UNIVERSITY OF GHANA

TIME SERIES ANALYSIS OF THE EXCHANGE RATE OF THE GHANAIAN CEDI (GHS) TO AMERICAN DOLLAR (USD)

BY

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A LONG ESSAY SUBMITTED TO THE DEPARTMENT OF STATISTICS/ACTUARIAL SCIENCE, UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE DEGREE IN ACTUARIAL SCIENCE.

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DECLARATION

I hereby state that this work is the result of my own research and has not been submitted by anybody else for consideration for any academic honors at this university or any other. All citations utilized in the work have been given due credit.

If there are any shortcomings, I am solely responsible.

……. ……

JOHNSON TSIMESE DATE

CERTIFICATION

I hereby attest that the supervision of this long essay followed the guidelines established by the University of Ghana.

…….……. ……

DR. EDWARD ACHEAMPONG DATE

DEDICATION

The entirety of this research is dedicated to my father, Mr. John Kwaku Tsimese and my entire family for the endless support.

ACKNOWLEDGEMENT

First of all, I would want to thank the Almighty Father for giving me the gift of life and for guiding me through the start and end of my academic career and thesis.

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ABSTRACT

This paper modelled the monthly rate between the Ghana Cedi and the United States Dollar and used time series analysis to predict future rates. Making use of the monthly data obtained from the research department of the Bank of Ghana which covered a period from January 1990 to August 2022, an ARIMA model was created using the Box and Jenkins approach of time series analysis and subsequently a diagnosis was undertaken to validate the accuracy of the model. Upon conclusion of the data preparation it was revealed that the anticipated rates were in line with the observed series' declining trend. The ARIMA (0,2,2) model was determined to be the most appropriate model, having the least Mean Absolute Percentage Error (MAPE) of 4.35387, Root Mean Square Error of 0.09183662, and Mean Absolute Error of 0.03300914. Ljung-Box statistics test was used to estimate the data, with (Q) = 12.662 and 8 degrees of freedom, and a p-value of 0.124; there was no autocorrelation between the residuals at various lag times. The estimate, which covered the ten-month period from September 2022 to June 2023, projected that the Ghana Cedi would weaken against the US Dollar.

Keywords: Inflation, ARIMA, GHC, USD, ADT test, Ljung-Box test, forecast

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CHAPTER I

INTRODUCTION

1.1 Background

Exchange rate as the value of one nation's currency versus the currency of another nation or economic zone. The idea of trading two currencies is what we call foreign exchange (FOREX). There are many currencies being traded on the forex market but our focus here is the relationship between the Ghana currency (GHS) and the United States of America currency (USD). It is represented as USD/GHS on the stock market. USD is the base currency and GHS is the quoted currency. This states how much units of the quoted currency (GHS) is required to buy 1 unit of the base currency (USD). A practitioner stated that a stable economy with a well-developed export basis, industrialization, and job creation has strong fundamentals. With little outside help needed, that kind of economy can mobilize resources locally and even borrow money more cheaply (Sarkodie, 2022). People who live in an economy of this type gain access to efficient transportation, health care, and educational systems. They have plenty of resources and are devoid of civic instability. He went on to say that "the Ghanaian economy is far from achieving these indicators of an economy with strong fundamentals".

1.1.1 Depreciation of the Cedi against Dollars

When we say a currency has depreciated, we mean that the value of the currency has fallen relative to another currency. Ghana's economy is import-dependent. As a result, the country continues to buy foreign currency to cover its import needs, while exports provide less foreign exchange. The main causes of currency depreciation are loose monetary policy, rising inflation, solid economic fundamentals, interest rate differentials, political unrest etc. As imports decreased due to border restrictions by most nations, the currency rate remained relatively steady, notably throughout the

peak of the COVID-19 period that occurred between 2020 and 2021. However, as of February 28, 2022, the Ghanaian cedi was the worst-performing currency in Africa, having depreciated by 7.6% in the first two months of the year (Sarkodie, 2022). Also, On 4th March 2022, The cedi has reportedly risen to GHC 7 to USD, according to the Bank of Ghana. Compared to the rate of GHC 4.2 at the end of December 2016, which indicates that the cedi has depreciated by 40.02% against dollar since January 2017. Ghana is facing a perilous combination of a sinking currency, heavy debt, and rising global food and energy prices. This is causing havoc on our capital and businesses across the country, as well as increasing the financial burden on the general populace."

1.1.2 Redenomination of the Cedi

The Ghana Cedi and the Ghana Pesewas are the result of the redenomination of the Cedi on July 3, 2007, when new money entered the economy. It was created to alleviate one significant lasting effect of previous macroeconomic instability and inflation. The rapid increases in price numbers and foreign exchange rates in terms of local currency were left over from previous instances of high inflation. The economy bore a heavy deadweight burden during the preceding note system. A Ghana Cedi, which was equal to 100 Ghana Pesewas, was created by redenominating the formerly obsolete Ten Thousand Cedis to one Ghana Cedi. As a result, GHC10,000 = GHC 1 = 100GP. The equivalent worth or purchasing power existed for both the new notes and coins.

1.1.3 Exchange rate volatility

Exchange rate volatility refers to the uncertainty or risk that is accompanied by the international transactions. In Ghana, before the introduction of liberal economic reforms, there was a fixed exchange rate system in 1983. This was done to bring exchange rate in line with economic fundamentals. The currency in use before was the British West African Pounds but after independence, Ghana established a central bank and later introduced the Ghana cedis. After the

introduction the country's external payment position started deteriorating because of falling world prices of cocoa, the mainstay of both external and domestic revenues. With inflation rate rising and exchange rate being fixed, the country's currency became overvalued making imports cheaper to domestic goods and deepening the external payment problem. Ghana's employed the flexible exchange rate system during the paradigm shift management in 1983. This was done to correct the hefty over valuation and its value was determined by the market forces. The concept of stability of Ghana cedis is meaningful in relative sense. This means that we can describe the cedi exchange rate as stable when it presents a very low rate of change in the period and unstable when it presents high rate of change in the period. Thus, the closer the rate gets to zero the more stable the exchange rate is said to be.

1.1.4 How exchange rates affects the insurance industry

The Ghanaian government formed the National Insurance Commission (NIC) in 1989 with the passage of PNDC Law 229. The NIC standardized the insurance industry, which had previously been made up of a multiplicity of private insurance businesses that operated with no government oversight. Act 724, which further regulated the insurance industry, was passed in 2006. "To ensure effective administration, supervision, regulation, and control of the business of insurance in Ghana," the NIC's mission stated. The Commission was also in charge of establishing insurance premium rates, offering a venue for complaint settlement, and acting as a mediator in disputes over insurance claims. Exchange rates have an impact on the insurance industry. Insurance deals with the principle of mutuality of risk pooling. Thus, risk is transferred from a few individuals over to a group so the average loss is substituted for the actual loss. The funds pooled are used for investment purposes by the insurers. The fluctuations in the exchange rate can become a source of risk for firms. This could lead to a loss when they trade their funds on the money, capital

markets. Also, international business transactions could expose the institution to currency rate risk. Due to the opportunity cost of not "waiting" before committing sizable sums of money as capital, the volatility does enhance the level of uncertainty around international investments and discourages foreign direct investment inflows.

1.2 Statement of the problem

For Ghana to sustain the value of the Cedi and lessen the effects of global capital shocks, exchange rate stability is essential. The exchange rate is becoming more important to businesses in Ghana as it directly impacts domestic selling prices, profitability, resource allocation, and investment decisions. Unfortunately, current trends have revealed that the fluctuations in the exchange rate have caused the value of the cedi to depreciate drastically and a further study of this instability predicts further depreciation down the line. The Government, Citizens, Investors, Stock brokers and other interested individuals have however failed to take cognizance of these fluctuations which have an impact on firm profitability and investment choices by increasing risk and uncertainty. These fluctuations and their adverse effects are neither being monitored nor remedied partly as a result of the lack of statistics or reports on the fluctuations and lack of projections as to continued depreciation. This research paper seeks to highlight the factors which influence the performance of the Ghanaian Cedis (GHC) against the American Dollar (USD) and employ statistical approaches to predict and forecast the performance of the cedi over a period of 10 months in hopes of providing insight that assists decision makers.

1.3 Purpose of Study

The goal of this research is to access and study the rise of US dollars relative to Ghana cedis. In order words, this paper shall examine the stability/fluctuations of the exchange rate between cedis

and dollars. Also, the analysis made from the fluctuations will be used to provide insight on how the instability of the exchange rate affects the country on an economic and social level.

Furthermore, the data provided by the Bank of Ghana will be used to forecast the trend between GHC and dollars to give us insight on the appreciation or depreciation of the currency over a period of 10 months.

This research seeks to give both forecast values rather than compare the forecasting abilities between other models and the selected ARIMA model. Lastly, this research paper aims at providing assistance to decision makers and interested parties such as Investors, Citizens, Stock brokers and Government officials.

1.4 Significance of the Study

This study will help insurance companies understand how to employ different hedging techniques and instruments available which would mitigate the adverse effect of exchange rate volatility. The paper will help companies in effective decision making and increase profitability in the firm as it will provide a forecast data on the increment or decrement of United States Dollars against the Ghanaian Cedi. It is also a great tool for conducting additional research in the field and for the development of hypotheses in the future by academics and researchers in a variety of fields.

It would assist Government officials in the generation of policies which manage the instability of the exchange rate and remedy the damage caused by this instability. Consequently these policy decisions shall benefit the Nation and her citizenry.

This paper will also serve as a guide to investors and stock brokers seeking to make investment decisions and other financial decisions.

