UNIVERSITY OF GHANA

VAT REVENUE FORECASTING IN GHANA

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DECLARATION

I hereby declare that this thesis is the result of research undertaken by me towards the award of the Master of Philosophy (MPhil) degree in Economics in the Department of Economics, University of Ghana under the supervision of the undersigned lecturers.

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ABSTRACT

It is prudent for a government to budget approximately for its expenditure based on expected or an accurately forecasted revenue. This will reduce the recurring budget deficit of the economy and bring the fiscal profile of an economy as Ghana to an acceptable level. There seem to be no clear guidelines from literature as to which econometric method provides the most accurate fiscal variables forecasts, but rather each forecasting case is considered and evaluated separately for individual country case. This study after a thorough scrutiny of applicable econometric methods of VAT Revenue forecasting, settled on comparing ARIMA with Intervention Analysis method and Holt linear Trend method to ascertain which model gives a better prediction of VAT Revenue in Ghana in terms of precision and accuracy. Monthly VAT revenue data which spanned the period 2002 to 2017 was used in the analysis. The study further explored the effect of Real GDP on VAT Revenue and the correlation that exists between the two economic variables to know if Real GDP can be an appropriate proxy VAT base in Ghana using quarterly data from 2006 to 2017 for both variables. ARIMA with Intervention Analysis method of forecasting outperformed the Holt trend model in forecast accuracy and precision, thus was used to forecast monthly VAT revenues for the next 24 months. (i.e. 2018 and 2019). Also, a positive effect and a high correlation between VAT Revenue and Real GDP was realised, suggesting that Real GDP can be used as a proxy VAT base in Ghana. The study recommends, therefore, that ARIMA with intervention analysis model should be compared with the in-house model used at Ghana Revenue Authority for forecast accuracy and prediction and if it outperforms the in-house model, it should be adopted by the Ghana Revenue Authority in forecasting monthly VAT revenues for the purpose of drawing half year and full year government budgets so that the ministry of finance budgets approximately expenditure based on expected or forecasted revenue. Also, because of the high correlation between Real GDP and VAT Revenue, real GDP can be used as proxy VAT base in forecasting VAT revenues.

DEDICATION

I dedicate this work to my parents, Mr. Samuel Ofori and Miss Dora Owusu for their sacrifices and support throughout my educational career.

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ABBREVIATIONS

ACF	Auto Correlation Function
ADF	Augmented Dickey Fuller
AIC	Akaike's Information Criterion
AICc	Akaike's Information Criterion corrected for small sample size
AR	Auto Regression
ARCH LM test	Auto Regressive Conditional Heteroscedasticity Lagrange Multiplier test
ARIMA	Auto Regressive Integrated Moving Average
BIC	Bayesian Information Criterion
CACF	Cross Auto Correlation Function
CI	Condition Indicies
CICE	Crédit d'impôt pour la compétitivité et l'emploi
CPI	Consumer Price Index
ECM	Error Correction Model
EU	European Union
FAUNRA	Federation Association and Union of National Revenue Agencies
GDP	Gross Domestic Product
GET Fund	Ghana Education Trust Fund
GRA	Ghana Revenue Authority
GSDP	Gross State Domestic Product
GSS	Ghana Statistical Service
GUTA	Ghana Union of Traders Association
HMRC	Her Majesty's Revenue and Customs

HTSTD	Historical Time Series Tax Data
IMF	International Monetary Fund
KRA	Kenya Revenue Authority
MA	Moving Average
MAD	Mean Absolute Deviation
MAPE	Mean Absolute Percentage Error
MAPE	Mean Absolute Percentage Error
MSE	Mean Square Error
NHIL	National Health Insurance Levy
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
PACF	Partial Auto Correlation Function
RMSD	Root Mean Square Deviation
RMSE	Root Mean Square Error
SAARC	South Asian Association for Regional Cooperation
SAARC	South Asian Association for Regional Cooperation
SARIMA	Seasonal Auto Regressive Integrated Moving Average
SIC	Schwarz Information Criterion
SSAP	Statement of Standard Accounting Practice
TARF	Tax Analysis and Revenue Forecasting
TVA	Taxes ur Valeur Ajoutée
U.K	United Kingdom
USA	United States of America

VAR	Vector Auto-Regressive
VAT	Value Added Tax
VFRS	VAT Flat Rate Scheme
VIF	Variance Inflation Factor

CHAPTER ONE

INTRODUCTION

1.0 Background of the Study

Revenue mobilization plays an extremely important role in the implementation of fiscal policy, especially in developing countries where there are high need and demand for public funds to finance pertinent public expenditure. Taxation can be considered as a better resource mobilization strategy than other alternatives such as money creation and deficit financing. For a country like Ghana to be able to provide for the welfare and security of its citizens, to develop and consolidate democracy, there is a dire need to raise enough resources. Public revenues in Ghana as in other African countries have much dependability on taxation. The ability of a country to collect enough tax revenue from domestic sources is determined by many and diverse factors. Determining factors of the level of tax revenue that is mobilized in a country may include the ability and willingness of inhabitants of the country to pay, the tax structure, the efficiency and adeptness of the institution in charge of tax administration, magnitude of tax rates, etc.

In recent decades, Value Added Tax (VAT) has evolved as the main workhorse of taxation in developing countries (Le *et al*, 2016). A VAT is a tax that is imposed on the value added to a good or service along different stages of its production and distribution. VAT eventually forms part of the final price the consumer pays for goods or services purchased. VAT as an indirect tax has the potential of mobilizing more resources/revenue for an economy that administers it because of its general broad-base, and trail of invoices it entails for efficient tax administration, compliance, and enforcement. A good and efficient VAT system will definitely result in mobilization of enough revenue to be used to pursue fiscal objectives. Empirical studies such as research conducted by Guran (2015), Njogu (2015) have shown that there is a positive correlation between the performance of VAT and economic growth and development. Thus, VAT performance of an economy will have a direct impact on the development and the macroeconomic stability of the economy.

Heady (2002) observed the use of VAT to mobilize sales tax revenues among OECD countries: "[The VAT becomes] the sales tax of choice in OECD countries. While these countries continue to rely heavily on income tax collection, the VAT revenues have risen steadily in both absolute and relative terms: the general consumption taxes (mainly VAT—in recent years) increased sharply from 12 percent of the total tax revenues in 1965 to 18 percent in 2000". (Heady, 2002). Many developing countries now make very good use of the VAT to mobilize revenue. An assessment by the IMF on increasing importance and global expansion of the VAT is as follows*:*

> "[The VAT has become] a key source of government revenue in over 120 countries. About 4 billion people, 70 percent of the world's population, now live in countries with VAT, and it raises about $18 trillion in tax revenue—roughly one-quarter of all government revenue. Much of the spread of the VAT, moreover, has taken place over the last ten years. From having been largely the preserve of more developed countries in Europe and Latin America, it has become a pivotal component of the tax systems of both developing and transition economies." (Ebrill *et al*. 2001).

Ghana is no exception in this assessment. This is because, in Ghana, VAT contribution to Total Government Revenue has been between 20% to 30% since its inception from 1995 to date. The VAT is, therefore, a major source of revenue for governments in both developed and developing nations.

1.1 Problem Statement

Analysis of the tax structure in Ghana shows that the greater part of government revenue comes from indirect taxes. The lion's share of the revenue accrued from indirect taxes in Ghana comes from Value Added Tax, which still has a potential of immense contribution to government revenue. In Ghana, the Government through the ministry of finance sets revenue targets for the Ghana Revenue Authority (GRA) which in turn sets revenue targets for its various divisions and revenue agencies. However, more often than not, the revenue agencies fail to achieve their given targets (VAT Service Dairy, 2006). At sundry times also, some revenue agencies exceed their given targets. This suggests the need to have some foresight of revenue that will be accrued from VAT collection to guide the government and the Ghana Revenue Authority in setting revenue targets and to also guide government to budget approximately expenditure based on expected or accurately projected revenue. Wildavsky (1986) mentioned that politicians usually accept projected revenue without questioning the forecast approach. Many government agencies have a little spur to improve forecast accuracy since they have not realized adverse consequences due to inaccurate forecasts in their economies. There is, therefore, no gravity to improve or introduce new and innovative techniques or strategies. These notwithstanding, accuracy in forecasting can be improved significantly if a systematic approach is tested and employed. To mitigate recurring fiscal imbalances and to set systematic and reasonable targets for the authority in charge of VAT administration in economies (for instance, Domestic Tax Revenue Division of the Ghana Revenue Authority in Ghana), accurate VAT revenue forecast is obligatory.

Edzie-Dadzie (2013) in his research "Time Series Analysis of Value Added Tax Revenue Collection in Ghana" employed the Box Jenkins method to make a two-year forecast of Domestic and Import VAT using monthly data from 1999 to 2009 (120 observations). However, after his period of study, there has been a change in the VAT rate (increase in rate by 2.5%, in 2014). Dadzie's work did not analyse the effect of the change in VAT rate since the change was done after his period of study. Though Nartey (2011) and Antwi *et al (2012)* both employed the ARDL Cointegration procedure to investigate the effects changes in VAT rate on VAT revenues in Ghana, they both used quarterly data spanning from 2003 to 2010 (32 observations), which is a small sample size. Thus, there is much likelihood of biasedness in their result. It has become necessary to conduct another study that will use a large enough sample size-monthly VAT data from 2002 to 2017 (180 observations are used in this study), to investigate the effect of a change in the VAT rate on VAT Revenue in Ghana, because the increase in sample size reduces the biasedness of the results. Also, since the change in VAT rate in 2014 may have affected the VAT revenues mobilised a priori, there is still a need to estimate new models to forecast VAT revenue (Domestic, Import and Total VAT revenue) in Ghana.

Fullerton (1989) compared ARIMA and regression models in fiscal forecasting and ruled out in favour of the latter. Moreover, the comparisons of the forecasting performance of different methods frequently find that ARIMA outperforms other models (Marcellino and Favero, 2005; Nazmi and Leuthold, 1988), at least in the short run. There seem to be no clear guidelines from the literature as to which econometric method provides the most accurate fiscal variables forecast, but rather each forecasting case should be considered and evaluated separately for an individual country case. Which econometric method is best for forecasting monthly VAT Revenue in the case of Ghana is a study yet to be conducted. It has thus become necessary to investigate which forecasting approach best can forecast VAT revenue in Ghana. Thus, this study takes a closer look at possibilities for applying the different econometric methods of VAT Revenue (Total, Domestic, and Import VAT) forecasting to reveal which gives the best predictability in the case of Ghana. A 24-month VAT revenue forecast is made with the best method, using monthly VAT Revenue Data (Total, Domestic, and Import VAT) for 180 months/15 years (i.e. from January 2002 to December 2017).

VAT revenue can also be forecasted using an appropriate VAT base or its proxy as a regressor. This is an area of study that has not been given much attention in the literature. Twerefou *et al* (2010) used Total Private Final Consumption as a proxy base for VAT since VAT incidence is on final consumption. Irizepova (2016) used GDP as the base macroeconomic indicator to forecast annual Value Added Tax Revenues for a ten-year period. Greene (2014), in a fiscal analysis and forecasting workshop at Bankok, Thailand dubbed "Revenue Fundamentals, Fiscal forecasting and the effective tax rate approach" stated that in selecting a proxy tax base for tax revenue forecasting, there should be a high correlation between observed tax revenue and the proxy tax base. He suggested private consumption expenditure and GDP as the proxy tax base for VAT (Total, Domestic, and Import VAT). A more appropriate benchmark or VAT base would be Total Private Consumption, which is an ideal VAT base for VAT revenue forecasting. However, data on Private consumption are not reported monthly or quarterly but annually in Ghana. Also, data on monthly purchases of exempt sectors are not available in Ghana, making it difficult to estimate an accurate VAT base for forecasting monthly VAT revenue. This study therefore also seeks to explore the effect of Real GDP on VAT Revenue and the correlation that exists between these two economic variables in Ghana to know if Real GDP can be an appropriate proxy VAT base for forecasting VAT Revenues.

1.2 Research Objectives

The general objective of this study is to evaluate various forecasting techniques to know the most accurate in terms of VAT (Total VAT, Domestic VAT and, Import VAT) revenue forecasting for the economy of Ghana.

The study has the following specific objectives:

i. To evaluate the forecasting approach that gives the most accurate prediction of Ghana's monthly VAT revenue.

ii. To access the effect of the 2.5% increment of VAT rate in 2014 on monthly VAT revenue in Ghana.

iii. To establish whether or not Real GDP can be an appropriate proxy VAT base in VAT revenue forecasting.

iv. To make a forecast of monthly VAT (Total VAT, Domestic VAT and, Import VAT) revenue in Ghana for the next twenty-four months (two years).

1.3 Research Questions

The research questions to be answered for the objectives to be achieved are as follows:

i. Which forecasting approach gives the most accurate prediction of Ghana's monthly VAT revenue?

ii. What was the effect of the 2.5% increment of VAT rate in 2014 on monthly VAT revenue in Ghana?

iii. Can Real GDP be an appropriate proxy VAT base in VAT revenue forecasting?

iv. How much monthly VAT revenue may be realised in Ghana for planning and budgeting for the next twenty-four months (two years)?

1.4 Significance of the Study

There seem to be no clear guidelines from the literature as to which econometric method provides the most accurate fiscal variables forecast. A very good forecast of government revenue will reduce the discrepancies that result when revenue receipts of the government are far lower or higher than what was projected or forecasted and the adverse consequences of such discrepancies are also avoided. Judgemental and indiscreet projection of tax revenues may later call for a change in the expenditure plan of the government and for a supplementary budget to be submitted to parliament for approval. There is thus a need to test and employ systematic methods of VAT revenue forecasting in order to make very good revenue projections and to avoid the adverse consequences of off beam revenue projections. Marcellino and Favero (2005) and Nazmi and Leuthold (1988), rule out in favour of ARIMA in forecast performance at least in the short run. Fullerton (1989) on the hand adjudged the unrestricted regression model as better in terms of forecast accuracy. Botrić and Vizek (2012) suggest that each forecasting case should be considered and evaluated separately for individual country case. The study adds to the literature by revealing the more accurate and precise approach to be employed in forecasting VAT Revenue in the case of Ghana. Also, the realized effect of the change in VAT rate on VAT revenues in Ghana from this study will keep fiscal policymakers informed of the expected VAT revenue changes that may result from a change in VAT rate.

Twerefou *et al* (2010) used Total Private Final Consumption as proxy base for VAT since VAT incidence is on final consumption in Ghana. Irizepova (2016) used GDP as the base macroeconomic indicator to forecast annual Value Added Tax Revenues for a ten-year period in Russia. Greene (2014), suggested private consumption expenditure, GDP, Import of Goods (for VAT on imports) can be used as VAT Base provided there exist a high correlation between VAT and the prospective VAT Base. To forecast quarterly VAT revenues, the proxy VAT base must have quarterly observations. This study explores the relationship and correlation between VAT Revenue and Real GDP to know if Real GDP can be an appropriate proxy VAT base to be considered in forecasting monthly VAT Revenue in the case of Ghana; a study not conducted yet in literature. Finally, this study will serve as a source of reference for further research.

1.5 Scope of the Study

The study looks at the VAT Revenues generated from the year 2002 to 2017. The following econometric methods of VAT Revenue forecasting were considered and evaluated with VAT revenue data of the aforementioned time interval: Auto-Regressive Integrated Moving Average (ARIMA) model with intervention analysis and Trend Models for the forecast models whiles Correlation-Regression Model was also considered for the effect of and correlation between Real GDP on VAT Revenue in Ghana. The forecasting models were tested to know which model gives the best predictability in the case of Ghana.

1.6 Organization of the Study

The study is organized into six (6) main chapters. Chapter one deals with the general introduction of the study, which consists of a background of the study, problem statement, objectives of the study, research questions, the scope and the organization of the study. Chapter two gives an overview of VAT and the administration of VAT in the Ghanaian economy. Chapter Three covers a review of the literature; the theoretical review, empirical review, the synthesis and knowledge gap which calls for the need to conduct this research. The next chapter (Chapter Four) describes the methodology and parameters that were used to carry out the research. This chapter contains discussions on the study design and data analysis techniques. Chapter five deals with results and discussions, and finally chapter six contains the summary of findings, conclusions and, recommendations of the research.

CHAPTER TWO

OVERVIEW OF VAT ADMINISTRATION

2.0 Introduction

This chapter gives an overview of VAT, its origin and how it is administered in other jurisdictions. Also elucidated in this chapter is a brief history of the inception of VAT in Ghana and its contribution to government revenue mobilisation over the period of study. The chapter further divulges discretionary VAT policies (change in the VAT rate, the introduction of VAT Flat Rate Scheme) that have been implemented in Ghana over the period of study, the current operation of VAT in Ghana and ends with the need for a good forecast of VAT Revenues in Ghana.

2.1 Value Added Tax (VAT)

2.1.1 Definition of VAT

One of the major sources of indirect tax revenues in most countries is Valued Added Tax (VAT). Bird (2005) defines value-added tax as a tax imposed on the value added to goods and services at their various stages of production and distribution and for services as they are rendered. He adds that this type of tax though is collected at each stage of production and distribution, it is ultimately borne by the final consumer. The United Kingdom Statement of Standard Accounting Practice (SSAP) No 5, defines VAT as "a tax on the supply of goods and services which are eventually borne by the final consumer but collected at each stage of production and distribution chain".

The term "Value Added" according to the VAT Act 486 (1994) of Ghana is "value of goods and services at each stage of production or transfer of goods and services". Thus, Value Added Tax is basically a tax levied on the additional value a good or service obtains as a result of activity in the next stage of production and/or distribution of the goods or rendering of the service. It is eventually borne by the final consumer even though it is collected at every stage of production or distribution. A tax credit is granted at every stage of production and/or distribution for tax paid at the pre-value-added stage. This payment of tax on the value added and claim of tax credit for tax paid at the pre-value added continues until the good or service reaches the final consumer. Value Added Tax (VAT) is therefore indirectly a tax on the final consumers or on the final consumption of goods or services. Value Added Tax applies to all sales and consumption, whether to and by private consumers or other businesses (who may be intermediate consumers who also add value to the good or service purchased for sale) unlike sales taxes (in the USA, for example) which aim to tax the purchases final consumers only.

According to Pritchard (2009) "VAT is a tax on consumers and is levied on the supplies of goods and services made by a taxable person in the course of furtherance of a business carried by him". Quarshie (2009) stated: "a properly implemented VAT is equivalent to a corresponding single-stage sales tax". He said, "Under the expenditure tax, the VAT is not genuinely a new form of taxation, but a mere sales tax administered in a different form". VAT is a consumption tax applied on the value added to a good or service which is a result of an activity of a business enterprise. The VAT is therefore borne by the purchaser of the good or service. Value added is clearly determined by finding the difference between the value of sales and the value of purchased inputs used in producing the commodity sold.

A VAT is also imposed on imported goods and services. It can therefore, be again defined as a tax levied on the difference between what a producer pays for inputs (including services such as advertising) and what the producer charges for the final good (s) and services and hence the word "value added" (Institute of Economic Affairs, 2011). Though by the definition of VAT, it is a consumption tax borne by the consumer, it will be practically unbearable for the VAT Administrator to collect the tax from each individual consumer. Thus, the trader, manufacturer or importer, is often registered as an agent for collecting the tax on behalf of the VAT administrator (Ali-Nakyea, 2008). Therefore, statutory incidence falls on the producer.

2.1.2 Origin of VAT

A German industrialist, Dr. Wilhelm Von Siemens proposed this brilliant scheme of taxation, Value Added Taxation (VAT) in 1918. During World War I, France and Germany implemented the VAT in the form of a general consumption tax. The modern variation of the Value Added Tax (VAT) was initially introduced and applied by France in 1948. The type of VAT that was at the beginning applied by France was the GNP-based VAT which covered up to only the manufacturing level, but in 1954, it was replaced with a consumption VAT which runs through to the final consumption of the good or service. VAT currently runs through to the final consumption and the tax incidence is on the final consumer.

