KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

A REGRESSION ANALYSIS ON THE IMPACT OF MACROECONOMIC INDICATORS ON GHANA'S ECONOMIC GROWTH

By

AGYENIM-BOATENG YAW

APPIAH MIRIAM

DAPILAH DANIEL ERIMANTAA

SEREBOUR NANA KWABENA

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Declaration

We hereby declare that this submission is our work towards the award of the undergraduate 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.

Agyenim-Boateng Yaw	.....	.....
Student	Signature	Date
Appiah Miriam	.....	.....
Student	Signature	Date
Dapilah Daniel Erimantaa	.....	.....
Student	Signature	Date
Serebour Nana Kwabena	.....	.....
Student	Signature	Date

Certified by:

Mr. Jonathan Kwaku Afriyie	.....	.....
Supervisor	Signature	Date

Certified by:

Prof. Atinuke Adebanji	.....	.....
Head of Department	Signature	Date

Dedication

We offer God the highest praise for this endeavour. He is the source of all of our inspiration, insight, knowledge, and comprehension. We also appreciate our families and loved ones for their encouragement and support by dedicating this work to them. Our feelings for you are unimaginable. Warmest regards to everyone.

Abstract

The study examines the macroeconomic indicators of economic growth in Ghana measured by Gross Domestic Product(GDP). We used economic data from BoG and GSS for a period of 36 years that is 1985 to 2021. Multiple Linear Regresson was used to establish a relationship between economic growth and its macroeconomic indicators. T-test was used to test zero means of residuals and Shapiro-Wilk test to check for normality of the error term of residuals. Studentizeed Breush-Pegan test was used to check for constant variance. The results show that exchange rate, export and balance of trade are the main indicators that have impact on Ghana's economic growth under a stable inflationary rate. The study recommended that there is a need to increase export, strengthen the currency and reduce the trade deficit.

Keywords: Regression, Macroeconomic Indicators, Ghana, Economic Growth.

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Contents

List of Tables

List of Figures

Chapter 1

Introduction

1.1 Background

Economic growth is a fundamental objective for countries worldwide, regardless of their level of development. It serves as a key driver of prosperity, job creation, and poverty reduction (Samimi and Jenatabadi, 2014). This objective holds at the global level and within the African continent, where countries face unique challenges and opportunities.

In the global context, economic growth is a shared goal among nations. Governments and policymakers strive to create an enabling environment that fosters sustainable economic expansion. This involves implementing policies that promote investment, innovation, productivity, and trade. By encouraging these factors, countries can achieve higher levels of output, income, and living standards.

(Sriyana, 2019) discusses the importance of maintaining economic growth sustainability in the global context. It highlights the role of the exchange rate as an international factor that can threaten economic growth sustainability. The study suggests that controlling the exchange rate at a safe level is crucial for maintaining sustainable economic growth. Within Africa, economic growth is a crucial priority for many nations. Governments and regional institutions, such as the African Union, and the African Development Bank, collaborate to promote inclusive and sustainable economic development. This collective effort recognizes the importance of economic growth in addressing poverty, inequality, and social development challenges across the continent.

In Ghana, the government implements monetary and fiscal policy to maintain high gross domestic product (GDP) growth while maintaining low inflation and

price stability. Ghana has set a target of achieving a single-digit average inflation rate. As part of these efforts, the monetary policy committee (MPC) of the Bank of Ghana reduced its policy rate from 13.5% to 13% on May 15, 2011, in response to improvements in the economy. This reduction was expected to decrease commercial banks' interest rates, making borrowing costs more affordable for businesses and individuals (Boyd et al., 2001).

(Frimpong et al., 2010) have suggested that a high inflation rate exceeding 14% always negatively impacts GDP. This is why the Bank of Ghana's monetary planning committee consistently targets a single-digit inflation rate.

However, as of December 2022, Ghana experienced an inflation rate of 54.1%, leading to unstable prices of goods and services. There was a slight decrease of 0.5% in January 2023. While extensive research has established those macroeconomic indicators such as inflation, interest rates, balance of trade, fiscal policy and exchange rates significantly influence GDP in developed countries, their effects on the economies of developing countries, including Ghana, have not been thoroughly established. The available literature on these indicators is limited and scattered, leaving uncertainties regarding the precise correlation between certain variables, particularly inflation, interest rate, balance of trade, fiscal policy, and exchange rates, and their impact on GDP. In any country, macroeconomic indicators play crucial roles in determining economic performance.

Therefore, the main objective of this research paper is to investigate the effects of changes in inflation, exchange rates, balance of trade, interest rate, and fiscal policy on Ghana's GDP over the past 37 years, from 1985 to 2021. Data for this study will be collected from various sources, including publications and bulletins from the Bank of Ghana (BoG), the Ghana Statistical Service (GSS), and the Institute of Statistical Social and Economic Research (ISSER).

Macroeconomic indicators serve as essential tools for measuring a country's economic performance. They provide valuable insights into the overall health of an economy, enabling policymakers to make informed decisions aimed at enhancing

economic growth. In Ghana, macroeconomic indicators such as inflation, interest rate, fiscal policy, balance of trade, and exchange rates have been the focal points of policy discussions, with the government implementing measures to stabilize these indicators and achieve sustainable economic growth.

Regression modeling, a widely used statistical technique, will be employed in this study to establish the relationship between independent variables (such as inflation, fiscal policy, exchange rates, and other macroeconomic indicators) and the dependent variable, Ghana's economic growth. Through multiple linear regression modeling, we aim to determine the extent to which these macroeconomic indicators affect Ghana's GDP. The findings of this study will contribute to a better understanding of the relationship between macroeconomic indicators and economic growth in Ghana, providing valuable insights for policymakers and stakeholders in formulating effective economic policies.

1.2 Problem Statement

In today's interconnected global economy, the pursuit of sustainable economic growth remains a paramount objective for countries across the world. Within the African continent, West Africa stands as a region with immense potential for economic development (WTO, 2021)

However, the challenges faced by individual countries within this region, such as Ghana, in achieving and maintaining robust economic growth cannot be overlooked. The economy of Ghana and its people have suffered greatly from the COVID-19 pandemic, the war between Russia and Ukraine, and other events. The government took steps to stop the spread of the infection, such as restricting some economic activities, shutting down borders, and enforcing a national lockdown. These measures led to a sharp drop in the value of the Ghana cedi compared to the US dollar. This cedi depreciation poses a significant threat to the country's economic stability and hampers its ability to attract foreign investment, maintain price stability, and foster sustainable development.

To address this pressing concern, it becomes imperative to delve into a comprehensive study that examines the intricate relationship between macroeconomic indicators and Ghana's economic growth. By employing a multiple linear regression model, this research aims to unravel the extent to which indicators such as inflation, balance of trade, exchange rates, and other macroeconomic indicators influence Ghana's economic growth trajectory.

By conducting this study, not only will we gain valuable insights into the specific macroeconomic drivers that impact Ghana's economic growth, but the findings will also contribute to the broader understanding of the interplay between macroeconomic stability and economic development in the African context.

Moreover, the outcomes of this research will provide policymakers, economists, and stakeholders with evidence-based recommendations to formulate effective strategies and policies that can mitigate the adverse effects of cedi depreciation and foster sustainable economic growth in Ghana and potentially other countries in West Africa.

In conclusion, this research endeavors to shed light on the crucial role of macroeconomic stability in driving economic growth, with a specific focus on Ghana within the context of West Africa. By examining the relationship between inflation, fiscal policy, exchange rates, and other macroeconomic indicators, this study aims to provide valuable insights and recommendations to address the challenges faced by Ghana in achieving sustainable economic development.

1.3 Purpose and Objective of Study

1.3.1 General Objective

The study is aimed at investigating the relationship between major macroeconomic indicators and GDP as well as how it affects the economic growth in Ghana.

1.3.2 Specific Objective

(a). To establish the degree and direction of association between GDP and the major macroeconomic indicators.

(b). To identify policy implications and recommendations: This objective aims to synthesize the findings of the study and provide policy implications and recommendations for policymakers, government agencies, and other stakeholders. By translating the research findings into actionable recommendations, the study can contribute to evidence-based decision-making and the formulation of effective policies to promote sustainable economic growth in Ghana.

By addressing these specific objectives, this study can provide a comprehensive analysis of the relationship between major macroeconomic variables and GDP growth in Ghana. The findings can contribute to a better understanding of the drivers of economic growth and inform policy decisions aimed at fostering sustainable development in the country.

1.4 Research Questions

(1). How does the balance of trade, including exports and imports, influence Ghana's economic growth? Are there specific sectors or industries that are more affected by changes in the balance of trade?

(2). What is the impact of interest rate fluctuations on investment and consumption in Ghana? How do changes in interest rates affect the overall economic growth and productivity of the country?

(3). How does fiscal policy, including government spending and taxation, influence Ghana's economic growth? Are there specific fiscal policy measures that have a more significant impact on economic performance?

(4) What is the relationship between inflation rates and economic growth in Ghana? Are there optimal inflation targets that promote sustainable economic growth without compromising price stability?

(5). How do exchange rate fluctuations affect Ghana's economic growth? Are there specific industries or sectors that are more vulnerable to currency depreciation or appreciation?

(6). What are the potential spillover effects of macroeconomic indicators on other sectors of the Ghanaian economy? For example, how do changes in interest rates or fiscal policy impact employment levels and income distribution?

(7). How do external factors, such as global economic conditions or geopolitical events, interact with macroeconomic indicators to influence Ghana's economic growth? Are there specific external shocks that have a more significant impact on the country's economic performance?

(8). What are the policy implications of the relationship between macroeconomic indicators and economic growth in Ghana? How can policymakers leverage these findings to design effective strategies for promoting sustainable economic development?

(9). Are there any non-linear relationships or threshold effects between macroeconomic indicators and economic growth in Ghana? For example, are there specific levels of inflation or exchange rate depreciation that have a more pronounced impact on economic performance?

(10). How do macroeconomic indicators interact with other factors, such as human capital development, infrastructure investment, or technological advancements, to influence Ghana's economic growth? Are there specific synergies or trade-offs between these factors? These research questions can help provide a more comprehensive understanding of the relationship between

macroeconomic indicators and economic growth in Ghana, allowing for a nuanced analysis of the factors driving the country's economic performance.

1.5 Significance of the Study

The results of this study will be helpful to decision-makers. The study of macroeconomic indicators will give decision-makers crucial data they need to create economic plans that will promote long-term economic growth. Policymakers may concentrate their efforts on bolstering those sectors to create a dependable and self-reliant economy by recognizing the primary forces behind economic growth. The analysis will once more help with planning and resource allocation. The government may direct resources to sectors that are most likely to have a beneficial effect on the growth of the economy by looking at how changes in economic indicators affect that growth. Investors and companies must have a thorough awareness of the economic indicators that affect the status of the economy in the nation to make wise decisions that will reduce costs, increase profits, and achieve the best results with the lowest risk. Investors locate investment opportunities and take calculated risks to increase profits. The study will also contribute to existing literature and advance the understanding of how macroeconomic indicators influence economic growth.

1.6 Scope and Limitation of the Study

1.6.1 Scope of the Study

The scope of study on macroeconomic indicators and their impact on GDP in Ghana can cover a range of economic factors and indicators that affect the overall performance of the country's economy. Some of the key six(6) macroeconomic variables that could be studied include Gross Domestic Product (GDP), Inflation, Interest rate, Exchange rate, Fiscal policy, and Balance of trade. A study on the

impact of these macroeconomic indicators on GDP in Ghana could help to identify the most important factors driving economic growth in the country, as well as provide insights into how policymakers can support sustainable and inclusive economic development.

