KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

REGRESSION ANALYSIS ON THE IMPACT OF MACROECONOMIC VARIABLES AND BANKING CHARACTERISTICS ON LENDING INTEREST RATE

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Declaration

We hereby declare that this submission is our own work towards the award of the Bsc degree and that, to the best of our knowledge, it contains no material previously published by another person nor material which had been accepted for the award of any other degree of the university, except where due acknowledgement had been made in the text.

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Dedication

This research work is dedicated to our parents for their utmost support and also our project supervisor Dr. Gabriel Asare Okyere (PhD)

Abstract

Investors, policy makers and government are keen about interest and the rate at which changes in the macroeconomic variables influence interest rate. This is because interest rates is an important determinant of investment and also an indication whether both domestic and foreigners can invest within a certain period of time, therefore the factors that influence interest rate are critical to all major stakeholders including individual investors, government , policy makers, firms and the societies at large. The study seeks to investigate the impact selected macroeconomic factors have on interest rate. The GDP growth rate, inflation rates, monetary policy rates, treasury bill rates and exchange rate from 2000-2019 from BoG and GSS were examined. A multiple linear regression analysis of these this variable revealed that GDP growth rate, inflation rates, monetary policy rates, treasury bill rates had no effect on interest rate during the period of study whiles exchange rate had significant impact on interest rate. It was observed from the regression analysis that exchange rate had positive relationship with interest rate. With a correlation coefficient (r) of 0.803, there was a high correlation between interest rate and exchange rate. Coefficient of determination was used to describe the amount of variability explained by the set of independent variables. With an Adjusted R^2 value of 0.625, which implied that 62.5% of variability in the interest rate was explained by exchange rate. It is recommended that potential investors both domestic and foreign must therefore pay attention to the relationship that exist between interest rate and exchange rate in the long run. Government and policy makers are advised to ensure that exchange rates are kept at stable levels. The Bank of Ghana must also do well by stabilizing the exchange rate by strengthening their forex reserves due to the fact that exchange rate was significant in predicting interest rate.

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We would like to thank our supervisor Dr. Gabriel Asare Okyere (PhD) for his great supervision.

CONTENTS

List of Abbreviation

NIM ..... Net Interest Margin

MLR ..... Multiple Linear Regression

SPSS ..... Statistical Package for Social Science

ARDL ..... Autoregressive Distributed Lag

LOA ..... Loan Advance

ANOVA ..... Analysis Of Variance

GDP ..... Gross Domestic Product

BoG ..... Bank of Ghana

GSS ..... Ghana Statistical Service

GDP ..... Gross Domestic Product

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CHAPTER 1

Introduction

An essential role in the development of an economy is by promoting capital formation and raising economic growth in a country through the banking sector. Institutional investor, investors and the ordinary Ghanaian believe that the interest rate in Ghana is on the higher side. Financial institutions also on the other side claim the opposite.

Bawumia et.al (2005), stated that interest rate spread in Ghanaian Banking industry are among the highest in Africa.

Folawewo et.al (2008) in their research titled "Determinants of interest rate spread in Sub-Saharan African countries" found that different macroeconomic variables play significant role in explaining variation in interest rate spread in the region.

Dr. Kwakye(2010) indicated that during June 2009-June 2010, banks' average lending rate declined by 2.12% points as compared to declines of 3.50% and 12.93% points in the Policy Rate and the 91-day Treasury Bill rate respectively. He also stated that monetary authorities use interest rate policy as a tool for managing inflation, exchange rate and economic activity

Theoretically, we know that interest rates are dependent on inflation but this is not the case in Ghana. Factors for the high interest rates in developing countries are:

- High reserve requirements which acts as implicit financial tax.
- High operational cost; banks shifting cost of operation on customers.

• Macroeconomic instability may also affect pricing behavior of commercial banks.

• The cost of capital banks hold to cushion themselves against risk is relatively more expensive and may lead to high spread.

1.1 Background of the study

In economics, interest is the payment for the services of the capital provided, Williamson (1996) (thus, interest is the price of hiring a capital). McKinnon and shaw theoretical framework poses low real interest rates is incumbrance to savings

Stiglitz and Weiss (1981) states that interest rates cannot be the main allocator of credit as it can be used as a screening device between high risk and low risk borrowers who rather have the potentials to invest.

According to Asamoah and Adu (2016), banks' lending rate in Ghana are positively influenced by nominal exchange rate and bank of Ghana's monetary policy rate but negative with fiscal deficits, real GDP and inflation in the long run. They further found that there is a positive dependence of the bank lending rate on exchange rates and monetary policy rate both in the short and long run. They also revealed that Ghana's monetary policy rate and the exchange rate shows strong simultaneous effects on the average bank lending rate in Ghana.

1.2 Problem Statement

Lending behavior of bank generally depends on type of bank, the capital base, the deposit base, density of the deposit, interest rate, exchange rate, inflation, gross domestic product, investment portfolio, liquidity, monetary and fiscal phenomena, the credit guidelines issued from time to time by the regulatory authority and

internal policies of the banks (Olusanyaet.al ,2012) The critical question to ask is how does macroeconomic variables and Banking industry characteristics affect or impact interest rate in Ghana

1.3 Objectives

The main objectives of this study are to investigate the determinants of interest rate in Ghana;

• To investigate the existence of a long run relationship between interest rate, macroeconomic variables and banking industry characteristics

• To examine the short and long run effects of macroeconomic variables on interest rate in Ghana.

• To examine the short and long run effects of banking industry characteristics on interest rate in Ghana.

1.4 Methodology

1.4.1 Data Collection

The study exploited secondary data collected from the websites of the Bank of Ghana and Ghana Statistical Service.

1.4.2 Data Analysis

Using R studio, we will be able to discover the estimated coefficients of the independent variables (that is, the factors) which will permit us determine the appropriate model that best fits the data and their implication to the model.

1.5 Significance of the Study

The findings of the study will therefore be of policy relevance to the industry players in particular; the Bank of Ghana, Government and organisational and individual investors. The research will also contribute to the body of knowledge and serve as a reference for future studies.

1.6 Organization of the study

The study comprises of five chapters.

Chapter one of this study communicates the general knowledge of the subject matter and the grounds upon which our study is based. In addition is the problem statement and a skeleton of what this study is to achieve.

Chapter two of this study involves central literature overview and previous studies and some theoretical concept on interest rate. It also involves some preceding studies that have been undertaken to examine the relationships between the selected macroeconomic factors and interest rate.

Chapter three gives details on the methodology that is to be employed in analyzing the impact macroeconomic factors have on share prices.

Chapter four reports the results of the data analysis and discussions.

Chapter five provides conclusions and the relevant recommendations made based on the analysis.

CHAPTER 2

Literature Review

2.1 Concept of Interest Rate

An interest rate is the amount of interest due per period, as a proportion of the amount lent, deposited or borrowed (called the principal sum). The total interest on an amount lent or borrowed depends on the principal sum, the interest rate, the compounding frequency, and the length of time over which it is lent, deposited or borrowed. It is defined as the proportion of an amount loaned which a lender charges as interest to the borrower, normally expressed as an annual percentage. It is the rate a bank or other lender charges to borrow its money, or the rate a bank pays its savers for keeping money in an account. The annual interest rate is the rate over a period of one year. Other interest rates apply over different periods, such as a month or a day, but they are usually annualised.
From an economic perspective, interest can be viewed as either the compensation received for deferring consumption, or the cost of consuming when resources are not available. Some people require a greater incentive to save, while others require a greater incentive to borrow, Bean (2017).

