THE DETERMINANTS OF THE KENYA SHILLING-UNITED STATES DOLLAR EXCHANGE RATE

BY

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DECLARATION

I declare that this is my original work and has not been presented for any award in any university.

Signed ..... Date 22/11/2022

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This research project has been submitted for examination with my approval as university supervisor.

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DEDICATION

This work is dedicated to my parents for standing with me through my adversities. They gave me unwavering love and support cheering me even during the most difficult periods.

ACKNOWLEDGEMENT

First, thanks to God with whose grace I accomplished this Project. I gratefully acknowledge the insightful guidance, encouragement and valuable advice from my supervisor Dr Winnie Nyamute which aided my efforts complete this project. I would also like to acknowledge Mr. Brandon Olunga for numerous conversations we had on the technical layout of the document also thank my family for their love and encouragement in the preparation of this project.

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LIST OF ABBREVIATIONS

BOE- Bank of England

CBK-central Bank of Kenya

ECB- European Central Bank

IFE- international Fisher effect

KES- Kenya Shilling

NEER- Nominal effective exchange rate

OECD- organization for economic cooperation and development

PPP- Purchasing power parity

REER- Real effective exchange rate

RPPP- relative purchasing power parity

USA- United States of America

USD- United States Dollar

ABSTRACT

There are many determinants of the KES-USD exchange rate. This study took a descriptive stance to look at interest rates differential and interest rate differentials and how they affect the exchange rate. For the period from august 2008 to July 2022. Purchasing power parity and international fisher effect are the theories on which the study was based on. STATA was the software that was used to analyze the data. The variables were tested for stationarity, cointergration, autocorrelation, normality, and heteroscedasticity and multi collinearity. Exchange rates and interest differentials were not found to be stationary and as a result the 1^{st} difference was calculated and used for analysis. There was no evidence of autocorrelation and multi-collinearity. Cointergration tests showed that there's a long run relationship, interest rate differential is significant at 5% while inflation differential is not. According to the STATA output, a significant P value of zero indicated existence of heteroscedasticity problem which was corrected using the robust command before analysis of the data. Inflation differential was found to have a positive but weak correlation with exchange rate with a correlation of 0.0378. Interest differential however has a stronger but negative correlation of -0.2830 with exchange rates. A correlation of 0.10234 is positive but weaker for the correlation between inflation differential and interest differentials. After correction the error term to normality using the robust command, the following output was obtained for the regression analysis. The null hypothesis of the F test is that $R^2= 0$ suggesting that the model has no explanatory variable while the alternative hypothesis is that $R^2 \neq 0$ suggesting that the model has explanatory power. With a P value of the F test of 0.3683, the model is **not** significant at the 10%, 5% or 1% significance levels. With an R^2 value of 0.0088, our model explains only about 0.8% of the exchange rate by the interest rate differential and inflation differential. The p tests for the independent variables are all statistically insignificant. The p test is significant at the 5% significance level with a p value of the t test of 0.015 for the constant. Coefficient of 0.013848 and -0.0498889 for inflation differential and interest rate differential both suggest that exchange rates vary positively with inflation differential and negatively with interest rate differential. The study found that both the purchasing power parity and international fisher effect were violated for the KES-USD exchange rate in Kenya.

CHAPTER 1: INTRODUCTION.

1.1 Background.

Comparison of inflation in two economies and holding other macroeconomic variables constant, capital is expected to move from a high inflation economy to a low inflation economy leading to a rise in the demand of the currency of the economy with low inflation leading to an appreciation of that economy's currency. For economies in a floating exchange rate regime, the respective central banks use interest to conduct monetary policy. Holding all other factors constant, higher interest rates in one economy compared to interest rates in another economy will lead to flow of capital from the low interest economy to the higher interest economy, this leads to a higher demand for the currency whose economy has higher interest rates thus leading to its appreciation.

Relative Purchasing power parity (PPP) and international fisher effect (IFE) shall be used to explain whether the parities hold in determining the exchange rate between the KES and USD. Both theories are similar as they examine the effect that nominal inflation differential and nominal interest differential may have in determining the nominal exchange rate

Currently, most countries with a floating exchange regime are running higher interest rates as they attempt to combat higher inflation that has arisen from the disruption of supply chains by sanctions due to the war in Ukraine. This has led to most currencies depreciating against the USD. The Euro, suffering inflation of up to 9.1% had its interest rates increased twice by the ECB to 1.25%.*combined monetary policy decisions and statement* (2022). The Sterling pound also experienced depreciation against the USD with inflation of 10.1% with the bank of England hiking its bank rate four times from 0.75% in March to 1.75% in August 2022.*monetary policy summary* (2022).

1.1.1 Exchange Rate Determinants.

Any variable that influences the demand and supply of a particular economy's currency will definitely lead to a change in the value of the exchange rate of that currency against other currencies thus it is evident that there are a lot of factors that can influence the exchange rate including GDP, current account balance, level of investments, interest rate, inflation rates and their differentials, political stability, money supply etc. in this study, inflation differentials and interest rate differentials were used to find out how they determine exchange rates.

According to Okoth (2013), Inflation refers to a general rise in the general price levels in an economy. Duarte, & Stockman (2002) mentions that a low inflation rate leads to a stronger currency since the purchasing power of the currency of high inflation economies will reduce compared to the currency of the lower inflation economy. The reason, according to Okoth (2013) is that there's a lot of money following fewer goods, or that demand in the economy is outpacing supply for an economy with high inflation as opposed to a low inflationary economy. In this study we aim to find out the effect of inflation differential and interest rate differential on the nominal exchange rate of the KES/USD.

Okoth (2013) goes on to mention that the rate of inflation is used to measure the price levels in the economy. Low levels of Inflation is important for the economy as opposed to deflation and hyperinflation as it provides an incentive for investment and business. Inflation could be measured as an index to show the fluctuation of the price levels in an economy.

Prowd (2020) in his article on determinants of inflation in Liberia, measures inflation as a function of the exchange rate, import value including freight cost and insurance, goods and services tax, international oil price and new money. With a coefficient of 0.663459, he found the exchange rate had a strong positive relationship with inflation. Import value, with a coefficient of -0.037886 was

found to be a weak determinant of inflation this was explained by surplus goods due to imports in the domestic economy causing a general drop in the price levels. He found that goods and service tax, had a somewhat strong positive relationship with inflation in the short run but a weak negative relationship with inflation in the long run. The international oil price also had a positive relationship with inflation with a 1% increase in the oil price leading to 14.4% increase in inflation in the long run. Printing of new money had the strongest positive relationship with inflation with a 1% increase in new money leading to a 77% increase in inflation as evidenced by its coefficient of 0.778380. Emeru (2020) in his paper determinants of inflation in Ethiopia measured inflation as a function of Broad Money Supply, Budget Deficit proportionate of GDP, Banks and financial institutions Lending Rate, Real GDP, Nominal exchange rate and the rainfall levels in Ethiopia. He found that inflation varied positively with broad money supply and financial institution lending rates while varying negatively with the other variables.

According to Kanwal, Abbasi, Burney, Mubin (2014), interest rates refers to any bank lending rate or any rate that a lender charges as a percentage of the principal to anyone that borrows or uses an asset. Interest rates can thus also be looked at as the price of borrowing money if we view money as an asset. Interest rates can be further classified as nominal interest rates and real interest rates. Nominal interest rates refers to the price of borrowing money before taking account of inflation while real interest rates refer to the nominal interest rates after deduction of inflation rates. In this study we shall be examining the effect of nominal inflation differentials on the exchange rate.

Interest rates are of much importance for institutions authorized to conduct monetary policy in an economy as they help to control the aggregate price levels in the economy and also to stabilize business cycles. According to Ogbonna (2013), by changing interest rates, the monetary authority tries to achieve maximum employment, stable prices and a good level of economic growth. Thus,

as interest rates drop, consumer spending increases and this in turn stimulates economic growth. Excessive economic growth can be harmful. Since hyperinflation can be introduced, resulting in difficulty in forecasting investments). Also, an economy with no inflation has essentially stagnated. The right level of economic growth, and thus inflation, is a delicate balance that has to be maintained by the monetary authority in that economy.