In 1967, VAT was introduced in Denmark and was extended to the retail sector. France and Germany also extended the VAT to the retail sector following after Denmark. A number of developing countries have also reformed their tax policies and introduced VAT as a means of augmenting their tax systems since it purported to have a neutral effect on businesses and also because of its high revenue mobilization potential. Nigeria, Senegal, Cote D'Ivoire, Morocco and Tunisia are examples of such developing countries. Almost unknown in 1960, VAT is at the present found in over 140 countries around the globe.

2.1.3 Features of VAT

The main tax under consideration in this study is Valued Added Tax (VAT). VAT as a type of indirect tax is characterised by certain specific features that distinguish it from other types of taxes. The following are purported to be the features of VAT, thus has made many countries adopt VAT as a very good tax in their economies; stability, neutrality, flexibility and, efficiency.

Neutrality

VAT does not burden exporters in any way, thus pertaining to foreign trade VAT is very neutral. Administration of VAT also does not become a disincentive to domestic production and distribution since the tax incidence is not the profits of producers and distributors but rather on consumers. Again, whether a product is produced with capital-intensive or labor-intensive technology, no matter the production technique or method by which a business is conducted, the tax liability of VAT is not influenced.

Stability

Since VAT is a tax on consumption and consumption as a share of Gross Domestic Product with time does not fluctuate much, VAT is normally considered to be a sure and relatively stable source of revenue to the government.

Flexibility

A change in the VAT rate almost immediately is able to translate into an increase or decrease in revenue accrued from VAT. This is because consumption, as mentioned earlier, as a share of Gross Domestic Product, does not fluctuate much. Thus, VAT is a very flexible discretionary instrument that can be used by governments to achieve an expected result.

Efficiency

Consumption taxes (including VAT) are very often purported as an efficient means of taxation because it has a less likelihood of distorting economic behaviour unlike income taxes (Atkinson and Stiglitz, 1980; and Kay, 1990). For instance, a high tax on income may become a disincentive for individuals to work hard. In the case where a consumption tax as VAT is in force until income is spent, it is not taxed, thus no significant distortion is instigated by VAT.

2.1.4 How VAT is Administered

A VAT is deemed more efficient according to theory and practice, if it is applied on every stage of consumption, has a broad base, and applied even through the wholesale and retail stage to the final consumer. A VAT taxes the value-added at every stage of the production of a good/service. The value added can easily be realised by finding the difference between the value of the goods and services sold (by the producing firm/party) to another party and the value of goods and services purchased (by the producing firm/party) as intermediate inputs. VAT, therefore, taxes the difference, which is the value added. In VAT administration, registered businesses offset the tax they have been charged on their purchases (Input VAT) against the liability (Output VAT) on their sales, remitting only the net amount due, hence the same value-added is never taxed twice. This calls for self-assessment (i.e. a registered entity accounts for tax on all of its sales and get credit for the tax paid on purchases of its inputs) which require firms to be able to keep good financial records, tracking their revenue and purchases. The result, if this sequence of output tax and input credit remains uninterrupted, is that tax revenues are not collected from intermediate goods and the ultimate base of the tax becomes the expenditure of final consumers on the final goods and services. This thus is an invoice-credit system known as standard VAT scheme. With this VAT scheme, the tax authority levies a given percentage on the Value Added at all stages of production and allows for a claim of tax credits for VAT paid when inputs of the production are purchased.

The universal practice is that exports are zero-rated and imports are fully subjected to VAT. By this practice, VAT is made to apply only to domestic consumption, which is consistent with the destination principle and is in contrast with the origin principle of taxation i.e. taxation by place of production (Crawford *et al*, 2010). The importer, manufacturer, wholesaler, and retailer all pay VAT on the good or service purchased, however each claims VAT credit to offset what was paid as VAT when they purchased their inputs. It is only the final consumer who receives no VAT credit after paying VAT on purchases. Thus, the final consumer absorbs the VAT in the form of the high price on the item. VAT thus is a systematic contrivance for taxing final consumption while making all other firms involved in the production process VAT administrators to collect taxes on behalf of the tax authority.

Another mode of VAT administration is the VAT Flat rate scheme. VAT Flat Rate Scheme is a VAT collection contrivance that applies a marginal tax rate on the value of taxable goods supplied which represents the net VAT payable. It is an alternative to the standard VAT scheme (i.e. Invoice-credit system) which levies a given percentage on the Value Added at all stages of production and allows for claim of tax credits for VAT paid when inputs of the production were purchased. The VAT Flat rate scheme is most times limited to all retailers (sometimes wholesalers inclusive) of taxable goods. Some countries aiming to tap into the enormous revenue mobilization potential from the retail/informal sectors, in their economies' objective to have an established buoyant revenue mobilization base that can upkeep government expenditure in order to reduce government budget deficits recorded in those economies adopt the VAT Flat rate scheme which is considered simple and easy to administer.

In economies with low literacy (Ghana is not an exception), there are poor record keeping capabilities in the retail sector, thus the compliance requirements of the standard VAT scheme (invoice credit system) in the informal sector are many at times not adequately fulfilled. The intricacies of collecting and accounting for the VAT (under the invoice credit system) frustrates traders which pose challenges to the administration of VAT in the retail sector. (Agyemang, 2011)**.** In the implementation of a flat rate scheme, businesses are freed from the trouble of calculating VAT on each singular input and output, rather, only the VAT Flat Rate will be passed to the VAT account. The very meaning of a "flat tax" is somewhat ambiguous especially in political debates and in the economic literature, however, two key features that are known of a flat rate tax system are: one fixed rate that is easy to administer and a very broad tax base (Caminada, 2001).

2.1.5 VAT in other jurisdictions

VAT is applied in many countries as a system of indirect taxation to raise substantial revenue for those countries. The system of administration of VAT varies from country to country, though the principles (of VAT) do not differ so much worldwide. The administration of VAT in just a few other Jurisdictions is briefly explained below to elucidate their difference/similarity to VAT administration in Ghana.

2.1.5.1 VAT System in France

France was the first country to launch VAT in the globe. VAT or Taxes ur Valeur Ajoutée (TVA) was introduced in France in the year 1954. In 1968, this type of tax was applied throughout the economy of France. For the last 22 years, the VAT system in France has undergone strategic reforms. In 1995, the VAT standard rate was increased to 20.6% from 18.6%. The rate was later, in the year 2000 reduced to 19.6%. The Parliament of France legislated a scheme in December 2012 known as *"Crédit d'impôt pour la compétitivité et l'emploi (CICE)",* which is a tax credit for those whose wages are between 1 and 2.5 times the minimum wage. In 2014, the VAT standard rate was increased from 19.6% to 20%. In the same year, the VAT Reduced Rate on restaurant food and similar services, renovations on buildings, etc. was also increased from 7% to 10%. Currently, there are four rates of VAT applied in France. These are:

i. 20% which is the standard rate.

ii. 10% which applies or is levied on passenger transport, restaurants, fast-food outlets, renovations on buildings, farming industry, household work, etc.

iii. 5.5% which is levied on basic necessities including water, food, electricity, gas, non-alcoholic beverages, books, special equipment and services for the disabled, sporting event tickets, etc.

iv. 2.1% Super Reduced Rate which is levied on newspapers/magazines, TV licenses, medicines reimbursed by the social security of France, the sale of live animals for slaughter, etc.

The 20% standard VAT rate in France is below the average standard VAT rate in the EU (21% in 2018). The VAT standard rate applies to approximately 55% of the products in the price index in France. (Gautier and Lalliard, 2013). Under the French VAT system, businesses with annual turnover below € 82,800 from sales or € 33,100 from services provided are exempt from VAT. However, such business may opt to pay VAT if they want to be able to claim VAT paid for inputs or on investments made for the business. Businesses whose annual turnover exceed the aforementioned amounts are required to register and pay VAT. Goods and services that are transported from France to any jurisdiction within the European Economic Community (E.E.C) will be exempt from VAT if:

i. The supplier is subject to VAT in France
ii. The buyer is subject to VAT in his country
iii. Delivery of the good or service is made against payment

The VAT system of France also allows exemptions for imports that are intended for re-exporting after processing or after a significant value is added to it so that what is produced for export (produced from the imports) are not identical to what was initially imported.

2.1.5.2 Vat in South Africa

VAT was in introduced in South Africa on September 1991. This type of tax was introduced to replace the then existing General Sales Tax. VAT, when it was introduced in 1991, was rated of 10% and since its inception, it has proven to be an effective source of revenue to the nation by its constant enormous contribution to the total government revenue of South Africa. According to Kearney *et al* (2005), VAT accounts for 14% of total revenue and it is the third highest contributor to government revenue in South Africa. The VAT rate according to Kearney *et al* (2005), was increased in 1993 from 10% to 14%. The 14% VAT rate has been the prevailing VAT rate throughout the years until 1st April 2018, when it was revised (increased) to 15%. Businesses that may have their taxable supplies in a 12-month period exceeding R1 million or expect to have their taxable supplies exceed R1 in a 12-month period are obligated to register for VAT remission. However, a business enterprise may decide to willingly register if the minimum threshold of R 20,000 was exceeded by the business enterprise in the past 12-month period.

Certain local goods and services are zero-rated in South Africa. Some of the zero-rated goods include: milk, rice, brown bread, maize meal, unprocessed vegetables, etc. Exports are also zero-rated in South Africa. Apart from the zero-rated goods and services, all local goods and services are subject to VAT in South Africa.

2.2 VAT in Ghana

2.2.1 A Brief account of VAT in Ghana (From its Inception to Current Administration)

Valued-Added Tax (VAT) was introduced in Ghana by an enactment from Parliament in December 1994, with the collection to commence on March 1995. Propelled by the need to augment the tax system, a feasibility study was jointly conducted by the Harvard Institute of International Development (USA) and the Crown Agent of the U.K in 1991 to examine the then-current tax system and recommend ways of ameliorating it. This led to the introduction of VAT in Ghana. One reason for the institution of VAT in Ghana was to widen the scope of the tax net which was expected to result in a broader tax base and by so doing increasing the tax revenue and the government revenue as a whole. Another reason was to replace the existing taxes (Sales Tax, Advertisement Tax, Hotels and Restaurants Customers Tax, Betting Tax and Entertainment Tax) with one common tax (Terpker, 1996). Terpker (1996) added that the introduction of VAT in March 1995 was as a result of the study and recommendation of the Harvard Institute of International Development (USA) and the Crown Agent of the U.K, as some deficiencies of the then existing consumption-based taxes (sales and services taxes) were identified which included:

- Unstable and low buoyancy of the consumption-based tax revenue (sales and services tax revenue), as the tax base was narrow since it was found to be excluding some key rapid growing sectors of the economy.
- Revenue loopholes owing to weaknesses in the system of tax collection. There was ineffectiveness of checks and controls.

- A need to introduce modern methods of tax collection that involves proper documentation to replace the crude fiscal surveillance, for potential tax evasion and corruption to be lessened.

According to Terpker (1996), VAT was adopted in Ghana to replace the Sales and Service Taxes regime that had been in existence since 1965 for the following reasons:

- Adopting a uniform system for collecting the tax revenues from General Consumption.
- Expanding, broadening and diversifying the tax base.
- Improving the efficiency in the collection of tax revenue.
- Easing and simplifying tax administration and compliance.
- Curbing smuggling.

The VAT was introduced in 1995 at a rate of 17.5 percent on goods and services. A new revenue collection agency was established in Ghana to administer the tax. This agency was named the VAT Service. All these were put in place as preparations were made for the introduction of the VAT. A public education campaign was implemented after the introduction of the VAT to keep the public informed and to make them comprehend the dynamics of the new tax introduced. Though there were expressions of public anxieties and dissatisfaction of the increase in tax burden (i.e. decrease in disposable income and welfare), also concerning the inflationary impacts, and incomprehensibleness with how the new tax rate operates and how it is calculated, the government was not hesitant to impose it, as it wanted to meet the expectation of International Monitory Fund (IMF) and the World Bank. The response of the public to the VAT was demonstrations and riots in the major cities leading to the shooting to death of some civilians. A demonstration which was dubbed "*kumi preko*" (meaning, just kill me) was staged against this new tax policy in 1995. In the history of Ghana, this is recorded as one of the major civil actions against imposed policies. The operation of VAT lasted for only three-and-a-half months. According to Terpker (1996), the VAT was fiercely resisted at the early stages of its implementation because:

- The initial VAT rate of 17½% was considered too high. This is because sales tax which initially existed covered few transactions and was at a rate of 15% but VAT which replaced the sales tax imposed a higher rate and also made many transactions taxable which was at first not taxable.
- There was not effective and adequate public education to make the public comprehend so well about the brass tacks of the new tax system.
- Appointed persons as VAT service officers and recruits who were to act as agents of the VAT Service were not very well trained to capacitate them in handling efficiently all aspects of the VAT. For instance, there was evidently lack of evenness in the assessment of tax.
- The threshold of annual turnover of ¢25 million which was set to define those to administer and also those to pay VAT was considered too low. The threshold made many persons taxable who were not so capable of paying and administering the VAT.
- The inception of the VAT unexpectedly aggravated the already existing high prices of goods and services in the country which shot up inflation. The welfare effects of this high inflation stirred up the public to agitate against the introduced Value Added Tax.

In May 1995, a motion was moved in the Parliament of Ghana to open critical deliberations on the VAT and its implementation. These critical deliberations became very necessary because of the public demonstrations against the VAT as the public perceived unbearable the impact of the VAT scheme on the economy. The Parliament of Ghana eventually decided to repeal the VAT law (though it undoubtedly contradicted the modern trend in global tax reforms) and finally reinstated the sales and other indirect tax regimes that were reformed for the inception of VAT. In that reinstatement, the service tax base was broadened from five to fifteen activities covering chiefly professional services. However, the sales tax remained unchanged in scope, rate, and converged as before. Aside from an ephemeral Value Added Tax in Vietnam which was in the early 1970s, no country has ever revoked VAT legislations. Ghana is probably the only exception (Terpker, 1996). However, the repeal of VAT when it was initially introduced in Ghana did not obliterate VAT in Ghana forever. In December 1998, VAT was again introduced by the government of Ghana after extensive consultation and technical assistance from the U.K. Department for International Development. The VAT rate this time around was lowered to 10 percent and it was accepted by the public.

Although in 1998 VAT was introduced at a low rate of 10%, revenue generated from the VAT was 20% more than the sales tax it replaced (World Bank PremNotes, 2001). VAT collection amounted to ¢792.1 billion (old cedis), exceeding the budget estimate of ¢700 billion (old cedis) by 13% (Agyemang, 2011). Also, import VAT duties collected amounted to ¢469.1 billion (old cedis) showing a 70.3% increase in revenue over the 1998 import sale tax revenue (The Budget Statement and Economic Policy of the Government of Ghana, 2000). In June 2000, the standard VAT rate was increased to 12.5% by an Act of Parliament-Act 578. The added 2.5% was specified for the Ghana Education Trust Fund (GET Fund) Secretariat to support quality education in Ghana. By another Act of Parliament-Act 650 in July 2004, a levy called the National Health Insurance Levy (NHIL) of rate 2.5% was introduced which was to be paid together with the VAT of 12.5% rate. The NHIL was introduced to support the National Health Insurance Scheme in Ghana. In essence, the standard VAT rate remained at 12.5% (including GET fund levy).

Following the presidential assent given in the VAT Act 2013 (Act 870), the standard VAT rate was increased from 12.5% to 15% and this took effect from January 2014. The standard VAT rate in Ghana has not been altered since 2014. An increase in VAT rate may affect the revenues generated from VAT quite significantly. This is because taxpayers would have to pay more than what they earlier paid. Also, such a discretionary tax policy change is very likely to affect the level of compliance of taxpayers. It is therefore worth giving attention to the trend of VAT revenues after a change in tax policy when considering to make a forecast of VAT revenues. For this reason, ARIMA with intervention analysis instead of ARIMA is considered for the analysis in this study.

2.2.1.1 VAT Flat Rate in Ghana

Aside from the standard VAT rate scheme (invoice credit VAT) that was introduced in 1995 and reintroduced in 1998 which has been in force till date, Ghana currently implements a VAT scheme that applies a flat tax rate on the goods and/or services of retailers and small businesses. This VAT scheme is known as Vat Flat Rate Scheme. The VAT Flat Rate Scheme in Ghana involves the application of a marginal tax rate of 3%, (representing the payable net VAT), on the value of taxable goods and services supplied for sale. It is an alternative to the invoice credit method percentage on sales deduction. Ghana's tax system has seen a number of reorganization and restructuring since its introduction. The government of Ghana has engaged in a number of tax reforms in its policies over the years in order to facilitate economic growth, economic development and poverty reduction in the economy of Ghana. In order to tap into the enormous revenue potential that could be mobilized in pursuant of the government's vision, in the medium to long-term, the VAT Flat Rate Scheme was introduced in 2007.

The introduction of the VAT Flat Rate Scheme was aimed at simplifying the compliance requirements of invoice credit scheme that looked complex and cumbersome especially to the informal sector. In Ghana, the retail sector is characterized by low literacy and low record keeping capacities, therefore, making the compliance requirements of the invoice credit scheme very difficult to meet by those in this sector. Thus, many in the retail sector due to the difficulty to comply with the requirements of the VAT administration and accounting get frustrated and eventually stops administering the VAT. All these reasons led to the introduction of a simpler scheme of VAT administration and accounting called VAT Flat Rate scheme. The aim of introducing the VAT Flat Rate Scheme was to be able to tap into the enormous revenue potential that could be mobilized as tax. Another aim of its inception was to reduce support normally received from development partners as more revenues were expected to be mobilized.

According to Kwarteng *et al.*, the VAT Service in 2005 made proposals for a number of initiatives for the retail sector of Ghana. Included in those initiatives for the retail sector was the introduction of a tax administration and accounting scheme that will address the challenges the informal/retail sector of the country is facing that obstruct effective compliance with the VAT administration and accounting; also a tax administration scheme that can enhance equity in the system of taxation by spreading the tax net to include more businesses in the retail/informal sector of Ghana. The main features of that VAT Flat Rate Scheme (VFRS) that was presented to parliament by the Minister of Finance and Economic Planning according to Kwarteng *et al* (2012) are as follows:

- A marginal flat rate of 3% will be applied on the value of each taxable good and service for sale.
- The VFRS administrators will issue to buyers/consumers a simplified VAT/NHIL invoice for each good and service sold.
- The VFRS administrators will also submit a simplified monthly VAT/NHIL returns form to the VAT Service.
- The VFRS administrators will not need to maintain a separate register on input taxes since they will not take credit for input taxes paid, rather they will recover such input taxes by inculcating it in the price of the good or service they sell. Thus, the tax is directly born by the final consumer.
- The VFRS administrators upon registration will be issued with the regular VAT Certificate of Registration.

- Minimal record keeping will be ensured and it will be very easy to determine the correct VAT/NHIL payable to the VAT Service.

Since the inception of the VFRS in Ghana, some merits of the scheme realized are:

- The scheme is very simple to operate, with very simplified and easy to complete return forms which to some extent solves the challenges that were faced by the informal/retail sector including the need to keep an input register and to know what input tax one can or cannot claim.
- The simplicity of the scheme encouraged more retailers who were previously not registered with the VAT Service to register. This widened the tax net and also broadened the tax base, and these have increased VAT revenues collected in Ghana over the years.
- The scheme to some extent has removed obstructions in compliance that plagued the effective administration of VAT in the informal/retail sector where the level of noncompliance was highest.

Notwithstanding these aforementioned merits of the VAT Flat rate scheme, it was realized that the VFRS becomes somewhat disadvantageous to a retailer if:

- He/she buys mostly VAT standard-rated items, as he/she cannot generally reclaim any VAT on his/her purchases.
- He/she makes a lot of zero-rated or VAT-exempt sales.

The VAT Flat Rate Scheme since its introduction has contributed massively to the total revenue available to the government for each of the years subsequent to its introduction. According to Prichard and Bentum (2009) the VFRS for the last four months of 2007 (the year of its introduction), has generated a total of GH¢ 2.69 million representing 0.79% of the total domestic revenue which amounted to GH¢ 337.27 million. For the 2008 fiscal year, out of the total domestic revenue of GH¢ 417.2million, revenue from VAT Flat Rate Scheme constituted about GH¢ 25.9 million.

