66	-2,211,903,302.353	84,782,530.00
2016	Q3	101.3	0.0697	374,751.78	141,281.90	-233,469.89	9.25	6.24	-2,304,737,314.906	103,464,370.00
2016	Q4	101.83	0.4047	367,822.34	138,420.92	-229,401.41	7.07	6.43	-2,252,788,078.170	106,634,189.00
2017	Q1	103.03	0.4891	422,703.92	150,849.50	-271,854.42	8.47	9.08	-2,638,594,778.220	143,675,490.00
2017	Q2	103.36	0.1183	423,497.13	149,045.65	-274,451.49	8.51	10.1	-2,655,296,923.375	176,045,642.00
2017	Q3	103.35	0.3800	451,651.19	144,963.69	-306,687.49	8.2	7.74	-2,967,464,828.254	189,853,273.00
2017	Q4	103.28	0.2401	427,770.31	149,269.42	-278,500.88	8.05	5.11	-2,696,561,580.170	161,913,988.00
2018	Q1	101.72	0.9460	438,503.37	161,712.56	-276,790.82	8.02	4.45	-2,721,105,190.720	396,496,850.00
2018	Q2	100.96	0.2129	460,640.79	158,230.69	-302,410.09	7.96	4.15	-2,995,345,582.409	463,021,538.00