There are essentially three main types of interest rates: the nominal interest rate, the effective rate, and the real interest rate. The nominal interest of an investment or loan is simply the stated rate on which interest payments are calculated. Essentially, this is the rate on which savings accrue interest over a period of time The effective interest rate takes into account compounding over the full term of the investment. It is often used to compare the annual interest rates with different compounding terms (daily, monthly, annually, etc.). This

means that a nominal interest rate of 5% compounded quarterly would equate to an effective rate of 5.095%, compounded monthly at 5.116%, and daily at 5.127%. Finally, the real interest rate is useful when considering the impact of inflation on nominal interest rates. In essence, the real interest rate deducts the rate of inflation from the nominal interest rate. This means that if the nominal interest rate is 5% and the inflation rate is also 5%, the real interest rate is effectively 0%.

2.2 Determinants of Interest Rate in Non-African Countries

Demirguc and Huizinga (1998) investigated the effect of microeconomic and macroeconomic factors on the commercial banks margin in eighty (80) industrial and developing countries over the period 1988-1995. Their results indicated that, ceteris paribus, assets to GDP ratio reduces the bank margin. Lower interest margins are also influenced by lower market concentration ratio. Gigineishvili (2011), Numerous empirical studies have found that the strength of the interest rate pass-through varies markedly across countries and markets. The causes of such heterogeneity have attracted considerably less attention so far. Unlike other studies that mainly focus on small groups of mostly developed and emerging markets in the same region, this paper expands the cross-sectional coverage to 70 countries from all regions, including low income, emerging and developed countries. It uses a wide range of macroeconomic and financial market structure variables to uncover structural determinants of pass-through. The paper finds that per capita GDP and inflation have positive effects on pass-through, while market volatility has a negative effect. Among financial market variables exchange rate flexibility, credit quality, overhead costs, and banking competition were found to strengthen pass-through, whereas excess banking liquidity to impede it. In Pakistan, Ali et. al (2016) analysis of some inner factors affecting the lending rate and commercial bank behavior revealed that only four out of seven

explanatory variables (ratio of investment to total assets, deposit to asset, loan to asset and liquidity ratio) have a significant relationship with lending rate. Two of the significant determinants (liquidity ratio and investment to asset ratio) are positively correlated while the remaining two significant explanatory variables (loan to asset ratio and deposit to asset ratio) are found to be negatively correlated with lending rate.For this purpose, seven bank-specific explanatory variables (capital adequacy, management efficiency, liquidity, asset quality, investment to asset, loan to asset and deposit to asset ratios) were selected to determine their impact on lending behavior.

In Latin America, Gelos (2006) established that high interest rates and reserve requirements were key contributors to high interest rate spreads, while GDP growth was associated with narrower interest rate spreads. Hakan and Malatyali (2001) analyzed the Determinants of Interest Rates in Turkey using Fisher hypothesis framework as the reference point suggested that anticipated inflation is the main determinant of interest rates: as the inflation rate increases by 1 percent, the rate of interest increases by 1 percent. This suggests that anticipated interest rates change in proportion to anticipated changes in inflation, or that anticipated real interest rates are invariant to the anticipated inflation.

2.3 Determinants of Interest Rate in African Countries

Aboagye et.al (2019) examined the effect of financial (banking) freedom and market power on bank net interest margins (NIM). The study uses data from 11 sub-Saharan African countries over the period, 2006-2012, and the system generalized method of moments to assess how financial freedom affects the relationship between market power and bank NIM. The authors found that both financial freedom and market power have positive relationships with bank NIM. However, there is some indication that the impact of market power on bank

margins is sensitive to the level of financial freedom prevailing in an economy. It appears that as competition intensifies, margins of banks in freer countries are likely to reduce faster than those in areas with more restrictions. Chirwa and Mlachila (2002) revealed that the wide interest rate spreads were associated with high discount rates (or bank rate), high reserve requirements (implicit tax) and high inflation rates in Malawi. In Kenya, Ngugi (2001) found that monetary policy tightening and increasing the treasury bills rate widened the interest spread. Mokaya et.al (2017), found that bank size and operation costs, had positive and significant effects whiles GDP growth rate had a negative effect on lending rates. Crowley (2007) found that higher reserve requirements were associated with higher interest rate spreads in English speaking African country. Olokoyo(2011), investigated the determinants of commercial banks' lending behaviour from a Nigerian perspective. The study aimed to test and confirm the effectiveness of the common determinants of commercial banks lending behaviour and how it affects the lending behaviour of commercial banks in Nigeria. The model used is estimated using Nigerian commercial banks loan advance (LOA) and other determinants or variables such as their volume of deposits (Vd), their investment portfolio (Ip), interest (lending) rate (Ir), specified cash reserve requirements ratio (Rr) and their liquidity ratio (Lr) for the period; 1980 – 2005. The model assumes that there is functional relationship between the dependent variable and the specified independent variables. From the regression analysis, the model was found to be significant and its estimators turned out as expected and it was discovered that commercial banks deposits have the greatest impacts on their lending behaviour. Taye (2019), investigated the determinants of lending interest rate of private commercial banks in Ethiopia. The study employed balanced panel model in investigating the regression model and collect data from eight private commercial banks covering the period of ten (10) consecutive years, 2008-2017 with a total of 80 observations. The study used a quantitative research approach by documentary analysis based on their audited financial statement.

The study employed panel data techniques specifically fixed effect model on the regression analysis and used E-view8 software. He used 'lending interest rate' as dependent variable, while: deposit rate, bank size, liquidity ratio, operating cost to total asset ratio, profitability, market concentration, and inflation rates are explanatory variables. The estimated regression results reveal that the liquidity ratio, profitability ratio and bank size had significant and negative effect on lending interest rate. Deposit rate, operating cost to total asset ratio, market concentration has positive and statistically significant effect on lending interest rate. Inflation rate has positive and statistically insignificant effect on lending interest rate of Ethiopian private commercial banks. Fom the regression result operating cost to total asset ratio and lending interest rate has a positive influence on private commercial banks of Ethiopia. This result is justified as high operating costs are likely to include costs due to inefficiency leading to higher lending interest rate. Banda(2011) the study investigates the effects of inflation, exchange rate volatility, reserve requirements and discount rates on interest rate spreads. The study uses Ordinary Least Squares to estimate the Log-Linear regression model to explain the main determinants of interest rate spreads in Zambia. Quarterly time series data is used from 1995 to 2008 and it was collected from the Bank of Zambia. The study found exchange rate volatility and inflation rate to be statistically insignificant

2.4 Determinants of Interest Rate in Ghana

According to Asamoah and Adu(2016), banks lending rate in Ghana are positively influenced by nominal Exchange rates and Bank of Ghana's monetary policy rate but negative with fiscal deficit, real GDP and inflation in the long run. There is a positive dependence of the Bank lending rate on the Exchange rates and monetary policy rate both in the short and long run. Asamoah and Adu also revealed that Ghana's Monetary policy rate and the Exchange rate show strong contemporaneous effects on the Average Bank Lending rates in Ghana.

