Mount Kenya University

School of Pure and Applied Sciences

Department of Natural Sciences

RESEARCH PROJECT

A REGRESSION ANALYSIS OF 4 FACTORS (CPI RATES, GDP GROWTH RATES, LENDING RATES AND EXCHANGE RATES) AFFECTING INFLATION RATES IN KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This project is our original work and has not been presented to any other University for any academic award.

JEREMIAH MAINA: BSS/2021/95727

Signature…… Date……

Recommendation

This project has been submitted with our approval as University supervisors.

MR. CHEGE CHARLES.

Lecturer, Mount Kenya University.

Signature …… Date: ……..

DEDICATION

This research project is dedicated to my dear parents, sisters, brothers and friends for their unconditional love, emotional support, patience and understanding during the entire study period. I would also like to dedicate this project to my supervisor, Mr. Chege Charles for always setting aside time from his busy schedule to be able to guide me and offer great advice on how to progress with the project from the start until now.

ABSTRACT

This paper sought to establish the main factors that influence the rates of inflation in Kenya for the period 1971-2022 by using both theoretical and empirical literature review to explain the process of inflation causation in Kenya. The study uses Ordinary Least Squares for estimation of time series data covering the research period. We will start by testing the quality of the data using various Statistical techniques. A multiple linear regression will then be used and the following independent variables regressed on the annual inflation rate that is the CPI Rates, Exchange rates, GDP rates and the Tax rates. The research will use data sourced from different websites such as the Central Bank of Kenya and https://databank.worldbank.org/ which provides variety of data on economic indicators. Our analysis will be used to assist the government of Kenya and the stakeholders to regulate and control the rates of inflation in Kenya for the coming years.

ABBREVIATIONS AND ACRONYMS

IMF	International Monetary Fund
GDP	Gross Domestic Product
KNBS	Kenya National Bureau of Statistics
CBK	Central Bank of Kenya
CPI	Consumer Price index
OLS	Ordinary Least Squares
VAT	Value Added Tax
SSR	Sum of Squares due to Regression
Kshs	Kenyan Shillings
USD	United States Dollars

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

High inflation rates can have a significant impact on an economy. In Kenya, inflation has been a persistent problem with inflation rates often exceeding the government target range. In the last decade, the country has experienced periods of high inflation which has had a severe impact on the Kenyan economy and the population (Shuaib et al., 2015).

There are many definitions of inflation, the IMF, in the Finance & Development (2010) defines Inflation as the gradual increase in prices over a given period of time while the London Oxford economic dictionary (2009) defines inflation as the consistent tendency for nominal prices to increase which leads to a decline in the purchasing power in a country's currency (Tas & Demir, 2013). Inflation rate therefore measures the rate of increase in prices over a given period of time which, in Kenya, this is achieved by measuring the consumer price index (a measure of the average change in prices of goods and services consumed by households over time). There are three main types of inflation;

- Demand pull inflation which is the inflation that results from excess demand that cannot be matched by production (Vogt, 2017)
- Cost push inflation which the Investopedia, explains as a result of the general increase in prices of factors of production.
- Imported inflation – this is the increase in prices of imported fuels, materials and components increase domestic cost of production, and lead to increase in the prices of domestically produced goods (Mr. Luis et al., 2013)

The government of Kenya has a target of 5% inflation rate with a flexible margin of 2.5% on either side, as specified by the National Treasury on the price stability and economic policies. However, in the previous years Kenya has had a considerably high inflation rate (Statistical abstract) since in most of the years the inflation rate is above the 5% target.

In 1982 Kenya experienced a sting of high inflation which was attributed to an oil tremor and attempted military coup in the country leading to a worsening in terms of trade (Economic Survey, 1983) and reduced investor confidence hence fall in investment and some capital flight. This was also attributed to the adjustment of the external value of the Kenyan shilling in 1981 and this led to a deflationary monetary policy with money supply increasing moderately so as to contain inflation (Economic survey, 1984). The highest inflation rate ever recorded in Kenya was in 1993 at 46%. The high inflation rate was ascribed to an excessive money supply and depreciation of the Kenyan shilling leading to a low investor confidence due to unfavorable surrounding caused by political instability (Economic Survey, 1994). The devaluation of the Kenya shilling was seen as one of the causes of inflationary pressures, coupled with excessive money supply in 1992 and early 1993.

Also in to the economic survey 0f 2018, the inflation rate (2017) increased from an average 6.30% to 8.01% which was the highest inflation rate recorded in the period of 5 years. In April 2017, the highest monthly inflation rate was also recorded at 11.7%. The survey attributed the rise in to a combination of factors including drought conditions which led to higher food prices, higher fuel prices and a weaker exchange rate. However, the government intervened to manage inflation through monetary policy measures such as increasing the central bank rates, increasing taxes and decreasing liquidity in the banking system, also it was able to create stability in foods prices in Kenya. As a result in 2019, 2020 and 2021 inflation rates became stable but gradually increasing with average inflation rate of 5.24%, 5.40% and 6.1% respectively. (Economic survey of 2020, 2021, 2022).

The surveys highlights several challenges that may impact inflation in the future. These includes; rising global oil prices, changes in exchanges rates, changes in bank rates etc. (Economic survey, 2022). Inflation can be a complex phenomenon and understanding the factors that contribute to high inflation rates is critical for policy makers.

In this project we will use regression analysis to identify the key factors that influence the inflation rates in Kenya. A regression analysis is a statistical method that allows us to examine the relationship between a dependent variable, in this case inflation, and one or more independent variables, which are the factors we believe may be contributing to inflation.

1.2 Problem statement

The purpose of this project is to examine how factors such as, taxes, CPI, GDP rate and exchange rate lead to high inflation in Kenya. It is aimed at ensuring that the inflation is stabilized and which factors have statistically significant impact on inflation.

A previous research was conducted by XN Iraqi an associate professor at the Faculty of Business and Management Science, University of Nairobi. He revealed that in Kenya a confluence of many factors has inflated prices particularly after Ukraine war and the pandemic of covid-19. He associated the high inflation rates with factors like elections, corruption and mismanagement. Under elections, he explained that lots of money was lost during electioneering since some of it was given out with no commensurate productivity. The second factor was corruption and mismanagement, For instance, if people make illegal water or power connections, honest people pay for it. As a result, the cost of corruption to the economy was translated to about 7% of GDP annually.

Our research seeks to fill the gap in accentuating the inflationary process in Kenya by attempting to understand the relationship between high inflation rates and the factor in question, in order to provide the policy makers with data driven insights for policy making and implementations.

Results from this research will go an extra mile to assist the government of Kenya to regulate and control the rates of inflation in Kenya for the coming years

1.3 Justification of the research

While significant efforts have been made to reduce inflation rates by government of Kenya. Inflation has been traumatizing the Kenyan economy for quite a long time, causing distortion in the motive to save, work and invest. Also it has led to erosion of the local currency, loss of purchasing power and increasing the cost of living (African leadership Magazine, 2023). According KNBS, between June 2020 and June 2021 Kenyan consumers paid 8% more on food and beverages, 14% more on transportation and 4% more on housing, water and electricity leading to an increase in cost of living.

There are different factors that influence rate of inflation in Kenya, some of these such as, food prices, GDP rate, wages rate, tax rates and exchange rates lead to high inflation in Kenya. Food prices for instance is one of the major contribution to inflations as the changes in the cost of food

can impact the cost of production and consumption across many sectors of the economy (Poore & Nemecek, 2018).Similarly GDP rate can impact inflation rate by effecting the level of economic of activity and the demand for goods and services. The IMF has explained that when the GDP of a country increases the employment rates in the country of interest are likely to increase leading to wages push inflation, an overall rise in the cost of goods and services due to rise in wages.