2.2.2 Current Operation of VAT in Ghana

Currently, two schemes of VAT are in operation in Ghana, namely; VAT Standard Rate Scheme and VAT Flat Rate Scheme. The VAT Standard Rate is levied at 12.5%. The National Health Insurance Levy (NHIL) of 2.5% is now combined with GET fund levy of 2.5%, making a charge of 5%. This new charge is termed the Health and Education Levy. The VAT Flat Rate which is levied on the supplies of registered retailers and wholesalers is 3%. This 3% marginal rate is the difference between the output VAT and the input VAT of the retailer/wholesaler (i.e. the net VAT payable, under the standard rate scheme). The VAT Flat rate covers the supply of all taxable goods, except the supply of any form of power, heat, refrigeration or ventilation (section 1(b) of VAT amendment Act, 2017 (Act 948)). Business enterprises who realise or expect to realise an annual turnover of GH¢ 200,000 and above are mandated to register with the Ghana Revenue Authority to start paying VAT. Nonetheless, voluntary registration for businesses that realise an annual turnover below the threshold is not prohibited.

All goods and services exported out of Ghana are zero-rated for both VAT and NHIL. Also, certain basic necessities are exempted from VAT in Ghana according to the provisions of the VAT amendment Act 948, 2017), for the lower income group in the country to enjoy some relief. Some goods and services exempted from VAT according to the Act are as follows:

- Agricultural foodstuff produced in their raw state such as rice, cassava, yam, cocoyam, plantain, millet, guinea corn, fruits, vegetables, etc. produced locally.
- Chicken, eggs, seafood, meat, etc. produced locally.
- Some locally produced drugs and some imported drugs determined by the Ministry of Health and approved by the Parliament of Ghana.
- Newspapers produced in Ghana.
- Supply of water, excluding distilled and packaged water.
- Medical Health and Dental Services.

- Domestic use of electricity
- Plant, machinery and, equipment used in industries.
- Transportation by railway, road, sea and, air.
- Education and training provided by an institution approved by the Ministry of Education.
- Core financial services
- Property rental.

Goods and services on which VAT/NHIL is levied are normally priced in two ways. Most retailers and wholesalers who pay the VAT flat rate include the VAT to the price of the item being sold. The VAT paid on the item (s) purchased by consumers is normally indicated in the till receipt that is issued to customers.

Other businesses under the standard rate scheme issue a VAT/NHIL invoice to their customers showing the amount of VAT/NHIL charged on the item purchased. Thus, VAT is indisputably paid by the final consumer.

2.3 The Need for a Good Forecast of VAT Revenues in Ghana

Many researchers have shown interest in conducting research on Value Added Tax (VAT) revenue collections for countries over the period. This is because many countries have replaced sales tax with Value Added Tax in their tax reforms, after getting to know the revenue mobilization potential of VAT. The contribution of VAT to government revenue mobilization in most countries that adopted VAT as an indirect tax has been immense and progressive. A critical analysis of the revenue mobilization of the tax system of Ghana over the years reveals that indirect taxes mobilize more revenues for the government than direct taxes. A further look at the revenue mobilization capacity of the various indirect taxes over the past seventeen (17) years also reveals clearly that Value Added Tax (VAT) mobilizes the lion's share of indirect tax revenue in Ghana. Value Added Tax (VAT) is therefore, an indirect tax that must be given much attention in an economy like Ghana. Table 2.1 shows revenues received from VAT from 2002 to 2017 and the percentage of these VAT receipts of total tax revenue for the time series.

Table 2.1 : Contribution of VAT to total Tax Revenue in Ghana

YEAR	VAT REVENUE (GH¢'000)	TOTAL INDIRECT TAX REVENUE (GH¢ '000)	TOTAL TAX REVENUE (GH¢ '000)	% OF VAT TO TOTAL TAX REVENEUE
2002	235.82	382.32	815.47	28.92
2003	353.22	620.59	1,271.29	27.78
2004	455.33	855.31	1,696.50	26.84
2005	523.86	1,070.69	2,057.60	25.46
2006	622.99	1,236.73	2,370.82	26.28
2007	872.38	1,566.96	3,043.29	28.67
2008	1,000.12	1,814.08	3,543.54	28.22
2009	1,399.20	2,273.92	4,704.03	29.74
2010	1,678.26	2,591.11	5,880.97	28.54
2011	2,028.17	3,065.13	7,447.15	27.23
2012	2,799.55	4,203.14	11,442.67	24.47
2013	3,767.96	5,576.21	15,609.52	24.14
2014	4,608.49	6,478.38	16,917.47	27.24
2015	5,797.57	12,623.78	21,536.26	26.92
2016	7,359.35	15,982.18	26,407.30	27.87
2017	8,358.88	19,061.75	33,606.40	24.87

Source: Ghana Revenue Authority, Tax Analysis and Revenue Forecasting Unit (2018)

It is observed from Table 2.1 that over the years, VAT in Ghana has been a major source of government revenue to the government of Ghana. Thus, reliable and informative revenue forecasts are critical to making good projections of expected revenue that will finance the expenditure of the government. The reliable forecasts of revenue are also very important for the medium to the long-term development plan of an economy. However, government agencies seldom forecast revenues for longer time periods than the next budget year. Forecasting beyond a year can be very useful in identifying the direction of economic trends. This can also assist the Ministry of Finance and Economic Planning to anticipate future challenges and put in place measures to avert them.

CHAPTER THREE

REVIEW OF LITERATURE

3.0 Introduction

This chapter presents the theoretical and empirical reviews of the study. Thus, the key terms and concepts of the study will be defined, and various theories related to the Valued Added Tax will be discussed. Also, literature analysis will be made to show the synthesis and knowledge gap which exists in this area.

3.1 Theoretical Review

3.1.1 The Concept of Taxation

Taxes, as defined by Taylor (1974), are “compulsory payments to governments without expectations of direct benefit to the taxpayer”. The revenues received as a result of the imposition of taxes is used by the state for the production of public goods and services, provision of infrastructure and maintenance of law and order. Bastable (1903), states that “A tax is a compulsory contribution from a person to the government to defray the expenses incurred in the common interest of all without reference to a special benefit conferred” (P.148). He added that “A tax is a compulsory contribution of the wealth of a person or body of persons for the service of the public powers”. The import of the definitions of the various authors makes it clear that taxes are obligatory contributions to a governing authority for common public purposes.

Some importance of taxation are to raise revenue for public expenditure, to bridge the inequality gap between high income earners and low income earners (i.e. redistribution of income), to discourage the consumption of harmful goods (e.g. cigarettes), to encourage the use of some goods and services in the country (e.g. condoms), to protect home industries, to promote foreign investment and to control certain aspects of the country’s economy (e.g. balance of payment and productivity). Taxes are basically classified into direct and indirect taxes. Though the actual definitions vary between jurisdictions, in general, a direct tax is a tax paid by an individual or a corporate entity to a government/authority on incomes or profits of the person or the corporate entity it is imposed on. An indirect tax, on the other hand, is a tax collected on behalf of the imposing authority (government) by an intermediary (usually within the supply chain) from the person/entity who bears the ultimate burden of the tax imposed. Thus, for direct taxes, the liability and burden to pay the tax lie on the same individual/entity whiles for indirect taxes the burden of the tax is shifted to another individual/entity to bear. Indirect taxes are mostly imposed on goods and services. Major types of direct taxes may include:

- Income Tax
- Corporate Tax
- Wealth Tax
- Estate Duty
- Gift Tax
- Fringe Benefit Tax

Major types of Indirect taxes may include:

- Excise Duty
- Sales Tax
- Custom Duty
- Entertainment Tax
- Service Tax
- Value Added Tax (VAT)

The major source of revenues for most governments is taxation. Revenues governments receive from taxation helps the governments to address the expenditure needs of their economies such as the provision of infrastructure, maintenance of law and order, salary payment of civil servants, etc. Taxation therefore in every economy has an instrumental role to play in the development of that economy.

3.1.2 Principles of Taxation

In the development of a good tax structure or in evaluating a tax structure, certain measures and standards have been proposed by economists such as Adam Smith (1776), Musgrave and Musgrave (1989), Bhartia (2009). These include; Equity, Certainty, Convenience, Economy, Simplicity, Productivity, Flexibility and, Diversity.

Equity Principle: This principle explains that every taxpayer must pay the tax in proportion to his/her income. Under this principle is horizontal equity and vertical equity. Horizontal equity means people with the same income level pay the same amount as tax. Vertical equity, on the other hand, means high-income earners will pay more tax while low-income earners pay less tax.

Certainty Principle: This principle also explains that the amount of tax, the manner of payment and the time of payment of the tax must not be arbitrary but very definite and clear to the taxpayer and everyone.

Convenience Principle: This principle also states that when, where and how to pay the tax must be always convenient to the taxpayer so that payment of tax is not hindered because of the inconvenience of taxpayers as to when, where and how to pay the tax.

Economy Principle: This principle also states that the administration of tax should be efficient to yield more benefits to the economy than the tax collected and cost of collecting the tax.

Productivity Principle: This principle explains that the administration of tax should mobilize appreciable revenue for productive government activities. Thus, how productive a tax is must frequently be measured by the revenues mobilised by the administration of the tax, to know if it has been adequate for the government to embark on productive activities.

Simplicity Principle: This principle also states that the tax should by no means appear cumbersome to taxpayers but very simple, plain and comprehensible even to a layman.

Flexibility Principle: This principle also explains that the tax should not be rigid but flexible enough to be used as a fiscal policy for stabilization and growth objectives.

Diversity Principle: This principle of taxation explains that states should not depend on just a few taxes as the main source of government revenue but rather have a diversity of taxes for mobilisation of government revenues.

3.1.3 Theories of Taxation

Economists at different times have set forth many theories of taxation to guide states on how to ensure fairness, equity, raising of adequate revenue and non-arbitrary administration in taxation. Some of these theories are the benefit theory, ability to pay theory, equal sacrifice theory and the cost of service theory. These theories of taxation are expounded below:

Benefit Theory

This theory was developed by Thomas Hobbes (1588-1679), an English Philosopher, and a German Jurist, Hugo Grotius (1583-1645) and John Locke (1632-1704), in the seventeenth century. The theory explains that since the government provides some benefits in a country, it is incumbent on the people who receive or enjoy the benefits the government provides to pay taxes. It further explains that individuals in a country should be taxed accordingly in proportion to the benefits they receive /enjoy from all the benefits the government provides in the form of public services, government programs and, projects. The benefit theory has come under several disparagement and criticisms. Some of these criticisms are as follows:

Most activities and services provided by the governments of countries benefits the poor more than the rich. This is because most government policies aim at ensuring equity in the allocation of resources thereby developing the underdeveloped areas of the country. Interestingly most underdeveloped areas in countries are dominated by poor people thus it is obvious that these poor people will receive more direct benefits from government activities. If the benefit theory is strictly applied, it means the poor will pay high taxes (because of the more benefits they receive from government activities) while the rich pay low taxes. This is contrary to the principle of justice (Saleemi, 2005). Furthermore, the possibility of strict applicability of the theory has been criticised. Critics mention that it is practically impossible to compute or estimate the benefits every individual received or enjoyed directly and indirectly from government activities in a day, month, a quarter or year.

Another statement of critics of the benefit theory is that since a tax is considered to be a compulsory payment or contribution to the government's revenue authority without expectation of direct benefit from the tax paid but to meet the expenditure plan of the government and provision of general benefit, connections between individual taxpayers and benefits they receive from the use of tax revenue are not maintained. They add that if such connections are maintained, it will contrast with the principle of tax. The administration of VAT and how VAT revenue is disbursed by the government does not conform to the benefit principle since VAT charged on businesses and consumers in countries are not according to the proportion of the benefits they receive /enjoy from their governments.

Ability-to-Pay Theory

The ability-to-pay theory of taxation is a theory that was instigated in the sixteenth century but was technically extended in the seventeenth and eighteenth centuries. The technical extension of this theory was done by Jeans Jacques Rosseu (1712-1778), a Swiss philosopher, Jean-Baptiste Say (1767-1832), a French political economist, and an English economist called John Stuart Mill (1806-1873). This theory holds that taxes should be levied accordingly in proportion with the income an individual receives or the ability of an individual to pay. It is based on this theory that progressive taxes are in such a way that as the taxable amount increases, the tax rate also increases (Jones & Rhoades, 2011).

This theory is considered a very equitable system of taxation since people who receive higher incomes or with greater wealth will definitely have the ability to pay higher taxes than others who receive low income, thus taking more taxes from high-income earners and very wealthy people through high tax rates and fewer taxes from low-income earners and poor people through low tax rates does not make any party worse off though both parties are paying different amounts to the government as tax. Many industrialised economies have adopted progressive taxation because of its equitability. The equitability will be realised if the ability-to-pay can be measured indisputably. This is the challenge encountered in practice when trying to fulfill this theory. Economists have proposed the following as measures of the ability-to-pay of an individual, though they are not unanimous of the precise measure:

i. Tax based on property owned: Some economists propose that a person's ability-to-pay can be determined based on the valued of property the person owns. What about a person who does not acquire valuable properties but earns high income? Such a person though earns so much income will not be subject to high taxes. On the other hand, an individual who inherits properties of high value but does not receive high income will be subject to high taxes. Thus, this idea cannot be accepted as a very good measure of the ability to pay

ii. Tax based on expenditure: Another assertion by some economists is that a person's expenditure can be a basis to adjudicate the ability-to-pay of the person. This assertion appears just and fair since rich people normally spend more than poor people. Nevertheless, a person's expenditure may be high because his/her expenditure is to cater for his/her many dependants. Such a person aside the burden of catering for his/her dependents will need to pay high taxes because his high expenditure presumes that he has the ability to pay high taxes. This will be unfair since another person in the same income class but has very few dependants as he/she spends less will be made to pay less tax.

iii. Tax based on income: Many economists hold the view that the ability-to-pay should be measured based on the income a person earns. This view also appears just since it is fair for persons to pay taxes proportionately to the income, they earn so that high-income earners pay high taxes whiles low-income earners pay low taxes. However, equitability may still not be realised if the number of dependants to be catered for with income earned by two persons who receive the same amount of income and have to pay the same amount as tax is different.

These criticisms of the measures of a person's ability to pay notwithstanding, taxing based on expenditure and income are more equitable and fairer than on the basis of property owned. Since the incidence of Value Added Tax is on final consumption, tax can be imposed on income and expenditure. This will be considerate on their ability-to-pay if multiple VAT rates are administered, imposing higher VAT rates on high expenditure and lower VAT rates on lower expenditure. For equitability to be realised, these multiple VAT rates should be applied on final consumption only. This is because if it is applied to all stages of production and distribution, goods that are bought wholesale for further distribution and for retailing will be overly expensive since the higher the expenditure, the higher the VAT rate.

Administration of VAT may not associate with this theory if consumers irrespective of the income they earn and their expenditure (final consumption) are charged VAT at a single rate. Therefore, as the income of a person rises, without a change in VAT rate, he/she will seem to be paying very low VAT since the VAT paid will be a smaller proportion of his/her income as compared to the earlier time before his/her income increased. On the other hand, without a change in VAT rate, one will seem to be paying very high VAT if his/her income decreases since the VAT paid after the income decrease will represent a bigger proportion of the person's income. (Jones & Rhoades, 2011).

Equal Sacrifice Theory

Another theory of taxation known as the equal sacrifice theory also called equal distribution theory or equal proportionate theory suggests that a fixed percentage of the taxpayers' income, wealth or transaction should be taxed. In this case, persons who earn higher incomes will be paying more taxes, however, the tax rate levied on their earnings will not be higher than what is levied on low-income earners. In other words, a fixed tax rate is maintained for all parties. Since the tax to be paid is a fixed proportion of the income earned, the amount paid as tax is obviously high for one earning high income and low for one earning low income, nonetheless in terms of sacrifice, both parties will seem to have sacrificed equally since the same percentage or proportion of their incomes is sacrificed to fulfil their tax obligation. Again, as a fixed percentage of the income of each individual is paid as tax, though the amounts paid may be different, the welfare loss as a result of paying tax from their income will be the same, percentage wise or proportionate wise.

The theory of equal sacrifice was acclaimed by J.S. Mill and some other classical economists to be a good theory that will fulfill the theory of justice in taxation (Musgrave & Musgrave, 1989). A major reason given by these economists to this acclamation is first, the same absolute degree of utility is sacrificed as a single percentage on all incomes are taxed though different amounts are paid as tax. On the other hand, some modern economists hold a contrary view as they hold the assertion that since the marginal utility of income decreases with an increase in income, the marginal utility that may be sacrificed by one who has had his/her income increased may not be equal (i.e. will be lower) to one who has experienced no change in income though they all pay the same percentage of their income as tax. They thus postulate that to really fulfill the equality of sacrifice in taxation, the tax rates levied on the incomes of higher income earners should be higher than that which is levied on the incomes of low-income earners.

The most contemporary economists, therefore, support the progressive tax system in all modern tax systems (Musgrave & Musgrave, 1989). VAT, as it is imposed on the value added of a good or service and its incidence, is on consumers does not associate with the theory of equal sacrifice since all consumers pay the same amount as tax (representing different percentage/proportion of each consumer's income), when they buy a particular product that is non-exempt from VAT. However, how VAT is administered in a country can make it conform to the theory of equal sacrifice. This can be realised if VAT is imposed at different rates on different goods and services. There may be particular goods and services that will be mostly consumed by low-income earners whiles high-income earners may not patronise such goods but will also consume particular goods and services the former party will not patronise. Thus, imposing a low VAT rate on the goods consumed mostly by low-income earners and high VAT rate on goods consumed mostly by high-income earners associates with the equal sacrifice theory. For instance, imposing a lower VAT rate in basic necessities and high VAT rates on luxurious products may be a step to fulfill the equal sacrifice theory. Examples of countries that administer multiple VAT rates are France, United Kingdom, and India.

3.2 Conceptual Framework of Forecasting techniques

The review is limited to the methodologies scrutinized in this work, namely: Trend analysis and ARIMA model. These methods are selected as they the best methods that can check out the possible models applicable to the VAT revenue data set. RMSE, MAD, MAPE are then used to measure the forecast accuracy of the applicable models.

3.2.1 Trend Analysis

Trend analysis fits an appropriate trend model to time series data and provides a forecast. This method is applied when there is no seasonal component in the time series data. Studies of researchers such as Gardner and Mckenzie (1985), Balandran (2005), and Mendelsohn (2000) have used trend models to make forecasts of time series data. There are a number of trend models one can choose from. These include linear trend, polynomial trend, logarithmic trend, power trend, exponential trend, Holt's linear trend method and, Holt winters model.

i. Linear Trend Analysis

A linear trend is normally employed when the data set for analysis is simply linear in nature. Historical data is considered linear if it is realised that the graphical pattern of the data is like a line.

ii. Logarithmic trend model

A logarithmic trend model is normally used when the rate of change in the data is very quick and levels out at an instance. A logarithmic trend line is a best-fit curved line and can assume both negative and positive values.

iii. Polynomial trend Model

A polynomial model is used for data that fluctuates. A polynomial trend line is therefore, a curved line. The number of fluctuations in the data or the number of bends (up bends and down bends) that appear in the curve determines the order of the polynomial. For instance, an order 4 polynomial commonly has up to three bends, and for order 3, one or two bends, and for order 2 only one bend.

iv. Power trend model

Some datasets, especially those that compare measurements increase at a specific rate. In such cases, the power trend model is employed. The power trend line therefore, is a curved shaped.

v. Exponential trend model

When data values are observed to be very volatile (undulates increasingly), an exponential trend model is sometimes considered. An exponential trend line is curved shaped. However, it is worth noting that it is not possible to create an exponential trend if the available data contains zero or negative values.

To make a choice among these trend models, as to which one best suit the features of the available data, it is necessary to examine a representation of the time series data in a graph form. If the graph appears linear, the linear trend model may be used. However, if the graph exhibits some curvature, the exponential, power or logarithmic model may be a better option to the linear trend model.

vi. Holt-Winters Model

Holt –Winter is used for exponential smoothing to make forecasts (advisably short-term forecasts by using “additive” or “multiplicative” models with trend and seasonality.

vii. Holt's linear trend method

Holt's trend corrected smoothing is applied when a time series displays changing level (mean) and the growth rate (slope). Holt’s linear method is to be employed for the case of a non-seasonal data that exhibits an addtive trend.