Ackah(2016) revealed that in the long run, Treasury bill rate and the total deposit mobilized by the banks have a significant and negative effect on the interest rate spread, whiles exchange rate have a significant and positive effect on the interest rate spread. In the short run, real GDP, treasury bill rate, total deposit mobilized by the banks and exchange rate have a negative effect on interest rate spread whiles inflation has a positive effect on interest rate spread. The study has demonstrated the importance of macroeconomic stability in reducing the spread in interest rate in Ghana. Specifically, inflation, exchange rate, Treasury bill rate and real GDP have important implication on the interest rate spread in Ghana. Aboagye et.al(2008), found that increases in the following factors significantly increase net interest margin — bank market power (or concentration), bank size, staff costs, administrative costs, extent of bank risk aversion and the rate of inflation. On the other hand, increases in the following variables decrease net interest margin significantly — bank excess cash reserves, the central bank lending rate, management efficiency and the passage of time. To help reduce interest rate margins, Aboagye, et al (2008) also used the banking sector specific variables, macroeconomic indicators among others to ascertain their influence on the spread in interest rate. For them, the industry specific variables are key in influencing interest rate spread. Their results revealed that the high rates on Treasury bill as well as surplus bank reserves leads to the lessening of the spread on interest rates. Their study also found out that high inflation, administrative and operational costs, monopoly power and the extent of risk averseness of the banks makes to increase the net interest margin. Saka and Aboagye(2012), suggested that efficiency of domestic banks has been positively affected by the entry of foreign banks and reduction in concentration. The effects of the entry of foreign banks and changes in bank concentration on the technical efficiency of domestic banks in Ghana over the period 2000–2008 is analyzed. Technical efficiency scores were obtained by the Data Envelopment Analysis. Then, the Tobit regression was used to analyze the impact of hypothesized explanatory variables on bank

efficiency. Foreign bank share of total industry assets was used to proxy the impact of foreign banks. Osei et.al(2013) investigated the determinants of bank lending behaviour in Ghana. Using the GMM-System estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998), they find that bank size and capital structure have a statistically significant and positive relationship with bank lending behaviour. They also revealed that there is a negative and significant impact of some macroeconomic indicators (central bank lending rate and exchange rate) on bank lending behavior.

Takyi and Obeng(2013) analyzed the determinants of financial development in Ghana using the Autoregressive Distributed Lag (ARDL) approach. Using quarterly data from 1988 to 2010, the study found a unique cointegrating relationship between financial development trade openness, inflation, per capita income, reserve requirement and government borrowing. The regression results show that trade openness and per capita income are important determinants of financial development in Ghana. Further, inflation, interest rate, and reserve requirement exerted negative and statistically significant effects on financial development both in the short-run and long-run suggesting that these variables adversely influence financial development in Ghana. However, government borrowing did not have any significant effect on financial development both in the long-run and short-run suggesting that higher government borrowing from banking sector will not have any significant effect on private credit or even crowd in private sector credit

Amuakwa-Mensah and Marbuah (2015) researched into the determinants of net interest margin and the role of the financial crisis in explaining net interest margin (NIM) in the banking industry in Ghana. Upon assessing the sensitivity of their results to the measure of credit risk. They realized a sharp drop in NIM and an increase in bad debt growth during the 2007–2009 financial crisis in Ghana's banking sector. Generally, they observed that NIM is explained by bank-specific, industry and macroeconomic factors. We find risk aversion, operating

cost, inflation rate and previous year's GDP growth to be robust drivers of NIM.

CHAPTER 3

Methodology

3.1 History of Regression

The earliest form of regression was the method of least squares, which was published by Legendre in 1805, and by Gauss in 1809. Legendre and Gauss both applied the method to the problem of determining, from astronomical observations, the orbits of bodies about the Sun (mostly comets, but also later the then newly discovered minor planets). Gauss published a further development of the theory of least squares in 1821, including a version of the Gauss–Markov theorem. The term "regression" was coined by Francis Galton in the nineteenth century to describe a biological phenomenon. The phenomenon was that the heights of descendants of tall ancestors tend to regress down towards a normal average (a phenomenon also known as regression toward the mean). For Galton, regression had only this biological meaning, but his work was later extended by Udny Yule and Karl Pearson to a more general statistical context. In the work of Yule and Pearson, the joint distribution of the response and explanatory variables is assumed to be Gaussian. This assumption was weakened by R.A. Fisher in his works of 1922 and 1925. Fisher assumed that the conditional distribution of the response variable is Gaussian, but the joint distribution need not be. In this respect, Fisher's assumption is closer to Gauss's formulation of 1821. In the 1950s and 1960s, economists used electromechanical desk "calculators" to calculate regressions. Before 1970, it sometimes took up to 24 hours to receive the result from one regression. Regression methods continue to be an area of active research. In recent decades, new methods have been developed for robust regression, regression involving correlated responses such as time series

and growth curves, regression in which the predictor (independent variable) or response variables are curves, images, graphs, or other complex data objects, regression methods accommodating various types of missing data, nonparametric regression, Bayesian methods for regression, regression in which the predictor variables are measured with error, regression with more predictor variables than observations, and causal inference with regression.

3.2 Regression Model

3.2.1 Response Variable

The response variables represent the outcome whose variation is being studied. It is the event of interest and considered likely to change whenever the controlled variable is manipulated. A response variable is also known as a "dependent"," explained"," regressand", "endogenous"," predictand", "outcome"," uncontrolled". It is usually denoted as Y. In study the response variable is commercial leading interest rate.

3.2.2 Stimulus Variable

The stimulus represents causes, that is, possible reasons for variation. A stimulus variable is also known as" independent"," explanatory"," regressor", "exogenous", "predictor", "covariate", "controlled" variable. It is usually denoted by X. In this study the stimulus variables are inflation rate, GDP growth rate, monetary policy rate, treasury bill rate and exchange rate.

3.3 Multiple Linear Regression

The general purpose of multiple linear regression is to seek for the linear relationship between a dependent variable and several independent variables. Multiple regression allows researchers to examine the effect of more than one

independent variables on response at the same time. In this study, the dependent variable identified is the commercial lending interest rate whiles the independent variables include inflation rate, GDP growth rate, monetary policy rate, treasury bill rate and exchange rate. This technique will help establish the linear relationship (if any) between the commercial lending interest rate and the selected macroeconomic variables.

3.3.1 Assumptions of Multiple Regression Analysis Model

The Multiple Linear Regression model is based on several assumptions, some of which are elaborated below;

1. Linearity: the relationship between the explained variable and the predictors is linear. The MLR model applies to linear relationships.If relationships are nonlinear,there are two recourses:

   •Transform the data to make the relationships linear

   •Use an alternative statistical model (e.g., neural networks, binary classification trees).