However, it is the responsibility of CBK to prevent inflation through monetary policy. This primarily involves changing interest rates and lowering prices of bonds to control the supply of money within the economy (Asterios, 2019). Thus consumption falls, prices fall and inflations slows down. Also the government intervenes through fiscal policy to assist in fighting inflation by reducing its spending and increasing taxes. (Mattesini & Rossi, 2014).

In this research project we wish to analyze the relationship between the determinants of inflation and the inflation rates in Kenya for the previous years.

1.4 Objectives of the study

1.4.1 General objective

To determine the effect of the 4 factors on inflation rates in Kenya, how they relate to the overall inflation situation and provide relevant recommendations to the Stake holders.

1.4.2 Specific objectives

- To determine the effect of economic growth to the inflation in Kenya
- To determine the effect of lending rates to the inflation in Kenya
- To determine the effect of variations in exchange rates to the overall inflation in Kenya
- To determine the effect of CPI rates to the inflation in Kenya

1.5 Research design

Our study will use four factors that we believe affect the rates of inflation as independent variables, these are lending rates, CPI, exchange rates and the GDP rates, to conduct a regression analysis with annual inflation rates as the dependent variable. This analysis will be used in soughting to fit a model that best explains the relationship of the independent variables to the dependent variable (inflation).

1.6 Organization of the study

In the first chapter an introduction of the study is presented explaining the concept of inflation, giving the background of the Kenyan Economy. The chapter also provides the problem statement, general objectives and the specific objectives of the study. Chapter Two discusses the literature written in that field which includes theoretical and empirical literature, an overview of the literature review is also provided in this chapter. The research methodology is discussed in chapter three which includes the regression analysis and statistical tests that will be used in the study while chapter four presents the data analysis and a summary and recommendations given in chapter five.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

In this chapter both theoretical and empirical review are going to be discussed. Which entails the aspects, causes and effects of inflation to Kenyan economy. Finally we look at how the government and stakeholders try to control inflation. By providing clear comprehensive overview of the inflation concepts and the determinants of inflation rates, this chapter lays the foundation for subsequence chapters of the research project

2.2 Theoretical review

Inflation is sustained increase in the general price level of goods and services in economy over period of time. Robert James Ball defines inflation as a rise in the general price level due to increases demand or due to increased import prices or cost push (Ball, 2017). There are different concepts of inflation that will be discussed in this chapter

2.2.1 Structural inflation

This is a type of inflation that occurs when there is persistent and prolonged imbalance in the economic system such as shortage of skilled labor which lead to higher prices. (Zhemkov, 2019) It is often associated with long term economic trends, for example, in demographic changes or shifts in the structure of the economy (joint center for housing studies of Harvard University (2021).

An example of Structural inflation is the health care industry. According to a report by Congressional Research Service, the health industry has experienced rising cost due to variety of factors including advancement in medical technology and changes in the ways health care is delivered. These structural changes have led to an increase in healthcare prices which has contributed to overall inflation in the economy of Kenya. The report notes that addressing the rising cost of healthcare will require policy changes in the national and county levels of administration.

2.2.2 Cost push inflation

When a country is experiencing increase in cost of production due to factors such as increase in prices of factors of production and raw materials, a country is said to be faces with cost push inflation. This type of inflation is associated with supply side factors such as disruption in

production increase in cost of production or geopolitical instability, which leads to the general increase in price of commodities. (Razzak, 2023). Cost push inflation is difficult to control because it is mainly caused by factors outside of the control of the policy makers.

Cost push inflation is brought about by other agents that make costs of goods and services to go up. These agents include wages, exchange rates and costs of inputs that activate inflation by causing costs of production to be higher and hence lower output. Consequently, these costs are passed on to the consumers through higher prices (Moosa, 2014). Cost push inflation is also related to wage push inflation since wages take the largest part of the total production cost (World Bank). Meanwhile, Supply shocks also lead to a sudden change in the price of a commodity and this may be due to the shortage of a particular good. A good example of this would be oil prices and when used as an input the price further goes up due to the high exchange rate in the international market (Ongeri, 2013).

2.2.3. Monetarism

The theory on monetarism was brought forward by Friedman (1982) and in his theory he looks at the quantity theory of money and linked spending to the total amount of money in the economy. His theory asserts that inflation was as a result of an increase in the supply of money in the economy. He concludes that inflation occurs if the growth of money supply in the economy supersedes the economic growth. This theory was also presented by Meghnad Desai (2013) who explained inflation as being caused by monetary growth and focused on the demand for the money during hyperinflation, and suggested that expectations of future inflation rates depends on then past inflation rates.

Monetarism maintains the view that inflation is as a result of higher rate of growth of money supply from the rate of growth in the economy, aimed at regulating the quantity, cost and allocation of money and credit in the whole economy (Miller, 2013). Moreover it aims at achieving a set of objectives to maintain growth and stability in the economy. Therefore any monetary policy seeks to stabilize both the exchange rates and prices, raise the level of employment, stable economic growth and interest rate smoothing (Hamouda et al., 2016).

2.2.4. Imported inflation

Imported inflation is a general increase in cost of goods and services due to an increase in the cost of imports or importing inflated goods (Constantino, 2013). This price increase comes in two ways,

first is when you import finished goods at high prices then have to sell them at higher prices at the domestic market. Secondly if you import inflated raw materials it will lead to an increase in the cost of production which will be reflected in higher prices of goods and services. Imported inflation is caused by a decline in the value of a country's currency (Ricky, 2019). The more the currency depreciates on the foreign exchange market, the higher the prices of imports. Effectively more money is needed to buy goods and services outside the country. With imported inflation, production costs are higher for the companies. These companies most often reflect this increase in selling price if the goods and services sold. As a result, prices within the country rise. (Vincent, 2019).

2.3 Empirical review

2.3.1 Determinants of inflation rates

In Kenya inflation rate can be caused by a number of factors and conditions, for example, an increase in government spending or decrease in taxes can lead to an increase in the money supply which can in turn lead to high inflation rate.

One of the main factors that can lead to inflation in Kenya is increase in money supply. (Moges, 2018). When the CBK provides more money it lead to an increase in the supply of money in the economy this causes a situation where more money is chasing few goods which can drive up prices of goods.

Another factors is the rise of demand of goods and services. When there is a high demand for goods and services, prices can rise especially if the supply of these goods and services is limited. This can happen if there is an increase in consumer spending, investments or government spending (Taylor, 2012). On the other hand, a decrease in the supply of goods and services can also lead to inflation in Kenya. When this happens, prices can rise due to scarcity which can be caused by disasters, crop failure or other factors that can disrupt the supply chain. (Poore et al., 2018).

2.3.2 Effects of inflation

One significant effect that inflation has is that it brings more inflation in an economy (Sidrauski, 2011). This is because it can lead to vicious cycle of rising prices and wages because as prices rise, workers demand more wages to maintain their standards of living which in turn increases production costs and leads to higher prices of commodities.

Also a decrease in consumer's purchasing power is an effect of high inflation rates, a decrease in real wages and an increase interest rates. According to the IMF, when prices rise, consumers can afford to buy less goods and services leading to a decrease in their standards of living. Also, increased poverty is a significant effect of high inflation rates in Kenya (Garcia, 2016).

Additionally, inflation can lead to an increase in interest rates as CBK may raise interest rates to control inflation (Sebree, 2020). Higher interest rates can make borrowing more expensive which can lead to decrease in investments and a slowdown in the economic growth. Finally, inflation can also lead to a decrease in international competitiveness, as higher prices can make exports more expensive and less competitive in the global market as articulated by Smith J. (2010) in the Journal of African Economics.