2018	Q3	100.77	0.1144	432,324.85	150,647.20	-281,677.66	7.69	4.92	-2,795,253,150.739	368,621,464.00
2018	Q4	101.97	0.7216	426,512.33	142,287.19	-284,225.14	7.41	5.56	-2,787,340,786.506	397,781,642.00

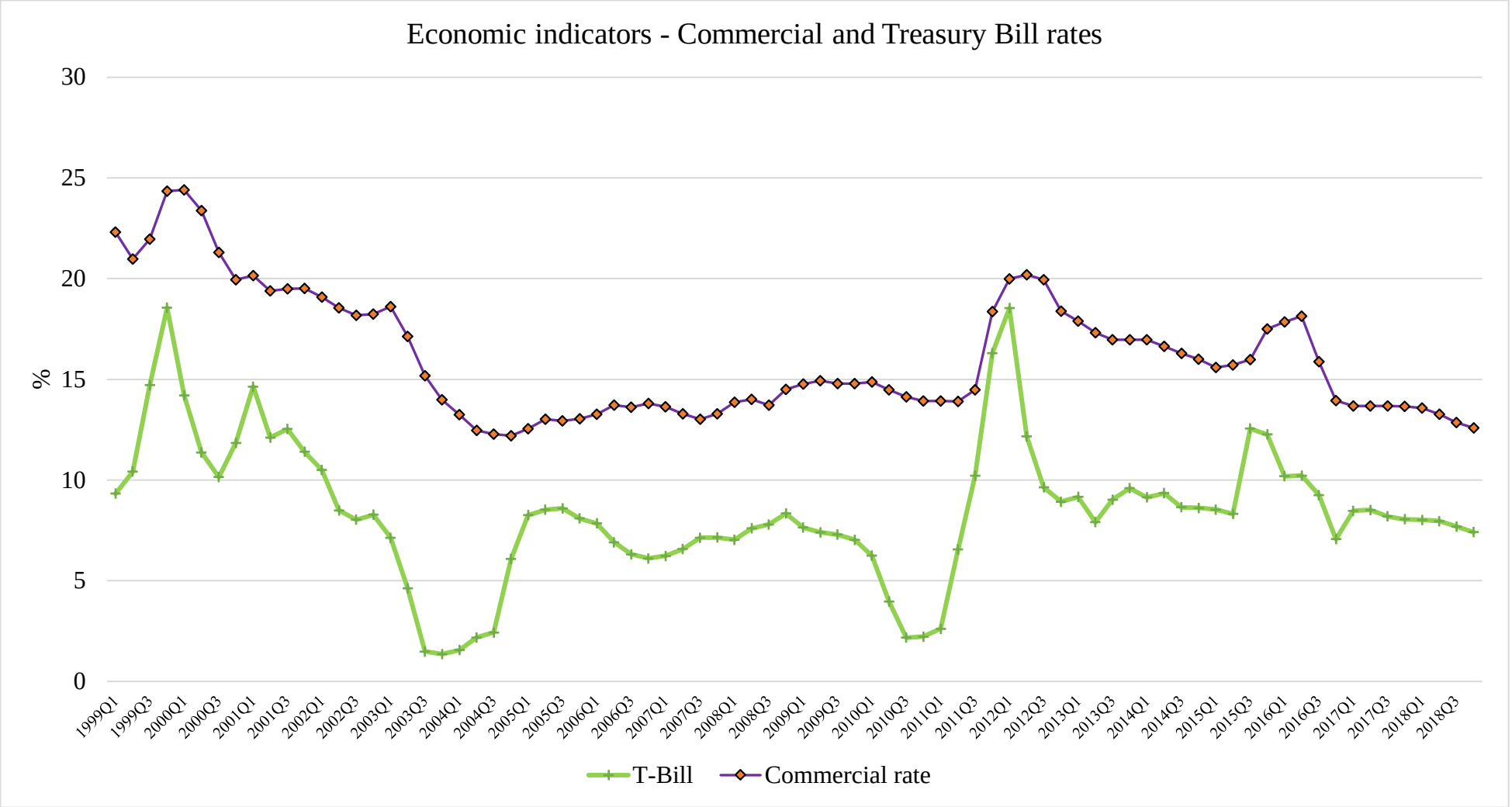