1.6.2 Limitations

The availability of quality data is one of the pressing limitations. Data on macroeconomic indicators may vary over time and some of the indicators may not be available for certain periods. The accuracy and consistency of the data used may affect the reliability of the regression model. Excluding non-market transactions, failing to account for or depict the level of income inequality in society, failing to determine whether the country's rate of growth is sustainable, failing to take into account the costs imposed on human health and the environment by negative externalities resulting from the production or consumption of the nation's output, and treating the replacement of depreciated capital as though it were the creation of new capital are all examples of these errors.

Different national and international organizations have created alternative measures to offer a more comprehensive assessment of a country's quality of life. These indicators are not captured in this study. The principle of causality: Every occurrence is caused by a previous event, which in turn produces a later event, according to the concept of causality, sometimes referred to as the principle of cause and effect. To put it another way, there is a causal link between occurrences, where one event causes another to occur. This idea is vital to both science and philosophy, and it serves as the foundation for a number of their respective theories. The axiom "there must be a cause for every effect" is a common way to describe the causality principle. (Bunge, Mario 1960) This suggests that while regression analysis can demonstrate the link between economic conditions and economic development, it is unable to explain causality.

As a result, it may be difficult to tell if a given macroeconomic indicator con-

tributes to economic development or just corrects it. Analyzing the impact of macroeconomic variables on Ghana's economic growth; however, other elements, such as political unrest, natural resources, and human capital, may also influence that growth and will not be considered in this study. The results of this study cannot necessarily be extrapolated to other nations because they are restricted to the particular environment of Ghana.

1.7 Basic Assumptions

(1) Linearity: The line of best fit through the data points is straight, rather than a curve or some sort of grouping factor.

(2) Multivariate Normality. Multiple regression assumes that the residuals are normally distributed.

(3) No multicollinearity. Multiple regression assumes that the independent variables are not highly correlated with each other. This assumption is tested using Variance Inflation Factor (VIF) values as well as a correlation matrix. (Bevans,2020)

(4) Homogeneity of variance (homoscedasticity): The size of the error in our prediction does not change significantly across the values of the independent variable(Bevans,2020).

(5) It covers a long period. Since the data points are from $1989 - 2021$ which constitute thirty-two datasets.

(6) The dataset is indexed by time. These sequences of data are collected yearly.

(7) The notion that a time series' statistical characteristics remain constant across time is known as the assumption of stationary data in time series analysis. A stationary time series, more particularly, is one in which the mean, variance, and autocorrelation structure do not change over time.

This is a crucial premise to make since many time series analysis methods, including those used for forecasting, are predicated on the notion that the underlying patterns and connections in the data persist through time. One common method is the Augmented Dickey-Fuller (ADF) test. It tests the null hypothesis that a time series has a unit root (i.e., it is non-stationary)

(8) Inflation, Exchange rate, Balance of trade, Interest rate, and Fiscal policy are assumed to affect all Ghanaians; both within the country and outside the country.

1.8 Operational Definitions of Terms

(1) Economic growth - For this study, economic growth refers to the increase in the real Gross Domestic Product (GDP) of Ghana over a specific period. It is measured as the percentage change in the value of goods and services produced within the country's borders.

(2) Inflation - Inflation is defined as the rate at which the general level of prices for goods and services rises and, consequently, the purchasing power of currency is falling. In this study, inflation refers to the annual percentage change in the Consumer Price Index (CPI) in Ghana.

(3) Exchange Rates - Exchange rates refer to the value of one currency in terms of another currency. In this study, exchange rates are measured as the value of the Ghana Cedi (GHS) relative to the US dollar (USD).

(4) Fiscal policy refers to the use of government spending and taxation to influence the overall level of economic activity and achieve specific economic objectives. In this study, fiscal policy includes government expenditure, taxation policies, and budget deficits or surpluses.

(5) Interest rate - Interest rates refer to the cost of borrowing or the return on investment. In this study, interest rates are measured as the percent-

age charged by financial institutions for loans or earned on savings and investments in Ghana.

(6) Balance of trade - The balance of trade is the difference between the value of a country's exports and the value of its imports. In this study, the balance of trade is measured as the net exports (exports minus imports) of goods and services in Ghana. Developed country: Typically, developed nations are those with advanced levels of social welfare, economic development, and technology. High per capita income, sophisticated infrastructure, high levels of education, and a strong healthcare system are typical characteristics of these nations. These nations frequently have high Human Development Indexes (HDIs), which are composite indices that gauge a nation's degree of human development based on factors including per capita income, life expectancy, and educational attainment. The United States, Canada, Japan, the United Kingdom, Germany, France, and Australia are a few examples of developed nations.

Chapter 2

Literature Review

2.1 Introduction

Due to the persistent nature of Ghana's macroeconomic problems, various macroeconomic indicators have fluctuated. This chapter explores the relationship between Ghana's economic expansion and macroeconomic indicators.

2.2 Regression Modelling in the Context of Ghana

Regression modelling is a statistical method for analyzing the connection between a dependent variable and one or more independent variables. It is frequently used to assess and forecast outcomes based on observable data in many different industries, including economics, finance, healthcare, and agriculture. Regression modelling has been used in Ghana to study a variety of topics and has yielded insightful results.

(Alhassan and Asare, 2016) looked at the impact of intellectual capital on bank productivity in Ghana in one of their studies. To evaluate this association, the researchers estimated a regression model, and they discovered evidence in favour of a favourable impact of intellectual capital on bank production. This study emphasizes the use of regression modelling in Ghana's banking industry.

Regression modelling has been employed in the study of factors affecting the completion of the continuum of care (CoC) in Ghana in the area of maternal and child health. To investigate the relationship between a woman's perception of childhood sickness and CoC completion, (Yeji et al., 2015) performed a regression analysis. In particular, for women in Navrongo, the study indicated that this connection was substantial. To comprehend the patterns of healthcare usage in

Ghana, this study uses regression modelling.

Analysis of non-adherence to advised antenatal care (ANC) visits is another area in Ghana where regression modelling has been used. Both (Dickson et al., 2023) and (Dickson et al., 2022) employed regression models, such as Geographically Weighted Regression (GWR) and Ordinary Least Squares (OLS), to find geographical determinants of ANC noncompliance in Ghana. These papers show how regression modelling may be used to better understand healthcare practices and maternal health outcomes.

The research on livelihood diversification tactics used by smallholder farmers in Northern Ghana has also used regression modelling. (Asravor, 2018) examined the effects of climatic variability on rural household diversification strategies and vulnerabilities using linear regression models. In response to climate variability, the study revealed that families in Northern Ghana have diversified their sources of income. Regression modelling is used in this study to show how it might be used in Ghana's agriculture industry.

The influence of infrastructure development and natural resources in luring FDI inflows to Ghana has been examined using regression modelling in the context of foreign direct investment (FDI). Regression studies were done by (Anarfo et al., 2017), and they discovered evidence of a favourable influence of natural resources and infrastructure development on FDI inflows. To understand the factors that influence FDI in Ghana, this study emphasizes the use of regression modelling.

Analysis of Ghanaian agricultural mechanization has also used regression modelling. (Akolgo et al., 2022) evaluated the effect of population growth and employment in the service sector on the degree of automation in agriculture using multiple regression models. The study discovered that Ghana's agricultural mechanization is significantly impacted by population expansion and employment in the service sector. Regression modelling is used in this study to explore the variables impacting agricultural practices in Ghana.

Regression modelling has been employed in several different study fields in Ghana,

including the prediction of sediment yield (Kusimi et al., 2021) and intimate partner violence (Amegbor et al., 2021). These examples are just a few. These works demonstrate the adaptability and usefulness of regression modelling in several Ghanaian study areas. Regression modelling has many different uses in Ghana, as shown by the examples provided in this chapter, which range from banking and healthcare to agricultural and environmental research. Regression modelling helps researchers in Ghana have a better grasp of the variables affecting results and make decisions based on empirical data.

2.3 Understanding Ghana's Economic Growth

It's critical to comprehend the underlying causes of Ghana's recent economic growth to fully appreciate its significance. Insightful information on the economy's performance is provided through macroeconomic indicators, which can aid decision-making by policymakers. With an emphasis on important issues including job creation, interest rates, stock market performance, non-performing loans, infrastructure development, and the effect of oil and gas resources, this article seeks to investigate the link between macroeconomic indicators and Ghana's economic growth.

2.3.1 Job Creation and Economic Growth

The caliber of newly generated employment is a crucial metric for assessing the degree to which macroeconomic expansion results in welfare improvements for the populace. According to (Aryeetey and Baah-Boateng, 2015), Ghana's employment growth has trailed behind economic development, with an estimated employment elasticity of production of 0.47. This implies that a 0.47 percent increase in total employment results from a 1 percent rise in yearly economic growth. However, "the high working poverty rate in the labour market is accompanied by a dominance of vulnerable employment" (Aryeetey and Baah-Boateng,

2015).

2.3.2 Interest Rates and Economic Growth

Interest rate spreads in Ghana are influenced by macroeconomic factors such as exchange rate volatility, fiscal deficit, economic growth, and public sector borrowing from commercial banks (Obeng and Sakyi, 2017). Indicating their influence on the total cost of borrowing and investment in the economy, these drivers have an impact on interest rate spreads in both the long and short runs (Obeng and Sakyi, 2017).

2.3.3 Stock Market Performance and Macroeconomic Variables

Macroeconomic factors have been found to significantly influence stock market movements in Ghana, including inflation, currency rates, interest rates, and inbound foreign direct investments (Adam and Tweneboah, 2008). While interest rates and inflation are relevant in the long run, exchange rates and inflation are important in the near term for share price fluctuations (Adam and Tweneboah, 2008). These results underline how crucial macroeconomic stability is for sustaining stock market performance. Loan Defaults and monetary policy dynamics Both macroeconomic and bank-specific variables affect non-performing loans (NPLs) in Ghana (Asiama and Amoah, 2019). The stability of the banking system and overall monetary policy dynamics are both impacted by macroeconomic factors, which are proven to be relevant in both short-run and long-run estimations (Asiama and Amoah, 2019).

2.3.4 Infrastructure Development and Economic Growth

Infrastructure development has a major influence on Ghana's economic growth (Owusu-Manu et al., 2019). Infrastructure such as transportation, electricity,

and telecommunications must be accessible and of sufficient quality to attract investment, increase productivity, and promote economic activity (Owusu-Manu et al., 2019). Spending on infrastructure is therefore essential to sustaining long-term economic growth.

2.3.5 Oil and Gas Resources and Economic Growth

It is shown that the impact of oil and gas resource rent on economic growth in Ghana is uneven (Adabor and Buabeng, 2021). The fact that oil resource rent strongly encourages economic growth supports the resource blessing hypothesis, whereas the fact that gas resource rent significantly limits economic growth supports the resource curse hypothesis (Adabor and Buabeng, 2021). These findings indicate the need for short-term policies that prioritize the expansion of oil resource businesses over gas resource firms, while long-term policies should concentrate on the development of both oil and gas resources in the country (Adabor and Buabeng, 2021).