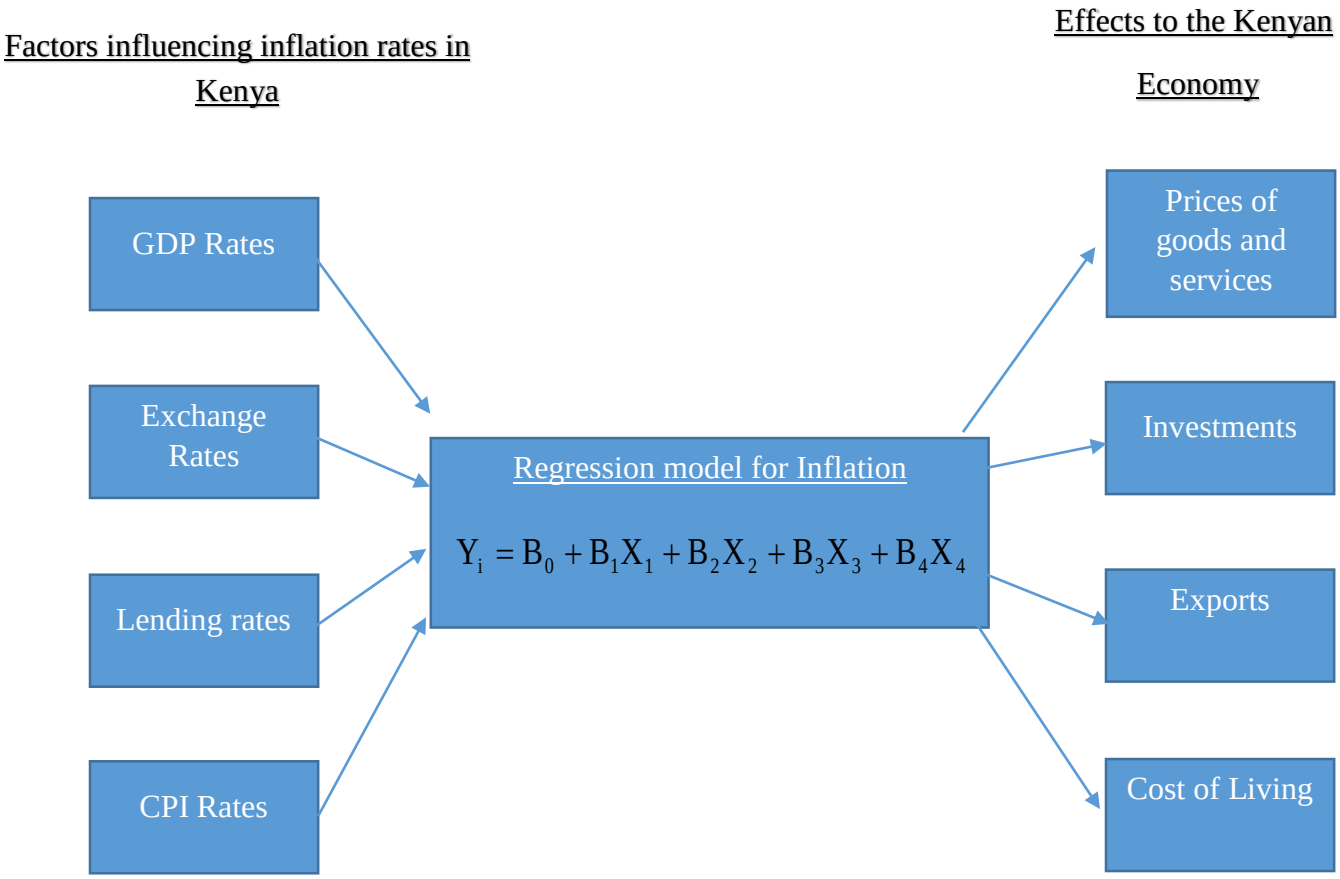
In the paper Monetary Policy in Kenya by Killick & Mwega (1990), notes that inflation in Kenya has never gone above 25% with moderate price increases after independence. They assert that monetary policy plays a crucial role to the performance of the Kenyan Economy.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

In this chapter we will illustrate the conceptual framework, discuss the data types and the sources of the data used in this research study. Thereafter, outline the method used in estimation of the parameters then specify the model used, explaining the basic expected results and describing our dependent and independent variables.

3.2 Conceptual Framework



The regression model is used to show how the changes in the independent variables, that is, the lending rates, GDP rates, exchange rates and CPI rates are associated with the dependent variable (Inflation) and how the changes are reflected to the situation of the Kenyan economy.

3.3 Estimation Method and Data Exploration Techniques

3.3.1 Ordinary Least Squares

In this study we will use the ordinary least squares (OLS) which was brought about by a French mathematician Adrien-Marie Legendre (1805) and later advanced by an English statistician Francis Galton in the late 19th century. This method is used to estimate the parameters of a linear regression model. OLS is a common method that minimizes the sum of squared errors between the observed values and the predicted values of the dependent variable as shown;

$$e = Y_i - Y$$

$$\sum_{i=1}^{n}(e)^2 = (Y_i - Y)^2$$

$$SSR = \sum_{i=1}^{n}(Y_i - \beta_0 - \beta_1 X_{1i} - \beta_2 X_{2i} - \beta_3 X_{3i} - \beta_4 X_{4i}))^2$$

Where e is the error terms and SSR is the sum of squares due to regression. The multiple regression equation of an Ordinary Least Squares model is illustrated as

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$$

Where the Y_i is the dependent variable, X_i's are the independent variables and β_i are the regression coefficients (Cleophas et al., 2021). For the equation, β_0 and β_i's are estimated as;

$$\beta_0 = Y_i - \beta_1 X_1 - \beta_2 X_2 - \beta_3 X_3 - \beta_4 X_4$$

$$\beta_1 = \frac{\{\sum_{i=1}^{n}(X_{1i}Y_i) - \bar{X}_1\sum_{i=1}^{n}(Y_i) - \beta_2\sum_{i=1}^{n}(X_{2i}Y_i) - \beta_3\sum_{i=1}^{n}(X_{3i}Y_i) - \beta_4\sum_{i=1}^{n}(X_{4i}Y_i)\}}{\{n\sum_{i=1}^{n}(X_{1i})^2 - (\sum_{i=1}^{n}(X_{1i}))^2 - \beta_2[n\sum_{i=1}^{n}(X_{1i}X_{2i}) - \sum_{i=1}^{n}(X_{1i})\sum_{i=1}^{n}(X_{2i})]}$$
$$- \beta_3[n\sum_{i=1}^{n}(X_{1i}X_{3i}) - \sum_{i=1}^{n}(X_{1i})\sum_{i=1}^{n}(X_{3i})] - \beta_4[n\sum_{i=1}^{n}(X_{1i}X_{4i}) - \sum_{i=1}^{n}(X_{1i})\sum_{i=1}^{n}(X_{4i})]\}$$

$$\beta_2 = \frac{\{\sum_{i=1}^{n}(X_{2i}Y_i) - \bar{X}_2\sum_{i=1}^{n}(Y_i) - \beta_1\sum_{i=1}^{n}(X_{1i}Y_i) - \beta_3\sum_{i=1}^{n}(X_{3i}Y_i) - \beta_4\sum_{i=1}^{n}(X_{4i}Y_i)\}}{\{n\sum_{i=1}^{n}(X_{2i})^2 - (\sum_{i=1}^{n}(X_{2i}))^2 - \beta_1[n\sum_{i=1}^{n}(X_{1i}X_{2i}) - \sum_{i=1}^{n}(X_{1i})\sum_{i=1}^{n}(X_{2i})] - \beta_3[n\sum_{i=1}^{n}(X_{2i}X_{3i}) - \sum_{i=1}^{n}(X_{2i})\sum_{i=1}^{n}(X_{3i})] - \beta_4[n\sum_{i=1}^{n}(X_{2i}X_{4i}) - \sum_{i=1}^{n}(X_{2i})\sum_{i=1}^{n}(X_{4i})]\}}$$