   •Scatterplots should be checked as an exploratory step in regression to identify possible departures from linearity

2. Zero mean: The expected value of the residuals is zero. This is not a problem because the least squares method of estimating regression equations guarantees that the mean is zero.

3. Constant variance: The variance of the residuals is constant. In time series applications, a violation of this assumption is indicated by some organized pattern of dependence of the residuals on time. An example of violation is a pattern of residuals whose scatter (variance) increases over time. Another aspect of this assumption is that the error variance should not change systematically with the size of the predicted values. For example, the

variance of errors should not be greater, when the explained variable is large than the explained variable is small.

4. Normality: the error term is normally distributed. This assumption must be satisfied for conventional tests of significance of coefficients and other statistics of the regression equation to be valid. It is also possible to make no explicit assumption about the form of the distribution and to appeal instead to the Central Limit Theorem to justify the use of such tests. The normality assumption is the least crucial of the regression assumptions.

3.4 Estimation Parameters of Multiple Linear Regression Model

Consider a multiple linear regression model with k predictor variables:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \epsilon$$

$$Y_1 = \beta_0 + \beta_1 X_{11} + \beta_2 X_{12} + ... + \beta_k X_{1k} + \epsilon_1$$

$$Y_2 = \beta_0 + \beta_1 X_{12} + \beta_2 X_{22} + ... + \beta_k X_{2k} + \epsilon_2$$

$$\dots$$

$$Y_n = \beta_0 + \beta_1 X_{n1} + \beta_2 X_{n2} + ... + \beta_k X_{nk} + \epsilon_n$$

The system of n equations shown previously can be represented in matrix notation as follows:

$$y = x\beta + \epsilon \tag{3.1}$$

Where;

$$y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} \quad x = \begin{bmatrix} 1 & x_{11} & x_{12} & \dots & x_{1k} \\ 1 & x_{21} & x_{22} & \dots & x_{2k} \\ 1 & \vdots & \vdots & \ddots & \vdots \\ 1 & x_{n1} & x_{n2} & \dots & x_{nk} \end{bmatrix} \quad \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_n \end{bmatrix} \quad \epsilon = \begin{bmatrix} \epsilon_1 \\ \epsilon_2 \\ \vdots \\ \epsilon_n \end{bmatrix}$$

The matrix x is referred to as the design matrix. It contains information about the levels of the predictor variables at which the observations are obtain. The vector β contains all the regression coefficients. To obtain the regression model, β should be known. β is estimated using least square estimates as shown below

$$\epsilon = y - x\beta \tag{3.2}$$

$$\epsilon^T\epsilon = (y - x\beta)^T(y - x\beta)$$
$$\epsilon^T\epsilon = y^Ty - 2\beta x^Ty + \beta^2 x^Tx$$

By Least Square Method

$$\frac{\partial \epsilon^T\epsilon}{\partial \beta} = -2x^Ty + 2\beta x^Tx = 0$$
$$x^Ty = x^Tx\beta$$

$$\hat{\beta} = (x^Tx)^{-1}x^Ty \tag{3.3}$$

Where T represents the transpose of the matrix while $(^{-1})$ represents the matrix inverse. Knowing the estimates, β and the multiple linear regression models can now be estimated as

$$\hat{y} = x\hat{\beta} \tag{3.4}$$

The estimated regression model is also referred to as the fitted model. The observations y_n may be different from the fitted values $\hat{y_n}$ obtained from this model. The difference between these two values is the residual, ϵ_n. The vector of residuals, ϵ is obtained as

$$\epsilon_n = y_n - \hat{y_n} \tag{3.5}$$

The fitted model can also be written as follows, using

$$\hat{\beta} = (x^Tx)^{-1}x^Ty$$
$$H = (x^Tx)^{-1}x^T$$

$$\hat{\beta} = Hy \tag{3.6}$$

The matrix H is referred to as the hat matrix, which transforms the vector of the observed response values, y to the vector of the fitted values $\hat{y}$.

3.5 Estimating the variance and covariance of the error term

$$E[\epsilon^T \epsilon] = \begin{bmatrix} \epsilon_1^2 & \epsilon_1\epsilon_2 & \dots & \epsilon_1\epsilon_n \\ \epsilon_2\epsilon_1 & \epsilon_2^2 & \dots & \epsilon_2\epsilon_n \\ \vdots & \vdots & \ddots & \vdots \\ \epsilon_n\epsilon_1 & \epsilon_n\epsilon_2 & \dots & \epsilon_n^2 \end{bmatrix}$$

But $\epsilon \sim N(0, \sigma^2)$

$$E[\epsilon^T \epsilon] = \begin{bmatrix} E[\epsilon_1^2] & 0 & \dots & 0 \\ 0 & E[\epsilon_2^2] & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & E[\epsilon_n^2] \end{bmatrix}$$

$$Var[\epsilon] = E[\epsilon^2] - (E[\epsilon])^2$$

$$E[\epsilon^2] = \sigma^2$$

$$E[\epsilon^T \epsilon] = \begin{bmatrix} \sigma^2 & 0 & \dots & 0 \\ 0 & \sigma^2 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \sigma^2 \end{bmatrix} = \sigma^2 \begin{bmatrix} 1 & 0 & \dots & 0 \\ 0 & 1 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1 \end{bmatrix}$$

$$E[\epsilon^T \epsilon] = \sigma^2 I_n \tag{3.7}$$

3.6 Properties of the least square estimators

3.6.1 Bias

$\hat{\beta}$ is unbiased estimator of β for the Multiple Linear Regression

From equations 3.1 and 3.3;

$$\hat{\beta} = (x^T x)^{-1} x^T (x\beta + \epsilon)$$
$$\hat{\beta} = (x^T x)^{-1} x^T x\beta + (x^T x)^{-1} x^T \epsilon$$
$$\text{but, } (x^T x)^{-1} x^T x = I_n$$

$$\hat{\beta} = \beta + (x^T x)^{-1} x^T \epsilon \tag{3.8}$$

$$E[\hat{\beta}] = \beta + (x^T x)^{-1} x^T E[\epsilon]$$

$$E[\hat{\beta}] = \beta \tag{3.9}$$

3.6.2 Linearity

Linearity is implicit in $\hat{\beta}$

3.6.3 Covariance of $\hat{\beta}$

$$Cov(\hat{\beta}) = E[(\hat{\beta} - E(\hat{\beta}))(\hat{\beta} - E(\hat{\beta}))^T$$

$$Cov(\hat{\beta}) = E[(\hat{\beta} - \beta)(\hat{\beta} - \beta)^T \tag{3.10}$$

From equation 3.8

$$\hat{\beta} - \beta = (x^T x)^{-1} x^T \epsilon \tag{3.11}$$

$$Cov(\hat{\beta}) = E[((x^T x)^{-1} x^T \epsilon)((x^T x)^{-1} x^T \epsilon^T)]$$

$$Cov(\hat{\beta}) = (x^T x)^{-1} x^T x E[\epsilon^2](x^T x)^{-1}$$

$$Cov(\hat{\beta}) = (x^T x)^{-1} \sigma^2 I_n$$

Hence, the variance property of $\hat{\beta}$ has been expressed by the covariance matix; which is a symmetric matix whose ith main diagonal element is the variance of the individual regression coefficient $\hat{\beta}_i$ and whose $(i, j)th$ element is the covariance between $\hat{\beta}_i$ and $\hat{\beta}_j$.