To understand Ghana's economic development, a thorough analysis of a wide range of macroeconomic data is required. Ghana's economic growth is significantly influenced by several factors, including oil and gas resources, interest rates, stock market performance, non-performing loans, infrastructure development, and employment creation. Policymakers should consider these measures as they develop policies to promote fair and sustainable economic growth in the country.

2.4 Macroeconomic Indicators Relevant to Ghana

Understanding and assessing a nation's economic performance depends heavily on macroeconomic indicators. In the case of Ghana, several variables, including GDP, inflation, trade balance, exchange rate, fiscal policy, interest rate, and exports, are important in determining the economic position of the nation.

2.4.1 Gross Domestic Product

A common metric for assessing a nation's overall economic success is its GDP. According to a Ghanaian study (Agalega and Antwi, 2013), there is a moderately significant positive link between GDP, interest rates, and inflation. Multiple linear regressions were utilized in the study, and it concluded that changes in interest rates and inflation affect GDP. However, it should be highlighted that only 44% of the change in GDP could be accounted for by inflation and interest rates.

2.4.2 Inflation and Interest Rates

The performance of Ghana's stock market is significantly influenced by these variables as well. According to a study, interest rates and inflation have a big impact on stock prices (Olokoyo et al., 2020). This implies that changes in these macroeconomic variables may have an impact on stock market performance as a whole and investment decisions. Another crucial macroeconomic indicator that has an impact on trade and economic stability is the exchange rate. It has been shown that the exchange rate affects the commerce in air freight in Ghana. According to a regression study, the interest rate and currency rate have a considerable impact on Ghana's air freight trade (Adenigbo et al., 2022). This emphasizes how crucial exchange rate stability is to fostering bilateral commerce and boosting domestic manufacturing and exports.

2.4.3 The Balance of Trade

This gauges the difference between a nation's exports and imports and serves as a key metric for determining the state of its economy. According to research on Ghana's trade balance, interest, and exchange rates have a considerable impact (Manu). This implies that changes in these macroeconomic variables may affect the trading position of the nation.

2.4.4 Fiscal Policy

Another significant macroeconomic indicator that it contains is the sustainability of government debt. Research on the sustainability of Nigeria's public debt discovered a non-linear link between public, private, and foreign direct investments and macroeconomic variables such as currency rate, inflation, and monetary policy rate (Onyele et al., 2023). This emphasizes the requirement for efficient fiscal strategies that encourage investment and manage debt sustainability.

2.4.5 Export

Economic growth and development are significantly influenced by exports. Even though the sources given do not specifically address how exports affect Ghana's economy, it is commonly accepted that exports help to increase GDP and foreign exchange revenues. To increase economic development and balance trade, government policies frequently place a major emphasis on export promotion. When evaluating Ghana's economic status, it is important to consider the macroeconomic indicators of GDP, inflation, balance of payments, exchange rate, fiscal policy, interest rate, and exports. These metrics give us important information about the stability, trade dynamics, and economic success of the nation. These indicators can help decision-makers and academics create plans and strategies for fostering sustainable economic growth and development.

2.5 Impact of Macroeconomic Indicators on Ghana's Economy

The impact of various macroeconomic factors on Ghana's economy has been the subject of extensive research. The impact of GDP, inflation, interest rate, balance of trade, fiscal policy, and exchange rate on Ghana's economy is significant. These factors interact with each other and influence the overall economic performance

of the country. Policies that target supply-side constraints, reduce inflation, stabilize interest rates, promote exports, and ensure prudent fiscal management can contribute to the sustainable economic growth of Ghana.

2.5.1 Gross Domestic Product

The GDP is a crucial measure of economic health. Structural Adjustment Programs (SAPs) were used in Ghana to strengthen the production capacity of struggling industries and to reverse the country's negative GDP growth from the 1970s (Agyei-Mensah and de Graft Aikins, 2010)). Additionally, substantial economic growth of 8.4% in 2008 was a result of considerable government investment ("Analysis of Ghana's Gross Domestic Product from 1960-2019", 2023). Although there have been both good and bad impacts on Ghana's economic growth, it is crucial to keep in mind that this influence is unclear ("Analysis of Ghana's Gross Domestic Product from 1960-2019", 2023).

2.5.2 Inflation

Another crucial element that has an impact on Ghana's frugalness is inflation. Empirical studies show that real output, nominal exchange rate, broad money supply, nominal interest rate, and fiscal deficit all have a major impact on Ghana's inflationary process. (Adu and Marbuah, 2011).

2.5.3 Interest Rate

The economy of Ghana is also significantly impacted by interest rates. It has been discovered that changes in interest rates have an impact on Ghana's Gross Domestic Product, with GDP, interest rates, and inflation showing a moderately significant positive association (Agalega and Antwi, 2013).

2.5.4 The Balance of Trade

Ghana's economy is also impacted by the country's trade balance, which measures the disparity between imports and exports. The beneficial effects of import and export on GDP imply that Ghana should concentrate on shifting its economy from one that is export-oriented to one that is import-oriented (Tumaku, 2018).

2.5.5 Fiscal Policy

Ghana's economic performance is significantly influenced by fiscal policy, including taxation and expenditure by the government. While prudent monetary policies that aim to reduce and stabilize inflation and interest rates are advised to boost the growth of the economy (Agalega and Antwi, 2013); "Analysis of Ghana's Gross Domestic Product from 1960 - 2019", 2023), high government spending in 2008 contributed to economic growth.

2.5.6 Exchange Rate

The economy of Ghana is significantly impacted by the currency rate. The exchange rate is influenced by several variables, including interest rates, inflation, trade balance, political stability, and the overall health of the economy (Egbunike and Okerekeoti, 2018). Understanding how foreign exchange risk affects a company's value and risk management is essential (Egbunike and Okerekeoti, 2018).

2.6 Evaluation of Previous Studies on Ghana's Economic Growth

Ghana's economy has grown significantly in recent decades. This has been influenced by several things. The theoretical and empirical review will list these aspects.

2.6.1 Theoretical Review

The claim that macroeconomic variables significantly influence Ghana's economic growth is supported by theoretical research. According to one research by (Owusu-Ankamah and Sakyi, 2021), Ghana's macroeconomic indicators are subject to substantial swings. In another study, (Mohseni and Jouzaryan, 2016) discovered a connection between inflation and economic expansion. Alavi's research, in contrast, concluded that the relationship between the exchange rate and GDP is positive. (Tulong et al., 2018) These studies emphasize how crucial it is to comprehend how macroeconomic indicators affect Ghana's economy. Commercial oil output has been seen to enhance real economic growth, suggesting its impact on overall economic performance.

Along with these factors, inflation and currency rate swings also affect Ghana's economic development. Inflation and economic growth are directly correlated, according to (Mohseni and Jouzaryan, 2016), underscoring the significance of controlling inflation rates for long-term prosperity.

Regarding the connection between the exchange rate and gross domestic product, the findings are contradictory. Alavi's research indicates a favourable correlation between the two factors, in contrast to contradictory results from previous studies. To fully comprehend this disparity and its economic ramifications for Ghana, more research is required.

The level of employment created by different industries is a crucial factor to take into account while studying macroeconomic growth. The behaviour of interest rates and inflation rates affected GDP growth, according to Agalega and Antwi's study on macroeconomic factors in Ghana (Kankpeyeng et al., 2021).

2.6.2 Empirical Review

Additional information on the effects of macroeconomic variables on Ghana's economic growth has come through empirical investigations. (Agalega and Antwi, 2013) performed research on the impact of macroeconomic factors on Ghana's GDP.

Their research showed that Ghana's GDP growth was highly impacted by the interest rate and inflation rate's behavioural tendencies. Additionally, Khan and Sattar looked at how interest rates affected the success of commercial banks in Pakistan and discovered a significant positive link (Tulong et al., 2018). These studies emphasize how crucial it is to take into account macroeconomic variables like interest rates and inflation rates while analyzing Ghana's economic development. The link between Ghana's macroeconomic indicators and economic development has also been the subject of several empirical research that have provided insight.

(Mavikela et al., 2019), for instance, looked at the connection between inflation and economic development in Ghana and South Africa (Kankpeyeng et al., 2021). According to their research, while inflation hurt economic growth in South Africa, it had no statistically significant effect on it in Ghana. In addition, (Kankpeyeng et al., 2021)'s analysis discovered that the overall level of inflation had a favourable impact on GDP growth in Ghana and was statistically significant at a 1% significance level. These empirical studies shed important light on how macroeconomic factors affect Ghana's economic expansion.

It is crucial to remember that the literature sometimes contains some contradictory findings. For instance, the vast majority of research on Ghana has found a negative correlation between inflation and GDP growth rate, while the vast majority of Ghanaian literature has found a negative correlation between macroeconomic variables like inflation and GDP growth rate (Kankpeyeng et al., 2021). Mbulawa also discovered that inflation had a favourable impact on Botswana's GDP growth (Kankpeyeng et al., 2021).

2.7 Regression Modelling and Ghana's Economic Future

Here, we highlight the knowledge base on this topic that still needs more research and offer ideas for future studies.

2.7.1 Foreign Direct Investment and Trade Openness

(Nketiah-Amponsah and Sarpong, 2020). (2020) investigate the relationship between foreign direct investment (FDI), trade openness, and economic growth in Ghana. The study finds that trade openness is the main factor affecting GDP growth in Ghana. While foreign direct investment and inflation have an impact on GDP growth, they are not statistically significant. These findings suggest that enhancing trade openness through encouraging exports and attracting FDI can contribute to Ghana's economic growth.

2.7.2 Fiscal Policy and Tax Revenue

(Crentsil, 2023) investigates how fiscal policy affects Ghana's economic growth and development. The study spans the years 2010 to 2019 and uses an Ordinary Least Squares (OLS) regression model. The study finds a strong correlation between fiscal policy instruments, particularly tax revenue and government expenditure, and GDP growth. Nevertheless, there is no statistically significant link between fiscal policy and infrastructural development. The research promotes careful management of tax revenue and public spending and emphasizes the need for sensible fiscal policies in promoting economic growth.

2.7.3 Inflation, Exchange Rates, and Economic Growth

In Ghana, (Asigbetse et al., 2022) investigate the connections between inflation, currency rates, sectoral structure, and economic development. According to the

analysis, there is a bad correlation between Ghanaian inflation and exchange rates. The survey also shows that services currently make up the bulk of Ghana's GDP, followed by industry and agriculture. In contrast to interactions between exchange rates and sectoral structure, the study emphasizes the distinct effects of interactions between inflation and sectoral structure on economic development. These results show that while establishing inflation and exchange rate strategies, policymakers should take the structure of the economy into account.

2.7.4 Bank-Specific and Macroeconomic Factors

(Yakubu et al., 2016) looks at the impact of macroeconomic and bank-specific factors on the profitability of commercial banks in Ghana. Using an OLS regression model, the study examines data from five commercial banks between 2010 and 2015. According to the results, profitability is positively correlated with bank size, liquidity, expenditure control, and real interest rates, but GDP growth and inflation rate are negatively correlated. The study underlines the significance of effectively managing bank-specific elements to raise the profitability of commercial banks.

Chapter 3

Methodology

3.1 Introduction

This section describes the multi-regression machine learning model's technique for analyzing the connection between Ghana's fundamental macroeconomic factors and its economic expansion. The study utilizes a rigorous methodology to provide precise analysis and reliable outcomes.

