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Clifford Nzioka Jones

November 2020

Submitted to the School of Mathematics in partial fulfilment for a degree in Post Graduate Diploma in Actuarial Science

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Post Graduate Diploma Thesis

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Submitted to: The Graduate School, University of Nairobi, Kenya

Abstract

One of the most pressing problems facing the Kenyan economy is the high inflation rates unstable gross domestic product and fluctuation of interest rates over the past few years. High and volatile inflation is a threat to good economic. Macroeconomic variable (Gross domestic product and interest rates) play a vital role in deciding fate of economy and future prospect of a country. As evident to theoretical point of view, a stable and efficient growth domestic product (GDP) is prerequisite for a booming economy of a particular nation. The causal relationship between gross domestic product and interest rate has not only stroke a sphere of activity on international research but also a great concern in the economy of Kenya and other developing countries.

In reference to past empirical reviews of Kenyan academicians in context on this topic has presented obscure results, interest rate fluctuation can be as a result of vast macroeconomic variable basing on economic status of a particular country as evident on study by Caleb Wandera (2017) research project on the effects of macroeconomic variables on interest rate spread in the commercial banking sector in Kenya; Boniface shihuma mmasi (2013) on analysis of interest rates and inflation rate in Kenya.

Current study is an attempt to shed light on whether there exists bidirectional Granger causal relationship between interest rates and gross domestic product, and to visualize if combined previous values of inflation rates and GDP granger causes interest rates. The study relied on quarterly time series data retrieved from the Kenya Bureau of Statistics Central Bank of Kenya from 2009 to 2019, the analysis was conducted using econometric model of granger causality in R statistics software and F statistics test was conducted to analyze the impact of restricting inflation rate from a full model containing previous values of variables under investigation. The results failed to support bidirectional relationship.

Relation between quarterly data of interest rates and gross domestic product in Kenya exhibit no granger causality 4 relationship at lag 1,2 and 3 but after conducting analysis on F test F calculated value (3.514) is more than F critical (2.850) value at 10 percent level of testing, hence a null hypothesis that coefficient of previous variable of inflation rate added and GDP is jointly equal to zero is rejected hence quite statistically definitive that adding previous values of inflation rate adds value to the model, i.e. values of quarterly data of inflation rate and GDP is granger causal on change on interest rates. Although inflation rates help improve significant of granger causality a further research analysis on the actual determiners of interest rates in an economy and extend on how such factors Impact interest rate fluctuations in Kenya.

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Declaration and Approval

I the undersigned, declare that this is my original work and has not been submitted to any institution or university other than the University of Nairobi for academic credit.

Signature Date

Clifford Nzioka Jones
Reg No. I46/12056/2018

This project has been presented for examination with my approval as the appointed supervisor.

Signature Date

Prof.Ivivi Mwaniki
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Dedication

This academic project is dedicated to the entire family of Jones Kitavi.

Contents

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My sincere heartfelt appreciation is registered to the almighty creator of all for enabling this study successful without major difficulties. I also extend my gratitude to my lecturer Prof. Ivivi. Mwaniki for guidance and supervision efforts to ensure the project yield much to me. Much worthy to mention is my guardians Bridget Mutiso,Patience Mutiso ,Januaries Mutiso for their unwavering support during this time of my studies. I am also indebted to all such friends from whose hands all supported whatsoever. It is impractible to thank everyone by names but I am grateful to all of you in your capacities for the support of all manners I received towards the end of the study.

I thank you all.

Clifford Nzioka Jones

Nairobi, 2020.

List of abbreviations

BoP - Balance of Payments

MPC - Monetary Policy Committee

CBK - Central Bank of Kenya

IRP - Interest Rate Parity

NSE - Nairobi Stock Exchange

GDP- Gross Domestic Product

CBR - Central Bank Rate

VAR- Vector Autoregressive Model

IRS - Interest Rate Spread

1 INTRODUCTION

1.1 Background

Macroeconomic variables have huge impact on a nation's economy, According to Andrew bloomental (dot dash publishing family,2019) The impact of macroeconomic variables are very crucial in dictating economic performance and its growth in a nation. A nation in which agricultural sector is the main factor of the economic growth, with a high agricultural production,the economy of such country will grow as agriculture-based companies have sufficient products to manufacture and the nationalities are fully engaged in production work and industrial work, minimizing unemployment rate. As a result, Gross domestic product of the nation will go high in which the impact can be realized on interest rates charged to the nationalities and inflation rate.

Such activities in the market keep economy growing, investors and entrepreneurs realizing news ideas to supplement income and in turn, interest rates keep changing due to market conditions. Current interest rates which banks and financial institution will give to its borrowers and lenders usually will not stay same each year due to time value of money concept and others factor, for example ; state of inflation rate, general production performance of the nation, the rate in which population borrow money and pay loan.(Njuguna and Ngugi, 2000), In particular situation whereby general economic is not doing well, general production on agriculture sector, industrial sector is poor, the government can make a decision basing on the facts and information of interest rates and gross domestic product collected. The government through central bank which regulates rates might think of reducing interest rates so that more people can lured to take loans, invest to boost the economy, the move is aimed at making money supply available to the nationalities at a low rate so that they can engage in different production activities at least to boost the economy as general production of the nation will increase.

However, it will have impact on inflation rate in the country too. According to (Okara and Mutuku, 2019), Rapid economic growth can be an issue to the population in general, as a speed and high rate economic growth may result in a situation whereby people need for the products and services is high than available one at their disposal. In order to slow down gross domestic product in such situation, interest rates offered to the nationalities will be a decision factor to aim at. An increase in general interest rates in banking sector by central bank of a country will aim to reduce supply of money to the people, as the rates will scare them away on taking huge loans that will be impossible pay back, with a decrease in money circulation in the market, production will be minimal, economic growth

of the country will go down due to slowed gross domestic product. However, inflation rate will be affected as the economy is not booming.