$$\beta_3 = \frac{\{\sum_{i=1}^{n}(X_{3i}Y_i) - \bar{X}_3\sum_{i=1}^{n}(Y_i) - \beta_1\sum_{i=1}^{n}(X_{1i}Y_i) - \beta_2\sum_{i=1}^{n}(X_{2i}Y_i) - \beta_4\sum_{i=1}^{n}(X_{4i}Y_i)\}}{\{n\sum_{i=1}^{n}(X_{3i})^2 - (\sum_{i=1}^{n}(X_{3i}))^2 - \beta_1[n\sum_{i=1}^{n}(X_{1i}X_{3i}) - \sum_{i=1}^{n}(X_{1i})\sum_{i=1}^{n}(X_{3i})] - \beta_2[n\sum_{i=1}^{n}(X_{2i}X_{3i}) - \sum_{i=1}^{n}(X_{2i})\sum_{i=1}^{n}(X_{3i})] - \beta_4[n\sum_{i=1}^{n}(X_{3i}X_{4i}) - \sum_{i=1}^{n}(X_{3i})\sum_{i=1}^{n}(X_{4i})]\}}$$

$$\beta_4 = \frac{\{\sum_{i=1}^{n}(X_{4i}Y_i) - \bar{X}_4\sum_{i=1}^{n}(Y_i) - \beta_1\sum_{i=1}^{n}(X_{1i}Y_i) - \beta_2\sum_{i=1}^{n}(X_{2i}Y_i) - \beta_3\sum_{i=1}^{n}(X_{3i}Y_i)\}}{\{n\sum_{i=1}^{n}(X_{4i})^2 - (\sum_{i=1}^{n}(X_{4i}))^2 - \beta_1[n\sum_{i=1}^{n}(X_{1i}X_{4i}) - \sum_{i=1}^{n}(X_{1i})\sum_{i=1}^{n}(X_{4i})] - \beta_2[n\sum_{i=1}^{n}(X_{2i}X_{4i}) - \sum_{i=1}^{n}(X_{2i})\sum_{i=1}^{n}(X_{4i})] - \beta_3[n\sum_{i=1}^{n}(X_{3i}X_{4i}) - \sum_{i=1}^{n}(X_{3i})\sum_{i=1}^{n}(X_{4i})]\}}$$

Where Y is the mean of the dependent variable and $\bar{X}$ is the mean of the independent variables.

3.3.2 Assumptions of Regression Analysis.

1) **Linearity:** This assumption states that there is a linear relationship between the independent variables and the dependent variable. In other words, the change in the dependent variable is directly proportional to the change in the independent variables (Porter, 2015).

2) **Independence:** This assumption assumes that the observations are not influenced by each other. Each observation should be independent and not affected by any other observation in the dataset.

3) **Homoscedasticity:** Homoscedasticity refers to the assumption that the variability of the residuals (the difference between the observed and predicted values) is constant across all levels of the independent variables. In simpler terms, it means that the spread of the residuals should be roughly the same for all values of the independent variables. (Damodar, 2015)

4) **Normality of Residuals**: This assumption suggests that the residuals follow a normal distribution. In other words, the distribution of the error terms should be symmetric and bell-shaped.

These assumptions are important to ensure the validity and reliability of the regression analysis results.

3.3.3 Advantages of OLS

OLS is the Best Linear Unbiased Estimator under Gauss Markov theorem, meaning that among all linear estimations that are unbiased, OLS has the smallest variance. It is also easy to understand and implement. Additionally, OLS is a robust method of estimation in such a way that it can handle a wide range of data types and distributions.

3.3.4 Limitations of OLS

It is sensitive to outliers, leverage points, and influential observations, which can distort the estimates and reduce their accuracy.

3.4 Data Types and Data sources

Our research basically uses secondary data, time series data, sourced from different websites such as the Central Bank of Kenya and https://databank.worldbank.org/ which provides variety of data on economic indicators, population and energy and commodity prices. Time series data tracks changes in a variable over time. The data used in our research is the record of the different economic indicators over a period of 50 years from the year 1971 to 2022.

3.5 Model Description

A multiple linear regression model of the form;

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$$

Will be used in this study. Where;

Y_i = Inflation rates X_1= GDP rates

X_2 = Exchange rates X_3= CPI rates

X_4= Lending rates β_i = Regression coefficients.

3.5.1 Description of variables

1) Exchange rates (Kshs vs USD)

Exchange rate is the rate at which one currency can be exchanged for another. It has a direct impact on the price of exports and imports in the country and increased money supply leads to the depreciation of nominal exchange rate. (Herin, 2019)

2) Lending rates

Lending rates refers to the interest rates that commercial banks or financial institutions charge when they lend money to individuals or businesses (OECD et al., 2016). These rates determine the cost of borrowing and can vary based on factors such as the borrower's creditworthiness and the prevailing market conditions.

3) CPI rates

It is used to estimate the average relation between two given periods in prices of products consumed by a household. Changes in CPI reflects price changes in the economy. When there is an up change in CPI this means that there has been an increase in the average changes in price over time.

4) GDP rates

It the total monetary or market value of all finished goods and services. Too much GDP growth is also dangerous as it will most likely come with an increase in inflation, which erodes stock market gains by making our money and future corporate profits less valuable.

3.5.2 Checking for Model Validity

To check the validity of the regression model, we can use different techniques.

a) **Goodness of fit:** We assess how well the model fits the data by examining measures like R-squared, adjusted R-squared, and the F-statistic (Mendenhall, 2019). These measures indicate the proportion of variance explained by the model and the overall significance of the model.

b) **Significance of coefficients**: We check if the coefficients of the independent variables are statistically significant. This is done by examining the p-values associated with the coefficients.

c) **Residual analysis:** We evaluate the residuals to check if they meet the assumptions of the regression model. This includes checking for normality, constant variance (homoscedasticity), and independence of residuals. To carry out residual analysis, we examine the residuals of the regression model by plotting a histogram or a Q-Q plot of the residuals or use the model visualization plots. (Mendenhall, 2019).

By performing these checks, we can assess the validity of the regression model and determine if it provides a reliable representation of the data.

CHAPTER FOUR: RESULTS AND FINDINGS

4.1 Introduction.

This chapter involves examining and interpreting the data collected for our study. We will explore the findings and draw meaningful conclusions from the descriptive statistics, data visualizations and the fitted regression model.

4.2 Descriptive Statistics.

This is the summary and description of the main features of the variables such as the central Tendency, variability and distribution. These statistics provide an overview of the data and help identify patterns and relationships in the variables.

```
> X=read.csv(file.choose())
> X
   YEARS GDP.GROWTH..RATES EXCHANGE.RATES CPI.RATES LENDING.RATES INFLATION.RATES
1   1971             22.17           7.14      0.93          9.00             3.78
2   1972             17.08           7.14      0.98          9.00             5.83
3   1973              5.90           7.00      1.07          9.00             9.28
4   1974              4.07           7.14      1.26          9.50            17.81
5   1975              0.88           7.34      1.50         10.00            19.12
6   1976              2.15           8.37      1.68         10.00            11.45
7   1977              9.45           8.28      1.92         10.00            14.82
8   1978              6.91           7.73      2.25         10.00            16.93
9   1979              7.62           7.48      2.43         10.00             7.98
10  1980              5.59           7.42      2.77         10.58            13.86
11  1981              3.77           9.05      3.09         12.42            11.60
12  1982              1.51          10.92      3.73         14.50            20.67
13  1983              1.31          13.31      4.15         15.83            11.40
14  1984              1.76          14.41      4.58         14.42            10.28
15  1985              4.30          16.43      5.17         14.00            13.01
16  1986              7.18          16.23      5.30         14.00             2.53
17  1987              5.94          16.45      5.76         14.00             8.64
18  1988              6.20          17.75      6.47         15.00            12.26
19  1989              4.69          20.57      7.36         17.25            13.79
20  1990              4.19          22.91      8.67         18.75            17.78
21  1991              1.44          27.51     10.41         19.00            20.08
22  1992             -0.80          32.22     13.26         21.07            27.33
23  1993              0.35          58.00     19.35         29.99            45.98
24  1994              2.63          56.05     24.93         36.24            28.81
25  1995              4.41          51.43     25.31         28.80             1.55
26  1996              4.15          57.11     27.56         33.79             8.86
27  1997              0.47          58.73     30.69         30.25            11.36
28  1998              3.29          60.37     32.75         29.49             6.72
29  1999              2.31          70.33     34.63         22.38             5.74
30  2000              0.60          76.18     38.09         22.34             9.98
31  2001              3.78          78.56     40.27         19.67             5.74
32  2002              0.55          78.75     41.06         18.45             1.96
33  2003              2.93          75.94     45.09         16.57             9.82
34  2004              5.10          79.17     50.34         12.53            11.62
35  2005              5.91          75.55     55.53         12.88            10.31
36  2006              6.47          72.10     63.55         13.64            14.45
37  2007              6.85          67.32     69.75         13.34             9.76
38  2008              0.23          69.18     88.06         14.02            26.24
39  2009              3.31          77.35     96.19         14.80             9.23
40  2010              8.06          79.23    100.00         14.37             3.96
41  2011              5.12          88.81    114.02         15.05            14.02
42  2012              4.57          84.53    124.72         19.72             9.38
43  2013              3.80          86.12    131.85         17.31             5.72
44  2014              5.02          87.92    140.91         16.51             6.88
45  2015              4.97          98.18    150.19         16.09             6.58
```