Ogbonna (2013) in his study of testing Fisher's hypothesis in Nigeria, measured interest rates as a function of inflation. He found that the results indicated no existence of a significant causal link from interest rates to inflation in the short run, suggesting that interest rates may be considered exogenous in inflation modeling in Nigeria. Iqbal (2018) modeled interest rates as a function of public debt and found that public debt shows a stronger linear correlation with long-term interest rates in times of financial pressure and also for higher sovereign risk economies. He also found that public debt ratio has non-linear relationship pattern with long-term interest rates; where low values of debt have negative correlation with long-term interest rates and higher values of debt corresponds to positive correlation.

1.1.2 KES/USD Exchange Rates.

Exchange rate refers to the price of one currency measured in terms of price of another currency. Exchange rates can be classified as real or nominal exchange rates. Nominal exchange rates can be further classified as spot exchange rates and forward exchange rates. Spot exchange rates refers to the rate at which a foreign currency can be bought or sold for immediate delivery, usually 1 or 2 days. The forward rate is the rate at which foreign currency can be bought or sold at some time in the future. The real exchange rate usually refers to the nominal exchange rate adjusted for inflation. Exchange rates can also be classified as nominal effective exchange rates (NEER) or real effective exchange rates (REER). Effective exchange rates, whether nominal or real, define the

home currency against a basket of foreign currencies and are usually used when trying to obtain an overall measure of a countries external competitiveness. NEER sums all of a countries bilateral exchange rates using trade weights. REER adjusts NEER by the appropriate composite foreign price level and deflates by the home price level. Ronald MacDonald (2007). In this study, the spot nominal exchange rate shall be studied as the dependent variable.

The exchange rate allows a country to trade with other economies that have different currencies. Ordinarily, exports are paid for in the currency of the importing country and then later converted to the currency of the exporting country so that it can pay for its expenses which are mostly in local currency. The exchange rate also allows comparison of asset prices between economies. Asset prices are usually recorded in the currency of their own economies thus with an exchange rate, currencies can be converted to one currency in order to allow for comparison.

In his study of the determinants of exchange rates in Bangladesh, Rahman and Hossain (2014), measures the exchange rates as a function of inflation, interest rate, GDP growth rate and current account balance. With coefficient values of 0.714 for inflation, 7.605 for the GDP growth rate, 1.240 for interest rates and 6.899 for the current account balance explaining 76% of the variation of the exchange rate in Bangladesh (R2 of 0.761). Abdurehman and Hacilar **(**2016) in his study of the relationship between exchange rate and inflation: an empirical study of turkey measured exchange rate as a function of the inflation differential between consumer price index (CPI) of Turkey and the UK. The study found no relationship between exchange rate and inflation. As the inflation differential could only explain 2.6% of the deviations in the exchange. The study concluded that PPP was not supported in turkey for the period under study.

1.1.3 Exchange Rates and its Determinants.

Okoli (2016), takes a monetarist's view in looking at inflation. He posits that a rise in money supply causes inflation. If the inflation persists, domestic goods and services become uncompetitive both within and without the economy as compared to the goods and services in other countries. This leads to an increase in imports and a fall in exports which influence the demand and supply of the currency whose economy is experiencing high inflation. A circle later emerges as the depreciation of the inflationary currency leads to an increase in exports and a decrease in imports which later leads to an appreciation of the currency. Brenner and Sokoler (2009) argues that inflation targeting should be practiced in an economy with a floating exchange rate regime if it intends to be able to conduct monetary policy on its economy.

According to the law of one price, identical goods and services should cost the same regardless of the currency that dominates the economy from which they are produced. The exchange rate therefore will always adjust to ensure that this parity is maintained.

Kyule (2016) used the interest theory in his attempts to explain the volatility of the Kenyan shilling against the US dollar. He found a negative correlation coefficient of -0.193.from Mutitu (2015)'s findings, the study concludes that there's little to no effect on foreign exchange rate and it can't be used alone to predict exchange rate fluctuations. This is due to a weak but positive relationship of 0.248 of between interest rate and foreign exchange rate.

The international fisher effect explains that the exchange rate changes equally in the opposite direction of the interest rate differential. The currency of the economy with a higher interest rate is expected to depreciate against the currency with a lower interest rate since higher interest rates are associated with higher inflation.

1.1.4 Exchange rates market in Kenya.

According to *Guidelines on foreign exchange* (2002), the regulatory environment for exchange rates in Kenya is liberal with the CBK taking a supervisory and regulatory role in enforcing compliance for the foreign exchange players in Kenya which include banks and foreign exchange bureaus. One of CBKs concern is the accurate and timely submission of statistical information of exchange rates in by the exchange rate dealers. The regulator sacrifices a fixed foreign exchange in order to allow free flow of capital albeit monitored daily and ability to conduct monetary policy. This is particularly important as fighting inflation as one of the core mandates for most Central banks around the world including the CBK. According to Brenner and Sokoler (2009), inflation targeting is credible under a floating exchange rate regime. One of the ways that central banks have fought inflation is through manipulation of the interest rates in order to influence money supply and ultimately inflation. Thus, as a country that persistently suffers high inflation, high interest rates and a depreciating currency it is important to understand what influences the exchange rate and to what extent.

1.2 Research Problem.

Various studies have found a positive correlation between inflation and interest rates. I.e. high inflation with depreciating currency. It is important for policy makers and businesses to understand the effect of inflation on exchange rates in order to allow for prediction thus leading to high quality decisions. Interest rates have also been found to vary positively with exchange rates. This is intuitive as economies with higher inflation also tend to have higher interest rates to combat inflation and inflation as we have seen varies positively with exchange rates.

High interest rates are associated with high inflation rates especially for countries that have an inflation targeting (IT) regime as monetary authorities attempt to control inflation by conducting monetary policy. Countries with credible IT regimes also run a floating exchange rate regime as it is impossible to have an inflation targeting regime with a fixed exchange rate regime or any other regime that does not give the monetary authority the flexibility to conduct monetary policy. Brenner and Sokoler (2009).

In the recent past, Kenya has experienced a rapid depreciation of KES with high levels of inflation and high interest rates. This has been a concern for the policy makers and the citizens as well. Most Kenyans are concerned with the rapidly decreasing purchasing power of their income since prices of the goods in and services in the country are rising faster than wages in the country. The central bank tries to combat the high levels of inflation which further exacerbates the issue as it becomes too high to access funds for investments and hence job creation due to high interest rates. It has been expected that the depreciation of the exchange rate could combat the effects of high inflation and interest rates but an uptick in the global prices of oil have also contributed to rising inflation as oil imports are increasingly expensive due to a depreciating currency.

Globally, scholarly articles have been published on factors that affect a given currency of interest. Some of the explanatory variables include Balance of payments, interest rates, inflation, elasticity of exports, elasticity of imports, value of imports, value of exports etc. There have been mixed results on the strength of some of the explanatory variables with variables such as interest rate differentials, which are expected to explain exchange rate variables by PPP found to have no effect at all on the exchange rate by some studies. A few studies have however focused on whether the respective currency of interest have respected the purchasing power parity theories and interest rate parity theories.

Locally, most scholars have attempted to explain other macroeconomic variables using the exchange rate as an explanatory variable, a few unpublished articles have attempted to explain the exchange rates with other macroeconomic variables with even fewer that have attempted to find out whether PPP and IFE are maintained by the KES/USD exchange rate. This study therefore seeks to answer the following questions; is PPP maintained by the KES/USD exchange rate in Kenya? Is IFE maintained by the KES/USD exchange rate in Kenya?

1.3 Research Objectives.

The study intends to establish the determinants of the KES/USD exchange rate in Kenya.

1.4 Value of the Study.

Businesses will gain a lot from this study as they will understand the determinants of the exchange rate and how the exchange rate affects their businesses. This will be especially useful for corporations and individuals that are in the export import business as an understanding of the variables affecting the exchange rate will assist them to navigate their international business.

Policymakers makers also gain from this study as an understanding of the determinants of the exchange rate will assist in formulation of policies that will be most beneficial for the citizens and businesses of Kenya since Kenya is an open economy that is import intensive it's more susceptible to the bad effects of exchange rate fluctuation.

Finally, this study will also be of benefit to other scholars who aim to add upon the current knowledge of factors that determine the exchange rate. An approval or disproval of the

determinants of exchange rate in this paper will help in the formulation of new theories that affect the exchange rate in Kenya.

CHAPTER 2: LITERATURE REVIEW.

2.1 Introduction.

This chapter is going to cover the theoretical review of the theories underpinning this study. The study will cover the determinants of the exchange rate followed by empirical studies around the determinants of exchange rates. We shall conclude the chapter with a summary of the literature review and the conceptual framework of the study.