According to Reem Heakal, 2019.when banking and micro finance institution lend money, they usually at risk of either the borrowers will fail to pay the loan on time or definitely they will not pay at all, such institutions will take into account all the risk associated on lending money,inflation rate due to the fact that purchasing power of money keep changing with time and as per 11 the market conditions and time value of money. Interest charged is aimed to protect loan issuerfrom inflation rate and provide compensation.

It is worth noting that gross domestic product rate relates with inflation rate, a growth in GDP will lead to a booming economy which in one way the prices of the products will go up so as to adjust with the growing economy and due to the fact that when the products supplied in the market are in demand price will definitely go up.The lower the interest rate, higher the rate of investment and growth in exports in GDP, all of Which tend to push the rate of unemployment down. But if labour markets become too tight inflation start rising and central bank must tighten up its monetary policy to keep inflation under control
According to Focus economics report (2019) Policy interest rates in percentage in some of East Africa countries from 2013 to 2016 kept changing as follows:

Kenya	8.50	8.50	11.50	10.00
Tanzania	16.01	15.75	16.39	15.60
Ethiopia	7.50	7.50	7.50	7.50

Table 1. Table

Economic growth in east African countries have experienced several setbacks. After colonial rule, when most of the countries gained independence, countries had to deal with a blow of mobilizing the population together to build the nation as most of manufacturing and large-scale plantations 12 were owned by the white people, view of the Africans had technical know how to operate in companies and industrial areas. In most of the countries especially Kenya, Uganda and Tanzania The government was faced with slow economic development challenge, with majority of the people unskilled, unemployed and poor health. Infrastructure development which is a key factor to boost the economy of most of African countries is also regarded as a main economic development drawback, as we know agricultural production and local industries are the main source contributor to the national gross domestic product in East African countries. However, when a country's economy is characteristic of having all indicators of stagnation of GDP growth rate.

The government in conjunction with central bank will evaluate economic indicators like GDP rates, inflation rates and interest rates to make a decision. In Kenya, volatility on

interest rates offered was experienced between 2010 to 2016. The central bank of Kenya (CBK) had to make changes on its lending rates so as to encourage investments, this was aim from the government to boost the economy which was hurt and slowed down by 2007 post-election violence and low rainfall experienced during that time. When volatility based on foreign exchange was experienced on 2011, CBK reacted by increasing base lending rates and as a result of high lending rates impacted on commercial banks, it had huge impact on interest rates and inflation rates which means people had to pay high interest rates to the banks than before and as a result inflation had to rise.

According to CBK report on 2019, its decision to leave interest rates unchanged during government financial years report on May 2019 was as result of the following factors; improved weather condition which led to creation of more employment opportunity in agricultural sector and 13 the prospective change in financial market in the coming future, the economy of the country was picking up and a decision to reduce or increase interest rates from 9 percent might have resulted into another economic crisis. It was worth noting by the bank that inflation rate had movement too, as 19-month inflation rate of 4.3 percent in march to 6.5 percent in April which might which could be as a result that the economy was not performing well, shortage of agricultural products in the market and food supply in general which led to increase in food cost and other basic products.

1.2 Statement of the problem

Interest rates in financial institutions keep fluctuating depending on market conditions and economy in the country. When the economy of a certain country is booming, investors and entrepreneurs will give money on it due to the prevailing market conditions, Increase in demand for fund supply in the market have impact too, as financial institutions and lenders will ask for more interest, it goes without saying, when the demand for money is high in the market for the investors and entrepreneurs due to prevailing market conditions the lenders will take the advantage and charge more. It elaborates general relationship between national growth of a country economy realized by gross domestic product and interest rates.

Interest rates fluctuation is a challenge in Kenyan economy, as most of financial institutions take the advantage of exploiting people, for instance it will be difficult to predict future financial growth uncertainties hence interest rates charges should be aimed at not only the current situation 14 of the economy and how much lenders wish to earn but how the future will be if high or low charges are affected.A rapid increase in interest rates is general will have an impact on GDP as it can lead to damage to the economy as insufficient supply of credit in the market will lead to low supply of new products and

goods in the market, it leads to the question of how commercial institutions and lenders should be cautious on interest rates charges and how is gross domestic product relates to interest rates Focus of the study is to establish extend to which interest rates changes relates with GDP and inflation rates, is it the GDP and inflation rates which causes rates to fluctuate or vice versa, impacts of rates changes to local nationalities, micro-finance investors and the country's economy in general as a result of macroeconomic factors selected, for instance, as evident from CBK report on benchmark interest rates from 2013 to 2019 signaled a drop in the cost of loans, though low rates have positive impact to the economy but also can have negative effect on the value of KSH compared to other countries.

Academicians have examined the relationships between exchange rates, balance of payments, interest rates and other macroeconomic variable which influence interest rates in a country economy, most have pointed out the correlations which have had mixed reaction. According to a study by (Mmasi, 2013), basing on annual data analysis it was clear of existence of unidirectional causal relationship and that it is inflation rates that causes fluctuation on interest rates (NAFUHO, 2017), on effects of macroeconomic variables on interest rates, slowing GDP growth tend to pull down interest rates (no demand for capital) consumers are unwilling to take on new debt.

If Gross domestic product increase so does the interest rate, if the two economic components are directly interrelated on each other, inflation rate have a minimal influence on 15 interest rate spread.In the previous studies ,academician preferred annual data to check causal relationship between macro-economic factors and interest rates, the current one aims to shade light if there exist bi-directional causal relation inflation rates, GDP and interest rate in Kenya, by comparing analysis of quarterly data results and analysis by that it will be possible to get wide range of understanding between the relationship between gross domestic product, inflation rates and interest rates in Kenya.

1.3 objectives

General objectives

Use granger causality technique to estimate if there exist a bidirectional or unidirectional granger causality between interest rates and GDP, estimate if combined previous values of GDP and inflation rate granger causes interest rates..

Specific objectives

1.To determine if Gross domestic product rate granger causes Interest rates
2.To estimate if Interest rates Granger causes Gross domestic product
3.To determine if adding inflation rate to a model with two variables interest rate and GDP adds explanatory power to the model.