46	2016	4.21	101.50	159.65	16.56	6.30
47	2017	3.84	103.41	172.43	13.67	8.01
48	2018	5.65	101.30	180.51	13.06	4.69
49	2019	5.11	101.99	189.97	12.44	5.24
50	2020	-0.27	106.45	200.23	12.00	5.40
51	2021	7.59	109.64	212.47	12.08	6.11
52	2022	4.85	117.87	228.74	12.34	7.66

```
> summary(X)
```

	GDP.GROWTH.RATES	EXCHANGE.RATES	CPI.RATES	LENDING.RATES	INFLATION.RATES
Minimum	-0.800	7.00	0.93	9.00	1.550
1st Quartile	2.270	14.13	4.473	12.40	6.253
Median	4.255	58.37	29.125	14.39	9.790
Mean	4.599	52.34	57.377	16.30	11.506
3rd Quartile	5.902	79.19	97.142	18.52	13.900
Maximum	22.170	117.87	228.740	36.24	45.980
S.D	3.875853	36.62541	67.61805	6.524063	7.880084
Skewness	2.30856016	0.04180871	1.1131215	1.42277171	2.02457811
Kurtosis	10.997722	1.513018	2.923248	4.464064	8.694079

Our summary statistics indicated that inflation hit its highest at 45.980% in 1993 with a standard deviation of 7.880084. However, only exchanges rates is approximately symmetric while the other variables are highly skewed. The standard deviation of exchange rates and CPI rates is relatively higher compared other variables, this means that exchange rates and CPI rates observations are more deviated from their mean. All variables have positive kurtosis values this indicates that they have relatively higher peaks than the normal curve distribution.

```
>Correlation matrix
> cor(X, method = c("pearson","kendall","spearman"))
```

	YEARS	GDP.GROWTH.RATES	EXCHANGE.RATES	CPI.RATES	LENDING.RATES	NFLATION.RATES
YEARS	1.000000	-0.24601433	0.9714401	0.90129731	0.17071831	-0.2589895
GDP.GROWTH.RATES	-0.24601	1.00000000	-0.2087752	-0.0606365	-0.4103590	-0.3658451
EXCHANGE.RATES	0.971440	-0.20877515	1.0000000	0.88091150	0.21547913	-0.2672189
CPI.RATES	0.901297	-0.06063657	0.8809115	1.00000000	-0.0997056	-0.3269809
LENDING.RATES	0.170718	-0.41035904	0.2154791	-0.0997056	1.00000000	0.2615392
INFLATION.RATES	-0.25898	-0.36584513	-0.2672189	-0.3269808	0.26153916	1.0000000

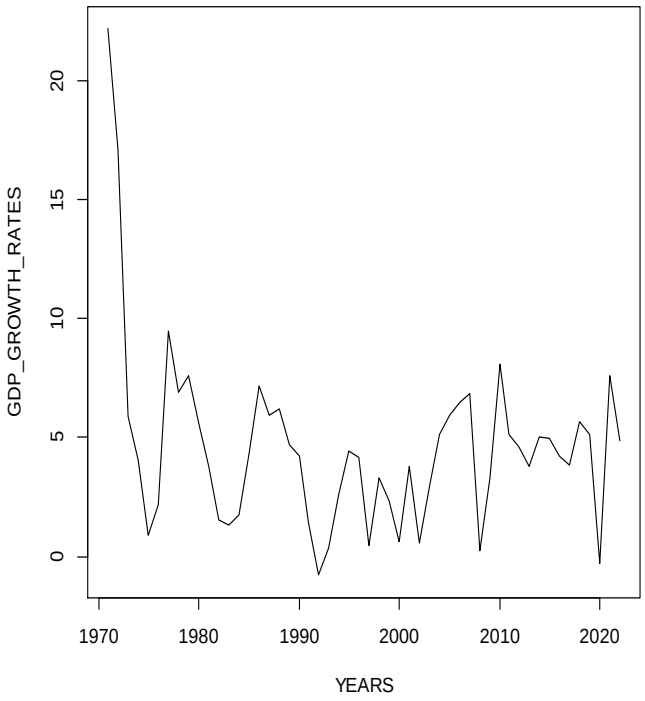
In our correlation matrix, the independent variables didn't show any serious relationships except for CPI rates and exchange rates with a positive correlation of 0.88091150. This means that CPI rates has a strong and positive relationship with exchange rates such that an increase in CPI rates will result to an increase in exchange rates and vice versa.

4.3 Data visualizations.

In our analysis we used a line graph to visualize the changes in the variables over the years. Also, a scatter plot was used to visualize the distribution, the spread of each variable and identify any outliers. Additionally, a histogram was used to show the shape of the distribution, identify its central tendency and observe any skewness.

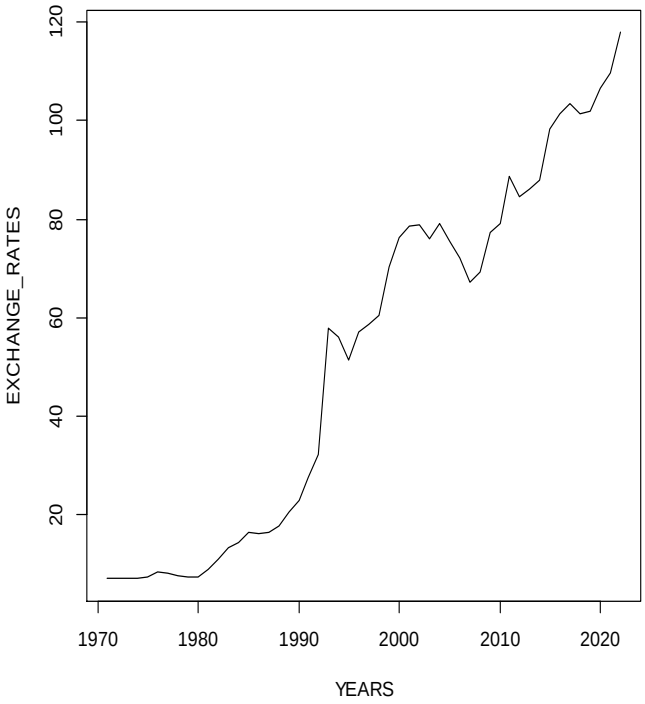
i) Line graph

```
> plot(YEARS,GDP_GROWTH_RATES,type="l")
```