3.6.4 The unbiased estimator of the variance in the multiple linear regression

$$The\ fitted\ model\ is \qquad \hat{y} = x\hat{\beta}$$

$$y = x\beta + \epsilon \qquad \Rightarrow \qquad \epsilon = y - x\beta$$

$$SSE = \sum_{I=1}^{n} (y_i - \hat{y})^2$$

$$SSE = \sum_{I=1}^{n} (\epsilon_i)^2 = \ \epsilon^T \epsilon$$

$$SSE = (y - x\beta)^T (y - x\beta)$$

$$SSE = y^T y - y x^T \beta^T - y^T x\beta + x^T \beta^T x\beta$$

$$SSE = y^T y - 2\beta^T x^T y + \beta^T x^T y$$

$$SSE = y^T y - 2\beta^T x^T y + \beta^T x^T y$$

$$SSE = y^T y - \beta^T x^T y$$

This is called residual sum of squares, and it has $(n - p)$ degrees of freedom associated with it

The mean square for error is

$$MSE = \frac{SSE}{n-p} = \frac{1}{n-p} \sum_{I=1}^{n} (y_i - \hat{y})^2$$

It can be shown that the expected value of MSE is σ^2;thus an unbiased estimated of σ^2 is given by

$E[MSE] = \hat{\sigma}^2$,here p is the number of parameters in the model.

3.7 Coefficient of Correlation

Linear correlation coefficient, measures the strength and the direction of a linear relationship between two variables. The linear correlation coefficient is sometimes referred to as the Pearson product moment correlation coefficient in honor of its developer Karl Pearson. It is denoted by "r". For example, the strength of the relationship (if any) between the commercial lending interest rate and the selected macroeconomic variables can be measured by the correlation coefficient.

$$r = \frac{Cov(x, y)}{\sqrt{Var\,(x)\,Var(y)}}$$

$$r = \frac{n\sum_{i=1}^{n} xy - \sum_{i=1}^{n} x \sum_{i=1}^{n} y}{\sqrt{n(\sum_{i=1}^{n} x^2) - (\sum_{i=1}^{n} x)^2}\,\sqrt{n(\sum_{i=1}^{n} y^2) - (\sum_{i=1}^{n} y)^2}}$$

The correlation coefficient assumes value within the interval $-1 \leq r \leq 1$, which is a dimensionless quantity;it does not depend on the units employed.

3.8 Analysis of Variance

Analysis of variance (ANOVA) is a collection of statistical models used to analyze the differences among group means and their associated procedures (such as "variation" among and between groups), developed by statistician and evolutionary biologist Ronald Fisher. In the ANOVA setting, the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form, ANOVA provides a statistical test of whether or not the means of several groups are equal, and therefore generalizes the t-test to more than two groups. As doing multiple two-sample t-tests would result in an increased chance of committing a statistical type I error, ANOVAs are useful for comparing (testing) three or more means variables for statistical significance.

Its general form is given by the ANOVA table shown below,

Table 3.1: ANOVA table

Sources	Degrees of freedom	Sum of Squares	Mean Square	F-Statistic
$Regression$	k	SSR	$MSR = \frac{SSR}{p-1}$	$F^* = \frac{MSR}{MSE}$
$Residual$	$n-(k+1)$	SSE	$MSE = \frac{SSE}{n-(k+1)}$	
$Total$	$n-1$	SST		

$Null\ Hypothesis \qquad H_0: \qquad \beta_j = 0 \qquad for\ all \qquad 0 \leq j \leq 5$

$Alternative\ Hypothesis \qquad H_a: \qquad \beta_j \neq 0 \qquad for\ at\ least\ one \qquad 0 \leq j \leq 5$

F-Statistic $(F^*) = \dfrac{MSR}{MSE}$

Critical Value $\sim F_k, n-(k+1), \alpha$

Decision Rule;

- When the F^* obtained is less than the critical value $F_k, n-(k+1), \alpha$, we fail to reject H_0 and conclude that the regression model is inefficient . • When the F^* obtained is greater than the critical value $F_k, n-(k+1), \alpha$, we reject H_0 and conclude the model is useful in predicting the values of commercial bank lending rate for a given macroeconomic variable.

3.9 Coefficient of Determination

The coefficient of determination is a measure of how well the regression line represents the data. If the regression line passes exactly through every point on the scatter plot, it would be able to explain all of the variation. The further the line is away from the points, the less it is able to explain. It is denoted by $R.^2$ It is useful because it gives the proportion of the variance of one variable that is predictable from the other variable. It is a measure that allows us to determine how certain one can be in making predictions from a certain model.
It is such that $0 < r^2 < 1$, and denotes the strength of the linear association between commercial bank lending interest rate and macroeconomic variable.

$$R^2 = \frac{SSR}{SST}$$

$$Since, \quad SSR = SST - SSE$$

$$R^2 = 1 - \frac{SSE}{SST}$$

CHAPTER 4

Data Analysis

4.1 Introduction

For the purpose of this study, we obtained a secondary monthly data which was converted to yearly data by averaging the data from Bank of Ghana to determine the relationship between commercial lending interest rate and the selected macroeconomic variables. Yearly data on commercial leading interest rate, inflation rate, GDP growth rate, monetary policy rate, treasury bill rate and exchange rate. which were collected from 2000 to 2019. This data was analyzed by employing the technique of multiple regression analysis as discussed in the methodology through R Studio and the statistical package for social science (SPSS).

4.2 Summary Statistic

Table 4.1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.803[a]	.645	.625	3.91845	1.068

a. Predictors: (Constant), Exchange Rate
b. Dependent Variable: Commercial Lending Interest Rate

From Table 4.1, the coefficient of correlation for the fitted model was 0.803 which signifies a weak positive relationship between the commercial leading interest rate and the independent variable (Exchange Rate). Further, the adjusted coefficient of determination (R^2) obtained was 0.625 which signifies that 62.5% of the variability in the commercial leading interest rate can be explained by the

independent variable. The Durbin-Watson value of 1.068 suggest that there's a serial correlation in the dataset.

Table 4.2: Anova Table Result

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	502.078	1	502.078	32.700	.000[b]
Residual	276.376	18	15.354		
Total	778.454	19			

From the ANOVA TABLE in 4.2, a Fisher value (F-value) of 32.700 with a probability value (p-value) of 0.000 which implies that at least one of the five(5) independent variables (inflation rate, GDP growth rate, monetary policy rate, treasury bill rate, exchange rate) is significant in estimating the commercial bank leading rate.

4.3 Regression Analysis Results

Table 4.3: Summary of coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	22.566	1.493		15.113	.000
	Exchange_Rate	3.398	.594	.803	5.718	.000

a. Dependent Variable: Commercial Lending Interest Rate

$B_0 = 22.566$ indicating commercial lending interest rate when Exchange rate is Zero.

$B_1 = 3.398$ indicating commercial lending interest rate with a unit increase in exchange rates.