1.4 Importance of the study

The study will be deemed worth to the following constituents;
a. **Goverment of Kenya**
Linkage of the macroeconomic variables can be very crucial to the government understanding how such factors affect interest rates can be helpful for a countries economy stability that is, to realize that high interest rates and low interest rates may affect value of money in a country. Government will make informed decision basing on how to control inflation, GDP and interest rates. Government should be able to set a given inflation rate target and the general economic growth to the expected level.
b. **Nationalities of Kenya**
The results of this project will enlighten nationalities not only in Kenya but globally on how to make informed decisions in financial economic market basing on interest rates offered by commercial institutions. It will provide financial investors and entrepreneurs with first in hand information on how to invest considering market conditions and making worthwhile investment decision.
c. **Central Bank of Kenya**
Results obtained from the study can be of very helpful to the Central Bank of Kenya in regulating and setting up base rates, with the view of market conditions and future expectation, since most of micro financial institutions may charge high rates which oppresses normal citizens.

1.5 Definition of terms

1. **Inflation rates** The inflation rates refer to the change in general price of good and service over a given time. Inflation rates have an impact on economy market as an increase or decrease in inflation rate will affect the purchasing power of money, during period of high inflation prices of good and service are expected to go high due to either insufficient supply of goods in demand or increased cost of production by an index.
2. **Interest rates** Is the compensation in monetary value form a lender will get after lending money for a specified period of time to the borrower, after all the risks and inconveniences encountered to part with an asset with high value and liquidity, the amount one will get can be defined as interest rate.
3. **Interest rates spread** (Gitau, 2014), Interest rates spread can be defined as the difference realized on the weighted average lending rates and the weighted average deposit rate of fund in a given economy.
4. **Repos rate** Refers to the rate that the regulator lends on short term basis to commercial banking players against their security as deposits with the regulator.
5. **Gross Domestic Product** Gross domestic product is value in monetary form of all finished goods and services which is produced by a country within its borders on a specified period of time. A real gross domestic product in an economy of a country considers inflation and the value of goods and services on previous years.

1.6 Chapter Summary

The chapter one has given a background of the study, identified and elaborated the problem and justified claim for the study. The purpose and specific questions are also presented. Chapter two reviews the relevant literature and highlights findings of previous studies on this subject. Chapter four elaborates a presentation of the data collected, its findings after analysis and chapter five is a conclusion and recommendation of the research study basing on data analysis findings realized.

2 LITERATURE REVIEW

2.1 Introduction

The chapter brings into light the literature review on the effects of select macroeconomic factors (Gross domestic product, inflation rate) on interest rate in Kenya. First section will outline and elaborate correlation between variables GDP rate, Inflation rates and interest rates and their effects on rates changes. The second section give a summary of conceptual framework and hypothesis that connects interest rates and macroeconomic variables, empirical study review and narrows down with summary elaborating how this study will assist further to existing literature.

2.2 Review of theoritical Literature

2.2.1 Theories Linking Macroeconomic Variables and Interest Rates

A study by mugeme and Ojuayi,2009 concluded that a weak and unstable macroeconomic environment creates uncertainty about financial and economic growth and returns on investments making defaults on loans more likely making commercial banking players rise the premium on loans to counter this credit risk hence a high interest rate spread.

According to (Janda and Zetek, 2013) on Macroeconomic factors influencing interest rates of microfinance institutions in Latin America, the realization of the study was macroeconomic variables are essential factors in growth investment of microfinance institutions as the institution always depend on the performance and current market conditions in their investment decision.

Caro (2017) pointed out that most of micro financial institutions aim on to the Nations with 20 high rate of inflation and a high rate growth of agricultural product, it is a clear as with high production in agriculture, GDP will keep on growing as well as the nation's economy in general as majority of nationalities are engaged in production. Economic development leads to high profits in financial institutions eventually. The level of GDP has a direct relation with the level of investments been done in the country.

A research study carried (NAFUHO, 2017) examined the effects of macroeconomic variables on interest spread in the commercial bank sectors, with regards to the study, it concluded that central bank rates, capital reserves requirement, inflation rate, treasury

bill and GDP growth have a productive relation which is positive on interest rate spread.

According to (Agoraki et al., 2010),with a low economy development in a country, the capacity of giving out loans by financial institutions and banks is reduced and weakened and credit risk will shoot high which consequently increase the interest rate margins. financial institutions can decide to raise interest rates due to increased potential risk or operational costs as a result of high unemployment rates which in turn increases poverty or due to unexpected increase in inflation (Kazi and Leonard, 2012).

Study carried by (Adofu, 2010) basing on Accelerating economic growth in Nigeria concluded that gross development product will always have effect on how borrowers will demand loans from banks, as bank loans increase due to low rates charges supply of money will increase for loan borrowers and with a good number of people taking and paying loans as anticipated the banks will accumulate high profits in general. Countries ability to transform the economic state and growth in the current condition by increasing production of good and services is very essential, as gross domestic product will have impact on inflation and interest rates. It is worth noting that a stable economic growth will be 21 impossible to achieve when the interest rates is not stable as it will hinder with production of good and services, microfinance and banking institutions decision making and a low fund supply eventually to the borrowers in event when economy is not booming.

In reference to a research study by (Obamuyi, 2009), the gross domestic product growth rate of a country has a long relationship with interest rates. According to Obamuyi, when interest rates are decreased and banks offer low rates to the borrowers, gross domestic products will automatically increase in the short run due to availability of funds for investments and production as a result of reduced rates. On the other hand, as interest rates decline gross domestic product will keep on increasing.

(Armesto et al., 2005) illustrated on the study research about the impacts of alternative monetary policy rules on inflation. The study revealed the fact that the lack of consistence of inflation rate experienced in a country economy may depend on decision making of Central Bank in the country, if Central Bank make decision to supply funds in the market by enforcing borrowers to be offered low interest rates in banks, inflation rates will be affected and market conditions will change.