Appendix III: Trends for Economic Indicators



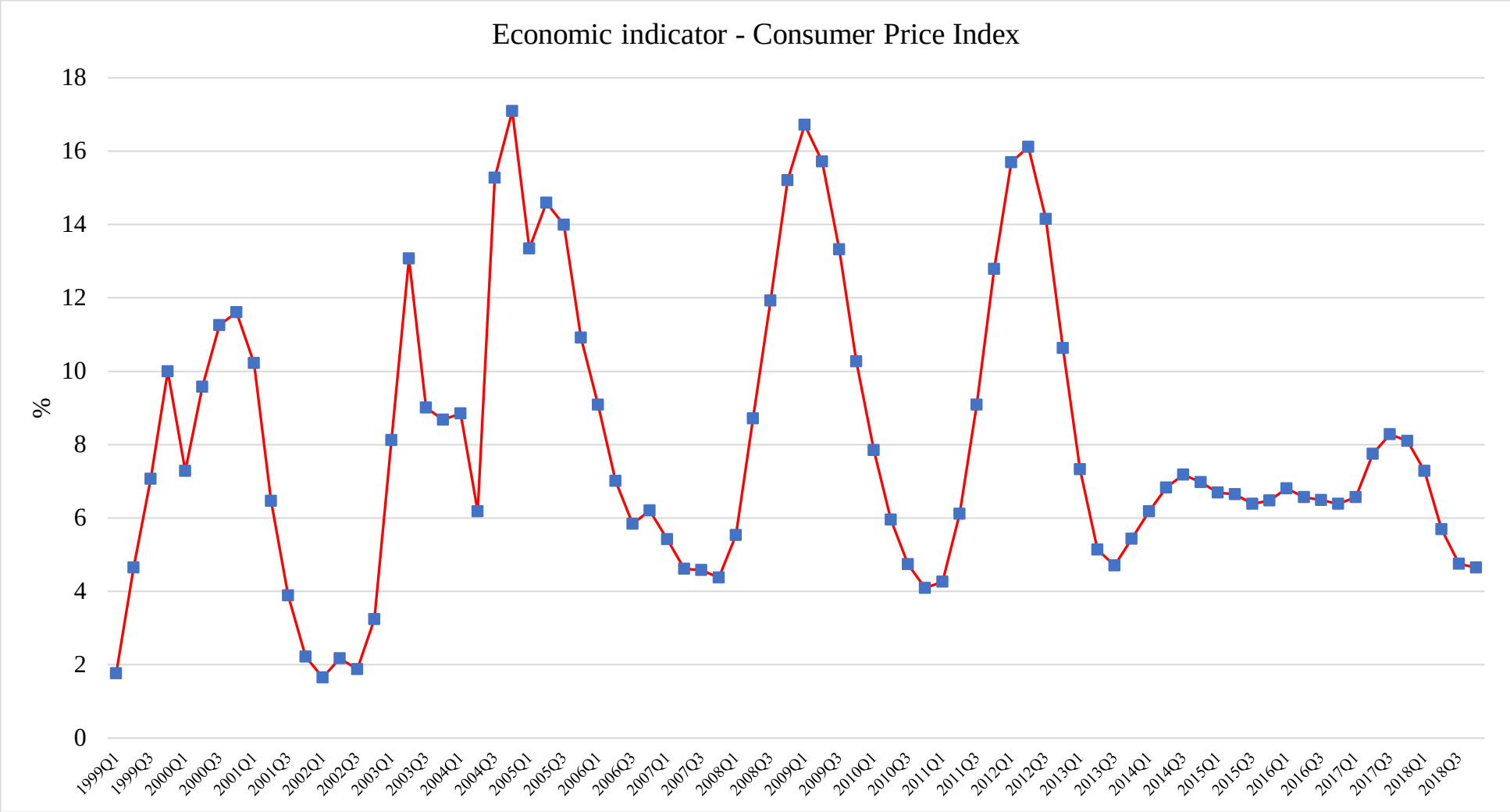
Graph 1: Exchange Rate



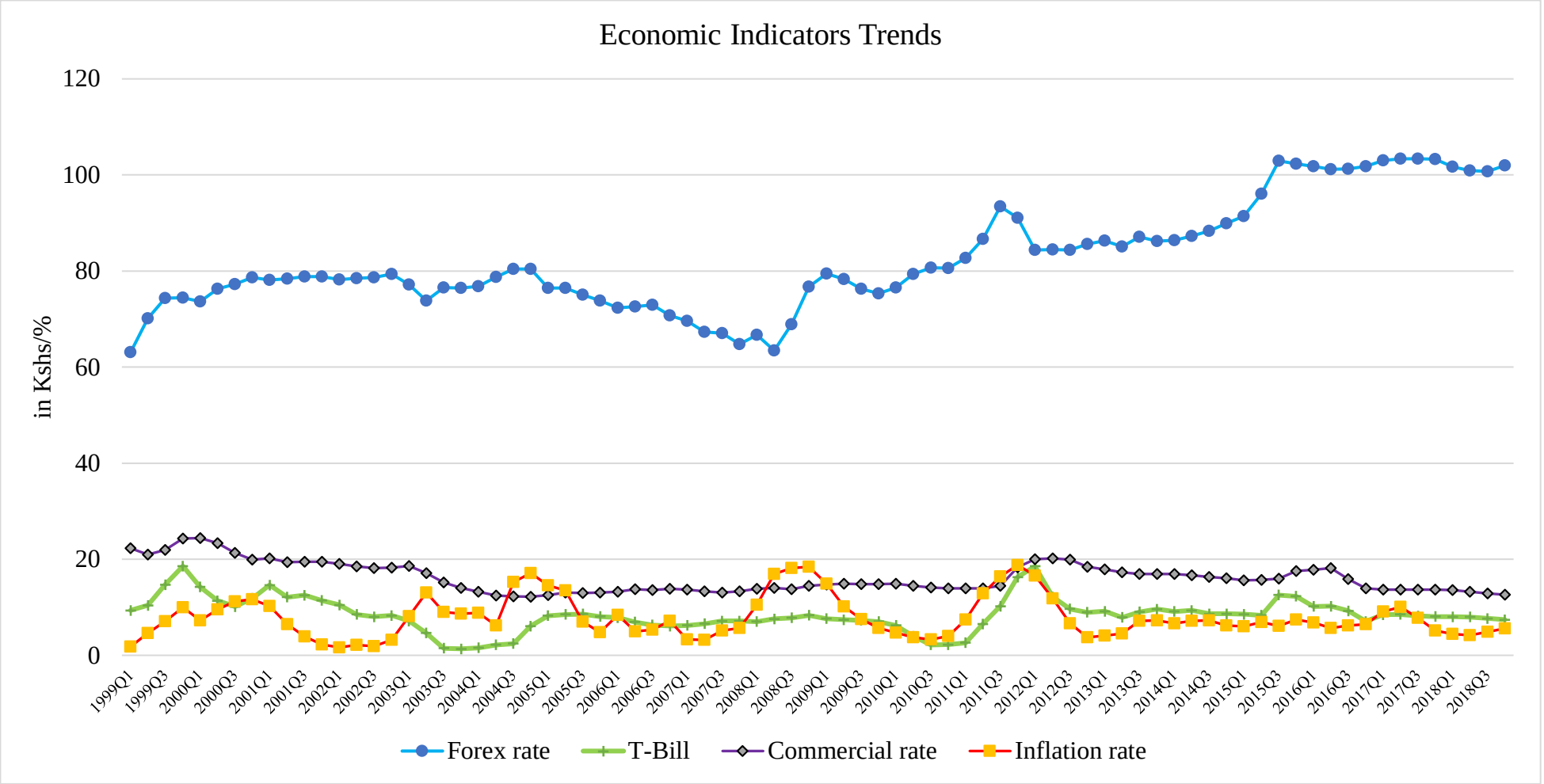
Graph 2: 90 – Day Treasury Bill rate



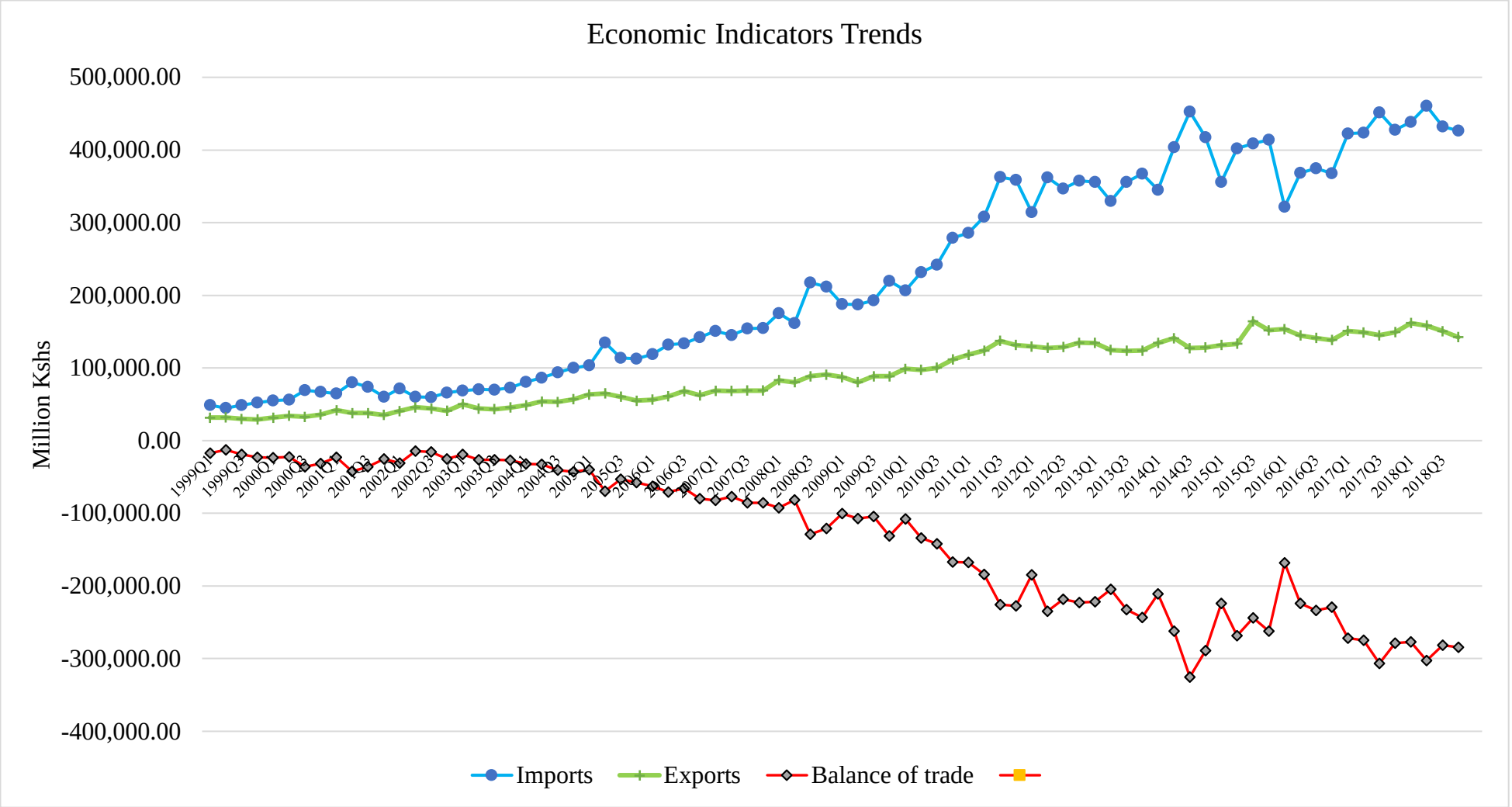