2.2 Theoretical Review.

2.2.1 Relative Purchasing Power Parity.

The theory of purchasing power parity was developed in its current form by Gustav Cassel in 1916 in his paper: *The present situation of the foreign trade*. At the time, Gustav was attempting to answer the question on how to determine the appropriate level at which exchange rates were to be fixed during restoration of the system of fixed exchange rates after the First World War. His recommendation was to fix the exchange rate at the levels corresponding to PPP. Under purchasing power parity, identical goods and services should cost the same once converted to a different currency. Thus the exchange rate should reflect the level at which prices of goods and services in different countries with different currencies are equal.

According to Nilgün & Tiraşoğlu (2018), some of the criticisms of the purchasing power parity theory include; the impact of shocks on relative exchange rates and consumer price indexes, the existence of policies preventing foreign trade, the different product baskets that make up consumer price indices and the cost of transport. Freight costs and insurance are also some of the factors that are implied by Prowd (2020) that cause deviation from PPP.

The theory of relative purchasing power parity is relevant for this study as it will inform us whether the KES/USD exchange rates supports purchasing power parity in Kenya.

2.2.2 International Fisher Effect.

The international fisher effect theory was developed by Irving Fisher who was an American economist and lived in the period of 1867-1947. According to the theory, the exchange rate can be predicted by differences in nominal interest rates of countries with different currencies.

According to Alam, Alam and Shuvo (2011) restrictions that prevent capital from freely flowing across borders to directly match nominal interest rate differentials include political risk, currency risk, transaction costs, taxes and psychological barriers. International fisher effect does not usually hold in countries with currency restrictions and other regulation that restrict flow of capital.

The international fisher effect theory is relevant for this study as it shall inform us as to whether the theory is supported by the changes in the KES/USD exchange rate.

2.3 Determinants of the Exchange Rate.

2.3.1 Inflation.

The exchange rate is determined by the following factors. Interest rates, inflation, balance of payments, political risks GDP levels etc. it is expected that with high inflation, capital will move to a low inflationary economy from a high inflationary economy holding all other factors constant.

Chowdhury and Hossain (2014) in his study: determinants of exchange rate in Bangladesh, explains the exchange rate using inflation, interest rates, GDP growth rate and the current account balance as the independent variables.in his study, he finds a weak positive relationship between the exchange rate and inflation as evidenced by coefficients of 0.141.

2.3.2 Interest Rates.

Holding all other factors constant, capital should move to high interest rate economy to a low interest rate economy thus leading to an appreciation of the currency whose economy has high interest rates. Okoth(2013) in his study of the effect of interest rate and inflation rate on exchange rates in Kenya conducted a time series analysis from 2007-2012. Multiple linear regression was used to model the relationship between the explanatory variables and the dependent variable. An R^2 value of 0. 871 meant that the chosen variables specifically inflation rate and interest rates affected the exchange rate by 87.1%. According to the study, a one unit increase in the forex rates increases the CBK interest rates by 1.006 or 100.6% all other factors held constant. Since the study is silent on whether a unit root test was done, this casts doubt of the validity of the conclusions provided by the study.

2.3.3 Balance of Payments.

Balance of payment is a record of economic transactions between an economies with the rest of the world. A nation's exports influences demand of its currency while its imports influence supply of its currency. Thus, together, it's clear that economic transactions influence demand and supply of a currency and hence its value. Jattani (2013), in her paper relationship between exchange rates and selected macroeconomic variables in Kenya looked at balance of payments as one of the variables that influence the exchange rate. The balance of payments was regressed on exchange rate and it was found that a unit increase in Balance of Payment will lead to an 8.401* 10009 increase in the exchange rates.

2.3.4 Gross Domestic Product (GDP).

An increase in GDP should lead to an appreciation of the currency since an increase in GDP means the country is producing more and hence an appreciation of its currency is expected. Kyule (2016) in his paper factors affecting Kenya shillings volatility against the US dollar, he modeled GDP as an independent variable that influences the Kenya shilling volatility. "The study revealed a positive association coefficient between aggregate national yield and Kenya shillings flimsiness, (p-value.257 significance of .051)."

2.3.5 Foreign direct investment.

Kipyegon (2016) models exchange rate as a function of foreign direct investment (FDI). He finds that Holding all other factors constant, foreign exchange rate will increase by 3.679432 units when foreign direct investment inflows as a percentage of GDP increase by one unit. This is fairly intuitive as an increase in FDI increases demand for the local currency thus leading to an appreciation of the local currency.

2.4 Empirical Studies.

2.4.1 Global Studies.

Abdurehman and Hacilar (2016) in their study of the relationship between exchange rate and inflation in turkey attempted to explain the UK pound and Turkish Lira exchange rate using the inflation differential between the two countries. The data covered included the period of January 2005- December 2014. The dependent variable was the realized change in the exchange rate of the

Lira and Pound. They studied the stationary nature of the variables using unit root test (Augmented Dickey-Fuller test (ADF) in order to conduct the time series analysis. They found the inflation differential non-stationary at the level. Its first difference however was stationary. After regressing the exchange rate on the inflation rate, it was found that PPP was violated and not supported in Turkey. This was evidenced by the value of β1 which was hypothesized to be one, being far from one and the value of β0 which was hypothesized to be zero was close to zero. Both values were not significant. In addition, the R^2 of 2.6% implied that the inflation differential could only explain 2.6% of the deviations in the exchange. PPP theory underpins the study, however the study is silent on the levels of trade between the UK and Turkey and whether the kinds of goods and services used to calculate the inflation index in the two countries is the same thus leaving a question on whether the inflation indexes used to calculate the inflation differential was appropriate.

Chowdhury and Hossain (2014), in their paper determinants of exchange rate in Bangladesh did a time series analysis covering the period of 1990-2011 to find out the determinants of the exchange rate in Bangladesh. They used a single equation linear regression model to regress inflation, GDP growth rate, interest rates and current account balance on the exchange rate. The unit root test and cointergration test were not considered in the study. This was explained by the sample size not being large enough to conduct the tests. 76% of the variation in the exchange rate in Bangladesh was explained by the repressor variables as evidenced by the R^2 value of 0.761. The study found a positive relationship between the exchange rate and all explanatory variables though with a weak relationship for interest rates and inflation as evidenced by their coefficients of 0.133 and 0.141 respectively. Since the sample size used for the study was confirmed by the authors to be small, it is possible that the data and conclusions generated from the study may not be representative of the

population. Also, since the study was a time series analysis, unit root tests ought to have been done to confirm stationarity.

2.4.2 Local Studies.

Jattani (2013) in her paper the relationship between exchange rates and selected macroeconomic variables in Kenya. The study covered the 2003-2012 period. A multivariate regression model was applied to determine the relative strength of each of the variables with respect to exchange rate in Kenya. ANOVA was preferred in the study because it could be used to examine differences among the means of several different groups at once. With an R^2 of 0.510, the model confirms that the regressor variables explain 51% of the variation in the dependent variable. The study confirms that a unit increase in Inflation Rates will decrease the exchange rates by 1.598 and a unit increase in the interest rate will increase the exchange rate by 1.598. Since this was a time series analysis, unit root tests ought to have been done to confirm stationarity. Since the study is silent on whether the test was done, this casts doubt of the validity of the conclusions provided by the study.

Okoth (2013) in his study of the effect of interest and inflation rates on exchange rates in Kenya conducted a time series analysis from 2007-2012. He used multiple linear regression to model the relationship between the independent variables and the dependent variable. An R^2 value of 0. 871 meant that inflation and interest rates affected the exchange rate by 87.1%. According to the study, increase in the forex rates by a unit increases the central bank rates by 1.006 or 100.6% all other factors held constant while a one unit increase in the forex rates decreases inflation by 0.342 or 34.2% all other factors held constant. Since the study is silent on whether the test was done, this casts doubt of the validity of the conclusions provided by the study.

2.5 Summary of the Literature Review.

Mixed results exists form the literature reviewed on the extent to which inflation and interest rates affect the exchange rate with some studies showing a strong positive relationship to some showing a weak positive relationship to those studies that show no relationship at all. One of the possible explanation to this diversity in views could be the different periods that were studied in each country and other macroeconomic variables that might have also affected the exchange rate in each of those countries. Thus, from literature reviewed, inflation and interest rates may not be the main determinants and definitely not the only determinants of the nominal exchange rate in a country. This study therefore aims to fill the gap in understanding whether inflation and interest rates are the main determinants of the exchange rate in Kenya as there currently exists few studies in the area.