According to(Gichuki et al., 2012) on "the choice of optimal monetary policy instrument for Kenya" found that a relation between inflation rate and interest rates exist in which when inflation rates are high interest rates increased, and reduced when inflation was low. In this case, inflation stabilization can be implemented through adjustment of inter-

est rates.

According to(Kaminsky and Reinhart, 1999) inflation rate is a key variable which will determine variability and consistence of interest rates, if the general economy of a nation is stable due to a consistent GDP rate growth prices of goods and service will also increase as the economy grows, as a result interest rates charges offered by financial institutions will increase. The move by commercial banks to increase interest rates charges is aimed at countering a loss of money value and maximize profit from the amount they lend to the borrowers.

2.3 Empirical review

Research have been done by different scholars on macroeconomic factors that influence interest rates, in a research study (Cull et al., 2010) on development of financial stability in Kenya concluded that in reliance of commercial bank data on operating costs, tax, and loan provision, a positive relation with interest rates spreads exists.
(Ngugi, 2001) on her research on interest rate spread (1970-1999) indicated that IRS in Kenya Was as result of high financial intermediation cost and inefficiencies on the economy.it indicated That there was high level on non-performing loans due to financial inefficiencies and distress in Borrowing. She also elaborated that an increase in Treasury bill rate and inflation rate over the Period spearheaded banks to rise their lending rates.
A research study conducted by (Mmasi, 2013), on granger causality analysis between interest rates and inflation rates realized findings that there exists no bidirectional granger causal relationship between the two variables, the test relied on annual data of both variables and that inflation rates granger causes interest rates hence unidirectional relationship exist between the two variables and it is inflation rate that granger causes interest rates.

2.4 Chapter Summary

The macroeconomic variables effects on interest rates have been carefully stated and analysed on This chapter. From literature review, it is clear that interest rates in commercial banks fluctuate depending on market condition and economy status of the country, Referring to (Brock et al., 2003), Interest rate spread can be determined and influenced by Macroeconomic factors in an economy. However, studies carried out in different countries and economy realized difference response outlining strong relation on macroeconomic variable and interest rates while different studies had contrary opinion on the same.The following chapter dwelt on the research methodology, data collection, analysis and validation which was used establish the effects of GDP on Interest rates in Kenya.

3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter will give a detailed elaboration of the methodology applied to analyze the data effective. It will aim to shed lights on the technique and analysis design used, the source of the data and how it was obtained, the validity and usefulness of the data and method adopted to achieve the main objective of the study.

3.2 DESIGN METHOD

Design method of research is a master plan or a strategy that a researcher applies to the collection, measurement, and analysis of data in order to give a mean full information an understandable content (Rahi et al., 2019) The current study applied descriptive idea with aim on establishing the relation of macroeconomic factors and interest rates. According to (Cooper and Schindler, 2014), descriptive research method observes the behavior of a subject without direct influence and elaborate the from data collected and tabulating the frequency of research variables and their interaction. The design was effective in establishing macroeconomic variable (GDP) relations and effects on interest rates. The concept enlightened the relationship of the variables via correlation study. This research aimed to explain relationship of GDP, inflation rate on interest rates in Kenya and determine whether GDP, inflation rate can be used forecast interest rates or vice versa.

3.3 Data collection

The research used secondary data, which can be explained as to a collection of data collected by someone else other than you for his or her primary purposes. To emphasize on importance of such data, it is worth noting that reliance of secondary data gives viable option for academicians with a short of time and resources at their disposal. As the required data for investigation was secondary, the data was retrieved from several government entities and statistical firms. More specifically quarterly reports by the Central Bank of Kenya (CBK) from (2009-2019).

3.4 Data validity and Reliability

Data validity in a research elaborates and gives detailed information on how sound, usefulness the research is and the fact that the results will effectively and genuinely represent phenomenal one has interest on. According to (Mugenda and Mugenda, 2003) ,reliability gives an estimate in which a measure will remain and stay on a concrete and unchanged state under a measure performed on same condition enhance validity and reliability study depended on sample of secondary data from retrieved from CBK, and keep an eye on interest rates, inflation rates change and trends in Central Bank of Kenya.

3.5 Data analysis

Data analysis aims at extracting the useful content and information from a select data and coming up with a final judgement decision basing on findings. Analyzing data is very crucial as it gives an easy time for a researcher to elaborate ideas in details and mostly make a worthwhile decision. According to (Mugenda and Mugenda, 2003),the idea of data analysis brings order and a clear meaning of a un analyzed information. The analysis of the data involved descriptive and inferential in nature whereby analysis involving finding of mean, variance, frequencies and calculation of percentage was done.

3.5.1 Estimation techniques

Granger-Causality test
The Granger -causality technique was first proposed and applied by Granger on 1969 and Sims on 1972, with an emphasis on relationship and interaction between time series data. It elaborates how one time series data can be used to make a prediction of another time series data by analysis of trends.

According to Granger, causality could be tested by analyzing ability to forecast a time series futures values and results with application of prior value of a certain time series data. In order to deal with “post hoc fallacy” error which elaborates on how a conclusion can be extrapolated, Granger sensitizes that one time series variable (A) is said to Granger-cause another variable (B) if it can be elaborated via a t-tests and F-tests on lagged values of both variables A and B. basing on the variables under investigation on the current study (Interest rates, inflation, GDP), it will be unwise to give a vivid conclusion of the relationship between the variable by observing the order of events occurrence.

In the context, Granger-causality methodology was relevant to investigate and deter-

mine causality between variables, in order to present a detailed analysis, an investigation of a full model with variables interest rates, Gross Domestic Product and inflation and a restricted model only with variables interest rates and Gross Domestic Product was conducted on quarterly data (2009-2019).This idea was aimed at exploring how the Granger causal relationship between the variable will differ i.e. if past values of GDP, interest rates and inflation rates are more significant for predicting interest rates than just applying only past values of GDP (significant change on the value or R^2 on both full model and restricted model).