3.2.2 ARIMA Model

The ARIMA model is one of the standard statistical models for forecasting time series data. The forecasting methodology was proposed by George Box and Gwilym Jenkins in their seminal 1970 textbook “Time Series Analysis: Forecasting and Control”. ARIMA is actually an acronym for Autoregressive Integrated Moving Average. It is forecasting technique, which bases the forecast solely on the history of the item being forecast. ARIMA models, like other time series models, are appropriate when you can assume a reasonable amount of continuity between the past and the future, i.e., the future patterns and trends will bear a resemblance to current patterns and trends. This is a reasonable assumption in the short term but becomes less accurate as the forecast period is lengthened. Hence these models are recommended for shorter-term forecasting. The key aspects of the model are as follows:

AR: Autoregression. A time series model that makes use of the dependent relationship between an observation and a number of its lagged observations.

I: Integrated. Making a raw times series data stationary by differencing the observations (i.e. subtracting an observation from an observation at the previous time step).

MA: Moving Average. A time series model that makes use of the dependency between an observation and residual errors from a moving model to lagged observations. It measures the adaptation of new forecasts to prior forecast errors.

These components are each specified as a parameter in the ARIMA model. ARIMA (p,d,q) is a standard notation of an ARIMA model, where p, d and, q are parameters which are substituted with integer values to specify the ARIMA model being used.

The parameters of the ARIMA model are defined as follows:

p: The order of the Auto Regression Term

d: The number of times that the raw data must be differenced (also called the degree of differencing) to de-trend the data.

q: the order of Moving Average.

ARIMA is considered as an iterative approach that consists of three (3) steps namely:

a. Identification. Using the data and all related information to help select a sub-class of model that may best summarize the data. This involves a unit root test to determine whether or not the data is stationary. The test must be repeated after each round of differencing to avoid over differencing. The identification process further involves configuring the AR and MA using the Autocorrelation Function (ACF) and the Partial Autocorrelation Function (PACF).
b. Estimation. This involves using numerical methods to minimize a loss or error term
c. Diagnostic Checking. This involves a check for evidence that the model is not a good fit for the data. Very essential areas in diagnostic checking are: Overfitting and Residual Errors. If the model overfits the data, it suggests that the model is more complex than it should be and that it captures random noise in the training data. This results in poor forecast performance because it impacts the ability of the model to generalize. A review of the distribution of the residual errors helps reveal bias in the model. Density plots,

histograms, and Q-Q plots are used for this diagnostic. ACF and PACF plots of the residual error times series are normally used to further check if the model is ideal (i.e. the model leaves no temporal structure in the time series of forecast residuals.

Many time series datasets are regularly affected by some peculiar actions or measures, such as policy regulations, strikes, marketing promotions, environmental procedures, and related events, according to Box, Jenkins, and Reinsel (2008). Intervention analysis was thus proposed by Box, Jenkins, and Reinsel (2008) as a technique to access the magnitude of impact that these various intervention mechanisms have on a time series data.

3.3 Empirical Literature Review

This subsection reviews empirical studies that have used and compared different Tax revenue forecasting techniques. Moreover, it essentially focuses on VAT revenue forecasting and VAT Base determination.

3.3.1 Tax Revenue Forecasting Techniques and VAT Revenue Forecasting

Armah (2003) mentioned that there are often queries on whether the revenue targets of Revenue Authorities effectually reflect the macroeconomic framework of most countries. This Armah (2003) said with reason that, many times in the past, revenue collecting agencies claim to have achieved their revenue targets, but the macroeconomic framework of those countries seems unchanged for the better. Armah (2003) suspected flaws in the revenue target setting mechanism and went on to describe it as poor. Wildavsky (1986) mentioned that politicians usually accept projected revenue without questioning the forecast approach. That notwithstanding, there is often a conservative predisposition of budget and finance officers to under forecast revenues. Rubin, 1987 revealed that under-forecasting has become a norm as budget and finance officers are required to maintain a balanced budget, so that there may be discretionary funds to cater for contingencies. This and many other reasons may explain why judgmental forecasting is preferred by budget and finance officers to a systematic approach to forecasting. However, accuracy in forecasting can be improved significantly if a systematic approach is tested and employed.

Many studies have explored the expediency of adopting more intricate models for forecasting fiscal variables. More intricate approaches in most cases are more appropriate for forecasting than simple judgemental approaches (Baguestani and Mc-Nown ,1992; Marcellino and Favero, 2005; Nazmi and Leuthold, 1988; Fullerton, 1989; Kong, 2007; Pike and Savage, 1998; Sentence *et al*, 1998; Giles and Hall, 1998). Although different authors advocate different estimation methods, many of these authors postulate that econometric methods result in more accurate and less biased fiscal revenues forecasts. Many researchers have tested the efficiency of many time series methods for fiscal forecasting. Some of the time series methods are as follows:

- ARIMA models (Baguestani and McNown, 1992; Marcellino and Favero, 2005; Nazmi and Leuthold, 1988; Fullerton, 1989; Kairala, 2011; Brojba, 2010; Slobodnitsky and Drucker, 2008)
- Vector Auto-Regressive (VAR) model (Baguestani and McNown, 1992; Marcellino and Favero, 2005).
- error correction models (Baguestani and McNown (1992)).
- semi-structural macroeconomic models (Marcellino and Favero, 2005; Pike and Savage, 1998; Sentence *et al*, 1998; Giles and Hall, 1998).
- random walk model (Marcellino and Favero, 2005).
- trend models (Kong; 2007; Anderson and Johnson, 2014).
- regression models (Nazmi and Leuthold, 1988; Fullerton, 1989; Clower and Weinastein, 2006; Kong, 2007; Irizepova, 2016).
- Holt-Winters Model (Pelinescu *et al*, 2010; Fomby, 2008; Makananisa, 2015).
- ARMA and GARCH models (Chimilila, 2017)

According to Joselito (2005), there are two ways in which revenue forecasting is normally practiced. First, the forecast may be calculated as an unconditional prediction of the most likely outcome. Secondly, a forecast may be performed conditionally on the accuracy of macroeconomic variables that are used as a basis for the prediction. Duke Centre for International Development (2007) in an annual program on Tax Analysis and Revenue Forecasting (TARF) for the past six years of the program through observed that VAT revenue in most of the participating countries had been increasing with time. It averred also that various revenue data yielded different forecasting models. For that matter, the forecasting model depends on the revenue pattern of the country.

Gardner and McKenze (1985), in their study aimed at testing the Holt linear trend and damped trend in forecasting time series to know which of the two approaches produces a more accurate forecast. In this study, the researchers developed an exponential smoothing model to damp erratic trends. Data used in this study was a 1,001 time series first analyzed by Makridakis *et al* (1982). This data consisted of 181 yearly, 203 quarterly and, 617 monthly series. 114 series were demographic series, 319 macroeconomic series, 302 series were of company series and 236 of industry sales. The study revealed that accurate forecast can be produced with Holt linear trend model when the trend of the time series observations is not erratic, however for erratic trends, developing a model to damp the trend produces a more accurate forecast compared to smoothing models based on a linear trend.

Nikolov (2002) in his research on "Tax Revenue Forecasting with Intervention Time Series Modelling" started with the Box-Jenkins model selection approach and continued with the effects of the intervention analyses. This work was done with monthly tax revenue collection for the period January 1998 to July 2002 from the Republic of Macedonia. He recommended from his analysis that the model is good for forecasting but because the variance of the forecasts in time series models becomes large in time it will produce good forecast results for only a few time units ahead and not for longer periods. Sologoub *et al* (2003) applied a stationary time series approach and established a long-term relationship between VAT (Value Added Tax) base and VAT productivity. They attempted to apply the ARIMA model for monthly data to forecast VAT revenue in the short run. They concluded that ARIMA is very consistent with the projections made by the government of Ukraine for its budget. They also argued that VAT refund, debt, numerous tax exemptions and, low VAT compliance has the potency of complicating the VAT revenue forecasting in Ukraine.

Slobodnitsky and Drucker (2008) in their research titled "VAT Revenue Forecasting in Israel" compared the results of Co-integration estimation and ARIMA methods and adjudged the ARIMA model better than the Co-integration estimation since the ARIMA specification had lesser absolute deviation. Data that was used in this study was monthly VAT revenue data of Israel which spanned from January 1987 to December 2006. To measure the accuracy of estimated monthly revenues against the actuals, the quadratic loss function was used. Monthly ARIMA was found more precise than the co-integration model. Fomby (2008), forecasting the Plano sales tax in Texas applied Holt-Winters models. In his study, monthly sales tax data of Plano which spanned from February 1990 to November 2006 was used. He divided the data into two sets, namely the in-sample data which spanned from February 1990 to December 2003 (i.e. 167 observations) and the model validating data which also spanned from January 2004 to November 2006 (i.e. 33 observations). Applying the Holt-Winters models, four competing models were derived which were examined for three horizons, which are one-step, three steps, and six steps ahead (h = 1, 3, 6). As a measure of accuracy, the Mean Absolute Percentage Error (MAPE) criterion was used and the additive Holt-Winters with trend and seasonality was adjudged the best with minimal MAPE of 4.3, 2.84 and 3.5 for the three horizons (h = 1, 3, 6) respectively. Fomby (2008) concluded that it is very important to understand the characteristics of the time series data because as shown in the case of Plano's sales tax, it helps to find the accurate exponential smoothing forecasts. He added moreover that using exponential smoothing will not be wrong if the forecast to be done will be for more lines within a minimal time limit, nonetheless, ARIMA models may be considered if time is not one of the limiting constraints. Brojba (2010) in a similar study modeled the total budget revenue for Romania using data on monthly earnings from January 2007 to December 2008 (the economic crisis period). He employed ARIMA models which were able to capture the data movement during the period of study (the economic crisis period) because the data exhibited the trend and seasonality. The fitted values were very close to the actuals to the actuals in the analysis of his study. Brojba (2010) therefore concluded that to set revenue targets, ARIMA models can be employed. Brojba (2010) however exposed the fact that most accurate forecasts using the ARIMA models are for short term because the parameters of the ARIMA models are sensitive to sample selection. Thus, he stated this as a limitation of the model.

Chimilila (2017) in his study, “Forecasting Tax Revenue and its Volatility in Tanzania” found that monthly tax revenue persistently increased over the period owing to expansion in incomes, discretionary changes in administration and tax rates. He further found that monthly tax revenue has high volatility which grows over time. Based on different econometric procedures and criteria, he estimated and compared several models. A linear combination of ARMA and S (12) for forecasting monthly tax revenue and GARCH (1,1) for volatility were ultimately selected as the best models. Irizepova (2016) using correlation-regression analysis forecasted the long-term connection VAT may have with expected values of GDP in Russia. She used historical annual data of VAT (Invoiced VAT and Paid VAT) and GDP from 2006 to 2014, to predict the annual VAT revenues from 2015 to 2025 for Russia. The study revealed a high correlation between VAT and GDP. A prediction model was built based on the correlation-regression analysis which was used to predict annual VAT Revenue from 2015 to 2025 for Russia. Thus, her research showed clearly that correlation-regression analysis can also be considered when selecting methods for accurate VAT Revenue forecasting on the basis that there exists a significant correlation between VAT Revenue and GDP.

A comparison of ARIMA and unrestricted linear regression model was done by Fullerton (1989) who ruled out in favour of the latter because it had lessor Root Mean Squared Error. Moreover, the comparisons of the forecasting performance of different methods frequently find that ARIMA outperforms other models (Marcellino and Favero (2005), Nazmi and Leuthold (1988)), at least in the short run. There actually seem to be no clear guidelines from the literature as to which econometric method provides the most accurate fiscal variables forecasts. Botrić and Vizek (2012) suggest that each forecasting case should be considered and evaluated separately for individual country case. All the above-mentioned papers refer to the fiscal forecasting practice in developed economies. The best model for fiscal forecasting (VAT Revenue Forecasting in this case) in a developing economy like Ghana has not yet been determined in literature. The aim of this study is to take a closer look at possibilities for applying different methods of VAT Revenue forecasting in Ghana to know which can provide a better or best forecast of VAT Revenue in Ghana.

Applicable approaches for forecasting will be tested to know the best forecasting approach for VAT revenue in Ghana. In testing the various applicable forecast approaches, Vector Error Correction Model and Regression will not be employed in this study because Real GDP which should be the main regressor is reported only annually and quarterly whiles the study seeks to forecast monthly VAT Revenue. Random walk and Holt Winter's model will also not be employed because the VAT revenue data is non-seasonal. The econometric methods that will be assessed therefore will be ARIMA with Intervention Time Series analysis and trend forecasting. This study differs from other studies because it compares the applicable approaches for forecasting VAT revenue in Ghana, to know which one can give a more accurate prediction

3.3.2 VAT Base Determination

One major consideration that is made to ensure a good Tax Revenue forecast which literature has paid much attention to over the years is the Tax base or its proxy that is used. Tax base as defined by Greene (2014) is "an event or condition that gives rise to taxation and is defined in the law". Twerefou *et al* (2010) in their study, sought to estimate the elasticity of the Ghanaian tax system. Historical Time Series Data for the period 1970-2007 was used in the study and Dummy Variable Technique was employed to control for effects of the Discretionary Tax Measures. Twerefou *et al* in the study used Total Private Final Consumption as a proxy base for VAT, explaining that it is an "aggregation of final private consumption based on the fact that VAT covers both retail and wholesale level of output". The study revealed that the overall tax system in Ghana was buoyant and elastic. The study thus recommended that measures such as identifying new items to include in the tax net (for instance building plots left idle for at least five years), creating a conducive business environment (for instance, easing business registration across the country) for businesses to flourish, increasing rates on items such as locally brewed spirit and alcoholic beverages, designing of tax stamps for businesses in the informal sector should be implemented and through the use of ICT registering more eligible taxpayers to broaden the tax base.

Irizepova (2016) used GDP as the base macroeconomic indicator to forecast annual Value Added Tax Revenues (Paid VAT and Invoiced VAT) for a ten-year period (2015 to 2025). In her research, she used correlation-regression analysis to determine the volumes of VAT revenue in connection with expected values of GDP. Greene (2014), in a fiscal analysis and forecasting workshop at Bankok, Thailand, stated that in selecting a proxy tax base, there should be a high correlation between observed tax revenue and the proxy tax base. Greene (2014) suggested that private consumption expenditure, GDP, Import of Goods can be proxy base for VAT. He added that if most VAT revenues are from the tourism sector, one must consider earnings from tourism.

On this basis, this study will explore the relationship and correlation between VAT Revenue and Real GDP to know if Real GDP can be an appropriate proxy VAT base in VAT revenue forecasting. A more appropriate benchmark or VAT base would be Total Private Consumption, which is an ideal VAT base for VAT revenue forecasting. However, time series (monthly or quarterly) data on private consumption expenditure and data on monthly purchases of exempt sectors were not available.

3.4 Synthesis and Knowledge Gaps

Some research has been conducted in the area of VAT revenue forecasting. Edzie-Dadzie (2013) in his research "Time Series Analysis of Value Added Tax Revenue Collection in Ghana" employed the Box Jenkins method to make a two-year forecast of Domestic and Import VAT using monthly data from 1999 to 2009 (a ten-year period). However, after his period of study, there has been a change in the VAT rate (increase in rate by 2.5%, in 2014). Dadzie's work did not analyse the effect of the change in VAT rate since the change was done after his period of study. Though Nartey (2011) and Antwi *et al* (2012) both employed the ARDL Cointegration procedure to investigate the effects of changes of VAT rate on VAT revenues in Ghana, they both used quarterly data spanning from 2003 to 2010 (32 observations), which is a small sample size. Thus, there is much likelihood of biasedness in their result. The need for another study that will use a large enough sample size-monthly VAT data from 2002 to 2017 (180 observations are used in this study), to investigate the effect of a change in the VAT rate on VAT Revenue in Ghana has arisen, because the increase in sample size reduces the biasedness of the results. Also, since the change in VAT rate in 2014 may have affected the VAT revenues mobilised a priori, there is still a need to estimate new models to forecast VAT revenue (Domestic, Import and Total VAT revenue) in Ghana.

The comparisons of the forecasting performance of different methods frequently show that ARIMA outperforms other models (Marcellino and Favero, 2005; Nazmi and Leuthold, 1988), at least in the short run because it is a univariate forecasting model and produces more consistent forecast figures. Fullerton (1989) in his study ruled out Ordinary Least Squares regression technique because it had lessor Root Mean Squared Error as compared to the ARIMA model. There seem to be no clear guidelines from the literature as to which econometric method provides the most accurate fiscal variables forecast. Rather each forecasting case should be considered and evaluated separately for individual country case. (Botrić and Vizek, 2012). This study seeks to employ the applicable econometric methods of VAT (Total, Domestic, and Import VAT)

Revenue forecasting to the economy of Ghana taking into consideration changes in VAT rate within the period of study and to assess which one is more reliable in terms of accuracy in forecasting, a study which has not been done yet by any researcher.

Also, empirical studies as reviewed in this chapter investigate the effect and/or impact of VAT Revenue on economic growth. Empirical studies such as done by Irizepova (2016) used GDP as the base macro-economic indicator to forecast annual Value Added Tax Revenues. Greene (2014) also suggested private consumption expenditure, GDP, Import of Goods (for VAT on imports). Proxies are normally used for VAT base in empirical studies. Twerefou *et al* (2010) in their study used Total Private Final Consumption whiles Bajrachaya and Kuo (2000) used a sum of Private Consumption and Government expenditure fewer purchases by exempt sectors as VAT base. Report on these VAT bases are always annual and cannot be used for forecasting monthly VAT revenue. This study converse to others studies, that investigate the effect and/or impact of VAT Revenue on economic growth, thus explores the relationship and correlation between VAT Revenue and Real GDP to know if Real GDP can be an appropriate proxy VAT base to be considered in forecasting monthly VAT Revenue in Ghana, which has not been explored yet in literature.

CHAPTER FOUR

METHODOLOGY

4.0 Introduction

This Chapter describes the research methodology used in the study. Two major methods of VAT Revenue forecasting namely ARIMA with Intervention Analysis method and Holt Linear Trend method are assessed to know which gives a better predicting VAT Revenue (Total VAT, Import VAT and, Domestic VAT) in Ghana in terms of precision and accuracy. Also, the methodology for regression analysis is expounded which will be used to analyse the effect of Real GDP on VAT Revenue and the correlation that exists between those two economic variables. The data sources, the model and the various tests that were used are all analysed in this chapter.

4.1 Theoretical Model

The forecasting model, ARIMA with intervention in this study is based on the following studies with modifications; Darkwah et al (2012), Edzie-Dadzie (2013), and Obu-Amoah (2017). The Holt linear trend model in this study is based on the studies of Gardner and Mckenzie (1998) with modifications.

4.1.1 Auto-Regressive Integrated Moving Average (ARIMA) Model

A systematic method of fitting and forecasting time series data is the Auto-Regressive Integrated Moving Average Model (ARIMA). This method is appropriate for time series of at least 50 observations. Given a time series; $X_1, X_2, X_3, \ldots X_t$ where *t* is the time periods and X is observations, in an attempt to fit an ARIMA model to a time series data, the first step is to check for stationarity. Stationarity also indicates that for all values of *t*, the mean and variance are constant. A stochastic process X_t is said to be strictly stationary if the joint distributions of

$X_{t_1}, X_{t_2}, ..., X_{t_n}$ and $X_{t_{1-m}}, X_{t_{2-m}-}, ..., X_{t_n-m}$ for all $t_1, t_2, ..., t_n$ are the same and lag m which is the time difference. In this case, $E(X_t) = E(X_{t-m}),\ Var(X_t) = Var(X_{t-m})$ for all *t* and *m*, and also $Cov(X_t, X_s) = Cov(X_{t-m}, X_{r-m})$ for all values of *t*, *m* and *r*.