2.6 Conceptual Framework.

According to Okoli (2016), He posits that a rise in money supply causes inflation. If the inflation persists, domestic goods and services become uncompetitive both within and without the economy as compared to the goods and services in other countries. This leads to an increase in imports and a fall in exports which influence the demand and supply of the currency whose economy is experiencing high inflation. A circle later emerges as the depreciation of the inflationary currency leads to an increase in exports and a decrease in imports which later leads to an appreciation of the currency.

The international fisher effect explains that the exchange rate changes equally in the opposite direction of the interest rate differential. The currency of the economy with a higher interest rate is expected to depreciate against the currency with a lower interest rate since higher interest rates reflect an expectation of inflation.

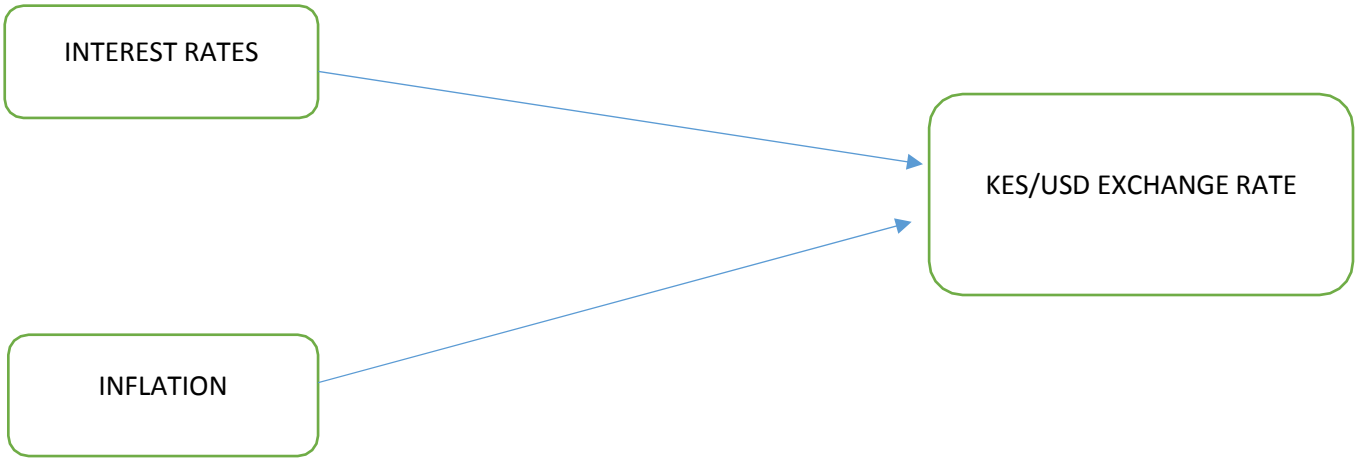

Figure 1: conceptual model of exchange rate for the exchange rate against interest rate differential and inflation differential.

CHAPTER THREE: RESEARCH METHODOLOGY.

3.1 Introduction.

In this chapter, we shall cover the research design and why it's appropriate for our study. We shall then define the population of our study we shall use for the study. We shall follow this by describing the sample obtained from the population and a description of the sampling technique to be used. Data collection shall follow next and data analysis shall conclude the study.

3.2 Research Design.

This study will take a descriptive research design stance to describe the factors determining the KES/USD exchange rate. Descriptive research design refers to "…studies concerned with specific predictions, with narration of facts and characteristics concerning an individual, group or situation…" Kothari & Garg (2014). Descriptive research design is appropriate for this study as the overall design is rigid. This allows for enough provision for protection against bias and maximizes for reliability. The statistical design, in descriptive research design, is also preplanned for analysis as compared to other kinds of research design. Also, the instruments for data collection are structured and well thought out in a descriptive research design.

3.3 Population.

According to the Kenya institute of public policy research and analysis (KIPPRA). Kenya adopted a free floating exchange rate regime in October of 1993. This study looks at the determinants of the KES/USD exchange rate in Kenya under a freely floating exchange rate regime. It then follows

that our population of study shall be 358 mean monthly data for the exchange rate, interest rates and inflation.

3.4 Sample.

The sample size for this study shall be 168 mean monthly data for all the variables. According to Kothari & Garg (2014), an optimum sample is one which fulfils the requirements of efficiency, representativeness, reliability and flexibility and that "…no irrelevant information should be collected and no essential information should be discarded…" this study uses a sample size of 64 because the central bank of Kenya started publishing the central bank rates on august of 2008. Therefore by using data since October 2008, this sample achieves the attributes of representativeness and reliability since the effect of non-response on the results is eliminated. This study adopted non-probability sampling, the reason for this was to reduce distorted results that may be introduced due to non-response of interest rate data before August of 2008.

3.5 Data Collection.

This study shall collect quantitative data for the nominal exchange rate, inflation differential and interest differential. For each of the variables, the mean monthly data shall be collected for the period of 2008-2021.quantitative data for the exchange rate shall be collected from the central bank of Kenya data base. The FED and CBK have been chosen as the appropriate source for data on interest rates as they are the monetary authority responsible for interest rate in their respective countries. Data to be used for the calculation of the inflation differential shall be collected from the Kenya National Bureau of statistics and OECD for the Kenyan and U.S inflation data respectively. All the data shall be extracted from the database of the relevant institutions that collect the data.

3.6 Data Analysis.

$y = \beta_0 + \beta_1 \chi_1 +$

$\beta_2 \chi_2 + \mu_i$ Where;

y- Exchange rate

β_o - intercept

β_1 - inflation differential coefficientχ_1 - inflation differential

β_2 - interest rate differential coefficientχ_2 - interest rate differential

μ_i - error term

The interest rate differential shall be calculated from the central bank rate (Kenya) and the federal funds rate (US). The inflation differential shall also be collected from the inflation rates of Kenya and USA. The inflation differential and interest rate differential shall then be regressed against the KES/USD nominal exchange rate. The regression results shall inform the study on the extent to which the inflation differential affects the KES/USD exchange rate and the extent to which the interest rate differential affects the KES/USD exchange rate. The inflation differential and interest rate differential shall be calculated as below;

Relative purchasing power parity equation

$\mathbf{(i_1 - i_2) / (1 + i_2)}$ where; $\mathbf{i_1}$ - inflation in Kenya, $\mathbf{i_2}$ - inflation in USA,

International Fisher effect equation

$(i_1 - i_2) / (1 + i_2)$ where; i_1 - interest rates in Kenya, i_2 - interest rates in USA,

Diagnostic Tests

Diagnostic tests in the study shall include stationarity, cointergration tests, multicollinearity autocorrelation, heteroscedasticity and normality.

Stationarity

"... a time series is stationary if its mean and variance do not vary over time…" (Gujarat 2004) if data is non-stationary, its estimate will vary over time leading to spurious estimates. If the data fails the stationarity test, Bias due to non-stationarity shall be eliminated by differentiation of the data until stationarity is achieved.

Cointergration

Cointegration is a statistical property of a collection of time series variables. The data shall be tested for cointergration using the Johansen test if all variables are stationary at level but shall apply the ARDL bounds test if the data are stationery at different difference levels.

Autocorrelation

Autocorrelation refers to an incidence where the error term is related to its preceding value. Autocorrelation occurs mostly in time series data. This study therefore uses Breusch-Godfrey test to check whether data experience serial

Heteroscedastisity

Heteroscedasticity refers to where the error term variance varies with the number of observations. The study shall test for heteroscedasticity using Breusch-Pagan-Godfrey test.

Multicollinearity

Multicollinearity refers to the existence of more than one linear relationship Gujarat (2004). It is measured by the variance inflationary factor (VIF). A VIF greater than 5 indicates the existence of multicollinearity. The test shall be done to find out if there's a linear relationship among the independent variables which may distort the results. If the data fails the multicollinearity test, the forward inclusion method of variable elimination shall be used.

Normality

As an assumption of the classical linear regression model, the error term has to be normally distributed with a mean of zero and constant variance. All other variables that affect the dependent variable are captured by the error term though this variables are assumed to be random and have an insignificant impact. For OLS to be applied, the error term must be normal (Gujarat, 2004).

Significance Tests.