For instance, basing on the idea of Granger, if we say that GDP can be used to predict Interest rates, then the regression of Interest rates is based on the past information of both GDP rates and interest rates added, hence it can well show explanatory of the regression of the variables and GDP rate can be referred to as Granger-cause of interest rates, otherwise is referred as non-Granger cause. However, to investigate if interest rates can be predicted better by considering past information of both interest rates, inflation and GDP, the regression of interest rates will be based on past values of interest rates, inflation and GDP, hence GDP and inflation can also be referred to as Granger-cause of interest rates.

A granger-causal analysis of variable requires the following conditions and step for a detailed and a genuine analysis, the stationarity of the time series data variable is necessary as we are performing a regression test variable with time features Before subjecting the time series to further scientific test, analysis on the variables was conducted;

Spurios Regression check

Spurious regression is a regression on which the ultimate result it will produce is statistically misleading as per linear relationship of the variable under analysis. In order to avoid inconclusive result of study analysis of the causal relationship between interest rates, inflation and GDP rates, A spurious regression test was conducted to check if the two variable under investigation were viable. The process involved to regress variables that we have not tested for stationarity and observe and make comparison on the value of R^2 and the Durbin Watson statistic value of the time series data.

A regression analysis of GDP, inflation and interest rates was performed with aim to evaluate the value of R^2 with the value of Durbin Watson statistic (DW). The rule of term was if R^2 is greater than Durbin Watson (DW) value, it is an evidence that the regression is spurious, its outcome cannot be used for forecasting, prediction, conducting hypothesis test.

Stationarity test

The application of Granger-causality test requires the time series data to be integrated at the same level, hence stationarity test is a necessary condition. It was important to perform stationarity test for the three variables (interest rates, inflation rate and Gross Domestic Product) as working on both stationary data will give a satisfactory result that causality makes economic sense in the context under investigation.

In the context, Augmented Dicky Fuller (ADF) test was pivotal to check presence of unit root (presence of an error term in statistical inferencing) in the data. In an autoregressive process of order one, if the rho parameter is one then process has a unit root; the presence of unit root is really important because if process has unit root, we know that the stability condition must be violated and we know that time series cannot be stationary.

Consider an autoregressive model below;

$y_t = \beta_1 + \rho y_{t-1} + \mu_t$.....(1)

in the model y_t depends on constant and its value in previous period plus error term (assume error terms are white noise) if $\rho = 0$, that will make time series completely static ($y_t = \beta_1 + \mu_t$) and if $\rho > 0$, the we have correlation between y_t and y_{t-1} if rho is between zero and one, i.e. $\rho is [0,1]$ (strictly less than one) then the stability condition is satisfied and the process maybe stationary.
If $\rho = 1$, we know that the stability condition cannot be satisfied. Assuming that rho is not negative as it very uncommon for y_t to depend negatively on its value in the previous period also excludes that rho is greater than one so that the process will not explode quickly toward infinity. Assuming that $\rho is [0,1]$, the interesting case is when If $\rho = 1$, then the process has a unit root. If the process is non stationary at level it is possible to perform first-difference then check if stationarity holds since granger causality test can be conducted for two variable which are non-stationary at level but stationary after the first difference. A simple first difference of the autoregressive model is required and is performed by subtracting y_{t-1} in both sides of the AR (1) equation.

$y_t - y_{t-1} = \beta_1 + \rho y_{t-1} - y_{t-1} + \mu_t$.....(2)

$\Delta y_t = \beta_1 + (\rho - 1) y_{t-1} + \mu_t$.....(3)

Let $\rho - 1 = \sigma$ then $\sigma is [-1,0]$

$\Delta y_t = \beta_1 + \sigma y_{t-1} + \mu_t$.....(4)

We have moved unit root from one to zero in sense that the process has a unit root if

$\sigma = 0$ formulated hypothesis will be;

$H_0 : \sigma = 0$

$H_1 : \sigma < 0$

If null hypothesis is true then the stability condition cannot hold, if we reject null hypothesis that means the stability condition holds and it is possible for the data to be stationary.

Correlation analysis

The linear relationship between interest rates, inflation and Gross Domestic Product was analyzed by performing a Pearson correlation test, test was conducted through R statistics program resulting in all cases the r value in proximity to zero, suggesting that there exhibits a weak relationship between the time series data hence a viable condition for granger causality test analysis.

Granger causality analysis between variables interest rates, GDP and inflation Rates

In reference to the current study, to establish if there exist a bidirectional causality relationship between interest rates and Gross Domestic Product, the following pair of regression was considered for the two variables;

$\Delta(GDP)_t = \beta_0 \Delta(GDP)_{t-i} + \beta_1 \Delta(INT)_{t-j} + \mu_{1t}$.....(5)

$\Delta(INT)_t = \beta_2 \Delta(INT)_{t-i} + \beta_3 \Delta(GDP)_{t-j} + \mu_{2t}$.....(6)

$\beta_i = (0, 1, 2, ..., n)$ are coefficients of variables

$\Delta(GDP)_{t-i} = firstdifferencelevelofGrossDomesticProducts$

$\Delta(INT)_{t-i} = firstdiffrencelevelofinterestrates$

The hypothesis was as follows, if H_o is that GDP do not granger cause interest rates, then GDP would be independent variable and interest rates dependent variable and if the outcome is that the probability value is less than 5 percent reject H_o, hence GDP granger causes interest rates. Similarly, whether interest rates granger causes GDP, H_o is that interest rates do not granger cause GDP then GDP would be dependent variable.

If the probability value is great than 5 percent, no sufficient evidence to reject H_o hence interest rates do not granger cause GDP Considering the three variables, a prediction on what will happen at the current time point can be made if we know what happened on the other variables in the past, we can use that data point to predict what will happen to the other variables in coming future i.e. Imagine that variable x and y are basically, the same, it will be trivial to predict what will happen on the future of x basing on what happened on the past values of y as what happened in previous time in variable x is exactly same to what happened in variable y previously as the two variables are basically the same. In order to account for this possibility, we need to extend the question by asking if we can predict what happens on variable x based on what happened on previous variables of both x, y and another variable z better than just predicting current value of variable x using only just past variable of x and y.