3.2 Data collection

In the first phase, pertinent macroeconomic data were extracted from dependable sources, such as the World Bank, Ghana Statistical Service, and Central Bank of Ghana, all of which are renowned for disseminating precise and unbiased economic data. The data collection spans a sizable amount of time, from 1985 to 2021, optimally capturing several business cycles and economic swings. The variables to be taken into account include economic development, or the country's gross domestic product(GDP) (response variable), and various factors affecting the economy(Explanatory variables), such as government spending (fiscal policy), rate of inflation, currency exchange rates, and balances of trade, interest rates, and export earnings of the country as a whole.

3.3 Data Pre-processing

The data is pre-processed once it was obtained to guarantee compatibility and uniformity. In this stage, the data collected will be cleaned by addressing missing information and correcting any discrepancies or inconsistencies (Hassani and

Huang, 2020). The exchange rate was determined and published in the old currency before the re-denomination of the cedi in 2007, whereas the exchange rate from 2007 is calculated in the new Ghana cedi. Exchange rate values from 1985 to 2006 were converted using a conversion scale of 10,000 cedis to one Ghanaian cedi(GH1.00) to have all the data points for the variable in a single unit and satisfy the stipulations of the multiple regression framework.

3.4 Econometric Analysis

In this section, Multiple linear Regression(MLR) (Pearson,1898) as an Econometric analytical technique is employed to establish and examine the relationship between economic shoot-ups and the various influencing factors or variables(explanatory variables) considered in the study.

3.4.1 Correlation test

The bivariate correlation, also known as the Person product-moment correlation coefficient (PPMCC) r, is a statistic that expresses the linear relation between two sets of data. It is essentially a normalized measurement of the covariance since it is the ratio between the covariance of two variables and the product of their standard deviations. The Pearson correlation coefficient denoted as r ranges from -1 to 1 with the absolute value of 1 indicating a linearly perfect association. The measure can only capture a linear correlation between variables, just like covariance itself, and ignores many other kinds of relationships or correlations. The Pearson moment-product correlation coefficient r, is given by:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})(y_i - \bar{y})}} \tag{3.1}$$

where,

r = is the correlation coefficient

x_i = values of the x-variable in a sample

$\bar{x}$ = mean of the values of the x-variable

y_i =values of the y-variable in a sample

$\bar{y}$= mean of the values of the y-variables

Null Hypothesis $(H_0) : r = 0$, if P-value is > 0.05, the two variables are not linearly related though they may exist other forms of association between the variables.

Alternative Hypothesis $(H_1) : r \neq 0$ When the p-value is < 0.05, the variables have a linear interaction, and the correlation coefficient (r) is not zero.

3.4.2 Model Specification

A model specification is the process through which variables are selected and included in a model (MacCallum, 1995). There is a contradiction in the model design between maintaining statistical power and including all relevant variables. To produce models that are as precise and economical as feasible, a variety of model specification techniques have been created. Although data scientists frequently employ the information criterion, P-values are often used in Discipline-based Education Research (DBER) (Henderson, 2017). The p-value technique typically results in simpler models that include fewer variables. What research questions may be addressed and the conclusions that can be made from them depend on the variables that are included in a model.

The stepwise regression modeling technique will be used to compute the best model. Stepwise regression is a statistical method for choosing a selection of predictors (independent variables) for inclusion in a regression model from a wider collection of variables. Its main objective is to find the most pertinent and significant predictors that explain the connection with the dependent variable.

Forward selection and backward elimination are the two primary procedures used in stepwise regression. These methods are iterative and add or remove predictors

by predetermined standards until an optimal model is attained.

The least squares(LS) method is used to find a line that fits the equation

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p + \varepsilon \tag{3.2}$$

where:

$i = n$ observations

y_i =dependent variable

x_i = explanatory variables

β_0 = y-intercept (constant term)

β_p = slope coefficients for each explanatory variable

ε = the error term of the model (also known as the residuals)

3.4.3 Multiple Regression Model in Matrix Notation

Multiple Regression Models can be presented in a compact form by using matrix notation;

let:

$$Y = \begin{bmatrix} Y_1 \\ Y_2 \\ . \\ . \\ . \\ Y_n \end{bmatrix} \tag{3.3}$$

$$y = \begin{bmatrix} y_1 \\ y_2 \\ . \\ . \\ . \\ y_n \end{bmatrix} \tag{3.4}$$

$$\varepsilon = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ . \\ . \\ . \\ \varepsilon_n \end{bmatrix} \tag{3.5}$$

be $n \times 1$ vectors of the random variables $Y_i s$, their observed values $y_i s$, and random errors $\varepsilon_i s$ respectively. Let :

$$X = \begin{bmatrix} 1 & x_{11} & \cdots & x_{1k} \\ 1 & x_{21} & \cdots & x_{2k} \\ . & . & & . \\ . & . & & . \\ . & . & & . \\ 1 & x_{n1} & \cdots & x_{nk} \end{bmatrix} \tag{3.6}$$

be the $n \times (k+1)$ matrix of the values of predictor variables (the first column corresponds to the constant term β_0)

$$\beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \cdot \\ \cdot \\ \cdot \\ \beta_k \end{bmatrix} \tag{3.7}$$

and

$$\hat{\beta} = \begin{bmatrix} \hat{\beta}_0 \\ \hat{\beta}_1 \\ \cdot \\ \cdot \\ \cdot \\ \hat{\beta}_k \end{bmatrix} \tag{3.8}$$

be the $n \times (k+1)$ vectors of unknown parameters and their LS estimates respectively.

The model is written as:

$$Y = X\beta + \varepsilon \tag{3.9}$$

The simultaneous linear equations whose solutions yield the LS estimates:

$$X'X\beta = X'y \tag{3.10}$$

If the matrix $X'X$ is not singular, then the solution is given by:

$$\hat{\beta} = (X'X)^{-1}X'y \tag{3.11}$$

3.5 Model Evaluation

In this section, the performance and quality of the model that incorporates several predictors (independent variables) is assessed

3.5.1 Analysis of variances

Analysis of Variance (ANOVA) is a statistical technique for testing the null hypothesis that all regression coefficients are equal to zero and evaluating the overall significance of the regression model. The entire variation in the dependent variable is divided by the ANOVA into two parts: residual variation that cannot be explained by the regression model (due to the predictors) and variance that is not explained by the regression model.

3.5.2 Analysis of Variance Table

Sources of variation	Sum of Squares	Degree of Freedom(df)	Mean Square	F-statistic
Regression (Explained)	$\sum(\hat{y}-\bar{y})^2$, sum the squares of the explained deviations (SSR)	N_o of parameters-1 or no. of predictor variables(k)	MSR= $\frac{SSR}{k}$	$\frac{MSR}{MSE}$
Residual or Error(Unexplained)	$\sum(y-\hat{y})^2$, the sum of the squares of the unexplained deviations (SSE)	$n-k-1$	MSE= $\frac{SSE}{n-k-1}$	
Total	$\sum(y-\bar{y})^2$, the sum of the squares of the deviations from the mean (SST)	sample size-1, $n-1$		

Table 3.1: Analysis of Variance Table

R-squared (Coefficient of Determination) calculates the percentage of the depen-

dent variable's variation that can be accounted for by the model's predictors. Higher R-squared values indicate better fits. R-squared, by itself, does not reveal anything about the model's goodness of fit or level of predictability.

R-squared(R^2) is given by:

$$R^2 = \frac{SSR}{SST} \tag{3.12}$$

Adjusted R-squared, the R-squared value is modified to consider the number of predictors in the model. When comparing models with differing numbers of predictors, it is often chosen over R-squared since it penalizes the inclusion of irrelevant variables.

$$\text{Adjusted}R^2 = 1 - \frac{(1 - R^2)(N - 1)}{N - k - 1} \tag{3.13}$$

where R^2 is the coefficient of determination N is the Total sample size k is the number of independent variables

3.5.3 The Goodness of Fit

To estimate an unknown variable, regression analysis uses the connection between a known value and the unknown variable. Here, the association between the variables is represented by a regression line, and a projection of the dependent variable is created corresponding to the values of the independent variables. The F-test of overall significance is used to assess how well the regression line established fits the provided data points.

The F-statistic evaluates the regression model's overall significance. It determines if all of the predictors significantly account for the variation in the dependent variable. A high F-statistic indicates that the model's ability to predict the dependent variable overall is substantial.

$$The\ test\ statistics = \frac{MSR}{MSE} \tag{3.14}$$

$$F\text{-}value\ (tabulated) = F_{0.05,n-k-1} \tag{3.15}$$

$H_0 : \beta_1 = \beta_2 = ... = \beta_k = 0$, If F-statistics ¡$F_{0.05,\ n-k-1}$, fail to reject H_0 and conclude that the model built is not fit for purpose. This will imply that all the slope coefficients of the IVs are significant or they have a coefficient of zero(0)
$H_1 : \beta_i \neq 0$, At least one β_i is not zero for at least one IV the model.
If F-statistics ¿ $F_{0.05,\ n-k-1}$, reject H_0 and conclude that the overall model is statistically significant, hence fit for purpose.

3.5.4 Determining the Statistical Significance of the Predictor Variables

We test the hypothesis: $H_0j : \beta_j = 0$ against $H_1j : \beta_j = 0$ If we canât reject $H_0j : \beta_j = 0$, then the corresponding variable x_j is not a useful predictor of y.
Note that j is generally distributed with mean Î²$jandvariance\sigma 2\ V_{jj}$, where V_{jj} is the jth diagonal entry of the matrix $V = (X'X)^{\hat{a}1}$

3.5.5 Likelihood Ratio Test(LRT)

The likelihood-ratio test by Neyman and Pearson (1928) in statistics evaluates the goodness of fit of two competing statistical models, especially one discovered via maximizing over the whole parameter space and another discovered after imposing some constraint. The two likelihoods should not differ by more than the sampling error if the observed data support the constraint (i.e., the null hypothesis). To determine if this ratio is statistically different from one, or whether its natural logarithm is significantly distinct from zero, the likelihood-ratio test is used.

Test statistic:

$$LRT = -2(\textit{log-likelihood of restricted model - log-likelihood of unrestricted model}) \tag{3.16}$$

$$LRT = \sim \chi^2(q\ df) \tag{3.17}$$

where $q = df$ of the reduced model- df of the full model and df =degrees of freedom

Null Hypothesis H_0: The restricted model(Reduced model) is statistically better than the unrestricted model (Full model) The likelihood-ratio test rejects the null hypothesis if the value of this statistic is too small, which implies the full model (the unrestricted model) is the optimal model obtained. How small is too small depends on the significance level of the test, i.e. on what probability of Type I error is considered tolerable (Type I errors consist of the rejection of a null hypothesis that is true).

3.5.6 Standardized Regression Coefficient Comparison

Direct comparison is challenging since the regression coefficients $\beta_1, ..., \beta_k$ may all be in different measurement units, Menard (2004); a small coefficient may be more significant than one with a larger value. This exemplifies the common issue of "trying to compare apples and oranges". By expressing the coefficients in terms of a single, common set of statistically appropriate units, the standardized regression coefficients eliminate this issue and enable at least an effort at comparison.
The influence of a change in X_i on Y with all other X variables remaining constant is shown by the regression coefficient β_i. Regression coefficient β_i is measured in units of Y per unit of X_i.
The coefficients are given by;

$$\beta_i^* = \beta_i \frac{s_{x_i}}{s_y} \tag{3.18}$$

3.6 Residual Analysis

Residual analysis is a crucial step in assessing the accuracy and premises of a regression model. Residuals are the variation between the dependent variable's actual values and its projected values as determined by the regression equation. By analyzing the residuals, one may evaluate the model's suitability and spot any possible problems or assumptions that have been violated.