1.5 Limitations of the study

Bureaucracy in dealing with the Bank of Ghana resulted in delays with data gathering which put a stall on the research.

This study also makes use a time-series forecasting tool that bases predictions exclusively on the past performance of the rates being predicted.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This section talks about various studies such as; the theoretical and empirical studies done on exchange rate.

2.2 Theoretical review

This section will only examine certain theories of how exchange rates are determined. While there are many theories on exchange rate, the five most popular ones in this study are as follows: the Quantity Theory of Money, the Mint Parity Theory, the Tightening Monetary Policy Theory, the Purchasing Power Parity Theory and the Balance of Payment Theory.

2.2.1 The Quantity Theory of Money

In monetary economics, the principle of QTM states that, the overall level of prices for goods and services is positively associated with the amount of money in circulation at that time. McCallum & Nelson (2010) defined the Quantity theory of money as;

$$MV = PY, \qquad (2.1)$$

where M, Y and P measures of the nominal quantity of money, real transaction or physical output and the price level respectively. The V represents monetary velocity. Over the years there have been different meanings to QTM by different writers. Friedman (1989) offers quantity theory of money demand, with money demand supposed to be determined by asset prices or relative returns as well as wealth or income. He demonstrates how a theory of stable money demand transforms into a theory of pricing and output. Hume (1752), in his treatment, investigated the scenario in which an increase in money causes prices to rise at a steady rate, as well as the scenario in an open economy where the expansion of metallic money led to its export. According to Patinkin (1969),

an increment in the supply of money was thought to result in a rise in the absolute price level but have no effect on the commodity market. He explained that the tight quantity theory could only be maintained by exerting influence on the commodity market via the real balance effect. As the theory many writers criticized the definition of the QTM. Keynes (1936) criticized the quantity theory of money. He stated that the money supply does not directly affect the price level. A real-world variable like output may be impacted by changes in the money supply. Mises (1990) acknowledged that the quantity theory had some merit, but he disagreed with it since it concentrated on the supply of money rather than fully addressing the demand for money. He claimed that it "fails to explain the mechanism of changes in the value of money."

2.2.2 The Mint Parity Theory

The Mint Parity Theory of Foreign Exchange Rates describes how exchange rates are established between nations that share a common metals standard. For example, in the gold standard system, the rate as a result of foreign exchange is based on the amount of gold in the two currency units. If currency P has 10 grams of gold and currency Q has 5 grams of gold, the exchange rate is $1P = 2Q$. In his paper, Chand (2014) explained that the gold sovereign (Pound) contained 113.0016 grains and the gold dollar held 23.2200 grains of standard purity gold. Based on mint parity, the rate of exchange between the US dollar and the British pound was $113.0016/23.2200$, or 4.8665. In other words, the exchange rate of $£\,1 = 4.8665$ can be thought of as the mint par rate between the pound and the dollar. The mint parity theory has been heavily questioned for a variety of reasons. To begin with, the worldwide gold standard has been fully abandoned since its collapse in the 1930s due to the Great Depression. As a result, analyzing the current exchange rate in terms of mint parities is unreasonable. Second, the hypothesis assumed that international gold movements were free. The unrestricted international purchase and sale of gold is prohibited by

modern governments. The mint parity hypothesis of exchange rate has little relevance in these situations. Third, the majority of countries currently use inconvertible paper currencies. The mint parity theory cannot establish the rate of exchange in such a system. Due to the aforementioned flaws, the classic mint-parity theory has no practical application in the establishment of foreign exchange rates. In today's world, it's little more than an academic exercise.

2.2.3 The Tightening Monetary Policy Theory

Zanzalari (2022) defined tight monetary policy as the actions that a central bank takes to limit inflation and an overheating economy. In other words, the purpose of the policy is to slow down hot economic growth, limit spending in an economy that appears to be advancing too quickly, or contain inflation that is rising too quickly. Inflation is the gradual increase in the price of goods such as groceries or clothing. To reduce or halt inflation, the Bank of Ghana could raise interest rates, making it more expensive for individuals to spend money and companies to borrow money. This is a type of contractionary monetary policy in which spending is restricted or contracted. The bank of Ghana reported that the current inflation rate in Ghana is 27.6%. The institution has monetary tools such as; the repurchase agreements (repos), the open market operations (OMO) instruments (the Bank of Ghana bills), term deposits, and reserve requirements to influence money supply and inflation

2.2.4 The Purchasing Power Parity Theory

The premise of purchasing-power parity is that over time, pricing for goods and services should become comparable across nations. The theory asserts that prices between countries should be equal. It was left to Professor Gustav Cassel, starting in 1916, to give the theory a name and to systematically explain it. Up until the present, he has remained a fervent supporter of it, but with

growing alterations. By accounting for regional disparities in buying power, the PPP measurement seeks to increase the validity of comparisons between two currencies.

Global organizations such as the World Bank, International Monetary Fund (IMF), and European Union (EU) frequently employ PPP measurements. Let's take an illustration. Consider buying a certain assortment of goods in the USA for one dollar. The identical assortment of things in Ghana cost 5 cedis. The exchange rate then will typically be 1 $dollar = 5\ cedis$. Imagine that the level of pricing in both countries are the same, but the exchange rate is changed to $\$1 = GHC\ 8$. At this exchange rate $\$1 = GHC\ 8$, it will be profitable for people to buy the given assortment of goods in Ghana for 5 cedis and sell them in the United States for $1 again, making a profit of USD 3 per transaction. As a result, while the market forces of supply and demand at any given moment determine the value of a unit of one currency of a country relative to another country (Amadeo, 2021). There are several reasons why we do not live in a world operating in Purchasing parity theory. First of all, there are variations in the price of transportation as well as in taxes and tariffs. Prices will increase as a result of these expenses. Prices will be lower in nations with a large number of trade agreements since they have less tariffs. Because socialist nations impose greater taxes, their costs will be higher. Also, the import prices are susceptible to changes in exchange rates. For instance, Ghanaians pay more for imports when the GHC declines. The foreign currency market is the main factor influencing how exchange rates fluctuate.

2.2.5 The Balance of Payment Theory

The theory highlights how similar the position of a country's balance of payments affects the currency rate. An improvement in the country's currency's external value results from a favorable balance of payments. External value declines as a result of an unfavorable balance of payments (Chand, 2014). The idea holds that a negative balance of payments results in the exchange rate

falling or declining, as opposed to a positive balance of payments increases the exchange reserves and results in an increase in the value of the domestic currency when compared to foreign currencies. The exchange rate differences between fixed rates and variable rates are crucial. We shall see money moving between nations to correct for disequilibrium when exchange rates are fixed between nations. Exchange rates are permitted to fluctuate with floating exchange rates in accordance with the dynamics of supply and demand for each currency in a free market. International money flows are used to adjust fixed exchange rates to changes in international monetary conditions, whereas exchange rate changes are used to modify floating exchange rates. Chand (2014) explained that In addition to the goods (exports and imports of products) included in the balance of payments, the theory highlights the existence of a number of dominant forces that affect the market supply and demand for foreign currency, which in turn affects the exchange rate. As a result, the theory is more plausible because it considers a wide range of important factors, rather than just the purchasing power as an expression of overall price levels.

2.3 Factors Influencing the Performance of Ghana Cedis

One important factor affecting a country's economy in a free-market economy is the exchange rate, another economic indicator. A stable or strong currency allows a country to import goods more affordably than it might have if its currency were weak. Exchange rates are vital in the world of international trade. Due to their propensity to influence the real value of the currency, exchange rates are another crucial element investors must take into account when making investments in the economy of a country. Antwi et. Al (2014) conducted a study to determine whether short-term changes in exchange rates can be predicted using historical data on GDP, imports, exchange rates, and government spending/expenditure, as well as the consumer price index. The study also looks into whether the variables have stable, long-term equilibrium relationships. The study's findings

demonstrate that the variables have significant long-run equilibrium relationships.. It demonstrates how important government spending is in predicting exchange rate fluctuations. Additionally, the exchange rates' recent past has a significant impact on projecting them. Controlling government spending is advised to prevent the fluctuation of exchange rate swings in the near future. Also, Mumuni & Owusu-Afriyie (2004) argued that speculation and underlying economic factors both affect the Ghanaian exchange rate. According to their reasoning, rising inflation causes the Cedi to depreciate while high domestic Treasury bill rates cause it to appreciate in the short term. This means that if the country's inflation rate and Treasury bill rate are seasonal, the exchange rate will be, too.

The following are the six variables that affect the Ghana cedi's exchange rate:

2.3.1 Inflation

A consistent increase in price is referred to as inflation. The consumer price index is an approach which is used to measure it. The percentage difference in the index between two specified periods is calculated to determine inflation within a nation or geographical area. This is how we calculate the inflation rate on a monthly and annual basis. When we say inflation has occurred, it does not always follow from an increase in the supply of money but rather there is a steady increment in the supply of money in comparison to the amount of wealth produced. This can also be termed as Gross Domestic Product (GDP). Chiaraah & Nkegbe (2014) studied the effects of Ghana's inflation on the exchange rate, GDP growth, and monetary policies. The dynamics of an error correction model reveal that the domestic money supply has little impact on the level of domestic prices in the short run, despite the fact that it has a significant long-term impact on how the inflation rate behaves. The study is unable to demonstrate a meaningful long-term association between Ghana's currency rate and inflation. The results are consistent with a long-term equilibrium relationship

between inflation, foreign prices as well as the supply of money and real income. The findings demonstrate that long-term inflation in Ghana is positively connected with the money supply but negatively correlated with real income and the level of global prices, in contrast to theoretical predictions. The study's findings strongly support the Bank of Ghana's present practice of tying inflation targets to monetary policy.