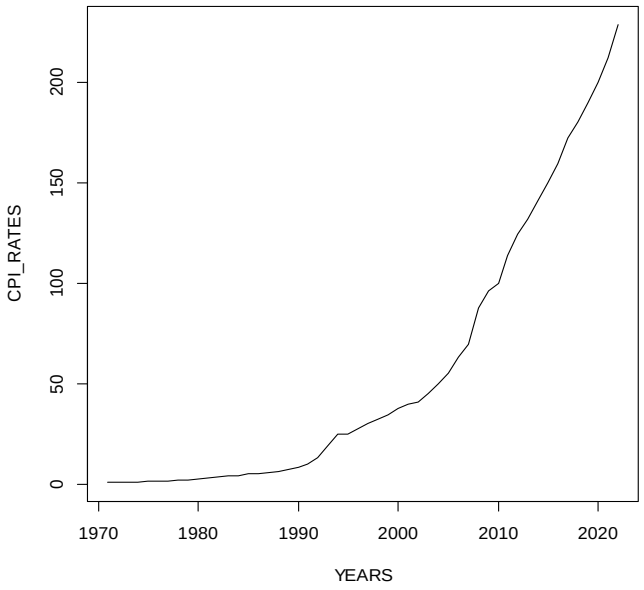
GDP growth rates seems to vary with time which shows fluctuations in economic activities.

```
> plot(YEARS,EXCHANGE_RATES,type="l")
```



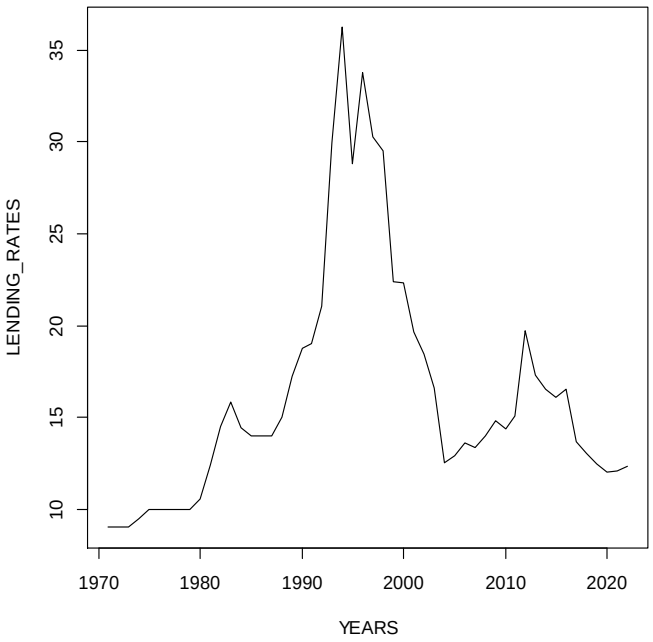
Exchange rates have a rising trend which indicates that the value of the Kenyan shilling is decreasing over time compared to the USD.

```
> plot(YEARS,CPI_RATES,type="l")
```



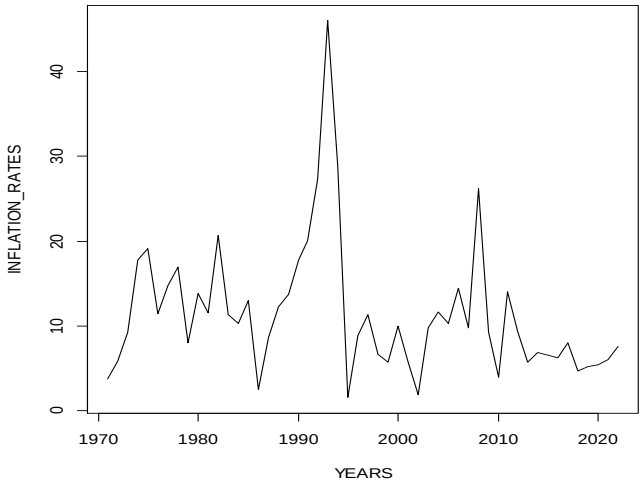
CPI rates trend indicates that the average prices of goods and services are gradually increasing over time.

```
> plot(YEARS,LENDING_RATES,type="l")
```



Lending rates trend indicates that higher lending rates cluster around the central year of our data (1995) with fewer rates at the extremes.

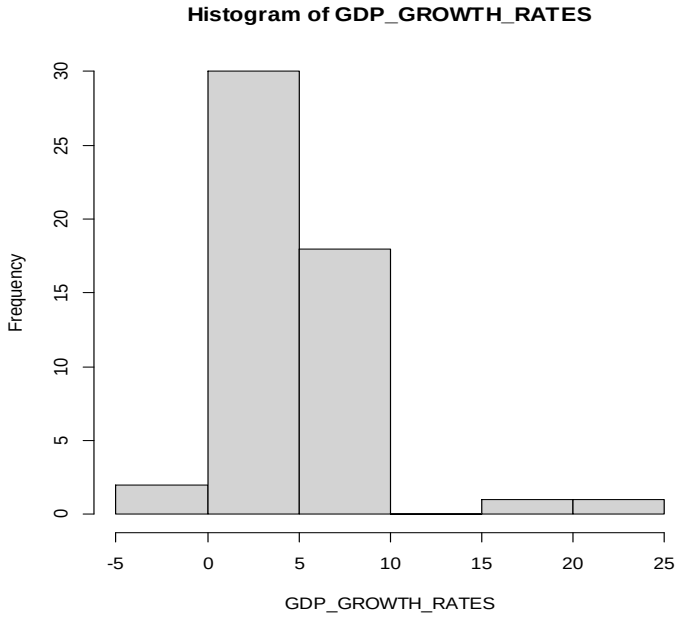
```
> plot(YEARS,INFLATION_RATES,type="l")
```



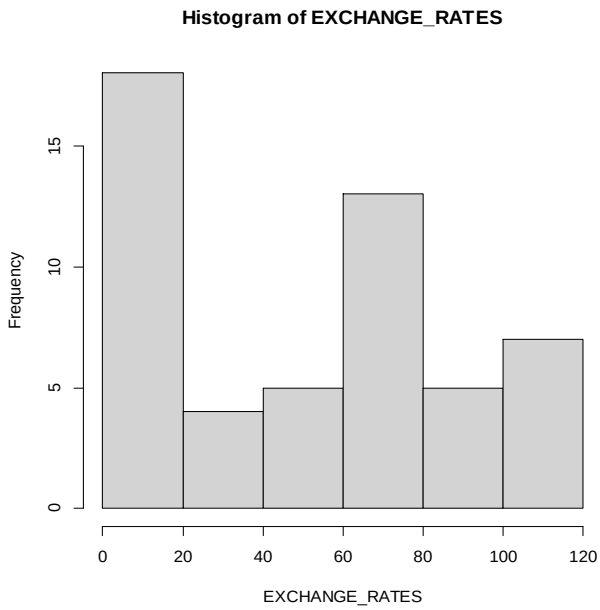
Inflation rates trend indicates that the rates vary with time which shows fluctuations prices of goods and services over the years.