In the study, an investigation of whether a change in interest rates can be explained by a change of both GDP and inflation rate statistically speaking was conducted. Gross Domestic Product is said to granger cause interest rates if interest rates can be predicted from the past values of interest rates and GDP rate together than the only considering past value of interest rate alone, to improve on the significant results, we introduce a third variable inflation rate. GDP, inflation is said to granger cause interest rates if interest rates can be better predicted from the past values of interest rates, inflation rate and GDP rate all together rather than considering past values of GDP and interest rates alone. i.e. interest rates will be better predicted basing on weighted combination of previous value of both variables GDP rates, inflation rates and interest rates. Consider the following equation of both variables interest rates (INT), Gross Domestic Product GDP rate and inflation rate (INF);

$$(INT)_t = D_t + \sum_i^t \beta_i (INT)_{t-i} + \sum_j^t \beta_j (GDP)_{t-j} + \mu_t .....restrictedmodel$$

$$(INT)_t = D_t + \sum_i^t \beta_i (INT)_{t-i} + \sum_j^t \beta_j (GDP)_{t-j} + \sum_k^t \beta_k (INF)_{t-k} + \mu_t .....fullmodel$$

Where $INT = interestrates, GDP = GrossDomesticProduct, INF = Inflationrate, D = Constant, \beta = coefficientsofthevariables$, $i = o, 1, 2, ...$ and $\mu_t = errorterm$

The context, restricted model will include only one variable at current state and the lagged values of that model i.e. lags of the dependent variable while as full model includes lagged model of the three variables (interest rates, inflation and GDP rates). If the full model is really a good fit to the time series data, its error term is statistically required to be very close to zero or small when compared to the error term of the restricted model, a large deflation means that it is not a good fit, i.e. if the current values of interest rates can be better predicted basing on previous values of variables GDP, interest rates and inflation rates, the coefficients of the variables are going to be non-zero hence a small error term, also the variance will be smaller than model with view variables (restricted model).

That is the key that leads to quantification of granger causality. In the study, F-test was applied to determine whether after controlling for past values of interest rates, past values of GDP and that of inflation rate can improve forecast interest rates, as we add one variable to the model it is obvious that in the model R^2 tend to increase so we want to know if R^2 will be significant or not, to draw conclusion on granger causal relationship, An F-test was conducted.

$$F - calculated = \frac{(R_f^2 - R_r^2)/q}{(1 - R_f^2)/(N - K - 1)}$$

Whereby, f-full model
r-restricted model
q-number of additional variables in the model
N-number of observation
K-number of variables in the full model

$H_0 : \beta_i (i = 1, 2, 3, ..., n) = 0$
Then Gross Domestic Product and inflation fails to granger - cause interest (INT)
$H_1 : \beta (i = 1, 2, 3, ..., n)$ is not equel to zero
Decision rule of the test and hypothesis, if F calculated is greater than F critical value a null hypothesis is rejected.

3.6 Ethical consideration

(Cooper and Schindler, 2014), it is very crucial that the research study does not depict negative consequences to other peoples and organization in general, hence ethical consideration was carefully observed on the source where the data was retrieved, methodologies and applications used during the research study and the entire process. This was purely an academic research; it aimed to keep and maintain professional safeguard of all information and data involved into the study.

3.7 Chapter Summary

The chapter gave a clear presentation of the source of the study data and how it was retrieved, methodology applied to get a conclusive analysis and application used in the study were discussed, which paved the way for research findings and results which were discussed in chapter four.

4 DATA ANALYSIS, FINDINGS AND RESULTS

4.1 Introduction

The chapter will give detailed analysis, presentation of the results realized from methodology In chapter three. Data analysis results will be in form of graphical representation of the variables , summary tables giving central tendency and figures, stationarity test results and causal relationship test results of both interest rates, inflation rate and Gross Domestic Product.

4.2 Analysis summary

On the tables below, a summary analysis of interest rates, inflation rate and Gross Domestic Product rates is presented;

Variables	Observation	Mean	Std deviation	Minimum	Maximum
Years				2009	2019
GDP	42	11.538	1.05	9.323	13.898
Interest rate	42	9.543	2.84	5.833	18
Inflation rate	42	7.468	3.82	3.33	19.19

Table 2. DESCRIPTIVE STATISTICS (2009-2019)

the table content of quarterly data (2009 to 2019), mean and SD realized from 42 observation of GDP rate was 11.538 percent and 1.05 percent respectively. Gross Domestic Product rate ranged from a minimum of 9.323 percent to a maximum of 13.898 percent. However, interest rates for the same 42 observation had a mean, SD of 9.543 percent and 2.84 percent respectively, interest rates ranged with a minimum rate of 5.833 percent with an highest rate of 18 percent. while inflation rate average mean was 7.468 percent, a standard deviation of 3.82 percent, a minimum of 3.33 percent and a maximum rate of 19.19 percent.

4.3 Granger Causality test results

4.3.1 spurious regression test

A spurious regression test was conducted to check if the series was spurious in both version of data. A regression of GDP, inflation rate and interest rates were performed with aim to evaluate the value of R^2 with Durbin Watson (DW) value statistic. Decision rule of term, if R^2 value is greater than DW value statistic, an evidence the time series is not genuinely fit for the current study.The output of analysis of quarterly GDP, inflation and interest rates revealed that R-squared 0.09486 was less than the value of Durbin-Watson 1.205 an evidence that the series of the time series data are stationary and the outcome of the regression is not spurious and can be used in prediction and forecasting. Analysis of the following tables show results on regression and Durbin-Watson.