3.6.1 Linearity

Plotting the residuals versus the independent variables or the projected values reveals information about the effectiveness of the model. The ideal plot should show a random pattern with no obvious trends, showing that the model appropriately reflects the connection between the variables. The residual plot may reveal patterns that point to problems like nonlinearity, heteroscedasticity, or outliers.

3.6.2 Normality Test

Checking the normality of regression residuals is an important assumption in linear regression analysis. To evaluate whether or not the residuals of the model attained follow a normal distribution, the Quantile-quantile plot (Q-Q plot) of the residuals is used. The normalcy assumption is satisfied if a reasonably straight diagonal line connects almost all of the points on the plot. Additionally, a histogram plot of the residuals and visually inspected for a bell-shaped or approximately normal distribution(Draper and Smith, 1981).

The Shapiro-Wilk test is a standardized normality test published by Shapiro and Wilk (1965). It is a statistical test that assesses the departure from normality. The test calculates a test statistic, W, and compares it to critical values to determine if the residuals significantly deviate from normality.

The Shapiro-Wilk normality test statistic is given by:

$$W = \frac{(\sum_{i=1}^{n} a_i x_i)^2}{(\sum_{i=1}^{n} x_i - \bar{x})^2} \sim W_\alpha \tag{3.19}$$

where,

$\bar{x} = sample\ mean$

$x_i = i^{th} smallest\ value\ of\ x$

$a_i = Shapiro\text{-}Wilk\ constant$

$n = is\ the\ sample\ size$

Null hypothesis(H_0): The residuals are normally distributed. Thus, reject the null hypothesis, if $W < W_\alpha (p - value < \alpha)$, and conclude that there is evidence that the data tested are not normally distributed. On the other hand, if the p-value is greater than the chosen alpha level, then the null hypothesis (that the data came from a normally distributed population) can not be rejected.

3.6.3 Multicollinearity

Multicollinearity refers to a high degree of correlation between two or more predictor variables in a regression model. It can cause issues in the model, such as unstable regression coefficients, difficulty in interpreting the individual effects of predictors, and reduced predictive accuracy. Testing for multicollinearity is important to identify and address this problem. The study will employ the correlation matrix, variance inflation factor (VIF), and Tolerance level as the principal technique to check multicollinearity. A correlation matrix provides a pairwise correlation between each pair of predictor variables. High correlation coefficients (close to 1 or -1) indicate a strong linear relationship between variables. Examining the correlation matrix can help identify potential pairs of variables that are highly correlated. The Variance Inflation Factor (VIF) measures how much multicollinearity has inflated the calculated regression coefficient's variance. A VIF value greater than 1 indicates some level of multicollinearity, with higher values

indicating a more severe problem. VIF values above 5 or 10 are often considered indicative of high multicollinearity (O'Brien 2007)

VIF is given by:

$$VIF_j = \frac{1}{1 - R_j^2} \tag{3.20}$$

If $VIF_j \geq 10$ then there is a problem of multicollinearity.

3.6.4 Constant Variance (Homoscedasticity)

Homoscedasticity is the presumption that the variance of the residuals in a regression model is constant at all levels of the predictor variables. This assumption can be broken, resulting in biased standard errors, incorrect hypothesis tests, and inaccurate coefficient estimations. In regression analysis, the homogeneity of variance of the residuals will be evaluated using a variety of tests and diagnostic methods.

A scatter plot of the residuals against the predicted values or the independent variables is one of the diagnostic methods that will be used. In a homoscedastic scenario, the points should form a random pattern around the horizontal line with approximately equal variability across all levels of the predictors.

Visually examining a scatter plot of the residuals versus the predicted values of the independent variables is one of the simplest techniques to identify homoscedasticity. With about equal variability across all levels of the predictors, the points in a homoscedastic situation should form a random pattern around the horizontal line.

BreuschâPagan test, developed in 1979 by Trevor Breusch and Adrian Pagan is a statistical procedure used to formally evaluate homoscedasticity. It entails executing an auxiliary regression to check the significance of the coefficient after regressing the squared residuals on the predictor variables. The test's null hypothesis is homoscedasticity, while a significant outcome i.e. p-value $< \alpha$ implies heteroscedasticity

The test statistic of Breusch-Pegan is given by:

$$LM = \frac{1}{2}(SST - SSR) \sim \chi^2_{p-1}(\alpha) \tag{3.21}$$

If $LM > \chi^2_{p-1}(\alpha)$, reject Ho and conclude that the residuals vary significantly at some levels of the predictor variables otherwise, homoscedasticity is satisfied.

3.6.5 Zero Means of the error

In regression analysis, one of the assumptions is that the error term (residuals) has a zero mean, meaning the average value of the residuals should be approximately zero. Violations of this assumption can indicate systematic errors in the model obtained. To statistically determine if the mean of the residuals substantially differs from zero, a one-sample t-test is used. The assumption that the residuals' mean is zero is the null hypothesis. The zero mean assumption is broken if the p-value for the t-test is less than the selected threshold of significance (i.e. 0.05). The test statistic is given by:

$$t = \frac{\bar{x} - \mu_0}{Se_x} \tag{3.22}$$

where, $\bar{x}$ is the sample mean μ_0 is the hypothesized value Se_x is the standard error given by $\frac{s}{\sqrt{n}}$ S is the sample standard deviation N is the sample size
Null Hypothesis $H_0 : \mu = 0$, if $-t_{\alpha,n-1} < t < t_{\alpha,n-1}$, then there is not enough evidence to reject H_0 and conclude that the error term is approximately zero.
Alternative Hypothesis $H_1 : \mu \neq 0$, if $t < |t_{\alpha,n-1}|$, reject H_0 and conclude that the sample is different from the hypothesized mean.

Chapter 4

Results and Discussion

4.1 Introduction

In this chapter, the results of the data analysis and empirical evaluation of the models used to predict the Gross Domestic Product (GDP) are presented. This section delves into the analysis of the impact of various macroeconomic variables on GDP and aims to provide a comprehensive understanding of the relationships between these variables and GDP, shedding light on the factors that significantly influence economic growth.

4.2 Data

The data is secondary data from the World Bank, the Bank of Ghana, and Macro trends. It consists of 37 yearly data points on the Gross Domestic Product (GDP), Exports, Balance of Trade, Fiscal Policy, Inflation, Exchange Rate, and Interest Rate in Ghana from 1985 to 2021.
The economic information was cleansed using Microsoft Excel (2016).

4.3 Empirical Analysis

The results of the evaluations of the data and the model, as well as the graphs of the dependent variables and the correlation matrix, are presented in this section.

From the graph, it appears that GDP has been increasing over time with some fluctuations. The graph shows an upward trend from 2010 to 2015 followed by a slight dip in 2016 and then a steady increase from 2017 to 2020. It is worth noting

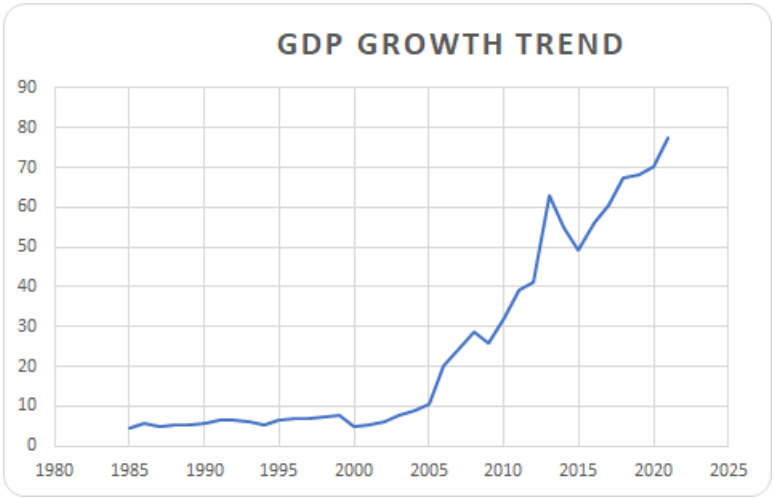

Figure 4.1: GDP Growth Trend

that the overall upward trend in GDP is positive and it suggests the economy has been growing over time.

4.4 Association Between the Dependent Variables and the Various Independent Variables.

This section examines the relationship between GDP and the independent variables. GDP with fiscal policy, GDP with exchange rate, how GDP relates to interest rate, how GDP relates to the balance of trade, GDP with inflation, and GDP with export.

4.4.1 GDP and Fiscal Policy

The figure below shows a scatter plot of the association between GDP and Fiscal policy.

There is a strong negative relationship between GDP and fiscal policy which means as GDP increases, Fiscal policy turns to decrease.

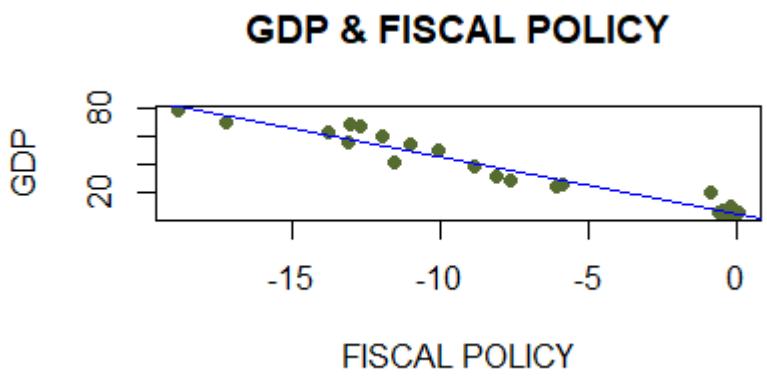

Figure 4.2: Scatter plot of GDP and fiscal policy

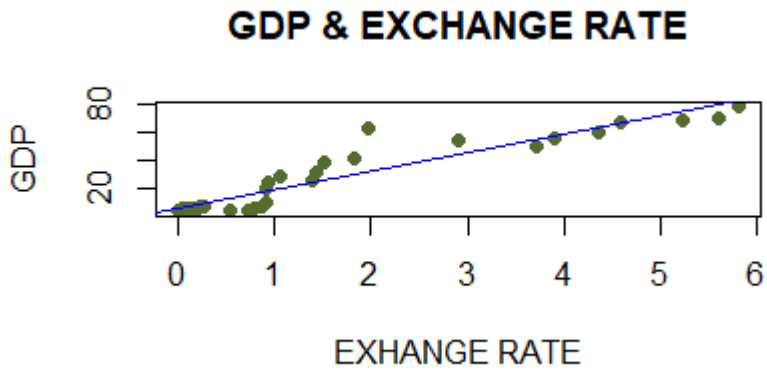

Figure 4.3: Scatter plot of GDP and exchange rate

4.4.2 GDP and Exchange Rate

The relationship between GDP and the exchange rate is positive linear meaning GDP increases with the exchange rate.

4.4.3 GDP and Inflation

The scatter plot suggests that there is a negative relationship between GDP and inflation. However, the relationship is not very strong.