A stationary time series allows analysis of the correlation between two successive values, X_t and X_{t+1}. If a series exhibits a simple trend, that series is non-stationary. This is because the values of such a series depend on *t*. This correlation is known as the **autocorrelation**. Consider an observed series $X_1, X_2, X_3, ...X_t$. We can form *n-1* pairs of observations, for instance; $(X_1, X_2), (X_2, X_3), ..., (X_{n-1}, X_n)$ where each pair of observation is separated by one-time interval. Taking the observations in each pair as separate variables, we can compute the autocorrelation between X_t and X_{t+1} as:

$$S_m = \frac{\sum_{t=1}^{n-m} (X_t - \overline{X)(X_{t+m}} - \bar{X})}{\sum_{t=1}^{n} (X_t - \bar{X})^2} \qquad (4.0)$$

Thus S_m is the **autocorrelation coefficient at lag m.** A plot of S_m against lag m for

m = 0, 1, 2 ... and k < n is called **sample Autocorrelation Function (ACF).**

Analysis for partial correlation in a stationary time series can also be done.

The **Partial Autocorrelation** is the correlation between X_t and X_{t-1} after removing the effect of the intervening variables $X_{t-1}, X_{t-2}, X_{t-3}, ..., X_{t-m+1}$. It is usually called the

Partial Autocorrelation Function (PACF) at lag m and if denoted by ϕ_{mm} it can be defined as: $\phi_{mm} = corr(X_t, X_{t-m} | X_{t-1}, X_{t-2}, X_{t-3}, \ldots, X_{t-m+1})$ (4.10)

Thus ϕ_{mm} measures the correlation between X_t and X_{t-m} given $X_{t-1}, X_{t-2}, X_{t-3}, \ldots, X_{t-m+1}$ or the correlation between X_t and X_{t-m} after adjusting for the effects of $X_{t-1}, X_{t-2}, X_{t-3}, \ldots, X_{t-m+1}$

Stationarity can be achieved if the pattern caused by the time-dependent autocorrelation is removed. Besides checking for stationarity with the time series plot, the sample Autocorrelation function (ACF) can also be used. According to Bowerman *et al* (2004), if the ACF of the time series values looks fairly steep (as indicated in Figure 4.1), then the time series values is stationary. Conversely, if the ACF of the time series values dies down gradually or slowly (as shown in Figure 4.2), then the time series values are non-stationary. To make an original time series which is non-stationary to be stationary, first and/or second differencing transformation must be performed on the original data.

The number of differencing on the original time series to achieve stationarity becomes the Order of Homogeneity. Trend in variance is also eliminated by taking logarithms.

First Difference: $Y_t = X_t - X_{t-1}$ where t=2, 3,…, n.

Second Difference: $Y_t = (X_t - X_{t-1}) - (X_{t-1} - X_{t-2})$ where t=3, 4,…, n.

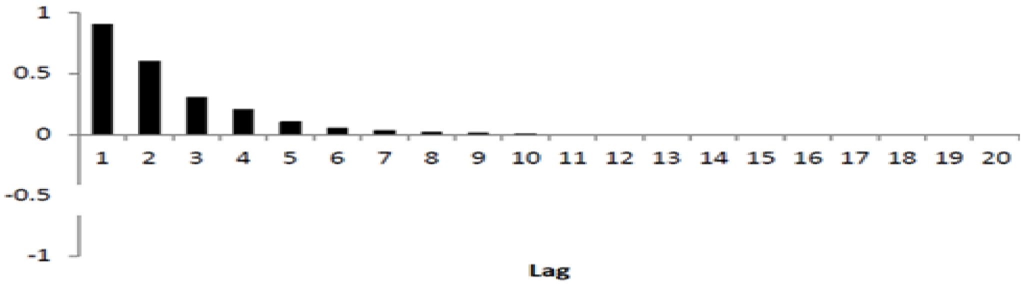

Figure 4. 1: ACF of a stationary time series data

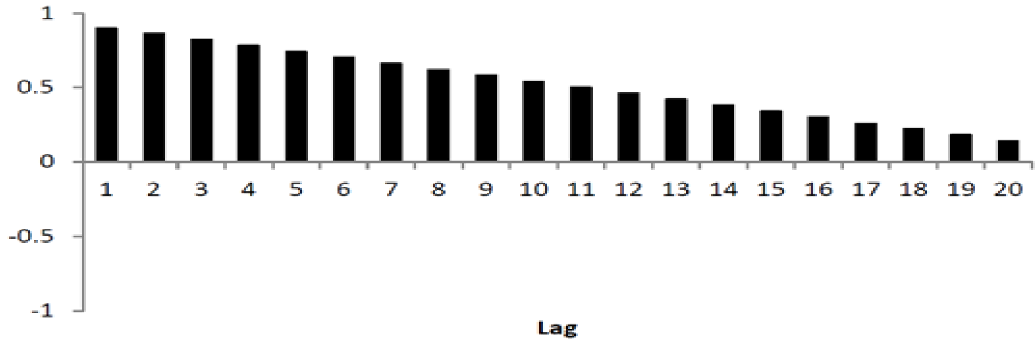

Figure 4. 2: ACF of a nonstationary time series data

Given that either the original time series $X_1, X_2, ..., X_n$ or the transformed time series $Y_a, Y_{a+1}, ..., Y_n$ is stationary, we can now look at the ACF and partial PACF for particular behaviours that indicate a theoretical non-seasonal Box-Jenkins model.

Figure 4.1 and 4.2 shows different behaviours of the ACF and PACF respectively. Three types of non-seasonal theoretical Box-Jenkins models are summarized below:

i. Moving average model of order *q*

Consider a white noise process (α_t) with zero mean and variance $\sigma_\alpha^{\ 2}$, then a process X_t is called moving average process of order q (MA (q) process) if

$$X_t = a_t - \delta_1 a_{t-1} - \delta_2 a_{t-2} - ... - \delta_q a_{t-q} \qquad (4.11)$$

Where the δ_i's are constants.

NB: A process a_t is called a White Noise if it is a sequence of uncorrelated random variables from a fixed distribution with constant mean $\mathrm{E}(a_t) = \mu_\alpha$, usually assumed to be zero, constant variance $\mathrm{Var}(a_t) = \sigma_\alpha^{\ 2}$ and $Y_m = Cov(a_t, a_{t+m}) = 0$ for all m≠0

The mean E (X_t)=0 and $Var(X_t) = \sigma^2{}_\alpha (1 + \sum_{i=1}^{q} \delta_i^{\ 2})$ =γ_0

$$\gamma_m = Cov(X_t X_{t+m}) = \begin{cases} \sigma_\alpha^{\ 2}(-\delta_i + \sum_{i=1}^{q-m} \delta_i \delta_{i+m} & m = 1, 2, 3, ..., q \\ 0, & m \succ q \end{cases} \quad (4.12)$$

$$\rho_m = \begin{cases} \dfrac{-\delta_m + \delta_1\delta_{m+1} + \delta_2\delta_{m+2} + \delta_3\delta_{m+3} + ... + \delta_{q-m}\delta_q}{1 + \delta_1^{\ 2} + \delta_2^{\ 2} + \delta_3^{\ 2} + ... + \delta_q^{\ 2}} & m = 1, 2, ..., q \\ 0, & m \succ q \end{cases} \quad (4.13)$$

For a moving average model of order q, the ACF cuts off after lag q while the PACF dies down.

ii. Autoregressive model of order *p*

Consider a white noise process (α_t) with zero mean and variance $\sigma_\alpha^{\ 2}$, then a process X_t is called Autoregressive process of order p (AR (p) process) if:

$$X_t = \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \alpha_3 X_{t-3} + ... + \alpha_p X_{t-p} + a_t \quad (4.14)$$

This model resembles a multiple regression model but the dependent variable in this case is X_t rather than separate independent or predictor variables. We can derive that:

$$\psi_m = \alpha_1 \psi_{m-1} + \alpha_2 \psi_{m-2} + \alpha_3 \psi_{m-3} + ... + \alpha_p \psi_{m-p}$$

and $\gamma_m = \alpha_1 \gamma_{m-1} + \alpha_2 \gamma_{m-2} + \alpha_3 \gamma_{m-3} + ... + \alpha_p \gamma_{m-p}$

Thus $\psi_0 = \alpha_1 \psi_1 + \alpha_2 \psi_2 + \alpha_3 \psi_3 + ... + \alpha_p^{\ 2} \psi_p + \sigma_a^{\ 2}$ (4.15)

But since $\rho_m = \frac{\psi_m}{\psi_0}$, hence the variance may be written as:

$$\psi_0 = \frac{\sigma_a^{\ 2}}{1-\alpha_1\rho_1-\alpha_2\rho_2-\alpha_3\rho_3-\ldots-\alpha_p\rho_p} \qquad (4.16)$$

For an Autoregressive model of order p, the ACF dies down and the PACF cuts off after lag

iii. Mixed autoregressive – moving average model of (*p, q*)

The combination of AR and MA processes produced ARMA. That is partially autoregressive and partially moving average and it is denoted by

$$X_t = \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \ldots + \alpha_p X_{t-p} + a_t - \delta_1 a_{t-1} - \delta_2 a_{t-2} - \ldots - \delta_q a_{t-q} \qquad (4.17)$$

Where X_t is Mixed Autoregressive Moving Average process of orders p and q (ARMA (p, q)).

For a Mixed Autoregressive Moving Average process of orders p and q (ARMA (p, q)), both the ACF and PACF die down.

Many original times series exhibit nonstationary behaviour before they undergo differencing transformation. The non-stationarity of most time series data may be due to trend in data, variation in the local mean or seasonal variation.

Methods of transforming non-stationary series into stationary may include:

i. Using the first differences of the series, $W_t = X_t - X_{t-1}$. This can be rewritten as $W_t = (1-B)\mathrm{X}_t$. Another form of the equation also is: $\alpha(B)(1-B)^d x_t = \beta(B)z_t$ (this is considered the general form), where *d* in the equation is the order of differencing. This is the Auto-Regressive Integrated Moving Average (ARIMA) (*p,d,q*) model.

ii. Fitting a least squares trend and the ARIMA model to the residuals. If the model reveals that the mean changes occasionally, then differencing once will make the model stationary.

After differencing a non-stationary time series to make it stationary, the resulting time series is called an integrated time series.

All Autoregressive (AR) (p) models can be represented as ARIMA (p, 0, 0) that is no differencing and no Moving Average (MA) (q) part, also MA (q) models can be represented as ARIMA (0, 0, q) meaning no differencing and no AR (p) part. The general model is represented as ARIMA (p, d, q) where p is the order of the Auto Regression (AR), d is the degree of differencing and q is the order of the Moving Average (MA). Suppose a series X_t is nonstationary.

Considering an ARIMA (p. 1, q) process if the first order difference is $W_t = X_t - X_{t-1}$ then we can express the new (differenced) series as:

$$W_t = \alpha_1 W_{t-1} + \alpha_2 W_{t-2} + ... \alpha_p W_{t-p} + \alpha_t - \delta_1 a_{t-1} - \delta_2 a_{t-2} - ... - \delta_q a_{t-q}$$

(4.18)

or in the original form:

$$X_t - X_{t-1} = \alpha_1 (X_{t-1} - X_{t-2}) + \alpha_2 (X_{t-2} - X_{t-3}) + ... + \alpha_p (X_{t-p} - X_{t-p-1}) + \alpha_t - \delta_1 a_{t-1} - \delta_2 a_{t-2} - ... - \delta_q a_{t-q}$$

(4.19)

Simplifying, we have:

$$X_t = (1+\alpha_1) X_{t-1} + (\alpha_2 - \alpha_1) X_{t-2} + (\alpha_3 - \alpha_2) X_{t-3} + ... + (\alpha_p - \alpha_{p-1}) X_{t-p} - \alpha_p X_{t-p-1} + a_t - \delta_1 a_{t-1} - \delta_2 a_{t-q}$$

(4.20)

Equation (4.20) represents a non-stationary ARIMA (p,1,q) process and it is called the Difference Equation Form.

For ARIMA (p,d,q) model both ACF and PACF dies down or tails off.

Lastly, in comparing models, the best model should have the smallest standard error, Akaike's Information Criterion (AIC), and Bayesian Information Criterion (BIC) values.

4.1.2 The Intervention Analysis Methods

According to Box, Jenkins, and Reinsel (2008), time series are time and again affected by measures, happenings or circumstances, such as strikes, economic shocks, policy changes, environmental regulations, and similar occurrences, which we shall refer to as *intervention* events. Intervention analysis is used to access the magnitude of impact that these various intervention mechanisms have on a time series data. A stochastic, time-series $ARIMA(p,d,q)$ model will help in analyzing the dynamics of changes, discrepancies and disruptions in the VAT Revenue through time series data. The core emphasis is to approximate the vibrant influence of the increase in VAT rate by 2.5% in January 2014 as an intervention mechanism on VAT Revenues collected. In building up a time series intervention analysis, we make an initial assumption that an intervention event had occurred at time T of the time series. This intervention analysis will help us access the exact impact of a known intervention on a time series data. It is of concern to determine whether there is any signal of change connected with this known intervention on the time series under the associated intervention mechanism.

4.1.2.1 Assumptions of Intervention Analysis Models

Intervention analysis or specifically impact assessment models are qualified by certain premises which serve as a guide to analysts to practically fit these models. These premises for the impact analysis are mentioned below:

i. The system in which both the input event and the impact reaction occur is normally assumed by researchers to be closed. It is as well presumed that the only exogenous impact on the series emanates from the intervening event in the noise model. Thus, it is presumed that the intervention event alone triggers the influence, whiles all other factors elicits no exogenous impact.

ii. It is also presumed that the temporal delimitations of the input event are well known. It must also be easy to detect the time of commencement, the duration, and the time of cessation of the input event. Moreover, it is required that the noise model that describes the pre-intervention series is stable with a mean of zero.

iii. An additional premise is that there should be sufficient observations in the series before and after the commencement of the intervention event for the researcher to distinctly model the pre-intervention and post-intervention series by any parameter estimation procedure the researcher may decide to use. The pre-intervention series is first to be modelled, then after, the impact of the intervention is also modelled. The modelling of the impact of the intervention is done in the conventional approach where there is sufficient dataset prior and subsequent to the intervention event.

4.1.2.2 Transfer Function and Univariate ARIMA Model

Transfer function denotes the process of accounting for the dynamic association between two-time series Y_t and X_t (where the latter represents the input series whiles the former represents the output series) where previous values of both series may be used in predicting Y_t, resulting in a substantial decreasing in the errors of the prediction. The overall transfer function of an ARIMA is of the form:

$$Y_t = \sum\left[\omega(B)/\delta(B)\right]B^b X_t + \left[\theta(B)/\varnothing(B)\right]\epsilon_t \tag{4.21}$$

where Y_t and X_t denotes both the output and input series respectively, b denotes the delay time for the impact of the intervention to occur, $\omega(B)/\delta(B)$ is the polynomial of transfer function, $\left[\theta(B)/\varnothing(B)\right]$ denotes the noise model and ϵ_t is the residual or simply the white noise.

The equation above can furthermore be simplified as

$$Y_t = V(B)X_t + N_t \tag{4.22}$$

Where

$$V(B) = \delta^{-1}(B)\omega(B)B^b$$

$$\omega(B) = \omega_0 + \omega_1 B + \ldots + \omega_s B^s$$

$$\delta(B) = 1 - \delta_1 B - \ldots - \delta_r B^r \text{ and}$$

$$N_t = \left[\theta(B)/\varnothing(B)\right]\epsilon_t$$

4.1.2.3 Intervention Analysis Procedure

According to Box and Tiao (1975), the general form of an intervention model is denoted by

$$Y_t = V(B)I_t + N_t \tag{4.23}$$

Where $V(B)$ denotes the transfer function, I_t is an intervention indicator of deterministic input series and N_t is a noise model.

The impact of an intervention has two forms of deterministic input series which have been established to be very beneficial in intervention analysis. The occurrence of a known intervention is denoted as 1 at time $t = T$ and as such in the case where the deterministic input series is a pulse function (when the known intervention occurs at a single index of time) and stays the same as 1 in the case of a step function (when the known intervention continuously occur beginning with a time index denoted say t_0).

Mathematically, the deterministic input series of an intervention analysis in terms of the pulse function is given as

$$P_t^{(T)} = \begin{cases} 0 & t \neq T \\ 1 & t = T \end{cases}$$

Whiles that of the step function is also denoted as

$$S_t^{(T)} = \begin{cases} 0 & t < T \\ 1 & t \geq T \end{cases}$$

Which will represent the influence of an identified intervention that is likely to continue permanently after time T to some point.

In this instance the intervention input begins in 2014 $(t = T)$ where t is coded as 1, and remains for just a period in the case of the pulse function, but remains as 1 for the entire presence of the intervention exercise in the case of the step function and is therefore with regard to the increase in VAT rate intervention event is formulated as;

$$Y_t = c + \omega_1 I_{1t} + \frac{\theta(B)}{\varnothing(B)} \in_t \tag{4.24}$$

Where $I_{1t} = S_t^{(2014)} = \begin{cases} 1 & t \geq 2014 \\ 0 & Otherwise \end{cases}$

c is a constant and Y is the level of variation with respect to gains or losses made in the value of reduction. The intervention variable in this study is a step function which relates to the increase in VAT rate intervention.

4.1.2.4 General Procedure for Developing the Intervention Model

The following stages may be followed to develop the Intervention Model:

- Stationarity/Unit root test and identifying the order of difference, i.e. d for the full period and also the Pre-Intervention period. This initial stage is important to make stationary the time-series data (if it is non-stationary) and decrease the residual. The Augmented Dickey-Fuller (ADF) test is frequently used to test for the presence of unit root. The hypothesis is stated as follows:

  Ho: The time series data has a unit root

  H1: The time series data has no unit root.

  If the null hypothesis is accepted, it means the time series data is non-stationary at levels, thus there will be a need for first differencing. Nonetheless, if the null hypothesis is rejected, it means that the times series data is stationary at levels, thus no need to difference. The Phillips-Perron unit root test can also be used to test for the presence of unit root or to confirm the results that may be produced by the ADF test.

- After stationarity is achieved, the next step is to specify the order of the pre-intervention ARIMA models. As explained earlier, the general model is represented as ARIMA (p, d, q) where p is the order of the AR, d is the degree of differencing and q is the order of the MA. The spikes of the partial autocorrelation plot (PACF) can be used to determine the order of the AR model whiles the spikes of the Autoregressive plot can also be used to determine the order of the Autocorrelation model. Spikes of these graphs that are initially above the limit are considered significant and the number of significant spikes determine the order of the PACF and the ACF. Furthermore, theoretically the value of the Partial Autocorrelation coefficients ϕ_{mm} [explained in equation (4.10)] which fall outside the limit $\pm\frac{2}{\sqrt{N}}$ are significantly different from zero. On the other hand, all Partial Autocorrelation coefficients within the range are considered insignificantly different from zero. The number of significant Partial Autocorrelation coefficients determine the order of the AR model. A PACF of an AR (p) model 'dies down' at lag p, implying that values beyond p are considered insignificantly different from zero.

The order of the MA (q) process conversely is normally determined from the sample ACF. Similar to the AR (p) model, for an MA (q) process, the theoretical autocorrelation function 'dies down' at lag q, and values beyond q are considered insignificantly different from zero.

Considering a pre-intervention ARIMA (p, d, q) process, the order of d will be the order of differencing that makes the series stationary. Thus, if the series is stationary at levels, d=0. If the series becomes stationary at first difference, d=1.

- Once the pre-intervention ARIMA models are well specified, the parameters of transfer function can be estimated. Very instrumental in this estimation are the ACF and the PACF. These functions are used to cautiously estimate and make diagnostic check for the parameters of the transfer function, whereas statistical procedures provide statistical confirmation of a suitable transfer function.
- The residual/noise diagnostic check is then performed using the Ljung-Box Q-statistics test based on the ACF and PACF of the residual. Also, ARCH-LM test is performed to test for heteroscedasticity.
- The model that provides adequate representation of the pre-intervention series is then used to fit the after-intervention series.
- The effect of the intervention can then be assessed by estimating the parameters explained in section 4.1.2.5.
- A forecast into the future can then be made into the future with the best-fit model.