2.3.2 Interest rates

This is the additional cost associated with using money that was borrowed from a creditor. The organization responsible for affecting interest rates in Ghana is the Bank of Ghana. An economy with higher interest rates provides lenders with a larger return compared to other nations. Higher interest rates so draw in foreign investment and lead to an increase in the currency rate. Mohammed et. Al (2021) brought up a suggestion in there that in order to reduce exchange rate volatility, the Bank of Ghana must keep borrowing costs low. This is no longer just a call; it is a vital requirement. Second, since money supply and inflation have a long-term impact on exchange rate volatility, it is crucial that the Bank of Ghana take action to reduce the pressure arising from inflation. This is because a quick rise in the supply of money will lead to higher inflation, which eventually destroys the value of our local currency.

2.3.3 Market Speculation

When investors decide to take actions that have an impact on the country's currency for reasons unrelated to economics, this is a form of economic activity. Typically, panic buying or rumor-mongering fuel market speculation. For instance, a brief decline in USD deposits may cause investors to exchange Ghana Cedis for such currencies if they believe it will persist for a long period of time. Due to this, the value of the country's currency is depreciated. An economy's stability is closely related to the health of the capital markets where it trades, and vice versa. The

dynamics of asset prices, which are typically predicted based on the projected rate of return, are linked to the stability of the capital market in turn. The implied market volatility determines the expected rate of return and market direction (VIX index) (Thimmaraya & Masuna, 2017).

2.3.4 Public Debt

When the government borrows money to pay for its expenses, either domestically or internationally, this happens. Due to Ghana's lower middle-income position, more money needs to be raised than in prior years. One method the government does this is by issuing bonds and other types of financial security. Foreign investors are less interested in investing in countries with high governmental deficits and debts. This occurs because high levels of debt encourage inflation. A government may print money to pay for a portion of a significant debt, but doing so invariably leads to inflation. A government must also increase the amount of assets available for sale to foreigners if it is unable to pay its deficit via domestic measures (selling domestic bonds, increasing the money supply).

2.4 EMPIRICAL REVIEW

The research studies on exchange rates conducted in recent years—both locally and internationally—are covered in this section. This chapter is a systematic review analysis where similar works done by researchers are studied. The various methods they employed to get meaningful insights from their data is also touched on in this section.

2.4.1 International reviews

The research done by Palamalai & Kalaivani (2013) employs the ARDL limits testing method suggested by Pesaran et al. (2001) to empirically evaluate the impact of fluctuating currency rates on India's actual exports. The empirical studies have been done for the years 1970 to 2011 using annual time series data. The study's findings support the notion that real exports are correlated with

real exchange rates, exchange rate volatility, gross domestic product, and international economic activity. The findings from the research indicate that the volatility in the exchange rate has a major negative effect on real exports. This occurs both in the short and long term and also indicates that increasing exchange rate variance tends to reduce real exports in India. The empirical findings show that while GDP has a positive and large long-term impact on India's real exports, the impact is negligible in the short term. Additionally, real exports are significantly impacted by foreign economic activity in both the short- and long-terms, with positive and negative effects, respectively.

Reuben et. Al (2016) used the GARCH (1,1) to analyze the naira's exchange rate in relation to the other international currencies such as; US dollar, British pound, British, Euro and Japanese yen in order to research the characteristics of Nigeria's exchange rate volatility and use independent variable to model it in order to assess whether the specified models have improved or not, as well as to assess how well they perform forecasting. Reuben et. Al (2016) used weekly series, along with other variables, which is relatively higher in frequency. The study differentiates itself from others by assessing their effects on the exchange rate return series using the approximated volatility series that was collected. Additionally, they employ daily data series with a higher frequency than those used in other studies, which allows them to capture the strength of data fluctuations.

In investment settings, Udokang et. Al (2022) conducted a study on the analysis of the risk associated in such trading due to foreign currency rate volatility. Time series data and model were employed in this study. The Central Bank of Nigeria (CBN) website, which is open to the public, was used to extract the monthly exchange rates of four of the most important foreign currencies in Nigeria, namely the US Dollar (USD), Great Britain Pound (GBP), Euro, and CFA Francs against the Nigerian Naira (NGN), from January 2004 to December 2019. The Generalized Autoregressive

Conditional Heteroscedastic (GARCH) model was an appropriate model employed at order 1 for parsimony to determine volatility used in determining Value at Risk due to how unpredictable the exchange rate is (VaR). The maximum loss (risk), as determined by VaR, that can happen at a 95% confidence level for a twelve-month trading forecast involving the pound was found to be the highest among the four currencies, with a percentage loss of between 15.5 and 16.2 percent. The CFA, however, has the lowest risk, with a VaR of 0.02 to 0.03 percent. According to the results, trading in GBP carries the highest level of risk when it comes to investing in foreign currency because of the high return-producing exchange rate variations. Investors will benefit from this study's analysis of the relationship between risk and return when they choose which foreign currency to trade. Since the risk involved can be calculated, Udokang et. Al (2022) suggested that the government should put laws in place to encourage current investors and new investors who wish to invest on foreign exchange to create employment.

Adenekan et. Al (2019) investigates how the Nigerian naira's returns are impacted by currency rates. The study calculated an AR(5)-TGARCH (1,1) utilizing the daily exchange rate returns between Naira and US Dollars in order to test for asymmetry in the temporal course of the naira exchange rate volatility. The results showed that exchange rate volatility causes exchange rate returns to rise (depreciation). Additionally, the movement of exchange rate volatility is asymmetrical in nature, which results in a greater reduction in volatility as a result of negative shocks that lower exchange rate returns than they do as a result of positive shocks of equal magnitude. To reduce excessive volatility or irregular market swings, the report advises the monetary authority to step up its surveillance of exchange rate behavior. In order to prevent arbitrage opportunities brought on by speculation and to promote trustworthy exchange rate

management, it should also continue to proper legislations and sanctions are put in place to regulate the market effectively.

2.4.2 Local review

In Ghana, Opoku-Afari et. Al (2004) modelled the real exchange rate using vector autoregressive techniques (VAR) in the long-run. Their key finding is that capital movements have little influence in the near run and only have an appreciating effect over the long run. Additionally, it is discovered that over time, exports, technical advancement, terms of trade etc. have a depreciating effect on the actual exchange rate.

Lossifov & Loukoianova (2007) estimate Ghana's BEER for the years 1984 to 2006 using quarterly data and a vector error correction methodology. While conducting their research, they discovered that over the long term, factors such as the interest rate differentials, GDP growth, and the global pricing of the country's primary export items all had an impact on the real exchange rate. In the preparation of their data analysis, they proceeded to ascertain the real misalignment of the real rate across the period using these determinants mentioned.

Mensah et. Al (2013) examined how Ghana's manufacturing sector's job growth was heavily influenced by exchange rate volatility. They used information from the Ghana Statistical Service, the World Bank, and the Ghanaian economy. The study assesses the effect of the instability of the exchange rate on the growth of job in the country while making use of the Ordinary Least Squares (OLS) regression method. The findings from the study also discovered that exchange rate volatility had an impact on the growth of jobs in the Ghanaian manufacturing sector of the country. That is, the rate of employment in Ghana's manufacturing sector has drastically decreased as a result of the Ghanaian currency's devaluation versus the US dollar.

Nyead & Atiga (2014) looked into how changes in the currency rate affected Ghana's export growth. The information, which comes from secondary sources, was taken from the websites of the Bank of Ghana, the United Nations, and the International Monetary Fund (IMF) over a 22-year period from 1990 to 2012. Exchange rate is employed as an independent variable in addition to other controllable factors, and growth on export is used as the dependent variable. Incorporating the OLS estimator, the findings from the research revealed that the exchange rate had no correlation with Ghana's export of goods and services rendered. However, the analysis discovers that export is significantly impacted by Gross Domestic Products (GDP) and other factors such as the gross national saving and total investment.

Appiah & Adetunde (2011) forecasted future rates by modeling the monthly exchange rate between the GHC and the USD using time series analysis; specifically, the Arima model. The data they gathered was on a monthly basis from January 1994 to December 2010. The ARIMA model generated was diagnosed and estimated to determine its accuracy using the Ljung-Box test. With the least Normalized Bayesian Information Criterion (BIC) of 9.111, the Mean Absolute Percentage Error (MAPE) of 0.915, the Root Mean Square Error of 93.873, and the highest value of R-Square of 1.000, the ARIMA (1, 1, 1) model was determined to be the most appropriate model. There was no autocorrelation between the residuals at different lag times. In the end, a prognosis for the two-year period from January 2011 to December 2012 was developed and indicated that the Ghana Cedi was losing value relative to the US Dollar.

The seasonal trend of exchange rates in Ghana is also revealed by a previous study by (Bawumia & Abradu-Otoo, 2003). The study contrasts a peak depreciation in the fourth quarter of the year with a steady depreciation in the first three (3) quarters. The study also shows that, in contrast to inflation, changes in the money supply are instantly reflected in the exchange rate. The money

supply has a pronounced year-end hump and is cyclical in nature. Therefore, the money supply, particularly in the fourth quarter, helps explain the seasonal behavior of the exchange rate in Ghana.