ii) Histogram

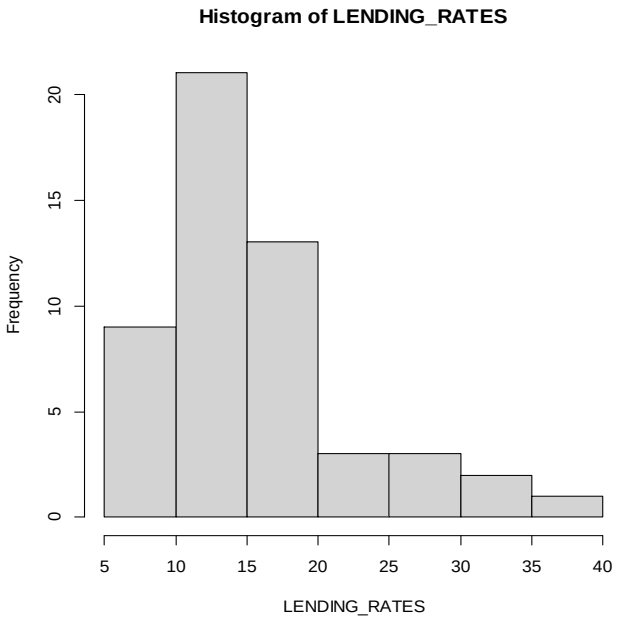
```
> hist(GDP_GROWTH_RATES)
```



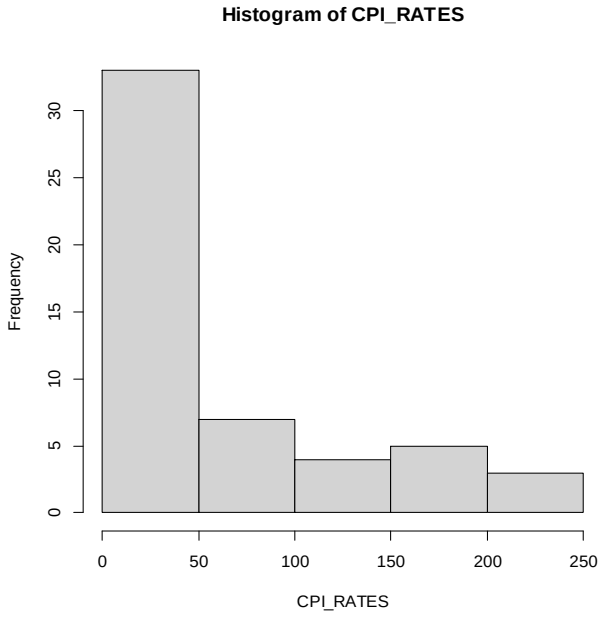

```
> hist(EXCHANGE_RATES)
```



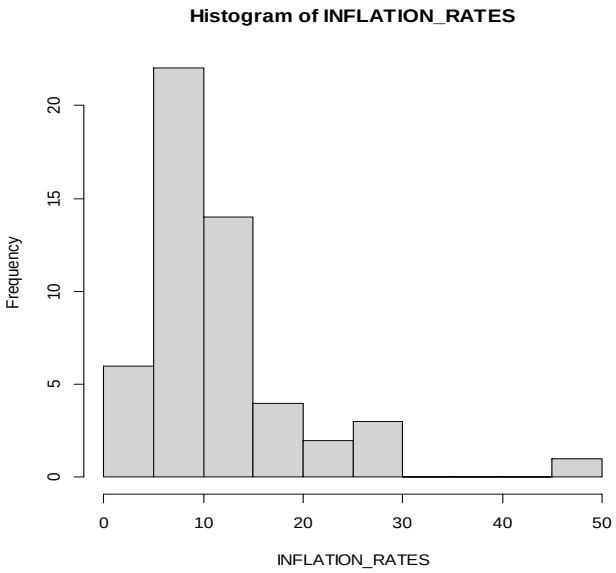

```
> hist(LENDING_RATES)
```




```
> hist(CPI_RATES)
```



```
> hist(INFLATION_RATES)
```



The histograms show that, except Exchange rates histogram which suggests that the exchange rates are scattered and random without any noticeable clustering, the other variables exhibit asymmetric properties. This can be translated to most of the data points being on the left side/lower values.

4.4 Multiple Linear Regression fitting.

A multiple linear regression was fitted using Inflation as the response variable and CPI rates, GDP growth rates, exchange rates and Lending rates as the predictor variables and the results were as follows;

```
>model=lm(INFLATION_RATES~GDP_GROWTH_RATES+EXCHANGE_RATES+CPI_RATES+LENDING_RATES,data=X)
>model

Call:
lm(formula=INFLATION_RATES~GDP_GROWTH_RATES+EXCHANGE_RATES+CPI_RATES+LENDING_RATES,data=X)

Coefficients:
     (Intercept)  GDP_GROWTH_RATES     EXCHANGE_RATES         CPI_RATES     LENDING_RATES
       15.329223         -0.747718          -0.097725           0.008431          0.260543
```

The multiple regression analysis conducted on the relationship between inflation rates and our predictor variables revealed that the intercept of the model is at 15.329223 which signifies the baseline inflation rate when all the predictor variables are neutral. Moving on to the coefficients of the independent variables, a notable inverse relationship emerges between GDP growth rates and inflation. Specifically, for every unit increase in GDP growth rates inflation rates are expected

to decrease by approximately 0.747718 units holding other variables constant. Similarly, exchange rates exhibit a negative impact on inflation with a unit increase in exchange rates associated with a decrease in inflation rates by around 0.097725 units. Conversely, Lending rates demonstrate a positive association with inflation indicating that a unit increase in lending rates correspond to an increase in inflation rates by approximately 0.260543 units. Lastly, the coefficient for CPI rates is relatively small indicating that changes in Consumer Price index have a minor impact on inflation rates.

4.5 Model Validation.

i) Model summary

The summary statistics of the final regression model was conducted and the results were as follows;

```
> summary(model)

Call:
lm(formula=INFLATION_RATES~GDP_GROWTH_RATES+EXCHANGE_RATES+CPI_RATES+LENDING_RATES,dat
a=X)
Residuals:
     Min       1Q   Median       3Q      Max
-13.1728  -3.9984  -0.6969   3.0624  28.6037
Coefficients:

                  Estimate Std. Error t value Pr(>|t|)
(Intercept)      15.329223   3.758272   4.079 0.000174 ***
GDP_GROWTH_RATES -0.747718   0.277006  -2.699 0.009626 **
EXCHANGE_RATES   -0.097725   0.073373  -1.332 0.189321
CPI_RATES         0.008431   0.038890   0.217 0.829312
LENDING_RATES     0.260543   0.203805   1.278 0.207388
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Residual standard error: 6.923 on 47 degrees of freedom
Multiple R-squared:  0.2887,      Adjusted R-squared:  0.2281
F-statistic: 4.769 on 4 and 47 DF,  p-value: 0.002599
```

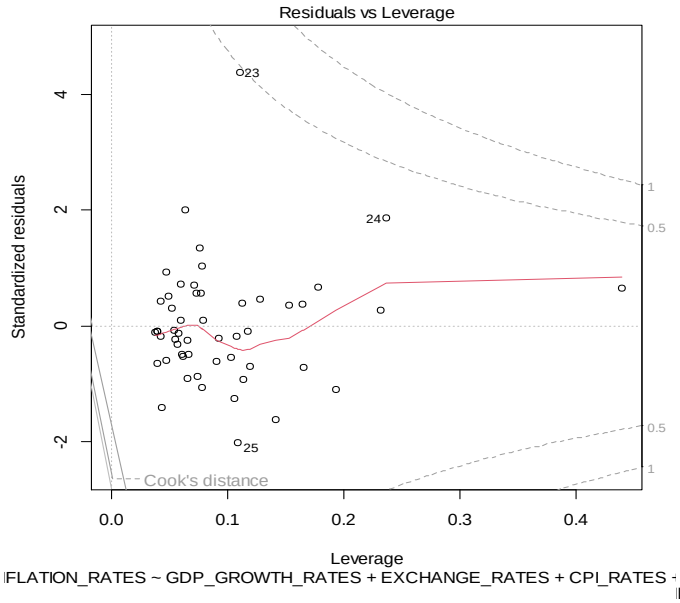
The model intercept (15.329223) and the coefficient of GDP growth rates (-0.747718) are statistically significant with a p-value of 0.000174 and 0.009626 respectively. This implies that the negative relationship between inflation rates and GDP growth rates is indeed realistic and a stronger economic growth tends to lead to lower inflationary pressures which aligns to economic theory. However, the coefficients for exchange rates, CPI rates and lending rates have p-values of 0.189321, 0.829312 and 0.207388 respectively. This shows that there is no enough evidence to conclude that there is any significant relationship between these variables and the inflation rates, that is, they do not have substantial influence on inflation rates in this model.