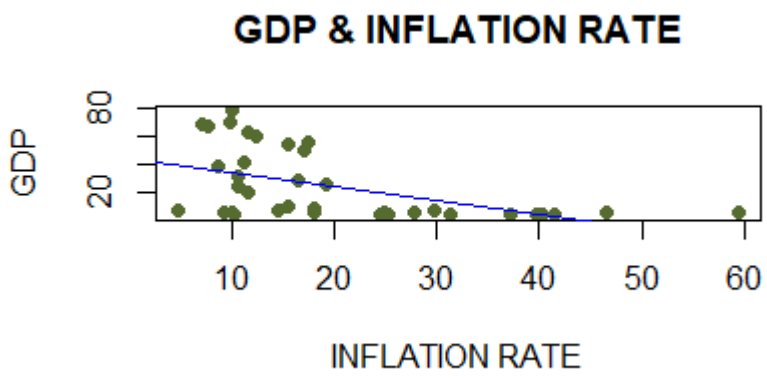

Figure 4.4: Scatter plot of GDP and inflation

4.4.4 GDP and Balance of Trade

Below is a scatter plot of the relationship between GDP and the Balance of trade.

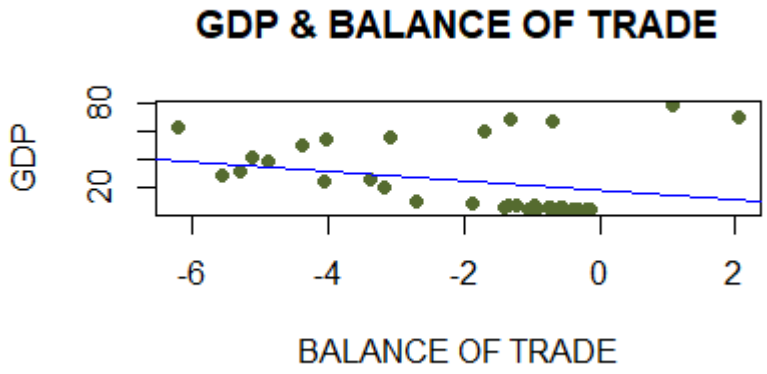

Figure 4.5: Scatter plot of GDP and balance of trade

There is a weak negative relationship between GDP and balance of trade.

4.4.5 GDP and Interest Rate

From the graph above, there is a negative correlation between GDP and the interest rate. A negative correlation implies that as GDP increases, the interest rate tends to decrease, and vice versa.

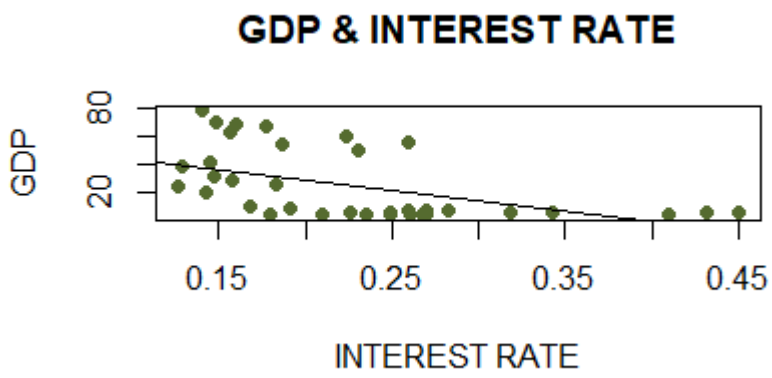

Figure 4.6: Scatter plot of GDP and interest rate

4.4.6 GDP and Export

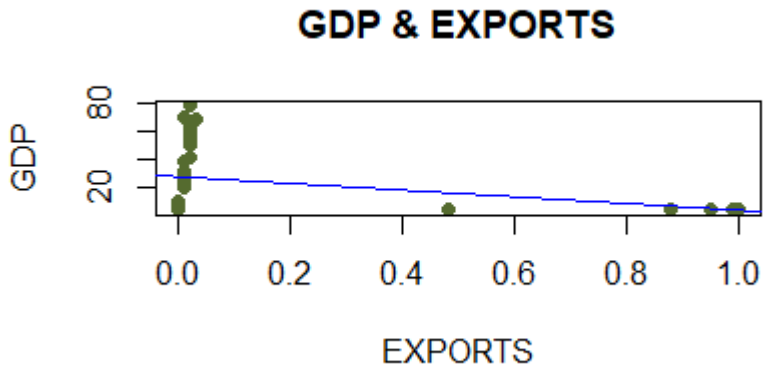

Figure 4.7: Scatter plot of GDP and export

GDP and exports have a negative correlation between them. This means that as GDP increases, exports tend to decrease, and vice versa.

4.5 Correlation Matrix

From the table, it can be observed that fiscal policy has the highest correlation coefficient in relation to GDP. This suggests a stronger relationship between fiscal policy and GDP compared to the other independent variables.

Additionally, the correlation coefficient between the balance of trade (BOT) and

	GDP	INF	BOT	EXR	FIP	INR	EXP
GDP	**1**						
INF	-0.5211	**1**					
BOT	-0.2623	0.3118	**1**				
EXR	0.9456	-0.4607	-0.0337	**1**			
FIP	-0.9821	0.5120	0.2921	-0.9154	**1**		
INR	-0.5337	0.6867	0.4053	-0.4613	0.5442	**1**	
EXP	-0.3232	0.3135	0.3226	-0.3268	0.3215	0.0113	**1**

Table 4.1: Correlation Matrix

the dependent variable is weak and negative, indicating a weak negative relationship between these variables.

4.6 Model Building

4.6.1 Full Model

The table below shows the model with all independent variables using all the data points.

Variable(coefficient)	**Estimate**	**Std. Error**	**t-value**	**P-value**
Intercept	**0.52956**	**3.16339**	**0.167**	**0.86818**
Inflation	**-0.8848**	**0.06952**	**-1.273**	**0.21293**
BOT	**-1.28962**	**0.46816**	**-2.755**	**0.00988**
Exchange rate	**6.01389**	**1.10606**	**5.437**	**6.78e-06**
Interest rate	**14.55843**	**11.16553**	**1.304**	**0.20219**
Export	**3.78906**	**2.33120**	**1.625**	**0.11455**
Fiscal policy	**-2.33286**	**0.32659**	**-7.143**	**6.03e-08**

Table 4.2: Coefficient of Full Model

In Table 4.2 above, the significant macroeconomic variables affecting economic growth in the full model are the Balance of Trade, Fiscal Policy and exchange rate. Other predictors such as inflation, Export and interest rate were not significant to predict GDP.

An R-squared value of 0.9829 suggests that approximately 98.29% of the variability in the dependent variable can be explained by the independent variables in the regression model. An adjusted R-squared value of 0.9795 suggests that approximately 97.95% of the variability in the dependent variable can be explained

Multiple R-Squared	**0.9829**
Adjusted R-Squared	**0.9795**
F Statistics	**228**
p-value	**2.2e-16**

Table 4.3: Measures of the Significance of the Full Model

by the independent variables, considering the number of variables and the sample size.

Test for Assumptions of the Full Model

Normality Test

The Shapiro- Wilk test is used to test the normality of the residuals.

Shapiro-Wilk normality test(alpha=0.5)

Data: residuals

W= 0.9345, p-value=0.03093

This means the error term is not normally distributed and hence the assumption for normality is not met.

Constant Variance

The Assumption of Homoscedasticity

Studentized Breusch-Pegan test

BP= 13.073, df=6, p-value= 0.0419

The p-value of 0.0419 is less than 0.05, suggesting that there is evidence to reject the null hypothesis. Therefore, we can conclude that there is a significant indication of heteroscedasticity in the regression model. This means that the assumption of homoscedasticity is violated, and the variance of the residuals is not constant across all levels of the independent variables

Zero Mean

One Sample t-test

data: full model

t = -7.0848e-18, df = 36, p-value = 1

alternative hypothesis: true mean is not equal to 0

95 percent confidence interval:

-1.062779 1.062779

sample estimates:

mean of x

-3.71266e-18

The p-value is greater than 0.05 indicating that there is enough evidence of failing to reject the claim of the error term having a mean of zero.

Mutlicollinearity Test

Inflation	**2.352909**
BOT	**2.509540**
Exchange Rate	**11.409687**
Fiscal Policy	**11.293367**
Interest Rate	**2.954334**
Export	**1.771383**

Table 4.4: Result for Multicollinearity Test

The variance inflation factor is used to calculate the existence of multicollinearity. A general rule of thumb is that a VIF value greater than 5 or 10 indicates a high degree of multicollinearity. From 4.6.4 on, Fiscal policy and exchange rate have a high degree of dependency, and as such, Fiscal policy is taken out for the model to be run again.

4.6.2 Revised Model I

Due to multicollinearity and the project's focus on growth, fiscal policy was excluded from the full model. The decision was based on the negative contribution of fiscal policy, which suggests that it does not significantly contribute to growth. The revised model, as presented in Table 4.5, reflects this adjustment.

Variable(coefficient)	**Estimate**	**Std. Error**	**t-value**	**P-value**
Intercept	**-3.354**	**5.0381**	**0.666**	**0.5105**
Inflation	**-0.1334**	**0.1119**	**-1.191**	**0.2425**
BOT	**-3.327**	**0.6000**	**-5.546**	**4.49e-06**
Exchange rate	**13.3080**	**0.6871**	**19368**	**<2e-16**
Interest rate	**18.8720**	**18.0246**	**1.047**	**0.3032**
Export	**7.4537**	**3.6764**	**2.027**	**0.0513**

Table 4.5: Coefficient of Revised Model I

From Table 4.5, the significant explanatory variable explaining GDP is the Balance of trade and Exchange rate. Other such as Inflation, Export and Interest rate are not significant.

Multiple R-Squared	**0.9539**
Adjusted R-Squared	**0.9465**
F Statistics	**128.3**
p-value	**2.2e-16**

Table 4.6: Measure of the Significance of the Revised Model I

The reduction in R-squared from 0.9829 to 0.9539 and the reduction in adjusted R-squared from 0.9795 to 0.9465 indicates that the removed variable was contributing significantly to the explained variation in the dependent variable. However, it was also highly correlated with other independent variables, leading to multicollinearity.

Test for Assumptions in Regression Modelling

Normality Test

The Shapiro- Wilks test is used to test the normality of the residuals.

Shapiro-Wilk normality test(alpha=0.05)

data: residuals

W= 0.93985, p-value=0.04563

Based on the p-value of 0.04563 being less than 0.05, It can be concluded that the residuals do not follow a normal distribution at the 5% significance level. Hence the normality assumption is not met.

Constant Variance

Studentized Breusch-Pegan test

BP= 8.581 df=5, p-value= 0.127

The p-value of 0.127 is greater than 0.05, and the conclusion drawn is that the variance of the error term is constant hence assumption for homoscedasticity is met.

Zero Mean

One Sample t-test

data: revisedmodelI

t = 6.2798e-17, df = 36, p-value = 1

alternative hypothesis: true mean is not equal to 0

95 percent confidence interval:

-1.746568 1.746568

sample estimates:

mean of x

5.408118e-17

The mean of the residuals is still zero, and hence the assumption is still met after taking out the Fiscal policy.

From the graph above, even though the mean of the residuals is zero but there are two outliers.