Evans & Tawiah (2015), in their study, explained that the two currencies investigated on; thus Cedi-US Dollar exchange rate follows a specific pattern throughout the year due to the seasonality of Ghanaian economic activity including agriculture as well as consumption and money supply, among others that affect exchange rates. This research conducted has revealed the quarterly behavior of both currencies mentioned earlier using Bank of Ghana's interbank exchange rate data for the three years 2000 to 2014. In order to do this, the US Census Bureau's X-12 Census ARIMA tool was used to compute trend, F-test, K-test, and regression data as well as statistical analysis. The regression results show a statistically negligible average mean difference between the quarters, despite the trend analysis suggesting seasonal depreciation of the Cedi with a peak in the fourth quarter. The shifting seasonality test, however, revealed a cycle of seasonal frequencies that changed from year to year. The study's overall finding is that the Ghana cedi's depreciation against USD follows a shifting seasonality with a pattern that is consistently repeated each year.

2.5 Summary of Literature review

The summary from pertinent theoretical and empirical review is presented in this part. The goals and objectives of the research are in line with an empirical examination of pertinent and current literature. Exchange rate volatility is characterized by the random swings of the exchange rate, according to the literature. Both the operating environment and profit risks are heightened by these unanticipated movements. This necessitates the application of various hedging procedures by the investing sector of the insurance market in order to reduce the risk posed by fluctuations in foreign exchange rates. Researchers from Ghana, including Opoku-Afari et. Al (2004), Evans & Tawiah

(2015), and Appiah & Adetunde (2011), found that the depreciation of the Ghana cedi against the dollar follows a shifting seasonality with a pattern that is repeatedly repeated from year to year. Additionally, over time, the actual exchange rate depreciates due to advances in technology, exports, and trade arrangements. Also, In the long run, real GDP growth, real interest rate differentials, and the real-world prices of Ghana's main export commodities all affect the real exchange rate, according to scholars like Lossifov & Loukoianova (2007) and Mensah et. Al (2013). They discovered that exchange rate volatility had an effect on job growth in Ghanaian manufacturing sector companies. That is, as a result of the devaluation of the Ghanaian currency in relation to the US dollar, the rate of employment in the country's industrial sector has significantly reduced. It is impossible to get to a convincing conclusion about the USD/GHC exchange rate by performing a cursory scan of the data. Therefore, in order to conduct empirical research on the impact of currency rate volatility in Ghana, strong statistical approaches are required.

CHAPTER III

METHODOLOGY

3.1 Introduction

In-depth discussion of the study's research methodology is provided in this chapter. The various techniques, plans, and methods that would be employed to perform the research were described in this chapter. In particular, it covered information about the data, data gathering methods, analytical model approach such as the ARIMA model and the Box-Jenkins method, and significance test. This paper's goal is to present both forecast values rather than to compare the forecasting abilities of the chosen random walk model and ARIMA model.

3.2 Data and data source of the study

Data was gathered from the Bank of Ghana (BoG) Research Department in Accra to meet the goals of this study. The data spans the years January 1990 to August 2022. The dependent variable and independent variable are both based on the two components of the data. In this paper, GHS exchange rate is the dependent variable and time is the independent variable. This is because exchange rate is an economic time series that is dependent over time. The duration of this study is expressed in months.

3.3 Time series

A time series is a chronological or time-oriented sequence of observations on an interest variable (Montgomery et. Al, 2008). Typically, such designs involve a single subject or research unit that is measured regularly at regular intervals over a significant number of observations. A longitudinal design can be seen as an example of timeseries analysis. Time series analysis can be used to analyze the results of either a planned or unplanned intervention, as well as to understand the underlying naturalistic process and the pattern of change over time. In other words, Time series

forecasting is the process of using a model to forecast future values based on values that have already been observed. Weather information, rainfall measurements, temperature readings, quarterly sales, stock prices, interest rates, stock trading etc. are some examples of time series analysis in action.

3.3.1 Time series analysis and techniques

There are numerous approaches for studying data, just as there are numerous types and models. Plotting a time series can show patterns like randomness, trends, level shifts, periods or cycles, odd observations, or a mixture of patterns (Montgomery et. Al, 2008). The three most common types of models and techniques are;

i) Box-Jenkins ARIMA models: They are univariate models which are used to forecast future data points of variables and to enhance understanding of a single time-dependent variable, such as temperature over time. Moving averages as well as, seasonal difference operators, and autoregressive terms are all taken into consideration by the ARIMA model.

ii) Box-Jenkins Multivariate models: These models are used to examine multiple time-dependent variables throughout time, such as temperature and humidity.

iii) Exponential Smoothing models: under this model, If seasonality is present in the data points, it is intended to forecast outcomes. Montgomery et. Al (2008) explained that the smoothing models use a straightforward function of prior observations to forecast the variable of interest. In other words, these models generate predictions that are most similar to current observations.

3.4 Modelling Approach

In this study, the Box-Jenkins ARIMA model is employed to forecast the data for analysis.

3.4.1 ARIMA model

In their groundbreaking textbook Time Series Analysis: Forecasting and Control, published in 1970, George Box and Gwilym Jenkins popularized ARIMA (Autoregressive Integrated Moving Average) models (Box et. Al , 2011). The model is made up of three components which aids in modelling a particular type of pattern.

The "AR" or autoregressive component makes an effort to explain any patterns that exist between any given time period and earlier ones. Box & Jenkins (1970) denoted the values of a process at equally spaced times t, $t - 1$, $t - 2$, … by z_t, z_{t-1}, z_{t-2}. Also let $\tilde{z}_t = z_{t-u}$ be the series of deviations from μ. They further established the formula;

$$\tilde{z}_t = \alpha_1 \tilde{z}_{t-1} + \alpha_2 \tilde{z}_{t-2} + \cdots + \alpha_p \tilde{z}_{t-p}, \qquad (3.1)$$

as the Autoregressive process of order p. The letter p is the order (number of time lags) of the AR model, z_t is the current value, z_{t-1}, z_{t-2} are the previous values in which z_t is dependent on. z_t, z_{t-1}, z_{t-2} is multiplied by a coefficient α. The parameter p is a non-negative integer. When an observation is correlating with its value at time t-1 in the recent past, it is said to be AR (1).

The "MA" or moving average component, often known as error feedback, assesses how well fresh forecasts adjust to previous forecast errors. (Stellwagen & Tashman, 2013). Maskey (2022) explained moving average as the dependency between an observation and a residual error. Box & Jenkins (1970) provided the formula;

$$\tilde{z}_t = \varepsilon_t + \beta_1 \varepsilon_{t-2} + \ldots + \beta_q \varepsilon_{t-q} \qquad (3.2)$$

Where the letter q is the order of the MA series, $\tilde{z}_t$ is the current value and $\varepsilon_t, \varepsilon_{t-1}, \varepsilon_{t-q}$ are the error term in which $\tilde{z}_t$ is dependent on and β is the coefficient. The formula is referred as a moving average with order q MA (q) and at is referred as the white noise. A white noise can be referred to as a time series that shows no autocorrelation.

Since ARIMA is a combination of the AR model and the MA model, the equation becomes

$$\tilde{z}_t = \alpha_1\tilde{z}_{t-1} + \alpha_2\tilde{z}_{t-2} + \cdots + \alpha_p\tilde{z}_{t-p} + \varepsilon_t + \beta_1\varepsilon_{t-2} + \ldots + \beta_q\varepsilon_{t-q} \ldots\ldots\ldots (3.3)$$

Stellwagen & Tashman (2013) explained that the integrated component, abbreviated "I," denotes a trend or other "integrative" process in the data. When trends are present, changes between months must be modeled rather than the monthly data themselves.

In order to quickly identify the ARIMA model being used, the parameters are substituted with integer values in the standard notation known as ARIMA (p, d, q). ARIMA models have proven to be capable of producing precise short-term estimates. It consistently outperformed complex structural models in terms of short-term prediction (Maskey, 2022). The fundamental benefit of ARIMA forecasting is that it simply needs information about the time series in issue. First, this functionality is helpful if one is predicting a lot of different time series. Second, it eliminates an issue that multivariate models occasionally run into (Meyler, Kenny, & Quinn, 1998).

3.4.2 Assumptions of Arima Model

Before we start with Arima modelling, we have to visualize our data and check for stationarity assumption

Stationarity

A stochastic process that is stationary has constant mean, variance, and autocorrelation structure. Montgomery et. Al (2008) explained that business data, such as interest rates and stock prices,

frequently display nonstationary behavior. We can also say that a stationary time series is one in which time has no impact on its values. Briefly, the time-series data is said to be stationary if these conditions are met;

A. The data should have a constant mean.

B. The data should have a constant standard deviation.

C. There is no repeated patterns in the data (seasonality).

If the data is not stationary, there are ways in which it can be transformed with the following techniques; Detrending, Differencing and Transformation

A. Detrending: In this process, the trend effects from the dataset that has been provided is removed and the values that diverge from the trend are displayed. It always makes it possible to recognize cyclical patterns. In other words, If there is a trend in the data, we can fit a curve to it and then model the residuals of that fit.
B. Differencing: The difference between the present time period and the preceding time period is the concept of differencing. If these numbers don't rotate around a constant mean and variance, we use the results of the first differencing to calculate the second. This is repeated until a steady series is obtained.
C. Transformation: There are three methods that are used under this process; Power Transform, Square Root, and Log Transfer. The Log Transfer is the most common technique among the three. By calculating the series' logarithm or square root, non-constant variance may be stabilized. Before performing the transformation on negative data, you can add a suitable constant to make all the data positive.

Testing for Stationarity

In order to test for stationarity, we employ the Dickey Fuller Test (DFT). The Dickey-Fuller test is used to evaluate whether a unit is present in an autoregressive model. It is named after American statisticians David Dickey and Wayne Fuller, who created the test in 1979.