In the assessment of which of the independent variables is actually significant in estimating commercial leading interest rate, the following t-value and p-values

were obtained.

Table 4.4: Anova Table

Independent variables	t- value	P-value	Decision Rule
Treasury_Bill_Rate	-1.577	1.33	reject H_0
Inflation_Rate	-.559	.584	reject H_0
GDP_Growth_Rate	.154	.879	reject H_0
Monetary_Policy_Rate	-1.049	.309	reject H_0
Exchange_Rate	5.718	0.000	Fail to reject H_0

Hence the regression equation is commercial leading interest rate= 22.566 + 3.398Exchange rate

From table table 4.3, the exchange rate is significant in estimating commercial leading interest rate during the period of study because the p-value was less than 0.05 whiles inflation rate, GDP growth rate, treasury bill rate and monetary policy rate are not significant in estimating commercial leading interest rate during the period of study because the p-value was greater than 0.05.

Microsoft Excel was employed to obtain a graphical representation of dependent variable and independent variables against the period of study (years).

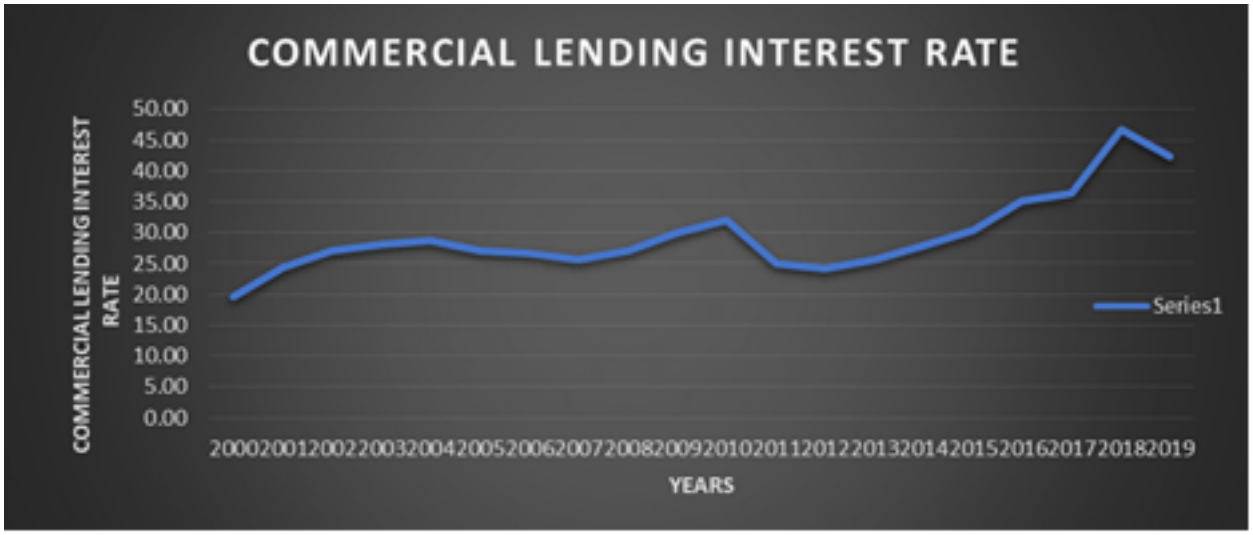

Figure 4.1: Line graph of commercial bank lending rate against years.

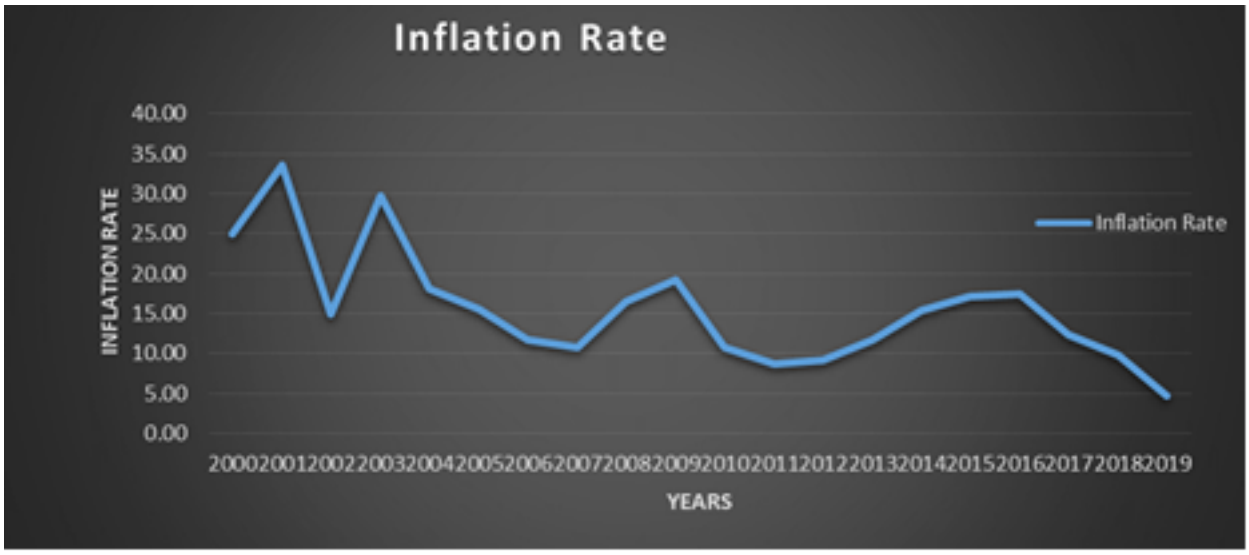

Figure 4.2: Line graph of inflation rate against years.

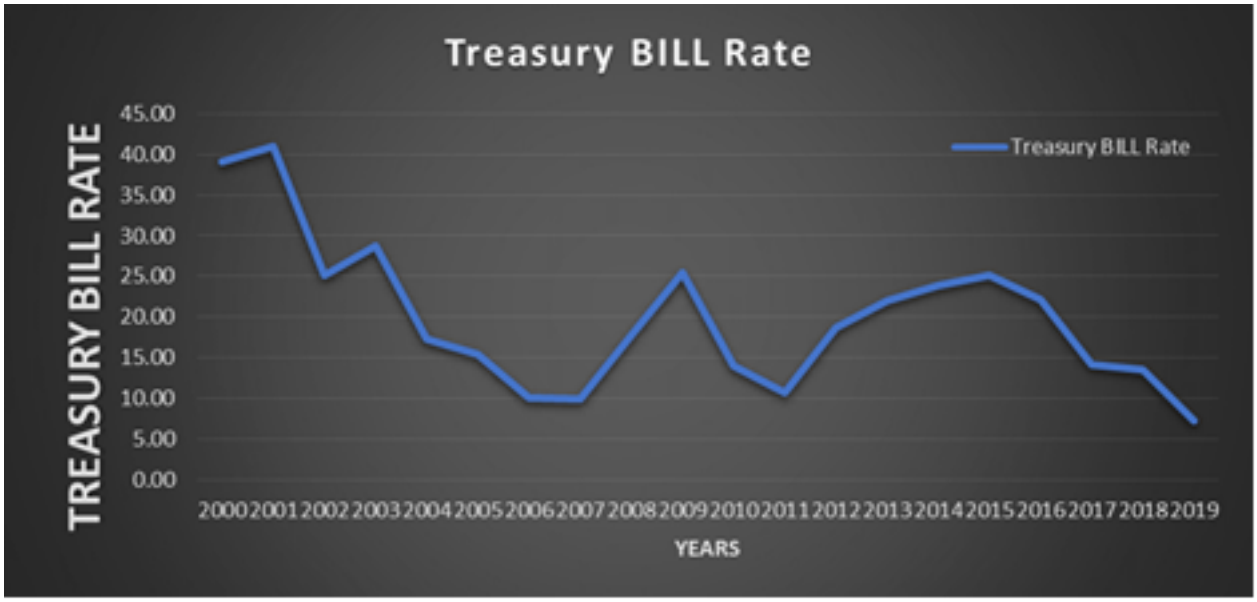

Figure 4.3: Line graph of teasury bill rate against years.