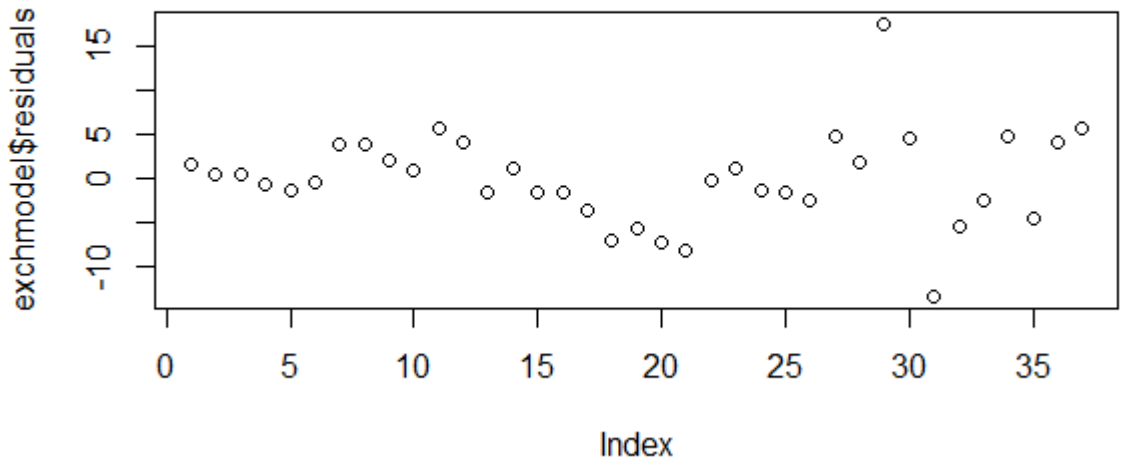

Figure 4.8: Residual Plot of Revised Model II

Multicollinearity Test

Inflation	BOT	Exchange rate	Interest rate	Export
2.333684	**1.577344**	**1.684631**	**2.945693**	**1.685590**

Table 4.7: Result for Multicollinearity Test

Based on the VIF result in Table 4.6, none of the variables have particularly high VIFs. This suggests that there is no severe multicollinearity issue among these variables in the regression model.

4.6.3 Revised Model II

Variable(coefficient)	Estimate	Std. Error	t-value	P-value
Intercept	**374300**	**369400**	**1.013**	**0.3190**
Inflation	**-0.1228**	**0.08956**	**-1.372**	**0.1804**
BOT	**-2.538**	**0.5139**	**-4.939**	**2.77e-05**
Exchange rate	**13.09**	**0.5518**	**23.726**	< 2e-16 ***
Interest rate	**0.0001695**	**0.0001672**	**1.013**	**0.3190**
Export	**6.145**	**2.956**	**2.079**	**0.0463 ***

0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Table 4.8: Coefficient of Revised Model II

Table 4.8 shows the output of the regression model after taking out the outlier from the data set. From the output, the Balance of trade, Exchange rate, and export are the significant variables at an alpha level of 0.05.

Multiple R-Squared	**0.9693**
Adjusted R-Squared	**0.9642**
F Statistics	**189.6**
p-value	**< 2.2e-16**

Table 4.9: Measure of the Significance of the Revised Model II

The R-squared value is 0.9693, which is very high. This means that the model fits the data very well. The F-statistic is 189.6, which is also very high. This means that the model is statistically significant. The overall p-value for the model is less than 0.05, which suggests that the model is significant.

Assumption Test Revised Model II

Normality Test

Shapiro-Wilk normality test W = 0.96751, p-value = 0.3616 Since the p-value is greater than 0.05, a conclusion can be drawn that the error of the residuals are normally distributed.

Test for Multicollinearity

Inflation	BOT	Exchange Rate	Interest Rate	Export
2.305126	1.554501	1.694166	2.895519	1.696358

Table 4.10: Result of Multicollinearity Test

The test for multicollinearity suggests that there is not a high degree of multicollinearity in the model.

Constant Variance

studentized Breusch-Pagan test
BP = 6.9865, df = 5, p-value = 0.2216 From the Breusch-Pagan test, the variance of the error term is constant (homoscedastic)

Zero Mean

One Sample t-test

data: revisedmodelII

t = -6.9721e-17, df = 35, **p-value = 1**

alternative hypothesis: the true mean is not equal to 0

95 per cent confidence interval:

-1.414313 1.414313

sample estimates:

mean of x

-4.857226e-17 The t-test also shows the mean of the error zero

4.6.4 Reduced Model

The stepwise regression was applied to model 4.6.3 which automatically removed the less- contributing independent variable. The final model is shown in Table 4.10 below

Variable	**Estimate**	**Std. Error**	**t-value**	**P-value**
Intercept	**0.2680**	**1.4647**	**0.183**	0.856
BOT	**-2.4169**	**0.4371**	**−5.530**	**4.25e-07**
Exchange rate	**13.0587**	**0.4499**	**29.023**	**< 2e-16**
Export	**4.4191**	**2.5441**	**1.737**	**0.092**

Table 4.11: Coefficient of Reduced Model

From table 4.11, the reduced model featured BOT, Exchange rate and Export as the most contributing independent variable in predicting GDP.

Multiple R-Squared	**0.9674**
Adjusted R-Squared	**0.9643**
F Statistics	**316.2**
p-value	**2.2e-16**
Residual standard error	**4.51**

Table 4.12: Measure of the Significance of the Reduced Model

Table 4.12 above shows the model appears to have a high adjusted R-squared value (0.9643), indicating that a 96.43% proportion of the variance in the response

variable is explained by the predictor variables while 3.57% is unexplained due to variations or error. The residuals are relatively evenly distributed, which indicates that the model is not overfitting the data. The standard error of the residuals is 4.51, which is relatively small. This means that the predictions from the model are likely to be accurate.

Assumption Test Reduced Model

Normality Test

Shapiro-Wilk normality test

W = 0.94449, p-value = 0.07015

Since the p-value is greater than 0.05, a conclusion can be drawn that the error of the residuals are normally distributed.

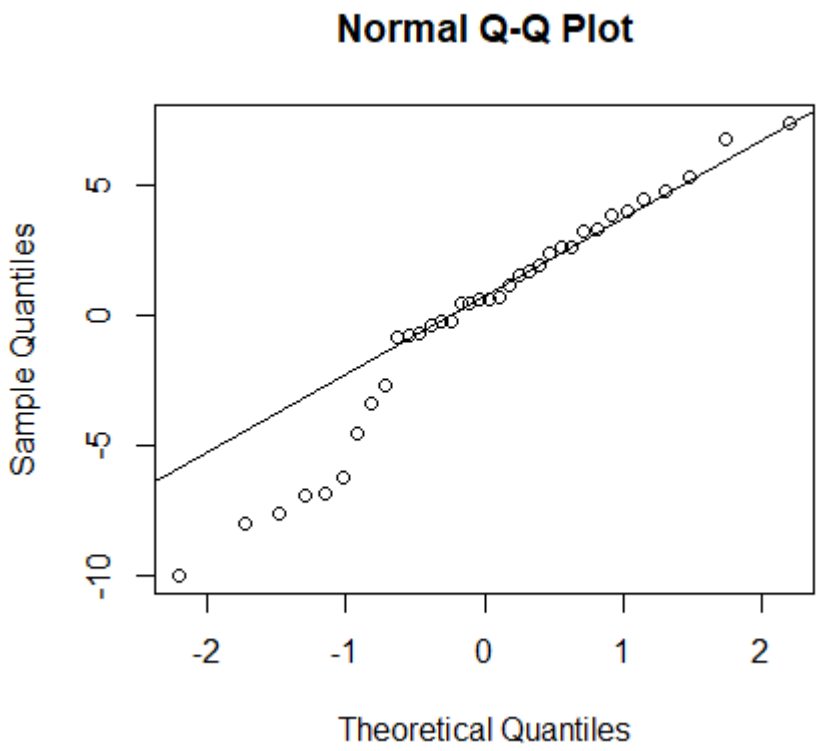

Figure 4.9: Q-Q Plot

Figure 4.9 also confirms the norlmacy assupmtion since there is a reasonably straight diagonal line connects almost all of the points on the plot.

Test for Multicollinearity

BOT	Exchange Rate	Export
1.126974	1.128935	1.259394

Table 4.13: Result of Multicollinearity Test

The test for multicollinearity suggests that there is not a high degree of multicollinearity in the model.

Constant Variance

studentized Breusch-Pagan test

BP = 5.5444, df = 3, p-value = 0.136 From the Breusch-Pagan test, the variance of the error term is constant (homoscedastic)

Zero Mean

One Sample t-test

data: reducedmodel

t = 1.438987e-16, df = 35, **p-value = 1**

alternative hypothesis: the true mean is not equal to 0

95 per cent confidence interval:

-1.458987 1.458987

sample estimates:

mean of x

1.032642e-16

The t-test also shows the mean of the error zero

Model	Residual Df	Residual deviance	Df	Sum of sq	P-value
Reduced	**32**	**650.78**			
Revised II	**30**	**611.54**	**2**	**39.244**	**0.3819**

Table 4.14: Result of Likelihood Ratio Test

4.7 Model Testing

4.7.1 Likelihood Ratio Test for Goodness of Fit of the Reduced Model

From table 4.13, the p-value for the likelihood ratio test,0.3819 is greater than $\alpha(0.05)$. This is evident that the revised model II is not better than the reduced model hence the reduced model is preferred. The final model is written as

GDP = 0.2680 - 2.4169**(Balance of trade)** + 13.0587**(Exchange Rate)** + 4.4191**(Exports)**

4.7.2 ANOVA Test of the Reduced Model

Variable	df	SS	MS	F value	Pr(>F)	F_m	P-value$_m$
BOT	1	666	666	32.735	0.00000243 ***	316.2	2.2e-16
EXCH	1	18562	18562	912.703	0 ***		
EXPORTS	1	61	61	3.017	0.092		
Residuals	32	651	20				
Total	35	19940					

Table 4.15: ANOVA Table of the Reduced Model

For the balance of trade, the F value is 32.735 with a p-value of 0.00000243 (extremely small). This indicates that there is strong evidence to reject the null hypothesis, suggesting that the variable BOT has a significant effect on the dependent variable.

For the variable exchange rate, the F value is 912.703 with a p-value of 0 (extremely small). This also indicates strong evidence to reject the null hypothesis, suggesting that the variable has a significant effect on the dependent variable.

For the variable EXPORTS, the F value is 3.017 with a p-value of 0.092. In this

case, the p-value is greater than the typical significance level of 0.05. but with a significance level of 0.10, the independent variable is significant. The F-statistic of 316.2 with a small p-value (¡ 2.2e-16) indicates a highly significant relationship between the independent variables and the dependent variable, supporting the overall significance of the regression model.

4.7.3 Standardized Regression Coefficient Comparison

Variable	**Value**
BOT	-0.18748382
EXCH	0.98484725
EXPORTS	0.06225414

Table 4.16: Result of the Standardized Regression Coefficient

These coefficients represent the change in the dependent variable (GDP) associated with a one-standard-deviation increase in the predictor while holding other predictors constant.

BOT has a beta coefficient of -0.1875. This suggests that a one standard deviation increase in BOT is associated with a 0.1875 standard deviation decrease in the dependent variable while holding the other variables constant.

The exchange rate has a beta coefficient of 0.9848. This indicates that a one standard deviation increase in EXCH is associated with a 0.9848 standard deviation increase in the dependent variable while controlling for the other variables.