The most common statistical test, the ADF test, is based on the following assumptions

Null Hypothesis (Ho): Series is non-stationary

Alternate Hypothesis (HA): Series is stationary

Furthermore, our decision criteria is stated below;

If the *P*-value > 0.05 Fail to reject (Ho)

P-value <= 0.05 reject (Ho)

Autocorrelation Function and Partial Autocorrelation Function

ACF is used to show how similar a value is to the previous value within a given time series. The time series' correlation with itself is where the autocorrelation function begins with a lag of 0, which yields a correlation of 1. ACF tends to answer the following questions; Is our data a white noise or random? And is it possible for our data to be modelled with MA model? If so then we use the ACF to determine the order q.

PACF always displays the correlation between the sequence and itself with a specific number of time units per sequence order, only displaying the direct influence; all other intermediary effects are subtracted from the provided time series. Similar to the ACF, a correlation of 1 is produced by PACF since it starts with a lag of 0, which is the time series' correlation with itself.

The ACF and PACF is very important because we use this process to determine whether to make use of the AR term or the MA term. The AR model is used if there is positive autocorrelation at lag 1 and we employ the MA model if there is a negative autocorrelation at lag 1. A time series is referred to as second-order stationary or weak stationary if it has a finite mean and autocovariance (Montgomery, Jennings, & Kulahci, 2008). There is another criterion to look at when deciding whether to choose the between the AR or MA model. Use an $AR(n)$ model if the PACF plot starts to decline at lag n; if it declines more gradually, use the MA term.

Table 3.1 A summary to determine the appropriate order of model to use

	AR(p)	**MA (q)**	**ARMA (p, q)**
ACF	Tails off (decaying towards zero)	Cuts off after lag q	Tails off
PACF	Cuts off after lag p	Tails off (decaying towards zero)	Tails off

3.5 Box-Jenkins method

For the purpose of estimating and predicting a univariate time series, Box-Jenkins advocated a three-step process that involved choosing an acceptable ARIMA model from a group of likely models. The analysis and forecasting methodology developed by Box and Jenkins is largely recognized as the most effective forecasting method and is frequently employed. The three phases are: (i) identification; (ii) estimation; and (iii) diagnostic checking.

I) Model Identification

The first step towards model selection is to difference the series in order to achieve stationarity. Stationary models assume that the process remains in statistical equilibrium with probabilistic properties that do not change over time, in particular varying about a fixed constant mean level

and with constant variance (Box et. Al, 2011). For observed data that are non-stationary, we use differencing to transform to stationary time series. A time series' variance can be stabilized with the aid of transformations like logarithms. By reducing variations in a time series' level, differencing can aid in stabilizing its mean.

II) Parameter Estimation

The Autocorrelation Function (ACF) and Partial Autocorrelation Function (PCF) are used to estimate the values of p and q of an ARMA model.

III) Diagnostics checking

To identify potential fit issues and determine the cause, diagnostic checks are used. The model is ready for usage if there are no signs of a lack of fit. The iterative cycle of identification, estimation, and diagnostic checking is repeated if any inadequacies are discovered until an acceptable representation is discovered. (Box et. Al, 2011). Figure 3.1 shows the iterative process using this method.

During the diagnostic check, we evaluate the model using the following statistical tools. They include;

A. Akaike Information Criteria: this evaluation metric is used to distill the model's simplicity and goodness of fit. The assumption under this diagnostic check is that, the AIC value should be as low as possible.
B. Bayesian Information Criterion: Similar to the AIC, the BIC is used to evaluate the model's goodness of fit and the lowest value is mostly preferred.
C. Mean Error: It can be defined as the difference between the measured value and the true value

D. Mean Absolute Error (MAE): The MAE does not take into account the direction of the errors when calculating their average magnitude in a collection of forecasts.

E. Mean Absolute Percentage Error (MAPE): evaluates a forecasting system's accuracy as a percentage. It can be calculated as the average absolute percent error for each time period less real values divided by actual values.

F. Root Mean Square Error (RMSE): we say errors are of the same magnitude when mean absolute error is equal to root mean square error.

G. Box-Ljung statistics: This statistics follows the following hypothesis.

Ho: Residuals in the data are independently distributed

H1: Residuals are not independently distributed

The ideal criteria for this test is to fail to reject Ho, meaning the P-value should be greater than the alpha level (0.05)

H. Arima residuals analysis: When checking residuals on ARIMA plot, we look at the seasonality and the normality of the residuals. The residuals should closely resemble those of white noise if the model is appropriately constructed and the parameter estimations are close to the true values. They ought to behave basically as independently distributed, identically distributed normal variables with similar standard deviations and zero means.

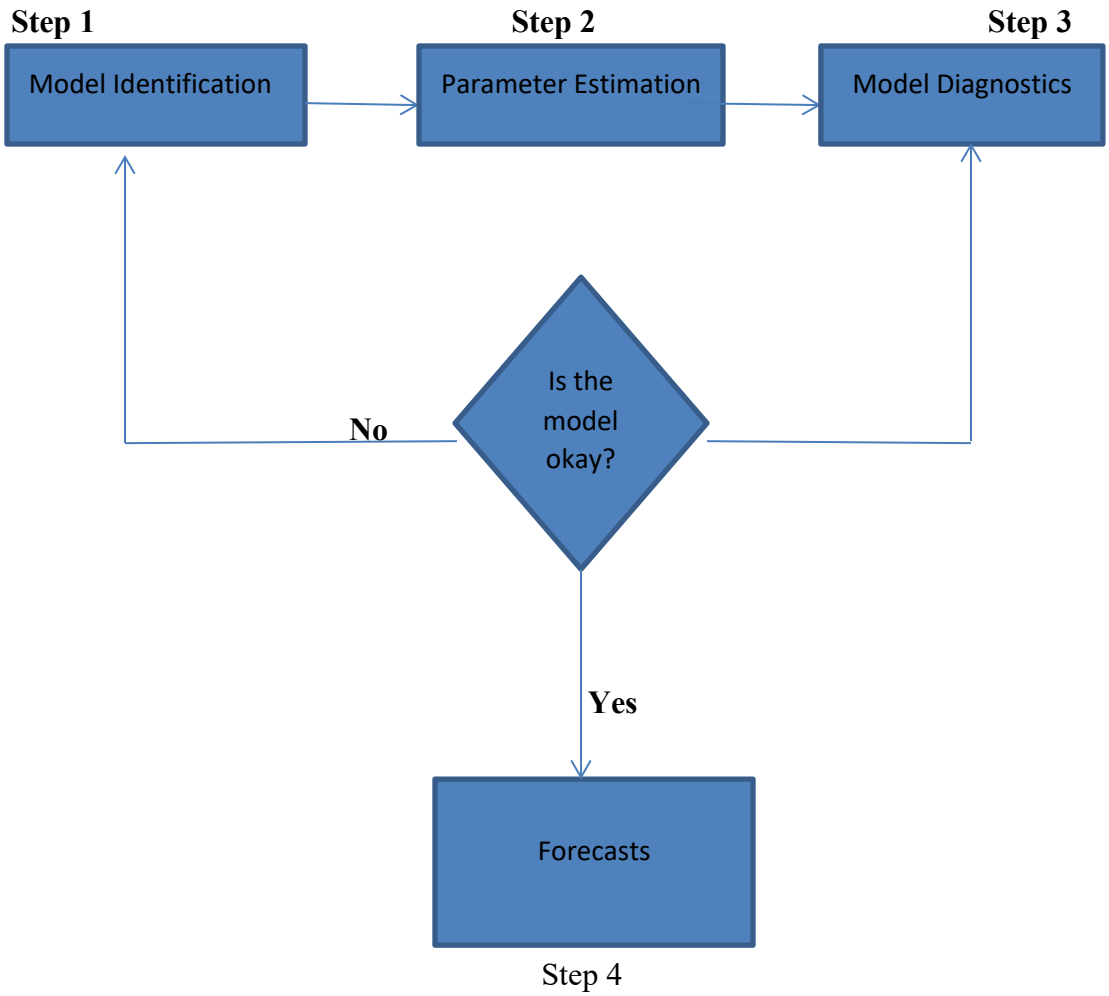

Figure 3.1: A diagram showing the Box-Jenkins Approach

CHAPTER IV

DATA ANALYSIS AND DISCUSSION OF FINDINGS

4.1 Data Visualization

Figure 4.1 depicts the observe data graph, which provides a general overview of the time series data. The time series data trend is stair-step in nature and not periodic. Additionally, it displays two noteworthy peaks that happened in January 1993 and June 2015. Since then, it has been clear that the Cedi has been steadily losing value at a quicker rate. As shown in the graph in Figure 4.1, the data is not stationary. The increasing trend in the time plot above suggests that the mean is shifting over time, and as a result, there is no stability in the variance of the time series data. This suggests that the time series data is not stationary. It is important to note that the variable time is in months