Results are said to be measurably significant inside the 0.05 level, thus implying that the noteworthiness esteem must be less than 0.05. Kothari, (2004). The Pearson Product Moment Correlation Coefficient shall be used to test the magnitude and direction of the relationship between the independent and dependent variables at 95% confidence level. The model significance shall be tested at confidence of 95%, using t-tests, F-tests, z-tests, and the chi-square.

CHAPTER 4: DATA ANALYSIS, RESULTS AND DISCUSSION.

4.1 Introduction.

This chapter presents the research findings on the determinants of the Kenya shilling- United States exchange rate. The study was conducted on 14 year period where secondary data for the period of August 2008 to July 2022 was used in the analysis.

4.2 Descriptive Statistics.

Descriptive Statistics is the investigation of information summarizes statistical information information definitively. It demonstrates the mean and middle of the diverse factors of enthusiasm for the study…" Kyule (2016). This study seeks to investigate the descriptive statistics of exchange rate, inflation, Interest rates.

Variable	Obs	Mean	Std. Dev.	Min	Max
EXCHANGERATE	168	94.63101	11.71116	67.68	118.32
INFDIFFERE~L	168	1.673174	9.608864	-61.15577	66.34716
INTDIFFERE~L	168	6.504456	3.134901	1.923977	16.75701

Table 1: descriptive statistics for exchange rates, interest rate differential and inflation differential

The above study shows a mean exchange rate of KES 94.63 with a standard deviation of 11.71 and a maximum exchange rate of 118.32 and a minimum exchange rate of 67.68 over a 14 year period. The standard deviation of 9.6 for the inflation differential and 3.1 for the interest differential is expected since developing countries' economy typically have more volatile interest rates.

4.3 Correlation Statistics.

	EXCHAN~E	INFDIF~L	INTDIF~L
EXCHANGERATE	1.0000		
INFDIFFERE~L	0.0378	1.0000	
INTDIFFERE~L	-0.2830	0.1034	1.0000

Table 2: correlation statistics table for exchange rate, interest rate differential and inflation differential.

Inflation differential has a positive but weak correlation with exchange rate with a correlation of 0.0378. Interest differential however has a stronger but negative correlation of -0.2830 with exchange rates. A correlation of 0.10234 is positive but a bit weaker for the correlation between inflation differential and interest differentials. This is expected as economies with higher inflation levels also run higher interest rates to combat inflation.

4.4 Diagnostic Tests.

The study conducted a multiple regression analysis to test the influence among the variables by using STATA.

4.4.1 STATIONARITY

Unit root test was conducted for each of the variables to find out whether the data was stationery as is customary for time series data. The augmented dickey-fuller test was used to check for stationarity.

Augmented Dickey-Fuller test for unit root Number of obs = 168

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	1.520	-2.591	-1.950	-1.614

Augmented Dickey-Fuller test for unit root Number of obs = 168

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-8.015	-2.591	-1.950	-1.614

Augmented Dickey-Fuller test for unit root Number of obs = 168

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-1.161	-2.591	-1.950	-1.614

Table 3: ADF tests for exchange rates, inflation differential and interest rate differential respectively.

As can be seen from the above STATA output of the augmented dickey-fuller test, the absolute value of the test statistic is less than the 5% critical value for both the exchange rate and interest rate differential. The value was however higher for the inflation differential. The output was crosschecked by including the trend term in regression to get the following results.

```
Augmented Dickey-Fuller test for unit root         Number of obs   =       168

                                 ---------- Interpolated Dickey-Fuller ---------
                    Test         1% Critical       5% Critical      10% Critical
                Statistic           Value             Value             Value
------------------------------------------------------------------------------------------------------------
 Z(t)             -3.625            -4.018            -3.441            -3.141
------------------------------------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0278


Augmented Dickey-Fuller test for unit root         Number of obs   =       168

                                 ---------- Interpolated Dickey-Fuller ---------
                    Test         1% Critical       5% Critical      10% Critical
                Statistic           Value             Value             Value
------------------------------------------------------------------------------------------------------------
 Z(t)             -8.239            -4.018            -3.441            -3.141
------------------------------------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

Augmented Dickey-Fuller test for unit root Number of obs = 168

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-3.177	-4.018	-3.441	-3.141

MacKinnon approximate p-value for Z(t) = 0.0891

Table 4: a crosscheck of ADF crosschecked by including the trend term in the regression.

It was thus revealed that the inflation differential was stationery at that level as the absolute values of its test statistic was higher than the absolute values at the 5% critical value. The study therefore went ahead to find the first difference of the exchange rate and interest rate differential variable.

After getting the first difference of the exchange rate and interest rate differential and conducting an augmented Dickey-fuller test, the results below were obtained.

Dickey-Fuller test for unit root Number of obs = 168

		---------- Interpolated Dickey-Fuller ---------		
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-8.579	-2.591	-1.950	-1.614

Dickey-Fuller test for unit root Number of obs = 168

		---------- Interpolated Dickey-Fuller ---------		
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-7.386	-2.591	-1.950	-1.614

Table 5: ADF tests for the 1st difference of exchange rates and interest rates differential.

The test statistic of -8.579 and -7.386 was greater than the 5% critical value of -1.950 and -7.386 for the exchange rate and interest rate thus suggesting that the data is stationery.

Optimum Lag Selection

According to the STATA output below, lag 1 was selected as the optimum lag.

```
varsoc xrate INFDIFFERENTIAL intdiff

   Selection-order criteria
   Sample:  3441m9 - 3455m3                        Number of obs      =       168
  +---------------------------------------------------------------------------------------------------+
  |lag |    LL      LR      df    p      FPE       AIC      HQIC      SBIC     |
  |----+----------------------------------------------------------------------------------------------|
  |  0 |  -1058.8                       91.3452   13.0283   13.0514   13.0852  |
  |  1 | -1001.96  113.68    9  0.000  50.7892*  12.4413*  12.5338*   12.669* |
  |  2 | -996.956  10.018    9  0.349   53.345   12.4903   12.6521   12.8888  |
  |  3 | -987.811  18.289*   9  0.032  53.2668   12.4885   12.7197   13.0579  |
  |  4 | -981.791   12.04    9  0.211  55.2813    12.525   12.8256   13.2653  |
  +---------------------------------------------------------------------------------------------------+
   Endogenous:  xrate INFDIFFERENTIAL intdiff
    Exogenous:  _cons
```

Table 6: optimum lag selection.

4.4.2 Cointergration Tests

Cointergration tests are conducted to find out if there's a long run relationship among the variables. Since the interest rate differential was stationery at 1st difference, then we shall use the bound test from ARDL to conduct the cointergration test.

The below output from STATA for the ARDL bounds test suggests that there's cointergration among the variables as the F statistics value is greater than the [IO] series which is evidence of a long run relationship among the variables.

```
Pesaran/Shin/Smith (2001) ARDL Bounds Test

H0: no levels relationship              F =  36.337

                                        t = -8.857


Critical Values (0.1-0.01), F-statistic, Case 3
```

```
      | [I_0]   [I_1]  | [I_0]   [I_1]  | [I_0]   [I_1]  | [I_0]   [I_1]
      |    L_1     L_1 |   L_05    L_05 |  L_025   L_025 |   L_01    L_01
------+----------------+----------------+----------------+----------------
  k_2 |   3.17    4.14 |   3.79    4.85 |   4.41    5.52 |   5.15    6.36
accept if F < critical value for I(0) regressors
reject if F > critical value for I(1) regressors

Critical Values (0.1-0.01), t-statistic, Case 3

      | [I_0]   [I_1]  | [I_0]   [I_1]  | [I_0]   [I_1]  | [I_0]   [I_1]
      |    L_1     L_1 |   L_05    L_05 |  L_025   L_025 |   L_01    L_01
------+----------------+----------------+----------------+----------------
  k_2 |  -2.57   -3.21 |  -2.86   -3.53 |  -3.13   -3.80 |  -3.43   -4.10
accept if t > critical value for I(0) regressors
reject if t < critical value for I(1) regressors

k: # of non-deterministic regressors in long-run relationship
Critical values from Pesaran/Shin/Smith (2001)
```

Table 7:ARDL bounds test

The results for the error correction for cointergration are as below. We see that in the long run relationship, interest rate differential is significant at 5% while inflation differential is not.