4.1.2.5 Methods of Intervention Models

The general intervention model can be expressed as

$$Y_t = \frac{\omega_0}{(1-\delta B)} I_{t-b} + N_t \qquad (4.25)$$

Where I_{t-b} is used to denote the intervention deterministic indicator variable commonly referred to as change agent. It takes two forms which is usually used to denote the existence or nonexistence of a known intervention event on a time series data. The value 0 is used to denote the nonexistence of the intervention event on the time series whiles the value 1 is used to denote the existence of the intervention event. ω_0 denotes the impact parameter which is used to measure the magnitude of impact of the intervention event on the time series data and δ denotes the decay parameter.

The interval between the start of the intervention event and the definite time it is impacting on the time series is denoted by b. Subject to the circumstances that prevails upon the existence of the intervention event, the impact may not necessarily be seen rapidly on the response time series. For example, when b is given a value of 3, it depicts that there will be exactly three time periods between the occurrence of the known intervention event and the time in which its impact will be completely recognized on the response series. Time series intervention analysis is generally categorized into two most important forms of impact assessment. These two most important forms are regularly based on the length and nature of impact of the known intervention event on the response series. Depending on the length of the intervention event, certain intervention events might give either a temporal or permanent impact. The nature of the impact can be viewed as an abrupt or gradual process. An abrupt permanent change is usually associated with step functions whiles an abrupt temporary change is mostly also associated to pulse functions.

4.2 Choosing the best trend model

Pegels (1969) proposed a taxonomy for choosing the best modelling framework for a given data. This taxonomy was extended by Gardener (1985), also extended by Makridakis, Wheelwright, and Hyndman (1998) and further modified by Hyndman *et al* (2002). The modified taxonomy by Hyndman *et al* (2002) is adopted in this study as a guide for selecting among the trend forecasting models. The taxonomy is shown in the Table 4.1

Table 4. 1: Taxonomy for selecting trend forecasting model

TREND COMPONENT	SEASONAL COMPONENT		
	N (NONE)	A (ADDITIVE)	M (MULTIPLICATIVE)
N (NONE)	NN (simple exponential smoothing)	NA	NM
A (ADDITIVE)	AN (Holt linear)	AA (Additive Holt Winters)	AM (multiplicative holt winters)
M (MULTIPLICATIVE)	MN	MA	MM
D (DAMPED)	DN	DA	DM

Source: Hyndman *et al (2002)*

From Table 4.1 above, considering the case in cell NN, simple exponential smoothing method is to be employed for modelling and forecasting. Holt's linear method is to be employed for the case in cell AN. Again, for the case in cell AA, the Additive Holt Winters method is to be employed and Multiplicative Holt Winters method for the case of AM for modelling and forecasting. Less commonly used modelling and forecasting methods are employed for the cases in the other cells. The Holt's linear method is the preferred trend model for this study because the VAT Revenue data is additive and non-seasonal.

4.3 Holt's linear trend method

Simple exponential smoothing was augmented by Holt (1957) to facilitate forecasting of data with a trend. This method of forecasting involves the following equations: Forecast equation and two smoothing equations (Level equation and trend equation) as shown below:

Forecast equation; $$\hat{x}_{t+h|t} = \ell_t + hb_t \quad (4.30)$$

Level equation; $$\ell_t = \alpha x_t + (1-\alpha)(\ell_{t-1} + b_{t-1}) \quad (4.31)$$

Trend equation; $$b_t = \beta(\ell_t - \ell_{t-1}) + (1-\beta)b_{t-1} \quad (4.32)$$

where ℓ_t represents an estimate of the level of the data series at time *t*, .b_t also represents an estimate of the trend (which can also be called the slope) of the data series at time *t*, α denotes the smoothing parameter for the level, $0 \le \alpha \le 1$ and β denotes the smoothing parameter for the trend, $0 \le \beta \le 1$.

The level equation of the Holt linear trend indicates that for the within-sample one-step-ahead forecast for *t*, which is given by $\ell_{t-1} + b_{t-1}$ with y_t as observation, ℓ_t is a weighted average. Also, based on $\ell_t - \ell_{t-1}$ and, b_{t-1}. (which is the previous estimate of the trend) b_t is a weighted average of the estimated trend at time *t*. The forecast function thus is trending and no longer flat. It is also worth noting that *h* times the last estimated trend value plus the last estimated level is equal to the *h*-h-step-ahead forecast, thus the forecasts will have a linear function.

4.4 Measures of Accuracy in Prediction

A frequently used measure of the accuracy of predictions is Root Mean Square Error (RMSE). The RMSE measures the deviations of predicted values from what is actually observed. The RSME aggregates the absolute values of the deviation of the predicted values from the observed values to obtain a single measure of prediction accuracy of a model. The RMSE is thus used to measure the prediction accuracy of different forecasting models using the same dataset for each model. The smaller the RMSE, the better the forecasting model in precision and vice versa. Fullerton (1989) in a study ruled out in Ordinary Least Squares regression technique because of its hard lessor Root Mean Squared Error as compared to the ARIMA model. To compare the prediction accuracy of the Holt linear trend model and the ARIMA with intervention analysis model in this study, both models will be used to predict the monthly VAT (Total VAT, Domestic VAT and Import VAT) revenues in 2017. The RMSE will be computed using the predicted values and the observed values in 2017 for both models. Thus, the model with the least RMSE will be adjudged the better in terms of accuracy in prediction.

The RSME is the square root of the Root Mean Error (RME)

Given a parameter ω and its estimator $\hat{\omega}$, the RMSE can be defined as:

$$RMSE(\hat{\omega}) = \sqrt{MSE(\hat{\omega})} = \sqrt{E((\hat{\omega} - \omega)^2)} \tag{4.33}$$

For this study, the RMSE is defined as:

$$RMSE = \sqrt{\frac{\sum_{t=1}^{T} (\hat{y}_t - y_t)}{T}} \tag{4.34}$$

Where $\hat{y}_t$ represents predicted monthly VAT (Total VAT, Domestic VAT and Import VAT) revenues,

y_t represents the observed monthly VAT (Total VAT, Domestic VAT and Import VAT) revenues and

T represents the prediction time period.

Another used measure of the accuracy of predictions is the Mean Absolute Deviation (MAD). This measures the average variability of predicted values from the observed. In other words, the MAD is the sum of all the absolute variances between the observed values and the predicted, divided by the number of observations. Goh & Law (2002) in their study "Modelling and Forecasting Tourism Demand for Arrivals with Stochastic Nonstationary Seasonality and Intervention" used the MAD as a forecast accuracy measure of the tourism demand the study predicted. Rogoff and Meese (1983) also in his study "Empirical Exchange Rate Models of the Seventies: Do they fit out of sample?" used RMSE and MAD as measures of out-of-sample forecast accuracy as he sought to compare the predictability of various structural and time series models.

It is defined in this study mathematically as: $$MAD = \frac{\sum_{t-1}^{n} |\hat{y} - y|}{n} \quad (4.35)$$

Where $\hat{y}_t$ represents predicted monthly VAT (Total VAT, Domestic VAT and Import VAT) revenues,

y_t represents the observed monthly VAT (Total VAT, Domestic VAT and Import VAT) revenues and *n represents* the number of observations.

As both models will be used to predict the monthly VAT (Total VAT, Domestic VAT and Import VAT) revenues in 2017, the MAD will be computed using the predicted values and the observed values in 2017 for both models. Thus, the model with the less MAD will be adjudged the better in terms of accuracy in prediction. Another used measure of prediction accuracy is the Mean Absolute Percentage Error (MAPE). This measure states the prediction as a percentage. It is thus the percentage variation of predicted values from the observed.

Hanke and Reitsch (1995) and Bowerman *et al* (2004) in their books recommend the used of MAPE as a primary measure of forecast accuracy in studies. In this study the MAPE is defined mathematically as:

$$MAPE = \frac{100\%}{n} \frac{\sum_{t=1}^{n} |\hat{y} - y|}{y} \quad (4.36)$$

Where $\hat{y}_t$ represents predicted monthly VAT (Total VAT, Domestic VAT and Import VAT) revenues,

y_t represents the observed monthly VAT (Total VAT, Domestic VAT and Import VAT) revenues and *n represents* the number of observations. These three measures (RMSE, MAD, MAPE) will all be used to measure the forecast accuracy of the models. The better model will hence be selected to forecast VAT (Total VAT, Domestic VAT and Import VAT) revenues for the next 24 months (i.e. for 2018 and 2019).

4.5 Linear Regression Model

Linear regression model is employed in modelling the linear relationship between a response (dependent or criterion) variable which is quantitative and one or more predictor (s) (independent or explanatory) variables. The model is given by

$$Y_i = \beta_o + \beta_1 X_{i1} + \cdots + \beta_p X_{ip} + \varepsilon_i,\ i = 1, 2, \cdots, n. \quad (4.37)$$

Where Y_i is the response variable on the i^{th} observation, $\beta_o, \beta_1, \cdots \beta_p$ are the parameters, X_i is the value of the independent variable on the i^{th} observation, and ε_i is a normally distributed random variable. The error $\varepsilon_i \sim N(0, \sigma^2)$ is not mutually correlated (Montgomery *et al*, 2012).

In this study, this methodology is employed to assess the effect of real GDP on VAT revenue and the correlation that exists between the two variables. This is to ascertain the behaviour of VAT revenue in the face of real GDP. Thus, the simple linear regression model was considered in this study. It is given by

$$VAT\,\mathrm{Re}\,v_i = \beta_o + \beta_1\,\mathrm{RGDP}_t + \beta_2 Ceffi_t + \beta_3 EffRate_t + \beta_4 Corr_t + \varepsilon_t \quad (4.38)$$

Where *t* represents time, which is from 2002 1st quarter to 2014 4th quarter. *VATRev* which the independent variable stands for VAT Revenues collected quarterly over the period of study.

RGDP stands for Real GDP of Ghana for each quarter of the sample period. The real GDP is under consideration to explore the effect of Real GDP on VAT revenue. Real GDP is expected to have a positive effect on VAT revenue since increase in Real GDP means increase in expenditure which will obviously increase revenues collected from VAT as VAT is consumption tax. *Ceffi* represents the C-efficiency of VAT for Ghana for the sample period. C-efficiency is employed in this regression analysis because it a broadly used measure of efficiency of VAT administration. According to Keen (2013), C-efficiency reveals the extent to which a countries VAT administration has departed from a tax that is levied on all consumption at an even rate and perfectly enforced. C-efficiency has been used by researchers including Gebauer *et al*. (2007) and De Mello (2009) to explore the determinants of VAT compliance. Other researchers including Jack (1996) and also Bird and Gendron (2007) employed C-efficiency in their studies to do a comparison of VAT evasion across many countries. Following the study of De Mello (2009), the *Ceffi* is calculated as follows:

Ceffi = (VAT Revenue ÷ Consumption Expenditure) ÷ Statutory VAT Rate

A higher absolute value of C-efficiency means a more efficient tax administration that checks tax evasion in the country. On the other hand, a lower absolute value of C-efficiency means a less efficient tax administration in the country. C-efficiency is expected to have a positive relationship with Total VAT revenue since improvement in tax administration efficiency has a positive impact on VAT Revenue by reducing tax evasion and increasing Total VAT Revenue (Engel *et al*., 2001). *EffRate* represents the Effective VAT Rate of Ghana for the sample period. Greene (2014) presents the calculation of Effective Tax Rate as follows:

Effective Tax Rate = Total Tax Revenues ÷ Tax Base

Following the formula of Greene (2014), Effective VAT rate will be calculated as follows:

Effective VAT Rate = Total VAT Revenues ÷ Tax Base (in this case final consumption expenditure)

According to Alm *et al*. (2013) an increase in tax rate is associated with increase in tax revenue, even though there will be a welfare loss in terms of decrease in private consumption.

Effective VAT Rate reveals the real effect of changes in VAT policy. It is also a measure of the effectiveness of implementation of VAT policy. The Effective VAT rate will increase if the Total VAT Revenues increase (as a result of an increase in statutory VAT rate) without a corresponding increase in the final consumption expenditure ceteris paribus. On the other hand, the Effective VAT Rate will decrease if the tax base increases (as a result of tax base broadening) without a corresponding increase in Total VAT revenue ceteris paribus. The latter instance reveals that broadening the tax base is ineffectual if it does not result with an increase in VAT revenue. Thus, the Effective VAT Rate is a measure of the effectiveness of government policies in increasing VAT revenue. Effective VAT Rate is expected to have a positive relationship with Total VAT Revenue.

Corr represents the level of corruption in Ghana over the sample period. The level of corruption is used in this study as a measure of Ghana's legal and institutional quality. The index ranges from 0 to 100. 100 is the lowest level of corruption whiles 0 is the highest level of corruption. High levels of corruption will decrease tax revenues in a country (Bird, 2008; Sokolovska, 2015). Therefore, it is expected that as the corruption index increases (which means low level of corruption) VAT revenue will increase, which means a positive relationship between the corruption index and VAT or revenue is anticipated. On the other hand, it is expected that there would be a negative relationship between the level of corruption and VAT Revenue.

4.5.1 Assumptions of the Model

- Regression function is linear
- Constancy of variance among error terms
- The residuals are independent and identically distributed
- The residuals should be "normally distributed"

4.5.2 Correlation Analysis and Multicollinearity

In the multiple regression analysis where two or more predictors are considered, there is always the need to assess the pairwise correlation among the variables. This is usually presented in matrix form. The aim is to examine collinearity among the variables and also to check out for outliers. The presence of outliers is ascertained based on the differences in the measures of the correlation coefficient. The Pearson correlation coefficient is the most adopted parametric measure whereas the nonparametric measure mostly used is the Spearman rank correlation coefficient. The presence of collinearity is usually suspected based on high pair-wise correlations. In this study, correlation analysis is used to particularly ascertain the level of correlation between Total VAT and Real GDP and to know if Real GDP can be used as proxy VAT base in Ghana. Greene (2014), stated that in selecting a proxy tax base, there should be high correlation between observed tax revenue and the proxy tax base. He suggested private consumption expenditure and GDP as proxy tax base for VAT (Total, Domestic, and Import VAT). Thus, if the analysis reveals high correlation between VAT Revenue and Real GDP in this case, the Real GDP may be accepted and recommended to be a proxy tax base for VAT in VAT revenue forecasting.

Multicollinearity exists if one of the regressors/predictor variables is perfectly correlated to another regressor (s)/predictor variable (s) in a regression model. Multicollinearity has consequences such as Imprecise coefficient values (the estimate of the impact of an independent variable on the dependent variable whiles controlling for the other independent variables) will be produced which may then result in imprecise out-of-sample predictions, small changes in a regressor may lead to large changes in the dependent variable which can even result in changes in the sign of parameter estimates that may be misleading and large standard errors may be produced in the related independent variables.

Ways to check for multicollinearity is to examine bivariate correlations between each of the predictor variables. For example, multicollinearity exists if bivariate correlations between two predictor variables is above 0.7. The Variance Inflation Factor (VIF) if it is above 4 also confirms the presence of multicollinearity. (Dormann, *et al*., 2012). Green *et al*. (1988) suggests 0.9 as the threshold of bivariate correlations. Tull and Hawkins (1990) also suggests 0.35 whiles Lehmann *et al*. (1988) also suggests 0.7 as the threshold of bivariate correlations. Inferring from these three suggestions, bivariate correlation beyond 0.9 is likely to have harmful collinearity effects. Other collinearity diagnostics include Condition Indicies (CI) and suggest Variance Inflation Factors (VIF). Johnston (1984) agrees with Belsley *et al*. (2005) that as far as the CI is less than 20 it is not problematic. Hair *et al*. (1995) also suggests that inconsequential collinearity should be suspected when the VIF is less than 10. In this study, 0.9 is the threshold of bivariate correlations.

4.5.3 Test for Autocorrelation

The Durbin Watson test will be used to test for autocorrelation. The Durbin-Watson Test Statistic (DW) and its p-value will be computed.

H0: The residuals exhibit no autocorrelation

H1: The residuals exhibit autocorrelation

The rule of thumb is, fail to reject H0 if 1.5 <DW <2.5 or p-value>0.05. In the case where no autocorrelation among the residuals, the OLS estimators are efficient in drawing conclusions on the estimates of the linear regression. However, if the residuals exhibit autocorrelation, the OLS estimators are efficient in drawing conclusions on the estimates of the linear regression since there will be a need to include dummy variable in data, estimate generalized least squares, or include a linear (trend) term if the residuals show a consistent increasing or decreasing pattern.

4.5.4 Elasticity

Aside from knowing the effect of one variable (in this case Real GDP) on another variable (in this case VAT Revenue) by simple regression, they may be a need to investigate into the elasticity between the variables. A constant elasticity model may have a generic form as follows:

$$Y = \alpha X_i^{\beta}$$

Taking the natural log of both sides converts it to the equation below:

$$\ln Y_i = \ln(\alpha) + \beta \ln Xi \qquad (4.44)$$

From the equation above, $\ln(\alpha)$ is the intercept. Thus, the equation can further be represented as follows:

$$\ln Y_i = \beta_0 + \beta_i \ln Xi \qquad (4.45)$$

Therefore, instead of the using the original scale for the variables, the model can be estimated with OLS by using natural log values for those variables.

Concerning the interpretation of the coefficients (with a simple log-log model), the use of calculus can show how to interpret the coefficients. For instance, having the model below:

$$\ln Y_i = \beta_0 + \beta_1 \ln Xi$$

By differentiating the model above, we obtain

$$\frac{\partial Y}{Y} = \beta_1 \frac{\partial X}{X} \qquad (4.46)$$

From the above, $\frac{\partial Y}{Y}$ is interpreted as the percentage change in Y whiles $\frac{\partial X}{X}$ is also measured as the percentage change in X. Thus, the elasticity coefficient is β_1.

In estimating a log-log regression, the β_1 which is the coefficient of X may be interpreted according to the magnitude it assumes. Below are interpretations that may be given to β_1.

If $\hat{\beta}_1 > 1$, it means a percentage change of the independent variable will result in a greater percentage change in the dependent variable (in a positive direction).

If $0 < \hat{\beta}_1 < 1$, it means a percentage change of the independent variable will result in a lesser percentage change in the dependent variable (in a positive direction).

If $\hat{\beta}_1 < 0$, it means a percentage/proportionate change of the independent variable/regressor will effect a percentage/proportionate change in the dependent variable in an inverse/negative direction. Therefore, the magnitude of $\hat{\beta}_1$ is the level of elasticity between the dependent and independent variable.

4.6 Data Source for the Study.

The study relies heavily on secondary data and consist of monthly and quarterly VAT revenue (Total VAT, Import VAT and Domestic VAT) collections from January 2002 to December 2017. The data on VAT Revenues and Statutory VAT Rate were collected from the Tax Analysis and Revenue Forecasting (TARF) Unit of the Ghana Revenue Authority. Also, quarterly Real GDP figures were obtained from the Ghana Statistical Service quarterly bulletin from 2006 first quarter to 2017 fourth quarter. Data on final consumption expenditure was also retrieved from the Ghana Statistical Service quarterly GDP bulletins. Time series data on corruption index of Ghana was retrieved from Transparency International's corruption perceptions index results table. Data on Effective VAT Rate was computed from the values of Total VAT Revenues and Final Consumption expenditure, whiles C-efficiency data was also computed from Total VAT Revenue, Final Consumption Expenditure and the Statutory VAT rate over the sample period.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.0 Introduction

In this chapter, the results of the study are presented, and it begins with basic statistical analysis involving graphical tools and basic statistics. Time series intervention analysis was employed to model VAT (Total, Domestic, and Import VAT) revenue in Ghana. By way of ascertaining the appropriate model for VAT revenue, Trend analysis was also performed. In addition, simple regression analysis was fitted to explore the effect of Real GDP on VAT revenue.

5.1 Exploration of Data

This section of the study explores the data for summary statistics, trend in the series, and assesses the stationarity of the series through the ADF unit root test. Table 5.1 presents the summary statistics of VAT revenue over the study period.