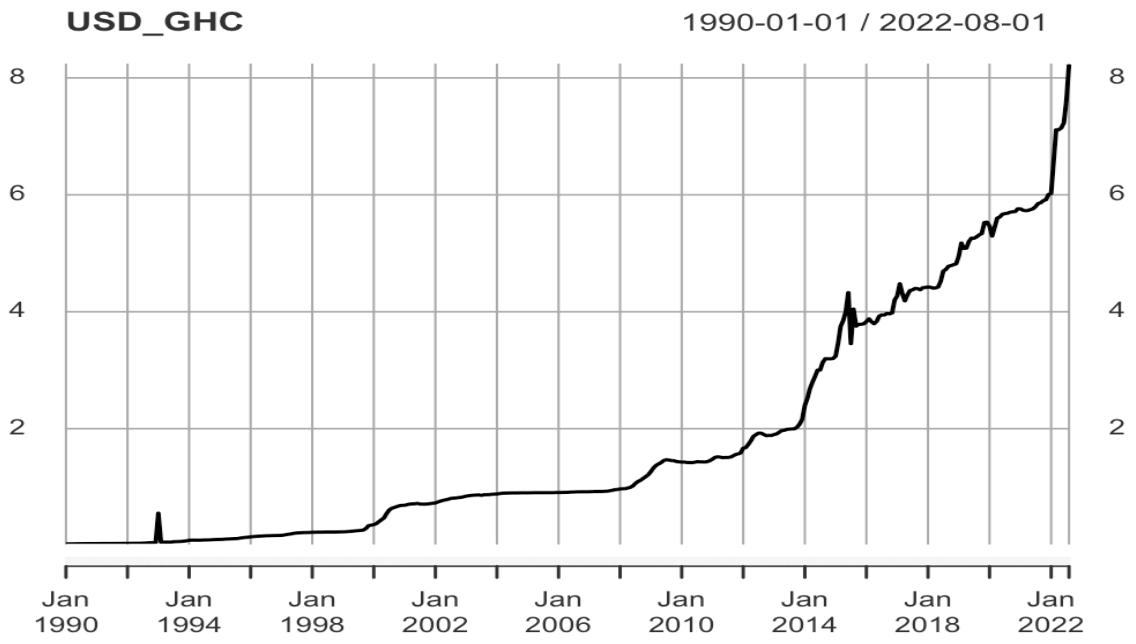

Figure 4.1: Data Visualization between The Ghanaian Cedi and The American Dollar

4.1.1 The Correlograms and ADF test

The correlograms in Figure 4.2 below shows the observed data's ACF and PACF and it is clear that the time series is most likely to have a random walk pattern. Additionally, the ACF saw a linear fall, which causes a moderate decline and just one notable peak in the PACF. The non-stationarity of the time series data is confirmed by the correlogram, which is shown below in graphical form. In other words, the autocorrelation coefficients are quite high at different lags, which is common for non-stationary time series data, and this is the most remarkable aspect of this correlogram. Now, in order to attain stationarity, it must be differenced, as will be seen in the pages that follow.

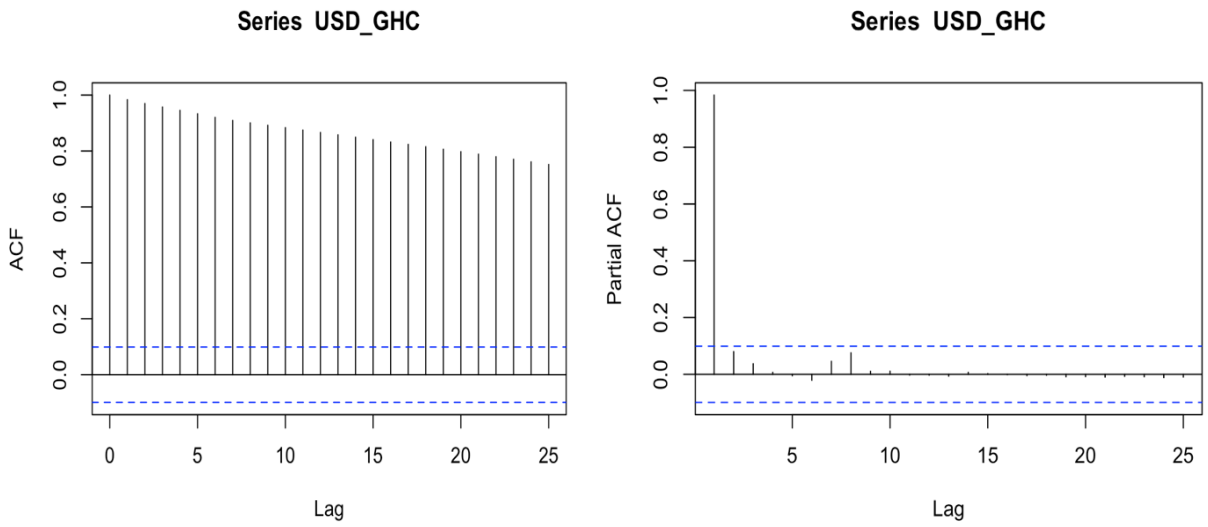

Figure 4.2: Plot showing the Autocorrelation Function (ACF) and the Partial Autocorrelation Function (PACF)

Table 4.1: Testing for Stationarity using the Augmented Dickey-Fuller Test

Augmented Dickey-Fuller Test			
Dickey-Fuller	Lag order	P-Value	Hypothesis
1.5916	7	0.99	Non-stationary

While our time series is stationary under the alternate hypothesis, the null hypothesis of the ADF states that it is not stationary. When the P-value from the ADF test is more than 0.05 (the significant level alpha), according to our decision criterion, we fail to reject the null hypothesis, and vice versa when P is less than alpha. As a result, we have completed the test to establish the series' stationarity condition after the ADF. It is clear from the findings in the Table 4.1 above that the exchange rate plot is non-stationary.

4.2 Data Visualization (After 1st Differencing)

The graph below Figure 4.3, indicate the first difference in the data, and it can be observed that the mean is approaching zero and the variance is constant in both situations. We perform stationarity test on the differenced data to determine if the mean and variance are indeed approaching zero and constant respectively.

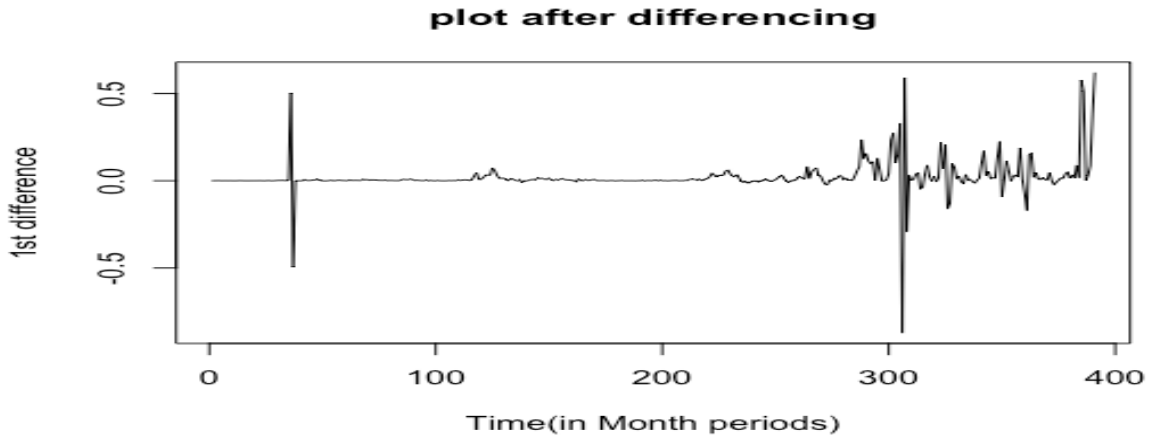

Figure 2.3: Plot showing the Exchange rate after the 1st differencing

4.2.1 ACF, PACF and ADT after 1st differencing

The ACF and PACF correlograms for the first difference in the data are shown in Figure 4.4. One can see that white noise is present in the ACF, which has many significant peaks at the second, fifth, and sixth lags. The PACF likewise exhibits three major peaks. ADF test was performed to check for stationarity. It showed in Table 4.2 that the data after the first differencing was non-stationary; since the p value is greater than the alpha level (0.05). Further differencing is then required.

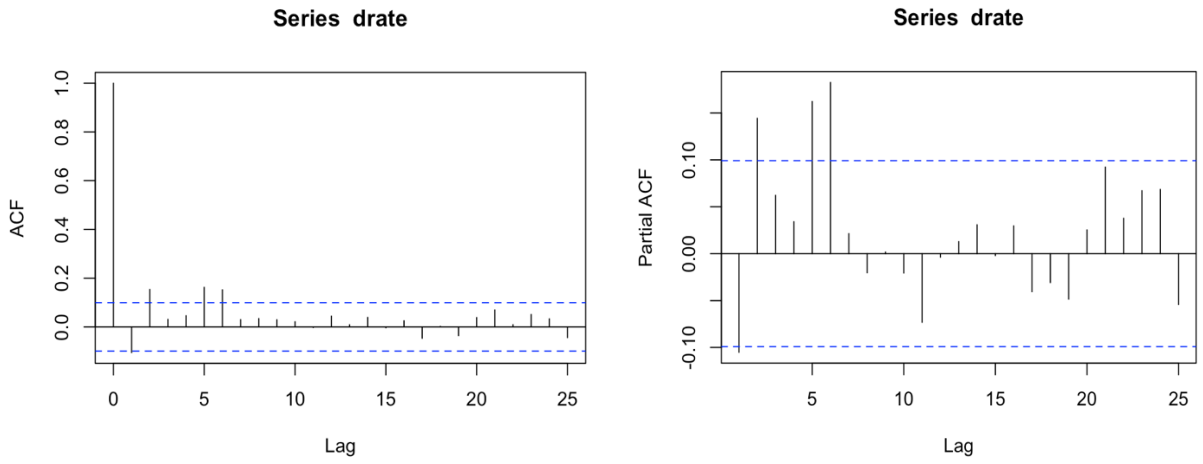

Figure 4.4: Plot showing the ACF and PACF after first differencing

Table 4.2: Stationarity test after 1st difference using ADT approach

Augmented Dickey-Fuller Test			
Dickey-Fuller	Lag order	P-Value	Hypothesis
-2.8308	7	0.2264	Non-stationary

4.3 Data visualization (After 2nd differencing)

The graph below Figure 4.5 shows the second differencing in the data. It is important to note that the differencing is not as a results of the difference between the original values and itself lagged by two periods, but rather, it is the first difference of the first difference. In other words, the values generated by the first difference are differenced at one time period. Figure 4.5 shows that the mean approaches zero and the variance is constant. The graph shows stationarity.