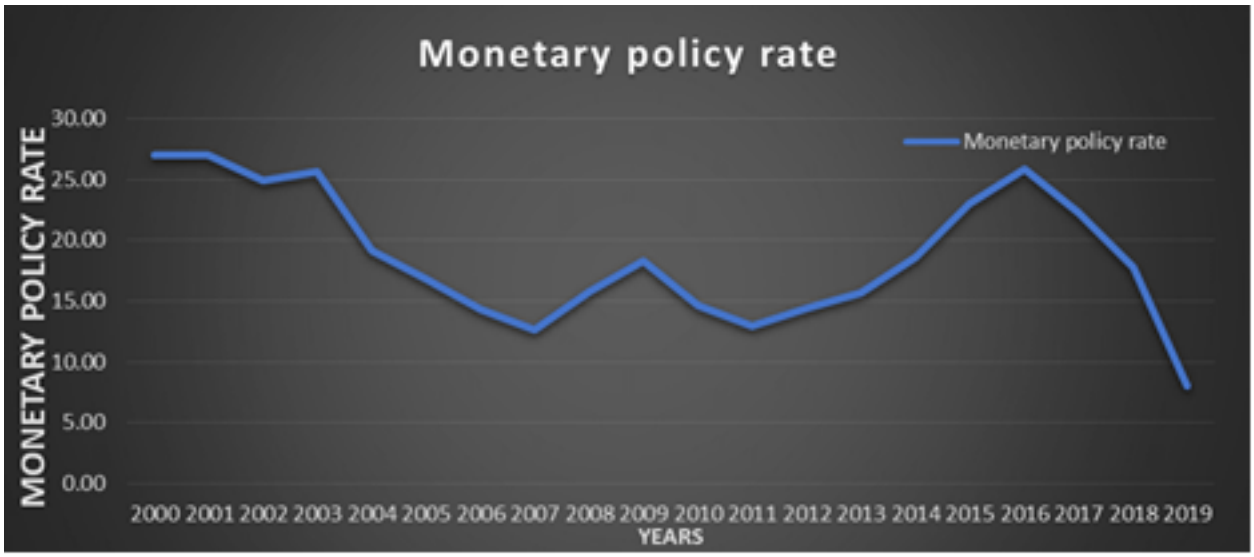

Figure 4.4: Line graph of monetary policy rate against years.

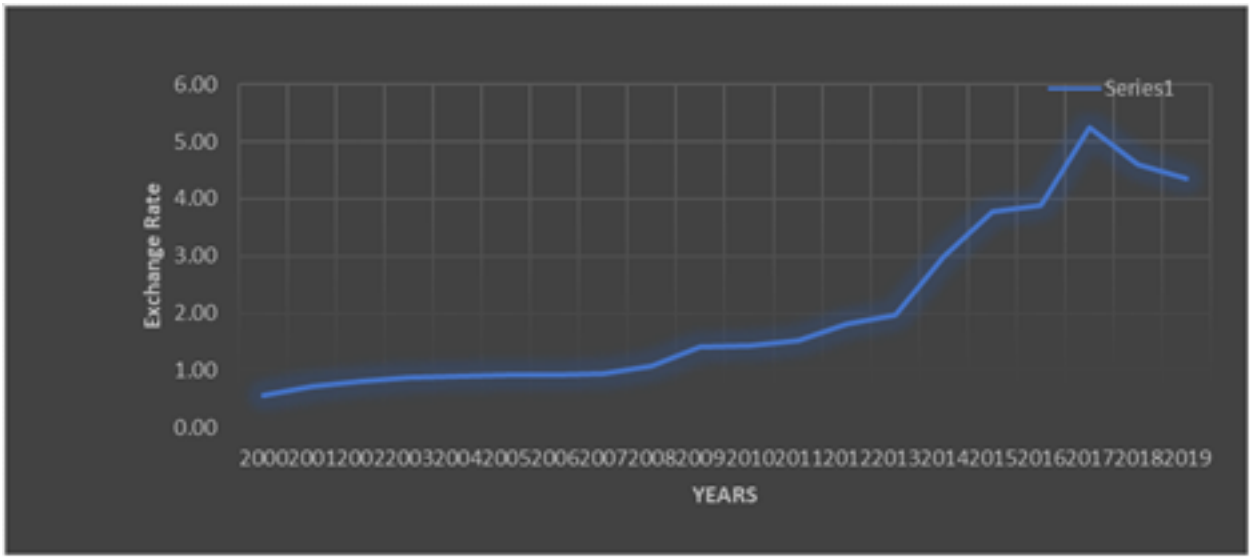

Figure 4.5: Line graph of exchange rate against years.