Table 5. 1: Summary Statistics of VAT Revenue Data

(GHS Million)

	Minimum	Maximum	Mean	Std. Deviation
Total VAT	15.90	777.37	220.8881	213.82763
Domestic VAT	4.94	340.06	88.7907	91.56817
Import VAT	10.89	461.30	132.0973	123.01570

Source: Author's own computation

From Table 5.1, the average domestic and import VAT recorded by the country are respectively 88.79 $\pm$ 91.57 and 132.10$\pm$ 123.02 (GHS Million). The average Total VAT received was 220.89$\pm$ 213.83. The country recorded a minimum and maximum domestic VAT of 4.94 and 340.06 respectively. Also, minimum and maximum import VAT of 10.89 and 461.30 (GHS Million) was recorded respectively.

Figure 5.0 presents the time series plot of the VAT revenue recorded.

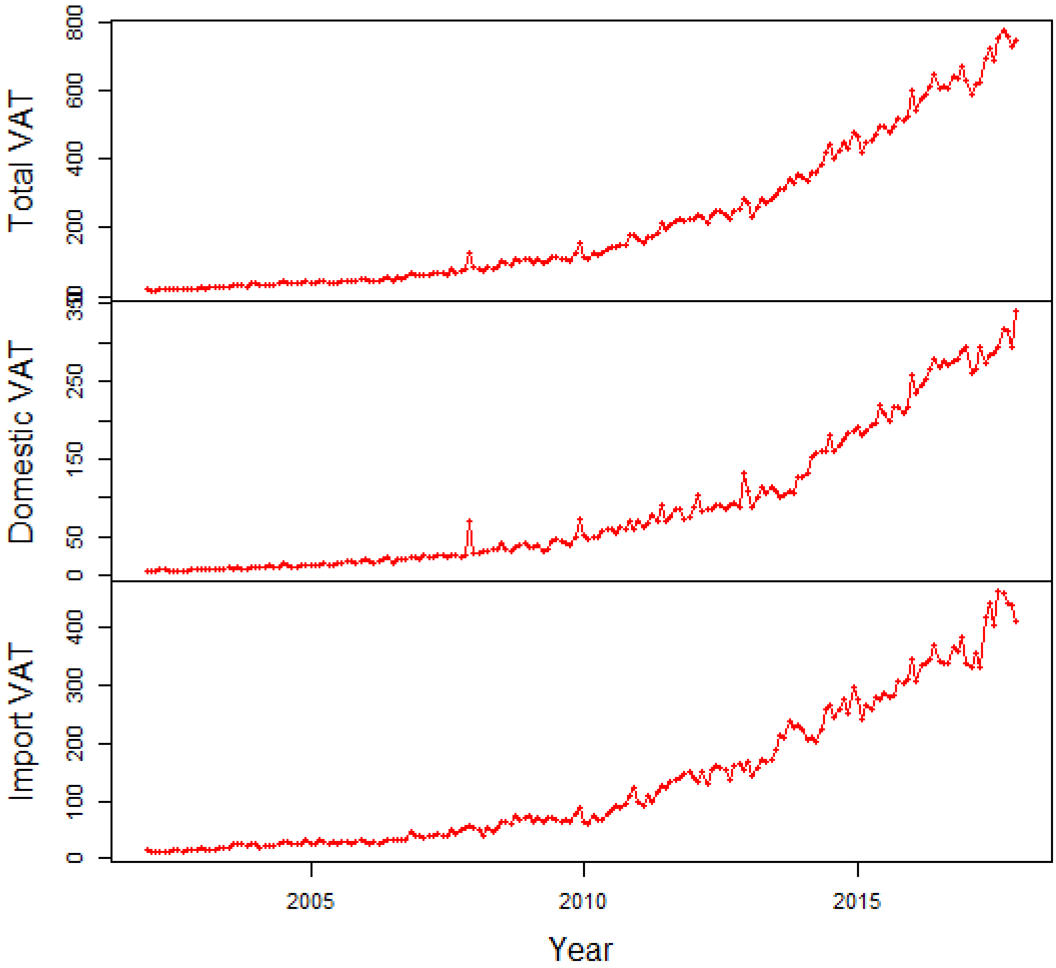

Figure 5. 1: Times Series Plot of Total VAT, Domestic VAT, and Import VAT Revenue Data

From Figure 5.1, VAT revenue in the country has been on the rise throughout the entire study period. Between the years of 2002 and 2010, increases in VAT revenue has been very steady. However, there was an unusual increase in Domestic VAT Revenue in December 2008. This may be as a result of the introduction of the 3% VAT Flat rate in September 2007. From

2011 to 2017, both domestic and import VAT revenue experienced several fluctuations while increasing. From the observed patterns in Figure 5.0, it is seen clearly that the Total VAT Revenue, Domestic VAT Revenue and Import VAT Revenue all have an increasing trend thus all likely to be nonstationary. The stationarity in the series is further explored by an ADF unit root test shown in Table 5.11 below.

Table 5.1 1: ADF Unit root test for VAT Revenue Data

Variable	Level		1st Difference	
	t-statistic	P – value	t-statistic	P – value
Total VAT	1.3061	1.0000	-6.4000	0.0000
Domestic VAT	3.5714	1.0000	-5.3852	0.0001
Import VAT	-1.3136	0.8815	-9.6805	0.0000

Source: Author's own computation

The null hypothesis of a unit root (that is integrated of order one, I (1) was tested with the ADF unit root test in both the non-differenced (level) and the differenced series. All series were non-stationary at the level$(p - values > 0.05)$. After first difference, all series were stationary$(p - values < 0.05)$.

Figure 5.10 presents the plot of the first-differenced series.

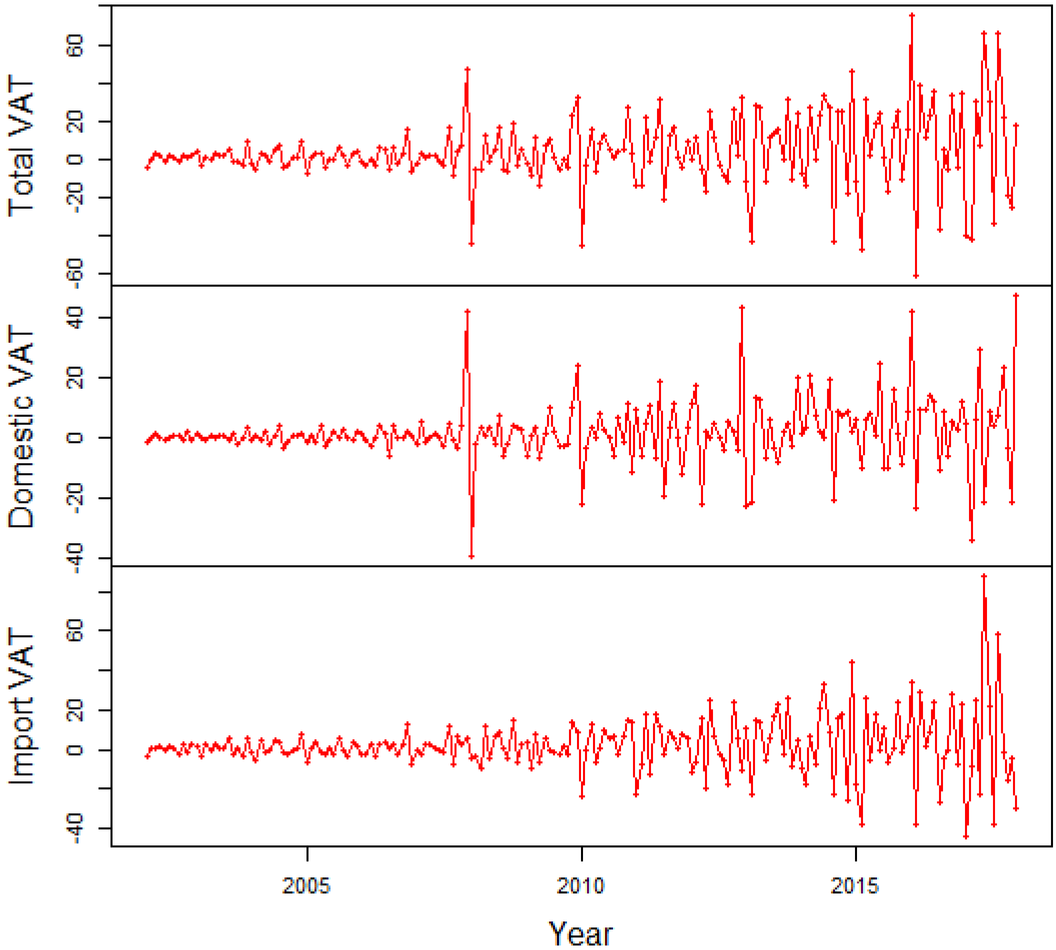

Figure 5. 2: Times Series Plot of First Difference of Total VAT, Domestic VAT, and Import VAT Revenue Data

After differencing the series once, the data appears to be stationary with respect to mean. However, there was high volatility (Figure 5.2).

Table 5.12 shows the Phillips-Perron unit root test for the VAT Revenue data.

Table 5.1 2: Phillips-Perron Unit root test for VAT Revenue Data

Variable	Level		1st Difference	
	t-statistic	P – value	t-statistic	P – value
Total VAT	4.4414	1.0000	-18.2144	0.0000
Domestic VAT	4.6342	1.0000	-18.8238	0.0000
Import VAT	1.7617	0.9997	-20.4580	0.0000

The Phillips-Perron unit root test was also employed to corroborate the result of the ADF unit root test. Since both unit root tests reveal were non-stationary at the level($p - vaules > 0.05$) and stationarity at first difference as indicated in Table 5.12, we can therefore indisputably conclude that the series is I (1).

5.2 The Intervention Time Series Modelling

In this section of the study, the effect of the intervention (increase in VAT standard rate from 12.5% to 15% which took effect from January 2014) on the series is assessed. Pre-intervention ARIMA model was fitted. In addition, the ARIMA model with the intervention effect was modeled. The pre-intervention period spans from the year 2002 to 2013. Thus, the pre-intervention model was developed with monthly VAT (Total VAT, Domestic VAT and Import VAT) data from 2002 to 2013.

Table 5.13 presents the ADF unit root test of the pre-intervention series.

Table 5.1 3: **ADF Unit root test pre-intervention series**

Variable	Level		Differenced	
	t-statistic	P – value	t-statistic	P – value
Total VAT	1.5847	1.0000	-4.0085	0.0105
Domestic VAT	3.0153	1.0000	-5.9712	0.0000
Import VAT	0.6122	0.9995	-7.5460	0.0000

Table 5.1 4**: Phillips-Perron Unit root test pre-intervention series**

Variable	Level		Differenced	
	t-statistic	P – value	t-statistic	P – value
Total VAT	4.7199	1.0000	-16.5161	0.0000
Domestic VAT	0.4578	0.9847	-26.3922	0.0000
Import VAT	4.8286	1.0000	-16.4334	0.0000

From Tables 5.13 and 5.14, it was observed that the pre-intervention series is I (1). All series were non-stationary at the levels but stationary after first difference.

5.2.1 Fitting an ARIMA Model for the Pre-Intervention Time Series Data

The ARIMA model for the pre-intervention model as well as the intervention time series model was estimated for Total, Domestic, and Import VAT in this section. The intervention effect was assessed, and the forecast made.

5.2.1.1 Total VAT Revenue

The plot of ACF and PACF of the First Differenced Total VAT data is depicted in Figure 5.11.

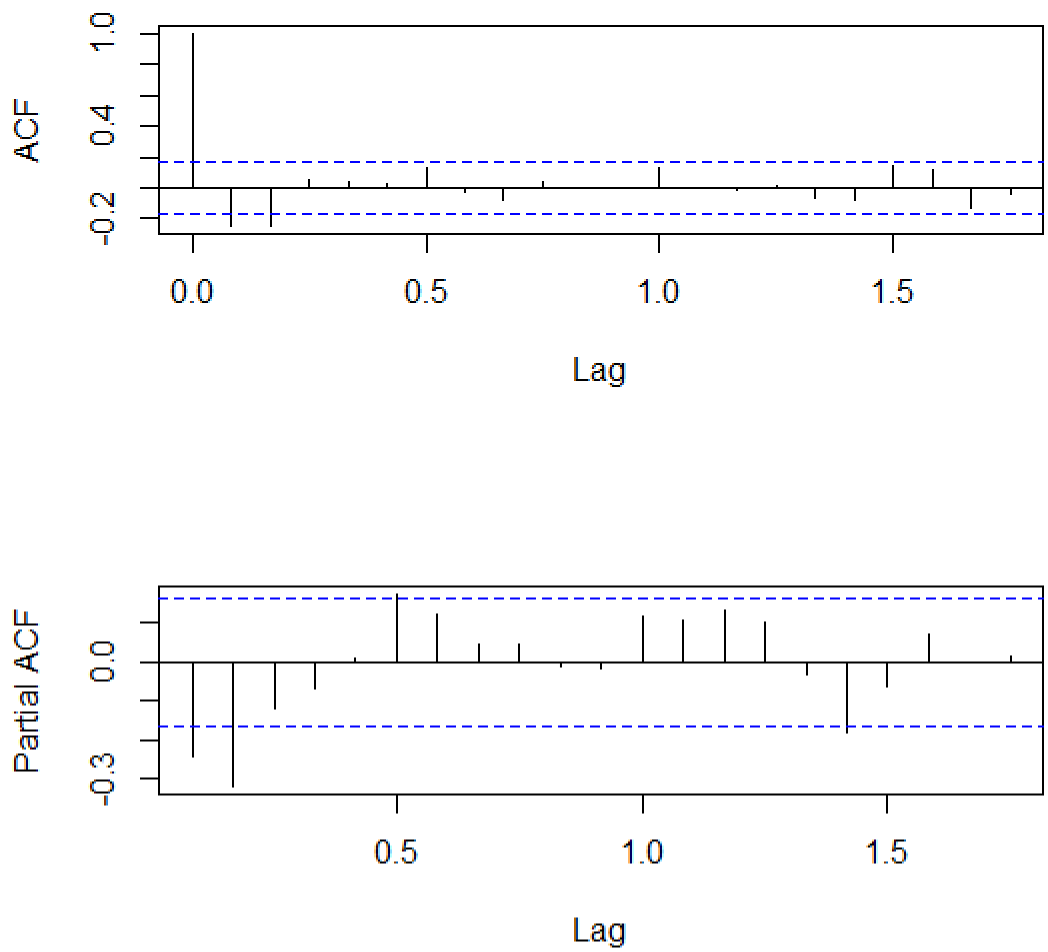

Figure 5. 3: Correlogram (ACF and PACF) First Differenced Pre-Intervention Total VAT Revenue Series

From Figure 5.3, it can be observed that there are two positive spikes which cut off after lag 2 as depicted by the PACF graph. However, the graph had other significant spikes at the other lags. It suffices that we may have a moving average with two periods. Furthermore, its ACF is in sinusoidal waves and it gradually tails off. Based on the significant lags of both the ACF and PACF, tentative models were identified for the Total VAT (Table 5.15).

Table 5.1 5: Tentative ARIMA Models for Pre-Intervention Total VAT Series

Model	AIC	AICc	BIC
$ARIMA(1,1,1)$	1133.35	1133.53	1142.24
$ARIMA(0,1,1)$	1132.28	1132.37	1138.21
$ARIMA(1,1,0)$	1136.62	1136.70	1142.54
$ARIMA(2,1,0)$*	**1129.11***	**1129.28***	**1138.00***
$ARIMA(0,1,2)$	1132.17	1132.34	1141.06
$ARIMA(2,1,1)$	1131.03	1131.32	1142.88

*: *Means best, based on the selection criteria*

From Table 5.15, using the values of AIC, AICc and BIC, the model $ARIMA(2,1,0)$ was the most appropriate model that projects the pre-intervention Total VAT revenue. The parameters of the model $ARIMA(2,1,0)$ were then estimated and presented in Table 5.16.

Table 5.1 6: Estimates of Parameters for $ARIMA(2,1,0)$ Model

Variable	Coefficient	Standard Error	t-statistic	p – value
α_1	-0.2586	0.0816	-3.17	0.0019
α_2	-0.2552	0.0813	-3.14	0.0021

Recalling the general form of the ARIMA model,

$$\alpha(B)(1-B)^d x_t = \beta(B)z_t$$

From Table 5.16, the ARIMA model for Total VAT is given by

$$\left(1-\alpha_1 B-\alpha_2 B^2\right)\left(1-B\right)x_t = z_t$$

$$\left(1+0.2586_1 B+0.2552B^2\right)\left(1-B\right)x_t = z_t$$

The goodness of fit of the model was assessed through the plot of the residuals, its ACF as well as PACF. Also, the Ljung-Box test (test of autocorrelation) and ARCH-LM test (test of heteroscedasticity) was performed. These are presented in Appendix A; Figure A1, Table A1, and Table A2. The plot of residual indicated a high level of volatility in the series. However, the plot of the ACF and PACF indicated that much variability was accounted for by the model. The Ljung-Box test indicated the absence of autocorrelation. However, the ARCH-LM test confirmed the presence of volatility in the data. It can be concluded that the model $ARIMA(2,1,0)$ provides adequate representation of the pre-intervention Total VAT revenue. Forecast for the after the intervention was obtained and is presented in Table A3, Appendix A.

The effect of the intervention was further explored and presented in Table 5.17.

Table 5.1 7: Parameter Estimates for Intervention Model for Total VAT

Variable	Coefficient	Standard Error	Z value	p – value
α_1	-0.2383	0.0714	-3.3382	0.0008
α_2	-0.1690	0.0716	-2.3619	0.0182
T1-AR1(δ)	0.0747	1.2565	0.0595	0.9526
T1-MA0(ω)	-2.9138	17.7435	-0.1642	0.8696

From Table 5.17 above, the various parameter estimates for the full intervention model with their respective coefficients, standard errors and z-values are shown. The coefficients for AR1 (α_1) and AR2 (α_2) are significant$(p - value < 0.05)$. However, TI-AR1 and T1-MA0 which represents both the decay or reduction parameter and the impact parameter had coefficients of 0.0747 and -2.9138 respectively which were statistically insignificant$(p - value > 0.05)$. This implies that the 2.5% increase in the standard VAT rate in January 2014 did not trigger a significant effect on Total VAT Revenue. The insignificant response of Total VAT Revenue to increase in the VAT rate agrees with the studies of Nartey (2011) and Antwi *et al* (2012) which also revealed insignificant response of Total VAT Revenue to increase in the VAT rate. However, it contradicts the studies of Narayan (2013), Slobodnitsky and Drucker (2008) and Charlet *et al* (2010) which concluded that increase in VAT rates results in significant increase in tax revenue and hence government revenue.

Figure 5.4 is the plot of both the observed and fitted total VAT using the time series intervention model. The fitted values for 2017 are presented in Table A6 in Appendix A.

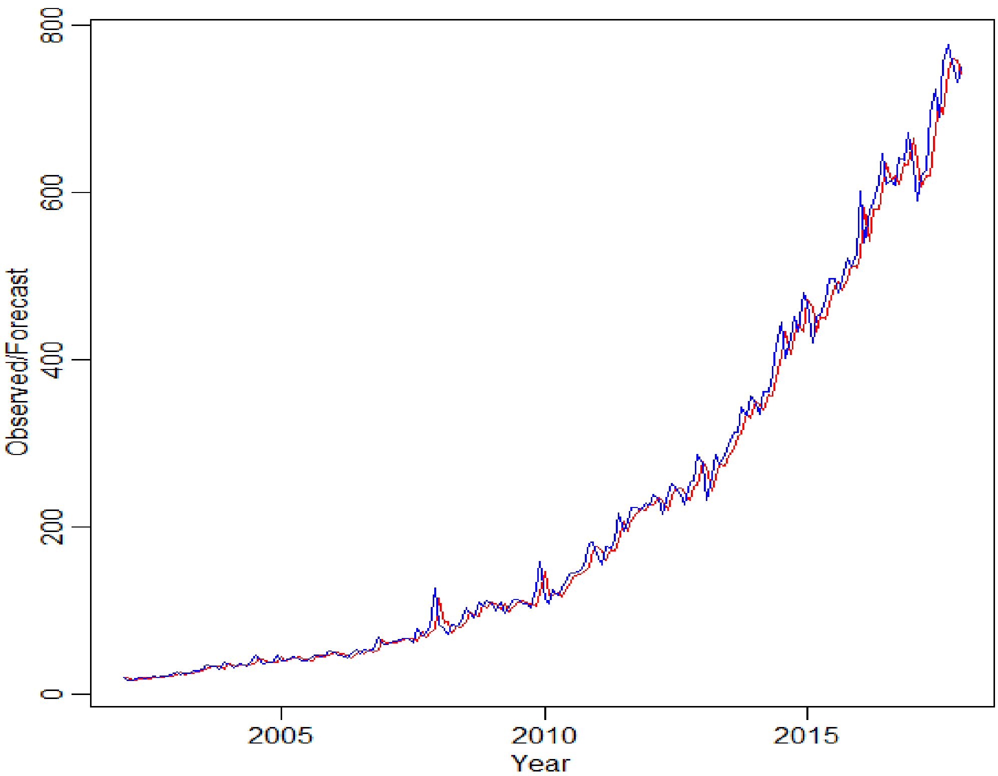

Figure 5. 4: Plot of Observed and Fitted Total VAT Revenue from Intervention Model

From Figure 5.4, fitted values follow the pattern of the observed values indicating a goodness of fit.