```
ARDL(1,0,1) regression


Sample:  3441m6 -  3455m3                       Number of obs     =        168
                                                R-squared         =     0.4056
                                                Adj R-squared     =     0.3909
Log likelihood =  -272.2323                     Root MSE          =     1.2666
```

D.xrate	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
ADJ						
xrate						
L1.	-.6595933	.0744673	-8.86	0.000	-.8066519	-.5125347
LR						
INFDIFFERENTIAL	.0142446	.0155082	0.92	0.360	-.0163811	.0448703
intdiff						
--.	-.8935558	.2754801	-3.24	0.001	-1.437576	-.3495355
SR						
intdiff						
D1.	.6253629	.1588533	3.94	0.000	.3116582	.9390676
_cons	.1670991	.1018259	1.64	0.103	-.0339876	.3681857

Table 8: ARDL bounds test error correction.

4.4.3 Autocorellation

According to the Durbin Watson test, a test statistic of 2.015074 indicates no autocorrelation.

4.4.4 Heteroscedasticity

According to the STATA output table below, a significant P value of zero indicates existence of heteroscedasticity problem. This was corrected using the robust command to get the output below.

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(14)     =    123.39
         Prob > chi2  =    0.0000

Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------------------------
              Source |       chi2     df       p
---------------------------+-----------------------------------------
  Heteroskedasticity |     123.39     14    0.0000
            Skewness |      39.23      4    0.0000
            Kurtosis |       1.76      1    0.1844
---------------------------+-----------------------------------------
               Total |     164.38     19    0.0000
```

Table 9: heteroscedasticity test.

The heteroskedastic problem was corrected using the legend command for the results below.

```
Linear regression                               Number of obs     =        168
                                                F(2, 164)         =       1.00
                                                Prob > F          =     0.3683
                                                R-squared         =     0.0088
                                                Root MSE          =     1.4523
------------------------------------------------------------------------------
             |               Robust
       xrate |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
INFDIFFERENTIAL |    .013848   .0098483     1.41   0.162    -.0055979    .0332939
        intdiff |   -.049889   .5109876    -0.10   0.922    -1.058852    .9590736
          _cons |   .2799616   .1143612     2.45   0.015     .0541514    .5057718
------------------------------------------------------------------------------
```

Table 10: heteroscedasticiy correction.

4.4.5 Multicollenearity

According to the VIF table below there does not seem to be a multicollinearity problem as the VIF value is less than 10.

```
    Variable |       VIF       1/VIF
-------------+----------------------
INFDIFFERE~L |      1.00    0.996185
     intdiff |      1.00    0.996185
-------------+----------------------
    Mean VIF |      1.00
```

Table 11: multicollinearity test.

4.4.6 Nomarlity

The skewness and kurtosis test and Shapiro-Wilk test were conducted to test for the normality of the error term. all tests found **no existence** of normality in the error term as all test values were below 0.05 as seen on the below STATA output.

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
eror	168	0.0000	0.0000	43.56	0.0000

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
eror	168	0.82432	22.417	7.090	0.00000

Table 12: normality tests.

4.5 Regression Analysis.

After correction the error term to normality using the robust command, the following output was obtained for the regression analysis. The null hypothesis of the F test is that R2= 0 suggesting that the model has no explanatory variable while the alternative hypothesis is that R2 ≠0 suggesting that our model has explanatory power. With a P value of the F test of 0.3683, the model is not significant at the 10%, 5% or 1% significance levels. The R^2 value, also known as the coefficient of determination, take a value between 0 and 1. With an R^2 value of 0.0088, our model explains only about 0.8% of the exchange rate by the interest rate differential and inflation differential. The p tests for the independent variables are all statistically insignificant. The p test is significant at the 5% significance level with a p value of the t test of 0.015 for

the constant. Coefficient of 0.013848 and -0.0498889 for inflation differential and interest rate differential both suggest that exchange rates vary positively with inflation differential and negatively with interest rate differential.

```
Linear regression                               Number of obs     =        168
                                                F(2, 164)         =       1.00
                                                Prob > F          =     0.3683
                                                R-squared         =     0.0088
                                                Root MSE          =     1.4523

------------------------------------------------------------------------------
             |               Robust
       xrate |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
INFDIFFEREN~L |    .013848   .0098483     1.41   0.162    -.0055979    .0332939
      intdiff |  -.0498889   .5109875    -0.10   0.922    -1.058851    .9590736
        _cons |   .2799616   .1143612     2.45   0.015     .0541514    .5057718
------------------------------------------------------------------------------
```

Table 13: regression analysis output using Robust command.

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATION.

5.1. Introduction.

This chapter puts forth the summary of findings, conclusion and recommendations further areas for research are outlined as well as the limitations of the study. This section presents a summary of the results of the effects of Interest rate differential and inflation differential on exchange rates. Based on the previous chapter, this study finds out whether purchasing power parity and the international fisher effect are maintained in Kenya.as a consequence, the generated results are applied by businesses, scholars and policy makers.

5.2. Summary of Findings

The study did not have any multi-collinearity of autocorrelation problem with a VIF factor of 1 and autocorrelation test statistic of 2.015074.

Inflation differential has a positive but weak correlation with exchange rate with a correlation of 0.0378. Interest differential however has a stronger but negative correlation of -0.2830 with exchange rates. A correlation of 0.10234 is positive but a bit weaker for the correlation between inflation differential and interest differentials. This is expected as economies with higher inflation levels also run higher interest rates to combat inflation.

From the STATA output of the augmented dickey-fuller test, the absolute value of the test statistic is less than the 5% critical value for both the exchange rate and interest rate differential. The value was however higher for the inflation differential. The output was crosschecked by including the trend term in regression. It was thus revealed that only the inflation differential was stationery at that level as the absolute values of its test statistic was higher than the absolute values at the 5%

critical value. The study therefore went ahead to find the first difference of the exchange rate and interest rate differential variable.

Output from STATA for the ARDL bounds test suggests that there's cointergration among the variables as the F statistics value is greater than the [IO] series which is evidence of a long run relationship among the variables. The study finds that in the long run relationship, interest rate differential is significant at 5% while inflation differential is not.

After correction the error term to normality using the robust command, the following output was obtained for the regression analysis. The null hypothesis of the F test is that R2= 0 suggesting that the model has no explanatory variable while the alternative hypothesis is that R2 ≠0 suggesting that our model has explanatory power. With a P value of the F test of 0.3683, the model is not significant at the 10%, 5% or 1% significance levels. The R^2 value, also known as the coefficient of determination, take a value between 0 and 1. With an R^2 value of 0.0088, our model explains only about 0.8% of the exchange rate by the interest rate differential and inflation differential. The p tests for the independent variables are all statistically insignificant. The p test is significant at the 5% significance level with a p value of the t test of 0.015 for the constant. Coefficient of 0.013848 and -0.0498889 for inflation differential and interest rate differential both suggest that exchange rates vary positively with inflation differential and negatively with interest rate differential.

5.2. Conclusion.

The model shows that both PPP and IFE have been violated in the KES/USD exchange rate. As a result arbitrage cannot be practiced in such environment as the exchange rate does not show signs of reverting back to the parity established by PPP and IFE. Thus exchange rates cannot be accurately predicted using interest differential and inflation differential.

5.4 Recommendations

Since the model had no explanatory power and did not reveal whether there's a linear relationship between exchange rates and interest rate differential and inflation differential it was concluded that both IFE and PPP were violated in Kenya for the KES-USD exchange rate. It was therefore recommended for businesses that any investment that requires exchange of the Kenya shilling for the US dollar and vice versa should not use PPP and IFE as an assumption in their calculations as they have been violated and are not supported in Kenya.

Attempts should be made to return the KES exchange rate against the USD to the PPP and IFE parity in order to increase certainty of costs when conducting business that may require change of currencies from KES to USD.

5.5. Suggestions for Further Studies.

Due to insufficient explanation of the exchange rate by the interest rate differential and inflation differential, further studies are recommended for determinants of the KES-USD exchange rate in Kenya. Balance of payment and debt levels should be included as some of the independent variables explaining the exchange rate in Kenya.

A study should be done to find out the reasons as to why the international fisher effect and purchasing power parity are not maintained in Kenya. This will inform whether corrective actions should be taken by the relevant parties to find out how the parities can be maintained.

Since the study did not have a multi-collinearity problem between interest rate differential and inflation differential, this raises questions as to whether the transmission mechanism of the CBK

policies works properly. Economies with higher inflation levels are also expected to have higher interest rate levels since the central bank of the respective economy attempts to combat inflation by raising interest rates. As a result, it is expected that there has to be a multi-collinearity problem with the independent variables. A study should therefore be conducted to find the sensitivity of interest the economy to open market operations by the central bank.