Call:				
$lm(formula = interest\ GDP + inflation)$				
Residuals:				
Coefficients:				
Approximates	Error	T.value	$Pr(>\|t\|)$	
(Intercept)	0.08068	0.27121	0.297	0.7678
GDP	-0.17272	0.24073	-0.717	0.4776
Inflation	0.22182	0.11671	1.900	0.0652
Multiple R-squared: 0.09486, Adjusted R-squared: 0.04594				

Table 3. Output R programming software

Durbin-watson test
$DW = 1.205, p - value = 0.004146$

Table 4. Summary of Durbin-Watson test of GDP,inflation rate and interest rates (2009-2019)

4.4 Discussion of the results

The current study applied Augmented Dickey Fuller test to check presence of unit root. Findings of the test realized that quarterly GDP rate being non stationary at level with test statistics value 0.4145 which is less than critical values at both 1 percent,5 percent

Augmented Dickey-Fuller Test Unit Root Test
Test regression none
Call:
$lm(formula = z.diff\ z.lag.1 - 1 + z.diff.lag)$
Value of test-statistic is: 0.4145
Critical values for test statistics:
1pct 5pct 10pct
$\tau 1 - 2.62 - 1.95 - 1.61$

Table 5. ADF unit root test quarterly data of GDP

Augmented Dickey-Fuller Test Unit Root Test
Test regression none
Call:
$lm(formula = z.diff\ z.lag.1 - 1 + z.diff.lag)$
Value of test-statistic is: -1.6153
Critical values for test statistics:
1pct 5pct 10pct $\tau 1 - 2.62 - 1.95 - 1.61$

Table 6. ADF unit root test Quarterly data of GDP after the first difference

and 10 percent (2.62,1.95.1.69) respectively, but after the first-difference it was stationary since the absolute value of test statistics (1.6153), greater than critical values at 10 percent (1.61), hence null hypothesis that their exist unit root content in the data in all level above is not accepted in favor that GDP rate is stationary.

However, same findings were realized on quarterly interest rates as test statistic value of 0.7871 was less than critical values at all levels, after the first difference a test statistics (3.7992), greater than critical values at all three level,10 percent (1.61), 1 percent (2.62),5 percent (1.95), null hypothesis that quarterly interest rate is non stationary is rejected at all levels in favor of alternative that interest rate is stationary after the first difference. Inflation rate was found non station at level with a test statistic value of 1.615 which is not greater than critical values at 1 percent and 5 percent (2.62,1.95) respectively but after the first difference the test static value of 3.8282 was realized which was more than critical values at all levels,1 percent,5 percent and 10 percent (2.62,1.95,1.61) respectively transforming the data to be stationary after the first difference The study applied R-programming software to analyze granger causality relationship between the two variables; interest rates and GDP, no formulation was necessary, the study applied following number of lags (1,2,3) to analyze the data and give a broad finding, otherwise in determining optimal lag structure for the model, Akaike Information Criterion is effective. The

Augmented Dickey-Fuller Test Unit Root Test
Test regression none
Call:
$lm(formula = z.diff\ z.lag.1 - 1 + z.diff.lag)$
Value of test-statistic is: -0.7871
Critical values for test statistics:
1pct 5pct 10pct
$\tau 1 - 2.62 - 1.95 - 1.61$

Table 7. ADF unit root test Quarterly data of interest rates

Augmented Dickey-Fuller Test Unit Root Test
Test regression none
Call:
$lm(formula = z.diff\ z.lag.1 - 1 + z.diff.lag)$
Value of test-statistic is: -3.7992
Critical values for test statistics:
1pct 5pct 10pct
$\tau 1$ -2.62 -1.95 -1.61

Table 8. ADF unit root test Quarterly data of interest rates after the first difference

table below highlights summary of the results;

Augmented Dickey-Fuller Test Unit Root Test
Test regression none
Call:
$lm(formula = z.diff\ z.lag.1 - 1 + z.diff.lag)$
Value of test-statistic is: -1.6153
Critical values for test statistics:
1pct 5pct 10pct
$\tau 1$ -2.62 -1.95 -1.61

Table 9. ADF unit root test on Quarterly data of Inflation rate

Augmented Dickey-Fuller Test Unit Root Test
Test regression none
Call:
$lm(formula = z.diff\ z.lag.1 - 1 + z.diff.lag)$
Value of test-statistic is: -3.8282
Critical values for test statistics:
1pct 5pct 10pct
$tau 1$ -2.62 -1.95 -1.61

Table 10. ADF unit root test Quarterly data of inflation rates after the first difference

H_0	lag	f-statistics	p-value
GDP do not	1	0.1104	0.7417
granger cause	2	0.1033	0.9021
interest rates	3	0.0885	0.9658
interest rates	1	0.0019	0.9655
do not granger	2	0.0101	0.9900
cause GDP	3	0.0061	0.9993

Table 11. summary findings

As evident from the tables above, there was insufficient evidence in all cases not to accept null hypothesis as the probability values were all great than 5 percent. However, in order to realize a more statistically detailed findings of granger causality relationship, a quarterly data of inflation rate was introduced as a variable, the aim was to visualize if combined previous values of inflation rates and GDP granger causes interest rates, an F statistics test was conducted to analyze the impact of restricting inflation rate from a full model containing previous values of variables under investigation. The table below shows findings realized;

$(INT)_t = D_t + \sum_i^t \beta_i (INT)_{t-i} + \sum_j^t \beta_j (GDP)_{t-j} + \sum_k^t \beta_k (INF)_{t-k} + \mu_t$.....full model

Call:

$lm(formula = DFI \sim DFI + Dgp + DFl)$

Coefficients:

(Intercept)	Dgp	DFl
0.08068	-0.17272	0.22182

Coefficients:

	Estimate	Std. Error	t value	$Pr(>\|t\|)$
(Intercept)	0.08068	0.27121	0.297	0.7678
Dgp	-0.17272	0.24073	-0.717	0.4776
DFl	0.22182	0.11671	1.900	0.0652

Residual standard error: 1.702 on 37 degrees of freedom

Multiple R-squared: 0.09486, Adjusted R-squared: 0.04594

Table 12. Summary of findings of the regression full model.