For the variable EXPORTS, the standardized beta coefficient is 0.0623. This suggests that a one standard deviation increase in EXPORTS is associated with a 0.0623 standard deviation increase in the dependent variable while holding the other variables constant.

4.8 Discussion

The significant macroeconomic variables affecting economic growth in the study are the balance of trade, the exchange rate, and exports. The result indicates a negative relationship between the balance of trade and economic growth; this means a unit increase in the balance of trade will cause GDP to decrease by -2.4169. This negative relationship implies that when a country's exports exceed its imports, it tends to have a positive impact on economic growth. This finding aligns with the notion that a favourable balance of trade or trade surplus can contribute to increased domestic production, economic activity and economic growth in general.

Further, there is a positive relationship between the exchange rate and GDP which indicates that a unit increase in the Ghana cedis in relation to the dollar will increase the economic growth of Ghana. This positive relationship suggests that a stronger cedis relative to the US dollar can stimulate economic growth. It may attract foreign investment, boost exports, and make imports relatively cheaper, thereby stimulating the GDP of Ghana, which in general will increase the economic growth of the country.

Last, there is a positive relationship between exports and GDP, which means that as exports increase, GDP tends to increase. This is because exports create jobs and generate income, which can boost economic growth. The empirical evidence contributes to the fact that higher levels of exports contribute to economic growth.

Chapter 5

Summary of Findings, Conclusion and Recommendation

5.1 Introduction

This chapter presents the summary of the findings, conclusion and recommendation of the data analyzed in the previous chapter.

5.2 Summary of Findings

The study used Multiple Linear Regression analysis to examine the relationship between GDP and macroeconomic indicators in Ghana. The full model included the following indicators: Fiscal policy, Exchange rate, Balance of trade, Inflation, Export and Interest rate. The results of the analysis showed that the significant macroeconomic indicators affecting Economic Growth in the full model were the Balance of trade, Fiscal policy and Exchange rate.

However, the full model did not meet all of the assumptions of regression analysis, including normality and homoscedasticity. To address these issues, an outlier was taken out from the data (i.e. 2013) and fiscal policy was also removed. The revised model still included the Balance of trade, Exchange rate, and Export indicator. The results of the revised model showed that the assumptions of regression analysis were met.

The final model included the Balance of trade, Exchange rate, and Export variables. The results of the reduced model showed that these indicators were significant predictors of GDP. The R-squared value for the reduced model was 0.9693, which means that approximately 97% of the variability in GDP can be explained

by these three variables.

The findings of the study suggest that the balance of trade, exchange rate, and export are important indicators affecting Ghana's economic growth. These findings can be used to inform policy decisions aimed at promoting economic growth in Ghana. The findings indicate that

(1). The model appears to be a good fit for the data, as evidenced by the high adjusted R-squared value (0.9643).

(2). The residuals are relatively evenly distributed, which indicates that the model is not overfitting the data.

(3). The standard error of the residuals is 4.51, which is relatively small. This means that the predictions from the model are likely to be accurate.

(4) The p-value for the likelihood ratio test is greater than the alpha value (0.05), which indicates that the revised model ll is not better than the reduced model.

(5). The final model is written as GDP = 0.2580-2.4169(Balance of trade) + 13.0587(Exchange Rate) + 4.4191(Exports)

(6). The F values for the balance of trade and exchange rate are both extremely small, indicating that these indicators significantly affect the dependent variable.

(7). The F value for exports is 3.017, which is greater than the alpha value (0.10), so the variable is significant at the 10% level.

(8). The standardized beta coefficients for the balance of trade, exchange rate, and exports are -0.1875, 0.9848, and 0.0623, respectively. This means that a one standard deviation increase in the balance of trade is associated with a 0.1875 standard deviation decrease in GDP and a one standard deviation increase in exports is associated with a 0.0623 standard deviation increase in GDP.

5.3 Conclusion

The study found that the balance of trade, exchange rate, and exports are important indicators affecting the economic growth of Ghana.

A positive balance of trade means that a country is exporting more than it is importing, which can lead to economic growth.

A strong exchange rate can make exports more expensive, which can hurt economic growth. Exports are goods and services that are sold to other countries. A strong export sector can boost economic growth.

The study also found that the model appears to fit the data well, as evidenced by the high adjusted R-squared value (0.9643). This means that the model explains an approximately 96% of the variation in GDP.

The residuals are also relatively evenly distributed, which indicates that the model is not over-fitting the data.

The findings of the study suggest that the economic growth of Ghana can be boosted by policies that improve the balance of trade, strengthen the exchange rate, and promote exports. These policies can help to attract foreign investment, create jobs, and generate income, which will also contribute to economic growth.

In a nutshell, the study provides a clear understanding of the indicators that affect economic growth in Ghana. The findings of the study can be used to inform policy decisions aimed at promoting economic growth in Ghana.

5.4 Recommendation

The findings of the study suggest that Ghana can boost its economic growth by increasing its exports, strengthening its currency, and reducing its trade deficit. These policies can help to attract foreign investment, create jobs, and generate income, which will all contribute to economic growth.

Increase Exports:The government can provide incentives for businesses to export their products, such as tax breaks or grants. It can also promote Ghanaian ex-

ports overseas through trade missions and other marketing efforts.

Strengthen the Currency: The government can intervene in the foreign exchange market to buy cedis and sell dollars. This will make the cedis stronger, which will make exports cheaper and imports more expensive.

Reduce the Trade Deficit: The government can reduce the trade deficit by increasing exports and reducing imports. This can be done by implementing policies that make it easier for businesses to export their products and by raising tariffs on imported goods.

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Appendix

```
library(readxl)
revised <- read_excel("C:/Users/User/Desktop/Project Work/
            revised.xlsx")
View(revised)

##Linear Models
x1= revised$`INFLATION(%)`
x2= revised$`BOT_(B$)`
x3= revised$`EXCHANGE_RATE`
x4= revised$`FISCAL_POLICY`
x5= revised$`INTEREST_RATE`
x6= revised$`EXPORTS(B$)`
x7= revised$`GDP_(B$)`
rr=data.frame(x7,x1,x2,x3,x4,x5,x6)
rr

##Scatter Plots

#Exchange Rate
plot(revised$EXCHANGE_RATE,revised$`GDP_(B$)`, pch=19,
     main = "GDP & EXCHANGE RATE",xlab="EXHANGE RATE",
     ylab="GDP",frame=T, col= "darkolivegreen")
abline(lm(revised$`GDP_(B$)`~ revised$EXCHANGE_RATE),
     col="blue")

#Inflation
```

```
plot(revised$`INFLATION(%)`,revised$`GDP_(B$)`, pch=19,
     main = "GDP & INFLATION", xlab="INFLATION",
     ylab="GDP",frame=T, col= "darkolivegreen")
abline(lm(revised$`GDP_(B$)`~ revised$`INFLATION(%)`),
     col="blue")

#Balance of Trade
plot(revised$`BOT_(B$)`,revised$`GDP_(B$)`, pch=19,
     main = "GDP & BALANCE OF TRADE",xlab="BALANCE OF TRADE",
     ylab="GDP",frame=T, col= "darkolivegreen")
abline(lm(revised$`GDP_(B$)`~ revised$`BOT_(B$)`),
     col="blue")

#Fiscal Policy
plot(revised$FISCAL_POLICY,revised$`GDP_(B$)`, pch=19,
     main = "GDP & FISCAL POLICY",xlab="FISCAL POLICY",
     ylab="GDP",frame=T, col= "darkolivegreen")
abline(lm(revised$`GDP_(B$)`~ revised$FISCAL_POLICY),
     col="blue")

#Interest Rate
plot(revised$INTEREST_RATE,revised$`GDP_(B$)`, pch=19,
     main = "GDP & INTEREST RATE",xlab="INTEREST RATE",
     ylab="GDP",frame=T, col= "darkolivegreen")
abline(lm(revised$`GDP_(B$)`~ revised$INTEREST_RATE),
     col="blue")

#Exports
plot(revised$`EXPORTS(B$)`,revised$`GDP_(B$)`, pch=19,
```

```
      main = "GDP & EXPORT", xlab="EXPORT", ylab="GDP",frame=T,
      col= "darkolivegreen")
abline(lm(revised$`GDP_(B$)`~ revised$`EXPORTS(B$)`),
      col="blue")

##Correlation matrix
cor(rr, method="pearson")

##Regression Analysis on Full Model
fullmodel=lm(revised$`GDP_(B$)`~ x1+x2+x3+x4+x5+x6)
fullmodel
summary(fullmodel)

#Assumptions Check on Full Model

#Test for Normality
shapiro.test(fullmodel$residuals)

#Test for Constant Variance
library(lmtest)
bptest(fullmodel)

#Test for Zero Mean
t.test(fullmodel$residuals)

#Test for Multicollinearity
library(car)
vif(fullmodel)
```

```
###Exchange Rate and Fiscal Policy are highly correlated
###Take Fiscal Policy out and Re-run lm

##Regression Analysis on Revised Model 1
revisedmodel1= lm(revised$`GDP_(B$)`~x1+x2+x3+x5+x6)
summary(revisedmodel1)

#Assumptions Check on Revised Model 1

#Test for Multicollinearity
library(car)
vif(revisedmodel1)

#Test for Zero Mean
t.test(revisedmodel1$residuals)
plot(revisedmodel1$residuals)
mean(revisedmodel1$residuals)

#Test for Constant Variance
library(lmtedt)
bptest(revisedmodel1)

#Test for Normality
shapiro.test(revisedmodel1$residuals)

###Take out the Outlier
library(readxl)
out <- read_excel("C:/Users/User/Desktop/Project work/
        out1.xlsx")
```

```
View(out)

##Regression Analysis on Revised Model 2
revisedmodel2 = lm(out1$GDP ~ out1$INFLATION + out1$BOT +
                   out1$EXCH + out1$INTEREST + out1$EXPORTS)
summary(revisdedmodel2)

#Assumptions Check on Revised Model 2

#Test for Normality
shapiro.test(revisedmodel2$residuals)
plot(reducedmodel2$residuals)

#Test for Multicollinearity
library(car)
vif(revisedmodel2)

#Test for Constant Variance
library(lmtest)
bptest(revisedmodel2)

#Test for Zero Mean
t.test(revisedmodel2$residuals)

library(QuantPsyc)
lm.beta(revisedmodel2)

##Stepwise Regression on Revised Model 2
stepwisemodel=step(revisedmodel2,direction = "both")
```

```
summary(stepwisemodel)

#Assumption Check on Stepwise Model

#Test for Multicollinearity
vif(stepwisemodel)

#Test for Constant Variance
library(lmtest)
bptest(stepwisemodel)

#Test for Zero Mean
t.test(stepwisemodel$residuals)

#Test for Normality
shapiro.test(stepwisemodel$residuals)

#Comparison between Nested Models
#Likelihood Ratio Test
lrtest=anova(stepwisemodel,revisedmodel2,test="Chisq")
lrtest

#Regression Coefficients
install.packages("Quantpsyc")
library(QuantPsyc)
lm.beta(stepwisemodel)

#ANOVA Test
f_test=aov(stepwisemodel)
```

```
summary(f_test)


#Q-Q Plot
qqnorm(stepwisemodel$residuals)
qqline(stepwisemodel$residuals)
```