5.6. Limitations of the Study

Different basket of goods and services included in the inflation figures. The basket of goods and services used to construct the inflation differential using both the Kenya and USA inflation data are constructed using different baskets of goods and services. The time required to standardize the inflation data for Kenya and USA to contain homogeneous basket of goods and services was limited. Time also limited the study of other independent variables that affect the exchange rate as only interest rate differentials and inflation differentials were analyzed and were found to affect the exchange rate insignificantly.

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Appendices.

APPENDIX 1: EXCHANGE RATE, INFLATION DIFFERENTIAL, INTEREST RATE DIFFERENTIAL, 1ST DIFFERENCE FOR EXCHANGE RATE, 1ST DIFFERENCE FOR INTEREST RATE DIFFERENTIAL AND NORMAL ERROR DATA.

DATE	EXCHANGE RATE	INF. DIFFERENTIAL	INT. DIFFERENTIAL	xrate	intdiff	eror
8/31/2008	67.68	1.027666982	2.333333333			
9/30/2008	71.41	1.361491054	2.558718861	3.73	0.225386	3.442429
10/31/2008	76.66	2.250138663	4.076142132	5.25	1.517423	5.014581
11/30/2008	78.18	6.851853641	6.194244604	1.52	2.118103	1.250824
12/31/2008	78.04	14.82352563	7.189655172	-0.14	0.995411	-0.57558
1/31/2009	78.95	16.0510848	7.260869565	0.91	0.071214	0.411316
2/28/2009	79.53	13.45569378	6.786885246	0.58	-0.47398	0.090057
3/31/2009	80.26	28.31329669	6.838983051	0.73	0.052098	0.060555
4/30/2009	79.63	66.34715673	7.043478261	-0.63	0.204495	-1.81854
5/31/2009	77.86	-61.15577254	6.627118644	-1.77	-0.41636	-1.22385
6/30/2009	77.85	-38.74813954	6.438016529	-0.01	-0.1891	0.237189
7/31/2009	76.75	-14.99065406	6.543103448	-1.1	0.105087	-1.16713
8/31/2009	76.37	-30.77192066	6.543103448	-0.38	0	-0.23383
9/30/2009	75.61	-47.85436364	6.608695652	-0.76	0.065592	-0.374
10/31/2009	75.24	14.19913622	6.8125	-0.37	0.203804	-0.83642
11/30/2009	74.74	2.960122552	6.142857143	-0.5	-0.66964	-0.85436
12/31/2009	75.43	1.751703624	6.142857143	0.69	0	0.385781
1/31/2010	75.79	1.658790322	6.207207207	0.36	0.06435	0.060278
2/28/2010	76.73	1.825027709	6.079646018	0.94	-0.12756	0.628402
3/31/2010	76.95	1.423083689	5.681034483	0.22	-0.39861	-0.09955
4/30/2010	77.25	1.261739494	5.458333333	0.3	-0.2227	-0.00854
5/31/2010	78.54	1.267471614	5.458333333	1.29	0	0.992487
6/30/2010	81.02	2.131469614	5.56779661	2.48	0.109463	2.175983
7/31/2010	81.43	1.697753617	4.93220339	0.41	-0.63559	0.074819
8/31/2010	80.44	1.648846309	4.882352941	-0.99	-0.04985	-1.29528
9/30/2010	80.91	1.519029166	4.882352941	0.47	0	0.169003
10/31/2010	80.71	1.357070382	4.882352941	-0.2	0	-0.49875
11/30/2010	80.46	1.342334524	4.882352941	-0.25	0	-0.54855
12/31/2010	80.57	0.987400044	4.93220339	0.11	0.04985	-0.18115
1/31/2011	81.03	0.873209195	4.769230769	0.46	-0.16297	0.159816
2/28/2011	81.47	0.625056113	4.818965517	0.44	0.049735	0.153864
3/31/2011	84.21	0.491198263	5.140350877	2.74	0.321385	2.46927

4/30/2011	83.89	0.489084888	5.363636364	-0.32	0.223286	-0.59559
5/31/2011	85.43	0.523427291	5.651376147	1.54	0.28774	1.267145
6/30/2011	89.05	0.728514434	5.651376147	3.62	0	3.32995
7/31/2011	89.9	0.918458596	5.775700935	0.85	0.124325	0.563522
8/31/2011	92.79	1.095905272	5.590909091	2.89	-0.18479	2.585643
9/30/2011	96.36	1.296462646	6.407407407	3.57	0.816498	3.312819
10/31/2011	101.27	1.760099001	10.21495327	4.91	3.807546	4.795619
11/30/2011	93.68	2.14492745	15.2037037	-7.59	4.98875	-7.65078
12/31/2011	86.66	2.790613764	16.75700935	-7.02	1.553306	-7.26111
1/31/2012	86.34	3.10168406	16.59259259	-0.32	-0.16442	-0.65112
2/29/2012	83.18	3.373435037	16.27272727	-3.16	-0.31987	-3.50264
3/31/2012	82.9	3.778991499	15.81415929	-0.28	-0.45857	-0.63517
4/30/2012	83.19	4.298630834	15.66666667	0.29	-0.14749	-0.05685
5/31/2012	84.38	5.434306837	15.37931034	1.19	-0.28736	0.820448
6/30/2012	84.79	5.370134467	15.37931034	0.41	0	0.055673
7/31/2012	84.14	5.755379287	14.0862069	-0.65	-1.2931	-1.07417
8/31/2012	84.08	4.693849194	14.48672566	-0.06	0.400519	-0.38498
9/30/2012	84.61	3.777215923	11.28070175	0.53	-3.20602	0.037786
10/31/2012	85.11	3.123523564	11.06896552	0.5	-0.21174	0.166221
11/30/2012	85.63	3.221937142	9.344827586	0.52	-1.72414	0.109406
12/31/2012	85.99	2.786908679	9.344827586	0.36	0	0.041445
1/31/2013	86.9	2.54546383	8.210526316	0.91	-1.1343	0.5382
2/28/2013	87.45	1.767028306	8.130434783	0.55	-0.08009	0.241573
3/31/2013	85.82	1.962937811	8.210526316	-1.63	0.080092	-1.93315
4/30/2013	84.19	2.203939731	8.130434783	-1.63	-0.08009	-1.94448
5/31/2013	84.15	1.523322742	7.558558559	-0.04	-0.57188	-0.36959
6/30/2013	85.49	1.018575982	7.71559633	1.34	0.157038	1.053768
7/31/2013	86.86	0.837414488	7.71559633	1.37	0	1.078442
8/31/2013	87.49	1.183954053	7.796296296	0.63	0.0807	0.337669
9/30/2013	87.41	1.631669279	7.796296296	-0.08	0	-0.38256
10/31/2013	85.31	2.081055648	7.71559633	-2.1	-0.0807	-2.41281
11/30/2013	86.1	1.85641231	7.796296296	0.79	0.0807	0.488357
12/31/2013	86.31	1.686134748	7.71559633	0.21	-0.0807	-0.09734
1/31/2014	86.21	1.718163654	7.878504673	-0.1	0.162908	-0.39563
2/28/2014	86.28	2.390788624	7.878504673	0.07	0	-0.24307
3/31/2014	86.49	1.941641261	7.796296296	0.21	-0.08221	-0.10095
4/30/2014	86.72	1.567004577	7.71559633	0.23	-0.0807	-0.07569
5/31/2014	87.41	1.510304239	7.71559633	0.69	0	0.389124
6/30/2014	87.61	1.620151865	7.636363636	0.2	-0.07923	-0.10635
7/31/2014	87.77	1.736998505	7.71559633	0.16	0.079233	-0.14006
8/31/2014	88.11	2.085629744	7.71559633	0.34	0	0.031157