$(INT)_t = D_t + \sum_i^t \beta_i (INT)_{t-i} + \sum_j^t \beta_j (GDP)_{t-j} + \mu_t$....Restricted model

Call:				
$lm(formula = DFI \sim DFI + Dgp$				
Coefficients:				
(Intercept)	Dgp			
0.0210	-0.1234			
Coefficients:				
	Estimate	Std. Error	t value	$Pr(>\|t\|)$
(Intercept)	0.0210	0.2785	0.075	0.940
Dgp	-0.1234	0.2474	-0.499	0.621
Residual standard error: 1.759 on 38 degrees of Freedom				
Multiple R-squared: 0.006505, Adjusted R-squar ed: -0.01964				

Table 13. Summary of findings of the regression restricted model.

$$F - calculated = \frac{(0.09486 - 0.006505)/1}{(1 - 0.09486)/(40 - 3 - 1)}$$

$$F_{1,36} = 3.514$$

To interpret the F test statistics, value of R squared of the full model and that of restricted model was determined, which was very useful in determining F calculated above, a comparison was made with critical value on the table. A critical value F-statistic with (1,36) degree of freedom was 2. 850.In the current study, the aim was to identify if adding previous variables of inflation rate in a restricted model with explanatory variables (GDP) help in prediction model better in granger causal way.The results realized above shows that F calculated value (3.514) is more than F critical (2.850) value at 10 percent level of testing, hence a null hypothesis that coefficient of previous variable of inflation rate added and GDP is jointly equal to zero is rejected hence quite statistically definitive that adding previous values of inflation rate adds value to the model, i.e. values of quarterly data of inflation rate and GDP is granger causal on change on interest rates.

4.5 Chapter summary

The current chapter elaborated analyses conducted, outlined the methodology in detail and findings. Summary of descriptive statistics, stationarity and granger causality test was highlighted too. The third section provided findings on relationship between GDP,inflation rates and interest rates.

5 SUMMARY, CONCLUSION AND RECCOMEDATIONS

5.1 Introduction

In this chapter a representation of summary findings, and conclusion made on the study will be elaborated in detail, however, a recommendation for policy, practice and area of further academic research.

5.2 Summary

The study was carried out to empirically address the causal behavior and impact on interest rate changes in Kenya; if interest rates fluctuation is granger caused by changes in GDP and if inflation rate has a granger causal impact on interest rates. Quarterly data from 2009 to 2019 was applied for the investigation.

To check causality in different frequencies. Spurious regression test revealed that all variables in the time series data categories where legible, its outcome was deemed fit for further scientific testing as the regression was spurious. The results of stationarity test check revealed interest rates, GDP and inflation rate were non stationary at level form, but after conducting the first difference the variables were stationarity.

In order to consider the parsimony principle lag selection in stationarity check, selection was made automatic based on Akaike Information Criterion. Findings realized there exist no bidirectional or unidirectional granger causality on quarterly data (2009-2019) of interest rates and gross domestic product and that with inclusion of variables of inflation rate, the full model of F test fits the data better than the restricted model hence that leads to the quantification of granger causality.

5.3 Conclusion

In analysis of granger causality between interest rates and Gross Domestic Product, it was clear that neither bidirectional nor unidirectional granger causality relationship exist, basing on analysis findings on analysis of quarterly data of both variables from year 2009 to 2019 ,hence It was clearly that quarterly data of interest rates and Gross Domestic Product exhibit no granger causality relationship. With effect of using different lags (1,2,3) prior rates of Gross Domestic Product do not granger cause interest rates of the current time and vice versa although although it is said by researchers that interest rates and GDP statistically relates with each other in forecasting and prediction. However, in F test analysis conducted to evaluate if adding another previous variables inflation rates to the model with two previous values of variables interest rates and GDP have a significant effect or not the analyses realized that adding previous of inflation rates adds value to the model hence inflation rate is granger causal on interest rates.

5.4 Recommendation

Study recommends that, in an effort to contribute on a sustainable and stable economy , Gross Domestic Product is key macroeconomic factor in predicting interest rates, in long run a rise in gross domestic product will keep interest rates low, as with a booming economy, nationalities are satisfied with productions of good and services in current situation, interest rates regulator will be forced to lower rates to attract more customers.
Inflation rate on the other hand is crucial in investment decision making, as investments are more favorable to occur in a state with high rate of GDP and inflation rate since there is high probability of realizing high profit eventually. To ensure investors' confidence in Kenya economy, the government should ensure that appropriate institutional factors like fair trading policies and interest regulation policies are strengthened in a favorable and fair way that promote economic development.
Although inflation rates help improve significant of granger causality a further research analysis on the actual determiners of interest rates in an economy and extend on how such factors Impact interest rate fluctuations in Kenya. There is also need to research on long run equilibrium on variables which reflects cointegration. Johansen cointegration test can be explored to shade light if there exist long-run relationship.

5.5 References

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5.6 Appendix

GDP	interest rates	inflation	logGDP
135372	8.4167	14.70	11.815782
132385	8.0833	10.21	11.793470
131295	7.7500	7.51	11.785202
131893	7.2500	5.65	11.789746
144015	6.9167	5.03	11.877673
142209	6.7500	3.68	11.865053
142244	6.0000	3.33	11.865299
146886	6.0000	3.84	11.897412
156560	5.8333	7.05	11.961195
153198	6.0833	13.16	11.939486
152103	6.5000	16.51	11.932313
155507	15.1667	19.19	11.954446
161620	18.0000	16.87	11.993003
157759	18.0000	11.78	11.968824
156959	15.3333	6.38	11.963740
160381	11.6667	3.53	11.985308
171367	9.5000	4.08	12.051563
169194	8.8333	4.37	12.038801
166969	8.5000	7.00	12.025563
166487	8.5000	7.42	12.022673
238996	8.5000	6.78	12.384202
11191	8.5000	7.03	9.322865
110027	8.5000	7.54	11.608481
27366	8.5000	6.18	10.217057
57815	8.5000	5.82	10.965004
81987	9.0000	7.00	11.314316
13154	11.5000	6.14	9.484481
74172	11.5000	7.35	11.214142
42756	11.5000	7.62	10.663265
66374	10.8333	5.36	11.103061
42210	10.0000	6.33	10.650412
24303	10.0000	6.50	10.098355
90315	10.0000	8.77	11.411059
74915	10.0000	10.80	11.224109