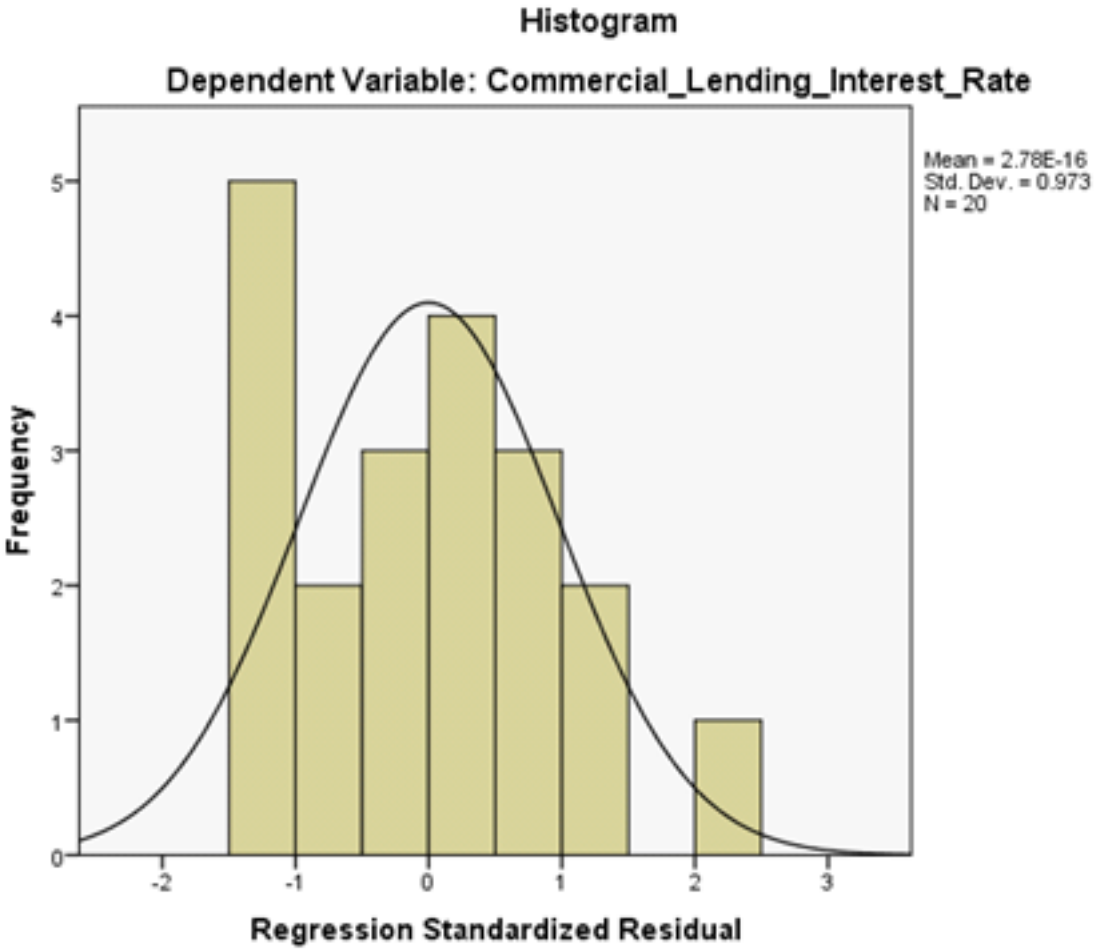

Figure 4.6: Testing the normality of the data

From the histogram illustrated above, it can be seen that the data used for this study satisfies the assumption of normality in the sense that it complies with the bell shaped assumption of the normal distribution.

4.4 Discussion of Findings

There was a significant relationship between commercial lending interest rate and Exchange rate. This study shows that not all selected macroeconomic variables have a significant effect on commercial lending interest rate.

With a correlation coefficient (R) of 0.803, there is a high positive correlation between commercial lending interest rate and Exchange rate.

Coefficient of determination is used to describe the amount of variability explained

by a set of independent variables, with an Adjusted R^2 value of .625, this implies that 62.5% of the variability in

commercial lending interest rate by Exchange rate, with the remaining 37.5% explained by factors not included in the model but catered for by the error term ϵ.

Hence the regression equation is:

$$\textit{commercial leading interest rate} = 22.566 + 3.398\text{Exchange\_Rate}$$

CHAPTER 5

Summary and Conclusion

5.1 Introduction

The purpose of this study was to determine the impact selected macroeconomic factors (inflation rate, GDP growth rate, monetary policy rate, treasury bill rate, exchange rate) have on the commercial lending interest rate. This study used nineteen (19) years data spanning from 2000 to 2019.

The multiple linear regression model was employed to help determine the relationship between the commercial lending interest rate (dependent variable) and the selected macroeconomic variables (independent variables). The Statistical Package for Social Science (SPSS) was used to implement the regression analysis of the data.

The coefficient of correlation was used to measure the strength and the direction of a linear relationship between two variables. We concluded that there was high correlation between the independent variables and commercial lending interest rate and also observed that there was a linear relationship between commercial lending interest rate and exchange rate from 2000 to 2019. The coefficient of determination was also used to measure how well the regression model fits the data. It describes the amount of variability explained by the independent variables. It was observed that 62.5% of the variability in the commercial lending interest rate can be explained by the independent variables.

The ANOVA table was constructed to test significance. it was realized that not all the independent variables were significant in estimating the commercial lending interest rate. That is, only exchange rate affected commercial lending interest rate. This suggest that inflation rate, GDP growth rate, monetary policy rate,

treasury bill rate have no bearing on commercial lending interest rate, however, exchange rate have a significant effect on commercial lending interest rate. Hence a significant change in exchange rate will in turn cause a significant change in commercial lending interest rate.

5.2 Conclusions

The study investigated the impact selected macroeconomic factors (inflation rates, GDP growth rates, monetary policy rates, treasury bill rates, exchange rate) have on the commercial lending interest rate. This study used nineteen (19) years data covering the period 2000 to 2019 was sourced from WDI, IFS and BoG. The study revealed that there is a relationship between commercial lending interest rate and exchange rate.

Finally, we can conclude;

1. The regression model obtained fits well in predicting the effects of commercial lending interest rate to exchange rate.

2. There's significant linear relationship between commercial lending interest rate and exchange rate only and not all the selected macroeconomic indicators namely; inflation rate, treasury bill rate, GDP growth rate, monetary policy rate.

3. Changes in inflation rate, GDP growth rate, monetary policy rate and treasury bill rate will not cause changes in the commercial lending interest rate. However, changes in exchange rate will elicit changes in commercial lending interest rate.

5.3 Recommendation

Based on the obtained results, it is recommended that,

1. Potential investors both domestic and foreign must therefore pay attention to the relationship that exists between interest rate and exchange rate in the long run. This is because as already concluded, exchange rate serves as a good variable in forecasting interest rate variability and this will inform them if it is worthwhile to invest in a certain period.

2. Government and policy makers must also be guided by this relationship and ensure that exchange rates are kept at stable levels. The Bank of Ghana in their attempt to regulate and targeting lower interest rates can also do so by stabilising the exchange rate by strengthening their forex reserves.

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Appendix A

DATA

YEAR	INTEREST RATE	INFLATION	TREASURY BILL RATE	MONETARY POLICY RATE	GDP GROWTH RATE	EXCHANGE RATE
2000	19.60	24.94	39.10	27.00	3.70	0.56
2001	24.47	33.59	40.99	27.00	4.20	0.72
2002	27.13	14.92	25.10	24.92	4.50	0.80
2003	28.14	29.76	28.80	25.71	5.20	0.87
2004	28.62	18.18	17.28	19.13	5.60	0.90
2005	27.01	15.48	15.43	16.83	5.90	0.91
2006	26.60	11.69	10.14	14.33	6.40	0.92
2007	25.53	10.73	9.90	12.67	4.30	0.94
2008	27.03	16.46	17.80	15.79	9.10	1.07
2009	29.93	19.30	25.38	18.29	4.80	1.42
2010	31.92	10.80	14.08	14.67	7.90	1.43
2011	25.03	8.73	10.68	12.92	14.00	1.51
2012	24.24	9.16	18.68	14.46	9.30	1.81
2013	25.71	11.65	21.96	15.67	7.40	1.97
2014	27.85	15.46	23.93	18.67	2.90	2.99
2015	30.33	17.13	25.09	23.00	2.20	3.77
2016	35.06	17.52	22.10	25.92	3.40	3.89
2017	36.35	12.38	14.11	22.25	8.10	5.25
2018	46.72	9.86	13.55	17.75	6.30	4.60
2019	42.33	4.62	7.36	8.00	6.70	4.36

Appendix B