Overall, the model exhibits statistical significance as indicated by the F-statistic of 4.769 with a p-value of 0.002599 meaning that the included variables together contribute significantly to explain the variations in the inflation rates. Additionally the model has a Residual standard error of 6.923 which means that the average difference between the predicted values and the actual values of the dependent variable is relatively small. Lastly, the multiple R-squared of 0.2887 implies that the model explains only 28.87% of the variability in inflation rates.

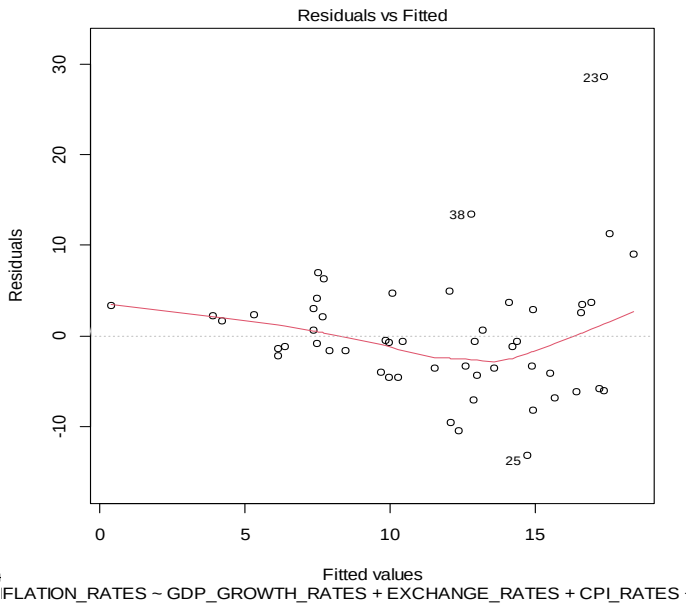
ii) Model Assessment

The model visualization plots are used to assess several assumptions of the multiple linear regression model and identify potential patterns in the model. These diagnostic plots are crucial for evaluating issues with the model such as heteroscedasticity, non-linearity and outliers.

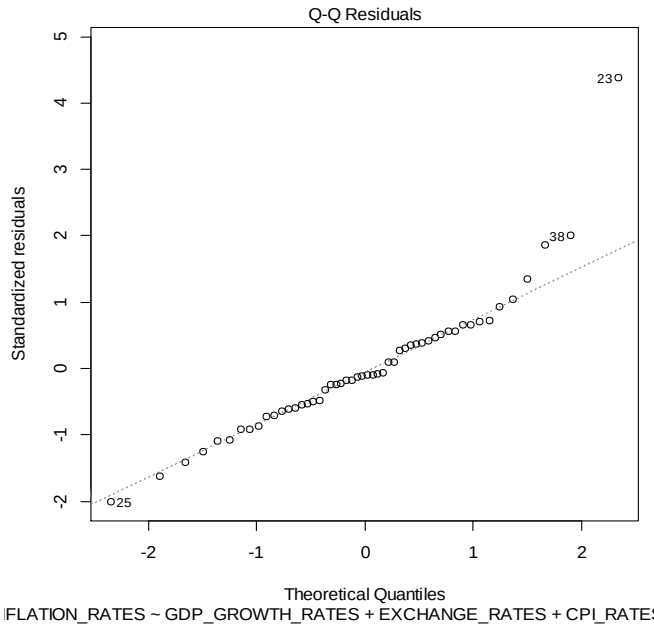
```
> plot(model)
```

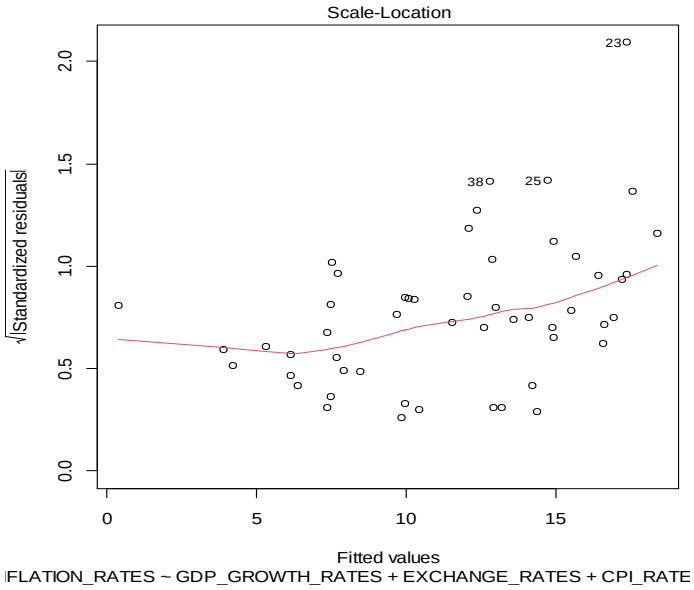


This plot is used to check for leverage points and influential points. Higher leverage points may affect the estimated coefficients if they are influential in the model. We use the cooks distance to determine which points are influential and needs further investigations. In our analysis, no data point lies outside the cooks distance.



This plot is used to assess the relationship between the fitted values and the predicted values. Since there is no discernible pattern in the data points, this suggests that the model adequately captures the assumption of linear relationship between variables.





This plot is used to assess the normality of residuals and check for tails in the model. A straight line indicates that the residuals follow a normal distribution while the points that deviate from the straight line indicates the tails. Our analysis revealed that the residuals follow a normal distribution and that our model isn't heavily tailed since almost all points are around the straight line.

The main purpose of scale location plot is to check for homoscedasticity. A random scatter of points around the middle line implies that the spread of residuals is approximately constant across the range of fitted value.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In this chapter we are going to discuss the effect of each independent variable on the inflation rates in Kenya and provide relevant recommendations on the same. The results of this research will be crucial for comprehending economic dynamics in Kenya and can potentially provide guidance for stakeholders and policy makers in decision making.

5.2 Conclusions

According to our results, GDP rates are significant determinants of inflation rates. They exhibit a strong negative association with the inflation rates, this means that as the GDP rates increases inflation decreases.

However, Lending rates, exchange rates and CPI rates showed an insignificant but notable association with the inflation rates. Firstly, exchange rates showed a negative impact on inflation with an increase in exchange rates associated with a decrease in inflation rates. On the other hand, the lending rates demonstrate a positive association with inflation rates indicating that the higher the interest rates commercial banks charge on loans to individuals and private sectors, the higher the inflation. Lastly, CPI rates also showed a positive association with the inflation rates.

Overall the multiple linear regression of these factors all together was significant. This means that this factors all together contribute significantly to the inflation rates in Kenya and a change in these independent variables would affect the inflation rates significantly.

5.3 Reccomendations

The government of Kenya should provide and encourage economic development plans such as development of industries. This will lead to the growth of the gross domestic product leading to reduction in the inflation rates. Also, economic development will be beneficial to the country as it will reduce the cost of living, reduce foreign dominance, increase on exports and correct the balance of payment deficit.

A good way to counter inflation using exchange rates is engaging in activities that will increase the price of the Kenyan shilling in the financial markets. This can be achieved by increasing the country's productivity by establishing better production plans. When the domestic production of

a country increases, the currency of that country gains value thus attracting investments and reducing the inflation rates.

Regulation of lending rates by the central bank of Kenya through directives or moral suasion could be an effective method to regulate the impact of excess money supply in the economy therefore controlling the inflation rates in Kenya.

This means that a decrease in the average price of a basket of goods and services consumed by households illustrate a reduction in inflation. Increase of subsidies for production and reduction of Value Added Taxes would be a good way of reducing the prices of these products.

5.4 Further research suggestions

The multiple linear regression model analysis shows that these factors only contributes 28.87% of the inflation rates in the Kenya, a potential area of study in this case is trying out the same model using more variables to increase the predictive power of the model or the same model can be used with different variables. Alternatively, another research area could be using different modeling techniques to model the factors influencing inflation rates in Kenya.

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