Graph 3: Commercial and 90 – Day Treasury Bill rate



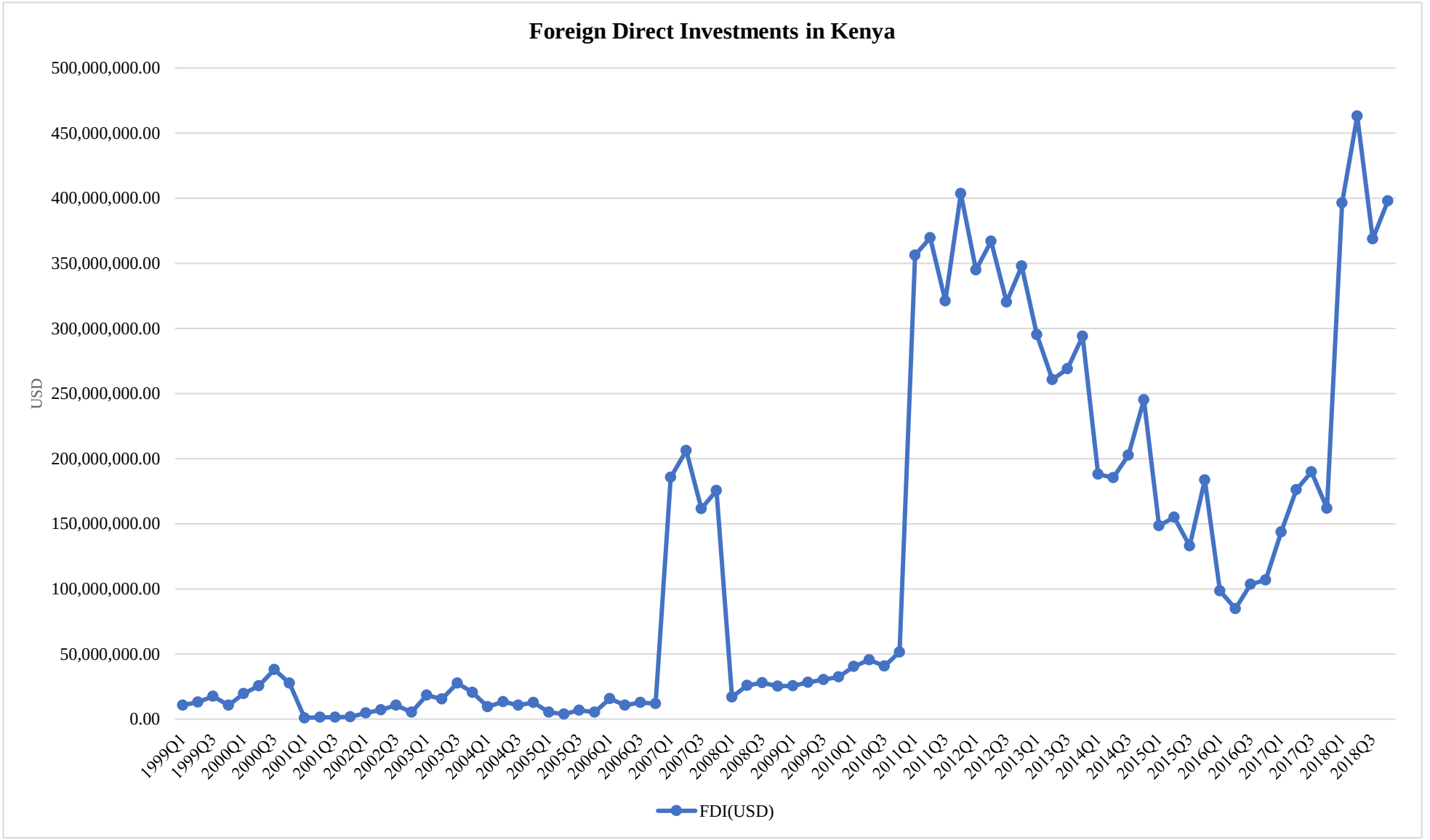
Graph 4: Inflation Rates



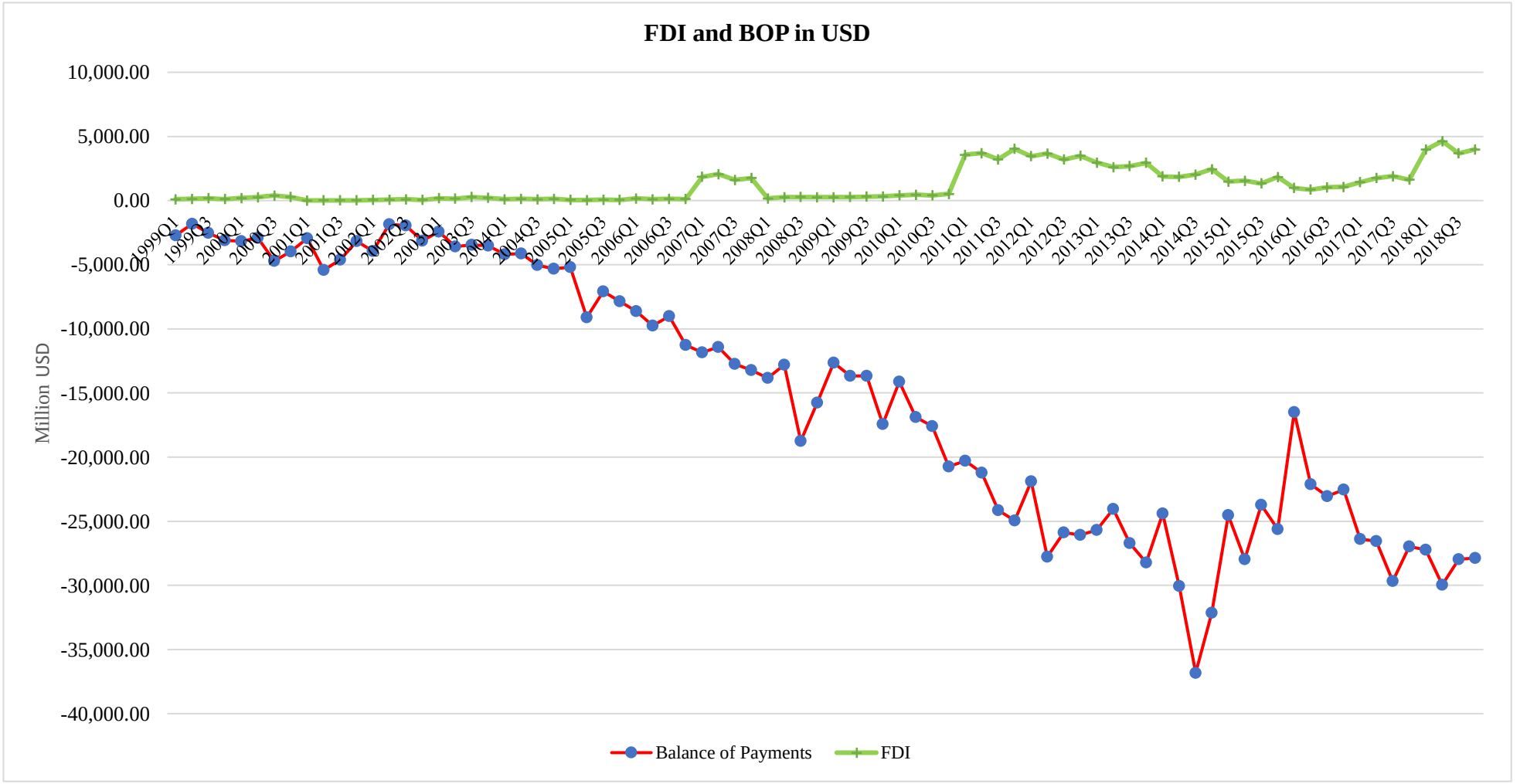
Graph 5: Comparative Graphs



Graph 6: Balance of Trade



Graph 7: Foreign Direct Investments Inflows



Graph 8: FDI and BO