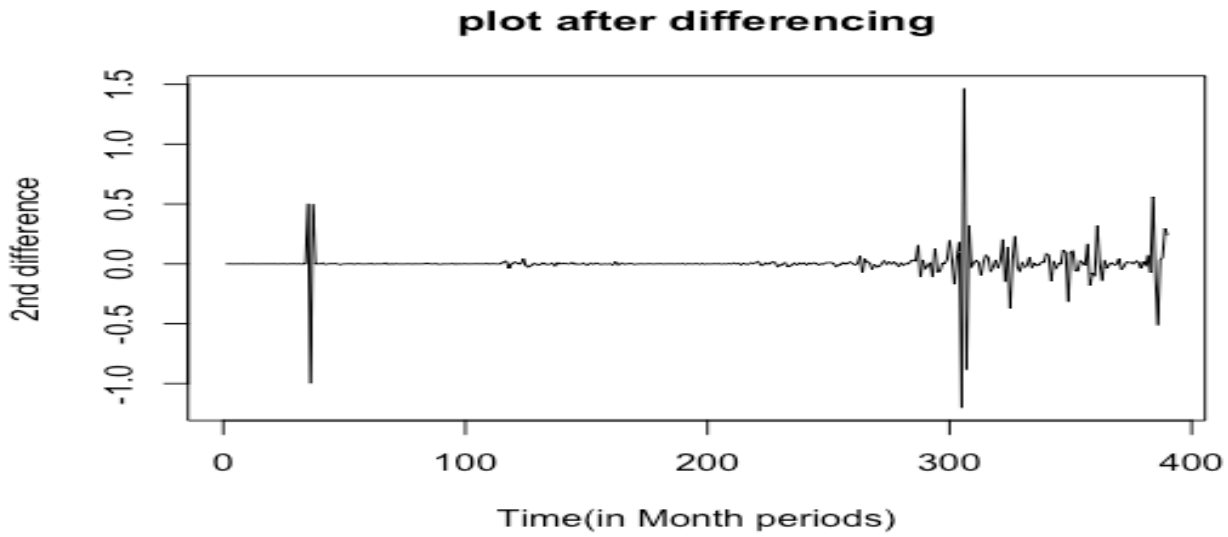

Figure 4.5: Data visualization of USD/GHC after second differencing

4.3.1 ACF, PACF and ADT after 2nd differencing

The ACF and PACF correlograms for the second difference in the data are also shown in Figure 4.6. The ACF displays white noise and two strong peaks at the first and second lags. The PACF displays a lot of negative peaks. The graph below (Figure 4.6) presents a fair idea of what model to use for analysis. Since the ACF cuts at lag 2, the MA model will be sufficient for forecasting. The ADF test results presented in Table 4.3 concluded that the data is stationary since the p value

(0.01) is less that the alpha level (0.05). The next step is to evaluate various models to determine which model produces accurate forecasting.

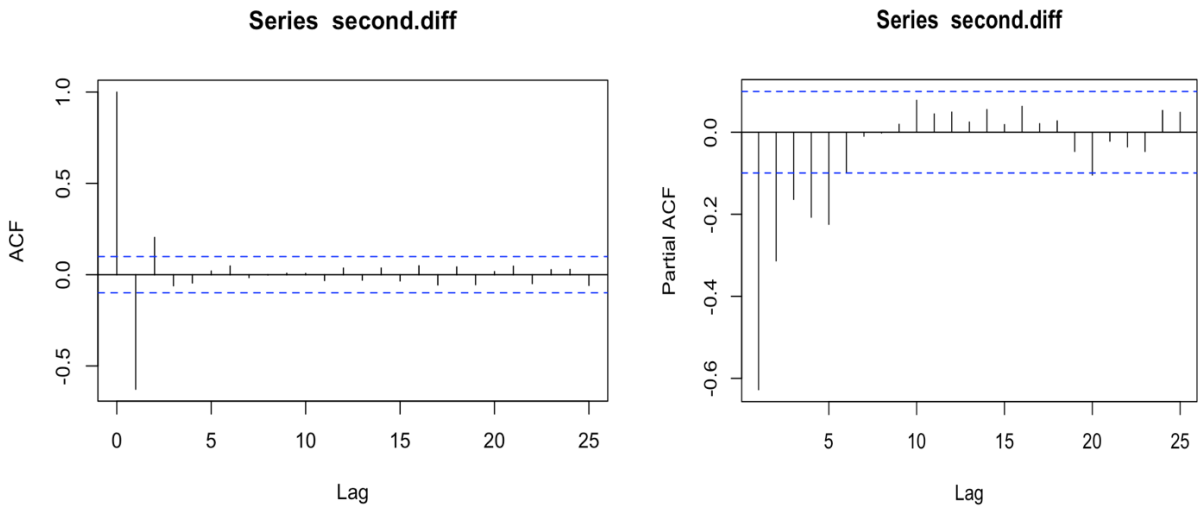

Figure 4.6: Plot showing the ACF and PACF of USD/GHC after second differencing

Table 2.3: Stationarity test after 2nd differencing using the ADT approach

Augmented Dickey-Fuller Test			
Dickey-Fuller	Lag order	P-Value	Hypothesis
-11.031	7	0.01	Stationary

4.4 Evaluation of various models

After differencing, several models were suggested for forecasting based on their capacity to provide accurate predictions. The AIC values were a criteria in selecting the best model and fitted with data ranging from January, 1990 to August 2022. Table 4.4 shows a list of all suggested ARIMA models. The lowest AIC value is preferrable. From Table 4.5 below, ARIMA (0, 2, 2)

was the best model with the lowest AIC (-739.8121). Further test is then required to determine how reliable the best suggested model is.

Table 4.4: Various ARIMA models suggested and their respective AIC values

Approx. Suggested ARIMA models	
Model	AIC value
ARIMA(2,2,2)	-736.5413
ARIMA(0,2,0)	-418.2788
ARIMA(1,2,0)	-612.4043
ARIMA(0,2,1)	-721.4718
ARIMA(1,2,2)	-737.5581
ARIMA(0,2,2)	-739.8121
ARIMA(0,2,3)	-737.8641
ARIMA(1,2,1)	-738.6081
ARIMA(1,2,3)	-735.2263

Table 4.5: Best ARIMA model with low AIC

Best Model without Approximation	
Model	AIC value
ARIMA(0,2,2)	-745.8258

4.5 Model estimation and Parameters

The parameters of the model Arima (0, 2, 2) has only MA coefficient since the order p is zero. The parameters for both MA coefficients are stated in Table 4.6 below. Table 4.6 shows the estimate of both lags and the tests whether each of the parameters are significant. The ARIMA (0,2,2) is explained by this formula;

$$\tilde{z}_t = 2\,\tilde{z}_{t-1} - \tilde{z}_{t-2} - \theta_1 e_{t-1} - \theta_2 e_{t-2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.1)$$

where $\tilde{z}_t$ represent the exchange rate in (GH¢ per US$), θ_1 and θ_2 are the MA(1) and MA(2) coefficients and e is the independent random shock term.

Table 4.6: Estimating the ARIMA parameters

Model	MA	Estimate	SE	Z value	Pr(>|z|)	Sig
ARIMA (0,2,2)	Lag 1	-1.1457	0.0536	-21.3890	2.2e-16	0.00
	Lag 2	0.2673	0.0561	4.7655	1.884e-06	0.00

The coefficients -1.1457 and 0.2673 are statistically significant because the significant level (0.00) were less than the alpha level 0.05. As a result, the exchange rate model is given by;

$$\tilde{z}_t = 2\,\tilde{z}_{t-1} - \tilde{z}_{t-2} + 1.1457 e_{t-1} - 0.2673 e_{t-2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.2)$$

4.6 Model Adequacy

The ARIMA (0,2,2) model's forecasting accuracy was tested using the RMSE, MAE MAPE and Box-Ljung Statistic test listed in table 4.7 below and the results show that the model successfully captured the correlation in the time series.

Table 4.7: Checking ARIMA adequacy using RMSE, MAE, MAPE and Box-Ljung Test

Model	Accuracy criterion			Box-Ljung Statistics (Q*)		
ARIMA	RMSE	MAE	MAPE	Q*	df	Sig.
(0, 2, 2)	0.09183662	0.03300914	4.35387	12.662	8	0.124

The ARIMA (0,2,2) model is adequate to forecast the exchange rate of GHS against USD, because the value of the Box -Ljung (Q*) statistic which is equals to (12.662) is less than the critical value of Chi-square ($\chi 2$) amount (15.507) at the significant level (α = 0.05), and the significant (p-value) (0.124) is greater than (α = 0.05). Moreover, low RMSE, MAE and MAPE indicates a good fit for a model making the forecasting accuracy very high.

4.7 Model diagnostics

From Figure 4.7 below, the residual from ARIMA (0,2,2) is seen to have an irregular pattern which means the ARIMA model (2,2,2) is adequate having a mean around 0 and a constant variance (Homoscedasticity). In an ideal case, The ACF lags wouldn't touch the confidence interval in the ACF plot below. This tells us how consistent the model is. The residuals is seen to have a bell shape thus, it is uniformly distributed.