9/30/2014	88.84	2.08135801	7.71559633	0.73	0	0.421216
10/31/2014	89.23	2.032645984	7.71559633	0.39	0	0.08189
11/30/2014	89.96	2.431861193	7.71559633	0.73	0	0.416362
12/31/2014	90.44	3.486211248	7.482142857	0.48	-0.23345	0.140115
1/31/2015	91.36	7.499407809	7.558558559	0.92	0.076416	0.539999
2/28/2015	91.49	6.826682978	7.558558559	0.13	0	-0.2445
3/31/2015	91.73	7.236515504	7.558558559	0.24	0	-0.14017
4/30/2015	93.44	8.606704755	7.482142857	1.71	-0.07642	1.30704
5/31/2015	96.39	6.968191812	7.482142857	2.95	0	2.573543
6/30/2015	97.71	5.789638318	8.734513274	1.32	1.25237	1.022343
7/31/2015	101.2	5.446814889	10.0619469	3.49	1.327434	3.200835
8/31/2015	102.43	5.141851842	9.964912281	1.23	-0.09703	0.873993
9/30/2015	105.28	6.563258644	9.964912281	2.85	0	2.47915
10/31/2015	102.78	5.244797426	10.16071429	-2.5	0.195802	-2.84282
11/30/2015	102.17	3.940745677	10.16071429	-0.61	0	-0.94453
12/31/2015	102.2	3.382719411	9.080645161	0.03	-1.08007	-0.35069
1/31/2016	102.31	2.274216242	8.328358209	0.11	-0.75229	-0.23899
2/29/2016	101.93	2.900287442	8.057971014	-0.38	-0.27039	-0.71361
3/31/2016	101.49	3.25362808	8.191176471	-0.44	0.133206	-0.75837
4/30/2016	101.23	2.632753128	8.124087591	-0.26	-0.06709	-0.57977
5/31/2016	100.73	2.75868546	7.394160584	-0.5	-0.72993	-0.85458
6/30/2016	101.15	2.734992752	7.333333333	0.42	-0.06083	0.09913
7/31/2016	101.33	3.071940238	7.273381295	0.18	-0.05995	-0.14549
8/31/2016	101.41	2.621159789	7.214285714	0.08	-0.0591	-0.23921
9/30/2016	101.27	2.044098022	6.857142857	-0.14	-0.35714	-0.46609
10/31/2016	101.32	1.837645695	6.857142857	0.05	0	-0.25541
11/30/2016	101.75	1.759479257	6.80141844	0.43	-0.05572	0.122893
12/31/2016	102.13	1.374275602	6.142857143	0.38	-0.65856	0.048153
1/31/2017	103.75	1.074260823	5.666666667	1.62	-0.47619	1.301405
2/28/2017	103.64	0.987716288	5.626506024	-0.11	-0.04016	-0.40564
3/31/2017	102.85	1.295442364	5.145251397	-0.79	-0.48125	-1.11191
4/30/2017	103.33	1.562748266	4.789473684	0.48	-0.35578	0.160648
5/31/2017	103.26	2.074913092	4.759162304	-0.07	-0.03031	-0.38021
6/30/2017	103.49	2.466884983	4.392156863	0.23	-0.36701	-0.10243
7/31/2017	103.88	2.376126934	4.11627907	0.39	-0.27588	0.063371
8/31/2017	103.56	2.184784894	4.092592593	-0.32	-0.02369	-0.6314
9/30/2017	103.12	1.907548615	4.11627907	-0.44	0.023687	-0.7452
10/31/2017	103.39	2.067939571	4.11627907	0.27	0	-0.0386
11/30/2017	103.57	1.85706881	4.092592593	0.18	-0.02369	-0.12686
12/31/2017	103.1	1.88831237	3.782608696	-0.47	-0.30998	-0.79158
1/31/2018	102.92	1.862718482	3.564315353	-0.18	-0.21829	-0.49665

2/28/2018	101.4	1.615359947	3.545454545	-1.52	-0.01886	-1.82327
3/31/2018	101.18	1.348416277	3.183266932	-0.22	-0.36219	-0.5367
4/30/2018	100.61	1.09082739	2.903345725	-0.57	-0.27992	-0.87903
5/31/2018	100.66	0.739010558	2.888888889	0.05	-0.01446	-0.24092
6/30/2018	101	0.601426613	2.723404255	0.34	-0.16548	0.043454
7/31/2018	100.67	0.506514091	2.436426117	-0.33	-0.28698	-0.63129
8/31/2018	100.61	0.521958921	2.436426117	-0.06	0	-0.34719
9/30/2018	100.83	0.687533491	2.389830508	0.22	-0.0466	-0.07181
10/31/2018	101.08	0.569921106	2.134796238	0.25	-0.25503	-0.05058
11/30/2018	102.36	0.759742568	2.125	1.28	-0.0098	0.989029
12/31/2018	102.29	0.955219629	2.058103976	-0.07	-0.0669	-0.36653
1/31/2019	101.58	1.226372718	1.941176471	-0.71	-0.11693	-1.01278
2/28/2019	100.23	1.241943388	1.941176471	-1.35	0	-1.64716
3/31/2019	100.36	0.980770111	1.93255132	0.13	-0.00863	-0.16397
4/30/2019	101.07	0.972340511	1.923976608	0.71	-0.00857	0.416146
5/31/2019	101.15	1.164697652	1.949852507	0.08	0.025876	-0.2148
6/30/2019	101.69	1.325857991	1.958579882	0.54	0.008727	0.242113
7/31/2019	103.16	1.247938352	1.941176471	1.47	-0.0174	1.171889
8/31/2019	103.3	1.327458924	2.194888179	0.14	0.253712	-0.14569
9/30/2019	103.8	1.301474751	2.289473684	0.5	0.094586	0.206734
10/31/2019	103.67	1.23947312	2.533568905	-0.13	0.244095	-0.41495
11/30/2019	102.39	1.028658156	2.725490196	-1.28	0.191921	-1.56463
12/31/2019	101.5	0.887292132	2.725490196	-0.89	0	-1.18225
1/31/2020	101.09	0.804064279	2.62745098	-0.41	-0.09804	-0.70599
2/29/2020	100.79	1.015068635	2.585271318	-0.3	-0.04218	-0.59612
3/31/2020	103.74	1.693627091	4	2.95	1.414729	2.717165
4/30/2020	106.41	4.28930664	6.619047619	2.67	2.619048	2.461302
5/31/2020	106.68	5.422605281	6.619047619	0.27	0	-0.08505
6/30/2020	106.4	3.350644707	6.407407407	-0.28	-0.21164	-0.61692
7/31/2020	107.27	2.529562579	6.339449541	0.87	-0.06796	0.551619
8/31/2020	108.14	1.974483092	6.272727273	0.87	-0.06672	0.559367
9/30/2020	108.41	1.863378069	6.339449541	0.27	0.066722	-0.03244
10/31/2020	108.64	2.056736139	6.339449541	0.23	0	-0.07844
11/30/2020	109.25	2.002939478	6.339449541	0.61	0	0.302302
12/31/2020	110.59	1.713796118	6.339449541	1.34	0	1.036306
1/31/2021	109.83	1.808602491	6.339449541	-0.76	0	-1.06501
2/28/2021	109.68	1.301758267	6.407407407	-0.15	0.067958	-0.4446
3/31/2021	109.73	0.704531955	6.476635514	0.05	0.069228	-0.23626
4/30/2021	107.95	0.096964065	6.476635514	-1.78	0	-2.0613
5/31/2021	107.43	0.034590879	6.547169811	-0.52	0.070534	-0.79692
6/30/2021	107.81	-0.006485382	6.407407407	0.38	-0.13976	0.093156

7/31/2021	108.14	0.025846461	6.272727273	0.33	-0.13468	0.042962
8/31/2021	109.24	0.073381545	6.339449541	1.1	0.066722	0.822351
9/30/2021	110.15	-0.006314053	6.407407407	0.91	0.067958	0.633516
10/31/2021	110.86	-0.021029044	6.407407407	0.71	0	0.43033
11/30/2021	111.92	-0.090793024	6.407407407	1.06	0	0.781296
12/31/2021	112.91	-0.176248379	6.407407407	0.99	0	0.712479
1/31/2022	113.38	-0.165081836	6.407407407	0.47	0	0.192325
2/28/2022	113.66	-0.184990662	6.407407407	0.28	0	0.0026
3/31/2022	114.32	-0.236045731	5.666666667	0.66	-0.74074	0.346352
4/30/2022	115.4	-0.238548252	5.015037594	1.08	-0.65163	0.770833
5/31/2022	116.28	-0.252727466	3.802259887	0.88	-1.21278	0.543034
6/30/2022	117.29	-0.27533048	2.846153846	1.01	-0.95611	0.686152
7/31/2022	118.32	-0.217832577	2.171641791	1.03	-0.67451	0.719404