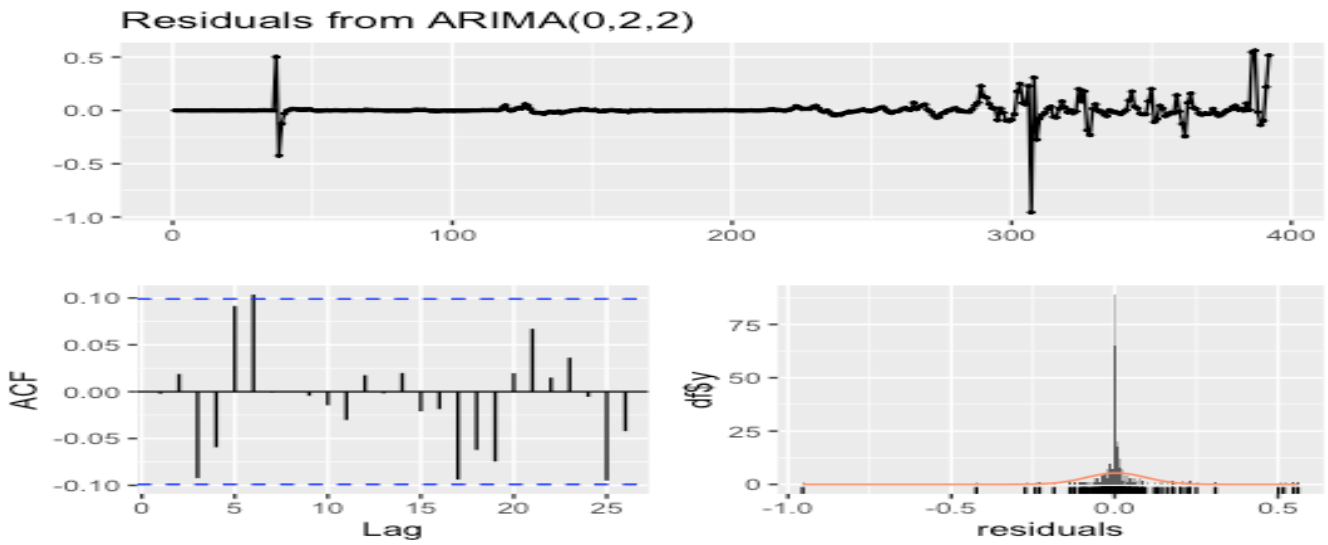

Figure 4.7: Residual, ACF, Normality of ARIMA (0,2,2) model

4.8 Forecasting using ARIMA model (0,2,2)

Following the diagnostic test, the model was fitted for a ten-month period. The projected model's graph revealed that the Ghana Cedi will weaken against the US dollar throughout the entire forecasted time in Figure 4.8. Table 4.8 below also provides the forecasted values and the confidence level for these forecasts.

Table 4.8:Forecast Point Estimate and 95% Low & High confidence interval for 10 months period

	SEPT 2022	OCT 2022	NOV 2022	DEC 2022	JAN 2023	FEB 2023	MARCH 2023	APR 2023	MAY 2023	JUNE 2023
P.E	8.32	8.54	8.77	8.99	9.22	9.44	9.67	9.89	10.12	10.35
Lo 95	8.14	8.31	8.47	8.64	8.80	8.96	9.12	9.23	9.43	9.58
HI 95	8.5	8.78	9.07	9.35	9.64	9.93	10.22	10.51	10.81	11.11

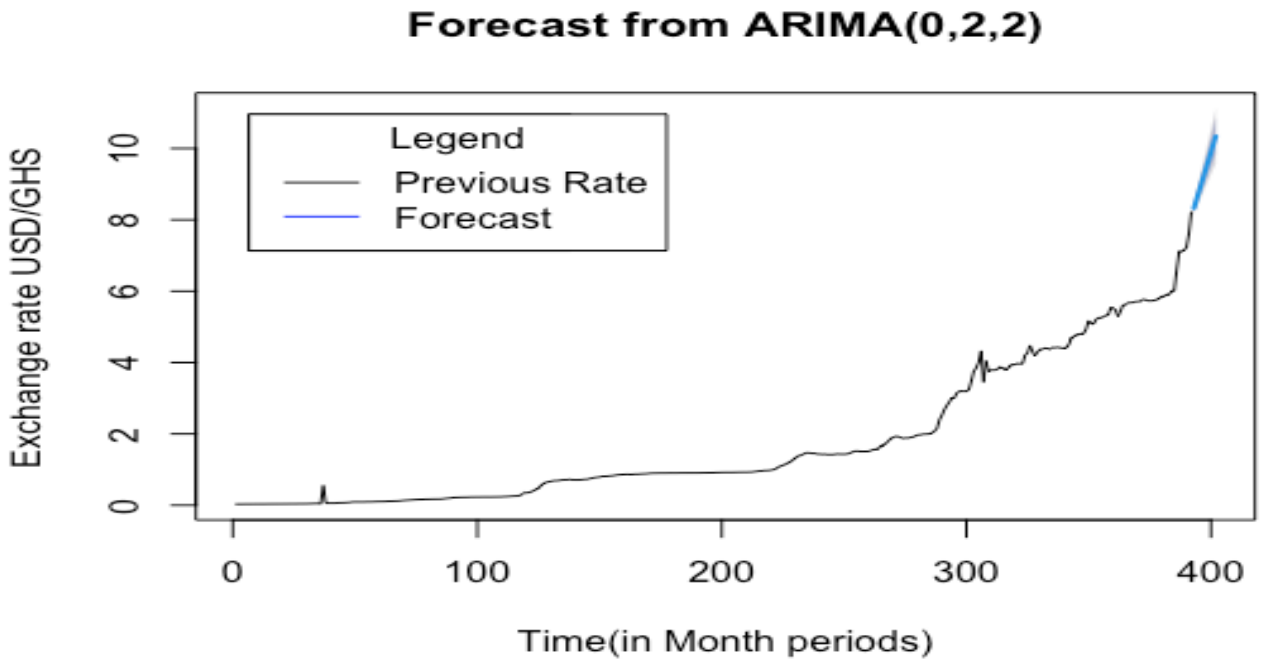

Figure 4.8: Data Visualization of forecasted Exchange Rate for 10 months period

4.9 Conclusion

The time series component found in the model was random variation. The data was non stationary which led to a stationarity test using the ACF, PACF and ADT as a criteria. After the first difference the data was constant around mean zero but the ADT showed that the exchange rate data was still non stationary. Further differencing was required. After the second difference, the data was seen to have a constant mean and variation. The ADT test showed that it was stationary. RStudio is the statistical software used for this analysis. The program generated suggested Arima models and the best model was ARIMA(0,2,2). Further evaluation on the model was done to determine its accuracy. The model selected was found to have a good fit and hence appropriate for this study. The ten-month prediction was determined to exhibit an upward trend. As a result, for the anticipated time period, the Cedi will lose value relative to the Dollar.

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

This is the final section of this study and it recaps the results discussed in the previous chapter and goes on to make insights. This chapter also provides recommendations in order to help reduce the depreciation rate of the Ghanaian currency. There has been drastic increase in the volatility of Ghana cedis which has raised concerns in the foreign exchange market

5.1 Summary

This study analyzed the exchange rate between United states of America dollars and the Ghanaian cedi. The data was extracted from the Bank of Ghana from the year 1990 to 2022. The variables of interest were time which was indicated in months and exchange rate of Ghana relative to 1 dollar. Time series model was used for this analysis. ARIMA model to be specific. The Arima model is a combination of the autoregressive model and the moving average model. And the I stands for integrated which also means transformation of the data. Examples of such transformations are log transformation, differencing, and detrending. The data was prepared, cleaned and tested with the RStudio software. Analysis were also made based on the results generated by the software. The data was found to be non-stationary so differencing was required. After two stages of differencing, it was found to be stationary by the help of the ADT test. The ADF test follows the following hypothesis;

Ho: Series is non-stationary

Ha: series is stationary

Several ARIMA models were suggested and the best model fit was ARIMA(0,2,2) due to its low AIC value. The model was estimated with parameters -1.1457 and 0.2673. These parameters were

proven to be statistically significant when tested. The MAPE, RMSE and MAE produced low values which indicated the adequacy of the model. In order to run model diagnostics, the residuals were used for interpretation in Fig 8. The plot generated a graph with a constant mean and variance. The bell shaped graph showed normality. The lags on the ACF plot showed stationarity (Fig. 8). The Box-Ljung statistics was also used to show the significance of the ARIMA model. The model was then used to forecast for 10 month period. The shorter the forecast time the accurate the prediction. It was seen that the cedis will depreciate in this 10 month period onwards. The findings revealed a significant and ongoing volatility in the Ghana cedis to dollar exchange rate.

5.2 Recommendation

Similarly, studies by researchers such as Opoku-Afari et. Al (2004), Evans & Tawiah (2015), and Appiah & Adetunde (2011) reached a similar conclusion with depreciation of the currency spiraling out of control.

This study recommends that in order to tone down the depreciation rate with the Ghanaian currency, the government should build more manufacturing facilities, decrease the rate of import, check interest rates. The increase of industrial facilities will enable the production of goods and services within the country as well as reduce the dependency on imports from foreign countries. The government could focus on their one district one factory scheme in order to help reduce the rate of depreciation of the Ghanaian currency. The government can also enforce the consumption of made in Ghana goods.

Also, the Bank of Ghana can interfere to when faced with the devaluation of the currency using fiscal and monetary policy methods. The bank of Ghana can lower the supply of money in the economy. In doing this, interest rate prices become high which will then lead to an increase in the market forces (demand and supply).

In the insurance market, companies can invest in foreign currencies in order to minimize losses on investment due to the devaluation of the Ghanaian currency. They could apply option tools to help hedge the risk at hand.

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