5.2.1.2 Domestic VAT Revenue

The plot of ACF and PACF of the first-differenced Domestic VAT data is presented in Figure 5.5.

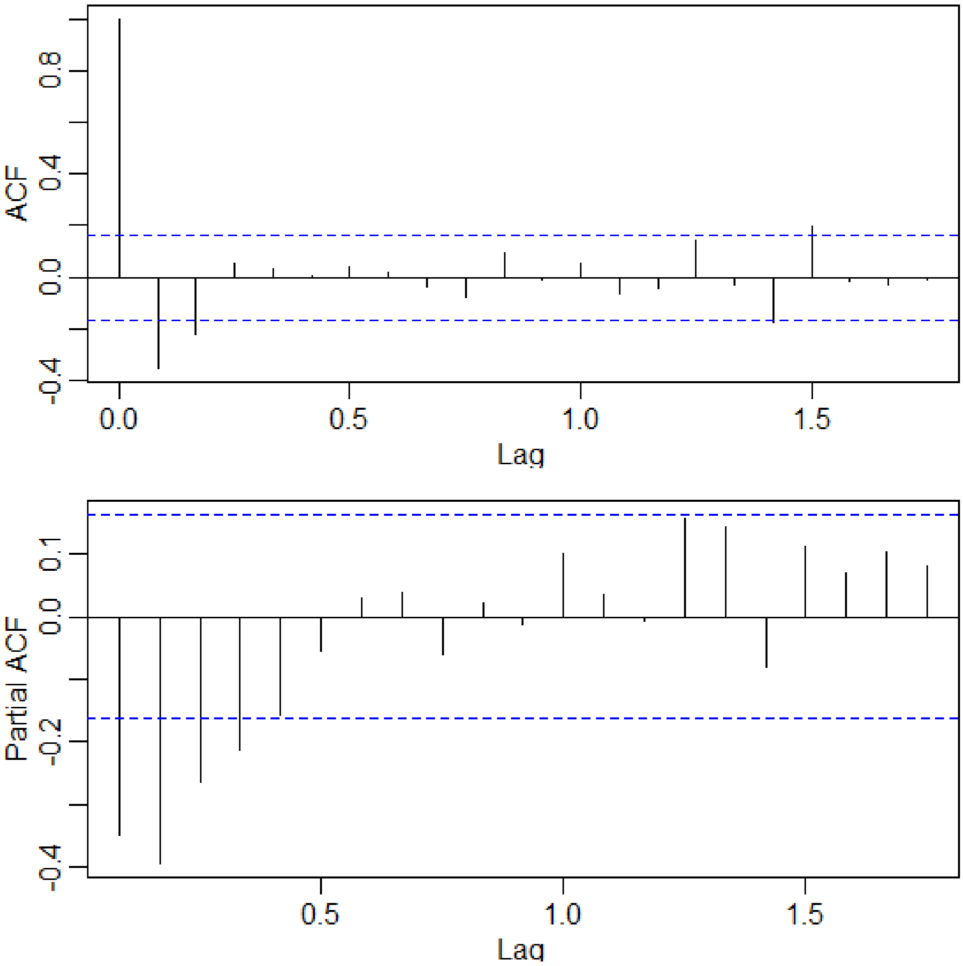

Figure 5. 5: Correlogram (ACF and PACF) First Differenced Pre-Intervention Domestic VAT Revenue Series

It can be observed that there are four significant spikes which cut off after lag 2 as depicted by the PACF graph. This is an indication of a moving average with four lags. Its ACF is in sinusoidal waves and it gradually tails off (Figure 5.5). Based on the significant lags of both the ACF and PACF, tentative models were identified for the Domestic VAT (Table 5.16).

Table 5.1 8: Tentative ARIMA Models for Pre-intervention Domestic VAT series

Model	AIC	AICc	BIC
$ARIMA(3,1,0)$	992.34	992.63	1004.19
$ARIMA(3,1,1)$	990.10	990.53	1004.91
$ARIMA(0,1,3)$	985.02	985.31	996.87
$ARIMA(1,1,3)$	979.03	979.47	993.84
$ARIMA(4,1,0)$	989.36	989.80	1004.18
$ARIMA(4,1,1)$	990.67	991.29	1008.45
$ARIMA(0,1,4)$	982.86	983.3	997.68
$ARIMA(1,1,4)$*	**967.13***	**967.74***	**984.90***

*: *Means best, based on the selection criteria*

From Table 5.18, using the values of AIC, AICc and BIC, the model $ARIMA(1,1,4)$ was the most appropriate model that projects the pre-intervention Domestic VAT revenue. The parameters of the model $ARIMA(1,1,4)$ were then estimated and presented in Table 5.19.

Table 5.1 9: Estimates of Parameters for $ARIMA(1,1,4)$ Model

Variable	Coefficient	Standard Error	t-statistic	p – value
α_1	0.9956	0.0063	164.49	0.0000
β_1	-1.8240	0.0836	-21.83	0.0000
β_2	0.5956	0.1648	3.61	0.0000
β_3	0.4387	0.1601	2.75	0.0068
β_4	-0.1978	0.0806	-2.45	0.0154

Recalling the general form of the ARIMA model,

$$\alpha(B)(1-B)^d x_t = \beta(B)z_t$$

From Table 5.19, the ARIMA model for Domestic VAT is given by

$$\left(1-\alpha_1 B\right)\left(1-B\right)x_t = \left(1+\beta_1 B+\beta_2 B^2+\beta_3 B^3+\beta_4 B^4\right)z_t$$

$$\left(1-0.9956B\right)\left(1-B\right)x_t = \left(1-1.8240B+0.5956B^2+0.4387B^3-0.1978B^4\right)z_t$$

Here also, the goodness of fit of the model was assessed through the plot of the residuals, its ACF as well as PACF. This is presented in Figure A2, Appendix A. Also, the Ljung-Box test (test of autocorrelation) and ARCH-LM test (test of heteroscedasticity) was performed and are presented in Tables A4 and A5, Appendix A. The plot of residual indicated a high level of volatility in the series. This was confirmed by the ARCH-LM test. The plot of the ACF and PACF indicated that much variability was accounted for by the model. In addition, the Ljung-Box test indicated the absence of autocorrelation. However, the ARCH-LM test confirmed the presence of volatility in the data. It can be concluded that the model $ARIMA(1,1,4)$ provides adequate representation of the pre-intervention Domestic VAT revenue. Forecast for the after the intervention was generated and is presented in Table A6, Appendix A. The effect of the intervention was further explored and presented in Table 5.1110

Table 5.1 10: Parameter Estimates for Intervention Model for Domestic VAT

Variable	Coefficient	Standard Error	t-statistic	p – value
α_1	-0.2455	0.7721	-0.3180	0.7505
β_1	-0.3165	0.8117	-0.3899	0.6966
β_2	-0.2951	0.4597	-0.6421	0.5208
β_3	0.2293	0.1121	2.0458	0.0408
β_4	0.1588	0.2314	0.6861	0.4926
T1-AR1(δ)	0.9635	0.0073	131.7026	0.0000
T1-MA0(ω)	8.0243	2.1056	3.8109	0.0001

From Table 5.1110 above, the various parameter estimates for the full intervention model with their respective coefficients, standard errors and z-values are shown. The coefficients for AR1(α_1), MA1(β_1), MA2(β_2), and (β_4) are insignificant$(p - value > 0.05)$. However, MA3 (β_3) was significant. In addition, TI-AR1 and T1-MA0 had coefficients of 0.9635 and 8.0243 respectively which were statistically significant$(p - value < 0.05)$. This implies that the 2.5% increase in the standard VAT rate in January 2014 triggered a positive effect (increase in Domestic VAT Revenue) of magnitude 8.0243, since the decay parameter has a positive coefficient (0.9635). Domestic VAT Revenue increased steadily in February 2014 and has had an increasing trend to date. The steady increase in Domestic VAT Revenue can therefore be attributed to the intervention (i.e. the 2.5% increase in VAT rate) in January 2014. The significant positive response of Domestic VAT Revenue to increase in the VAT rate may be further attributed to the efficiency in tax administration which has reduced VAT avoidance and evasion, increased tax compliance, broadened the Domestic VAT base in Ghana and lessoned corruption. This agrees with the studies of Jack (1996), Gebauer *et al*. (2007), Bird and Gendron (2007), De

Mello (2009), and Keen (2013) which all corroborate that efficiency in tax administration will always result in tax revenue growth.

The significant response of Domestic VAT Revenue to increase in the VAT rate agrees with Narayan (2013), Slobodnitsky and Drucker (2008) and Charlet *et al* (2010) who concluded that increase in VAT rates results in significant increase in tax revenue and hence government revenue. However, it contradicts the studies of Nartey (2011) and Antwi *et al* (2012) which revealed an insignificant response of Total VAT Revenue to increase in the VAT rate. Figure 5.14 is the plot of both the observed and fitted domestic VAT using the time series intervention model. The fitted values for 2017 are presented in Table A7 in Appendix A.

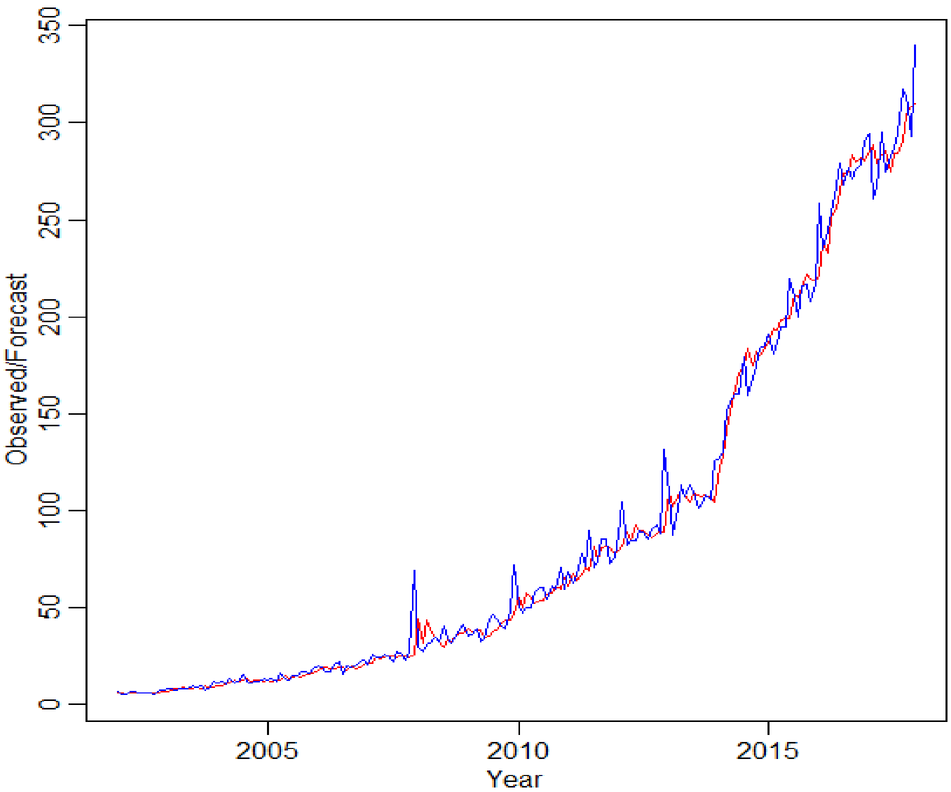

Figure 5. 6: Plot of Observed and Fitted Domestic VAT revenue from intervention model

From Figure 5.6, fitted values follow the pattern of the observed values indicating a goodness of fit.

5.2.1.3 Import VAT

The plot of ACF and PACF of the First differenced Import VAT data is presented in Figure 5.7.

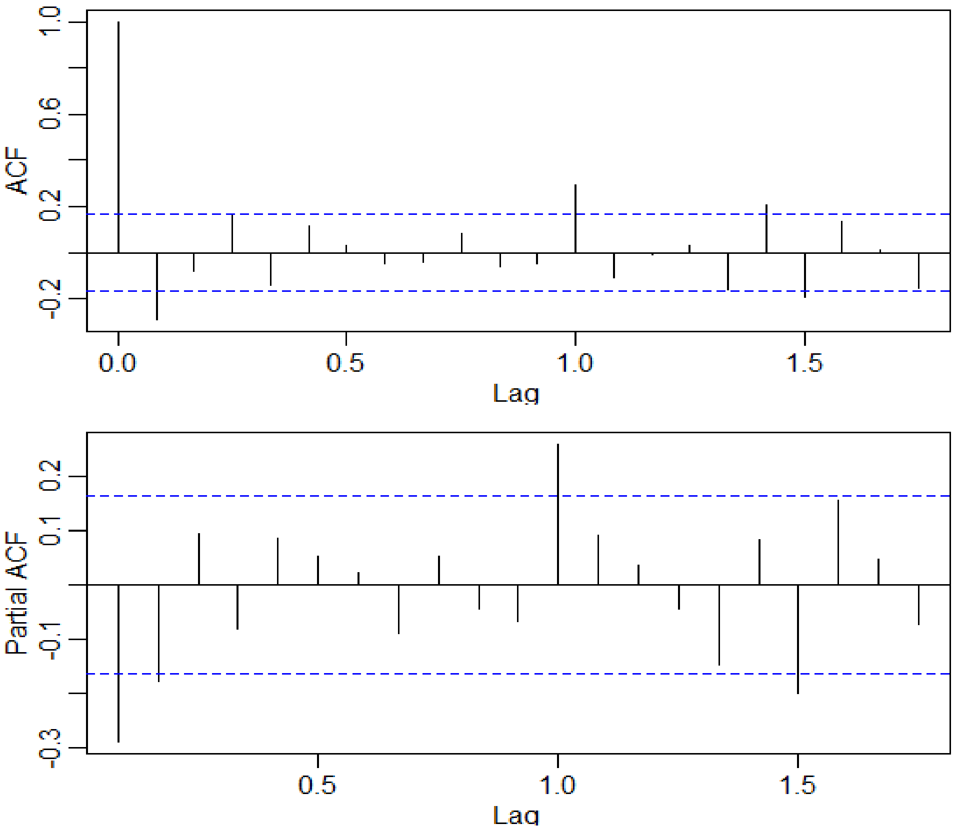

Figure 5. 7: Correlogram (ACF and PACF) first differenced Import VAT

It can be observed that there are two significant spikes which cut off after lag 2 as depicted by the PACF graph. There were other observed significant lags. Also, ACF has two significant lags and depicts sinusoidal waves which gradually tails off (Figure 5.7). Based on the significant lags of both the ACF and PACF, tentative models were identified for the Import VAT (Table 5.111).

Table 5.1 11: Tentative ARIMA Models for Import VAT

Model	AIC	AICc	BIC
$ARIMA(1,1,1)$	1017.02	1017.19	1025.90
$ARIMA(0,1,1)$	1015.13	1015.21	1021.05
$ARIMA(1,1,0)$	1015.82	1015.91	1021.75
$ARIMA(2,1,0)$	1015.97	1016.14	1024.86
$ARIMA(0,1,2)$	1016.85	1017.02	1025.74
$\boldsymbol{ARIMA(2,1,1)}$*	**1013.56***	**1013.85***	**1025.41***

*: *Means best, based on the selection criteria*

From Table 5.111, using the values of AIC, AICc, and BIC, the model $ARIMA(2,1,1)$ was the most appropriate model that projects the pre-intervention Import VAT revenue. The parameters of the model $ARIMA(2,1,1)$ were then estimated and presented in Table 5.112.

Table 5.1 12: Estimates of Parameters for $\boldsymbol{ARIMA(2,1,1)}$ Model

Variable	Coefficient	Standard Error	t-statistic	p – value
α_1	-1.0115	0.1933	-5.23	0.0000
α_2	-0.3246	0.0808	-4.02	0.0000
β_1	0.7640	0.1959	3.89	0.0000

Recalling the general form of the ARIMA model,

$$\alpha(B)(1-B)^d x_t = \beta(B)z_t$$

From Table 5.19, the ARIMA model for Import VAT is given by

$$\left(1-\alpha_1 B-\alpha_2 B^2\right)\left(1-B\right)x_t=(1+\beta_1 B)z_t$$

$$\left(1+1.0115B+0.3246B^2\right)\left(1-B\right)x_t=(1+0.7640B)z_t$$

Furthermore, the goodness of fit of the model was assessed through the plot of the residuals, its ACF as well as PACF. This is presented in Figure A3, Appendix A. Also, the Ljung-Box test (test of autocorrelation) and ARCH-LM test (test of heteroscedasticity) was performed and are presented in Tables A7 and A8, Appendix A. The plot of residual indicated a high level of volatility in the series. This was confirmed by the ARCH-LM test. The plot of the ACF and PACF indicated that much variability was accounted for by the model. In addition, the Ljung-Box test indicated the absence of autocorrelation. However, the ARCH-LM test confirmed the presence of volatility in the data.

It can be concluded that the model $ARIMA(2,1,1)$ provides adequate representation of the pre-intervention Import VAT revenue. Forecast for the post-intervention was obtained and is presented in Table A10, Appendix A. The effect of the intervention on Import VAT was further explored and presented in Table 5.113

Table 5.1 13: Parameter Estimates for Intervention Model for Import VAT

Variable	Coefficient	Standard Error	t-statistic	p – value
α_1	-1.1126	0.0845	-13.1722	0.0000
α_2	-0.4336	0.0672	-6.4542	0.0000
β_1	0.8650	0.0730	11.845	0.0000
T1-AR1(δ)	0.2819	0.3455	0.8159	0.4146
T1-MA0(ω)	-16.008	11.412	-1.4027	0.1607

From Table 5.113 above, the various parameter estimates for the full intervention model with their respective coefficients, standard errors and z-values are shown. The coefficients for AR1 (α_1), AR2 (α_2), and MA1 (β_1) are significant $(p - value < 0.05)$. However, TI-AR1 and T1-MA0 had coefficients of 0.2819 and, -16.008 respectively which were statistically insignificant $(p - value > 0.05)$. This implies that the 2.5% increase in the standard VAT rate in January 2014 did not trigger a significant effect on Import VAT Revenue. The insignificant positive response of Import VAT Revenue to increase in the VAT rate may be attributed to inefficiencies in VAT administration which may include corrupt practices between importers and custom officers in Ghana. This agrees with the findings of Bird et al (2008) and Sokolovska (2015) who stated that high levels of corruption slow down tax revenue growth. Igbinosa (2016), also realising from his study that Customs Excise Tax was negatively related to GDP, attributed the aberrant result to smuggling and corrupt practices by importers and custom officers.

The insignificant response of Import VAT Revenue to increase in the VAT rate agrees with the studies of Nartey (2011) and Antwi *et al* (2012) which also revealed insignificant response of Import VAT Revenue to increase in the VAT rate. However, it contradicts the studies of Narayan (2013), Slobodnitsky and Drucker (2008) and Charlet *et al* (2010) which concluded that increase in VAT rates results in significant increase in tax revenue and hence government revenue. Also, though not many imports are exempt and zero-rated from VAT, there was not a significant change in Import VAT Revenue because the very valuable imported plant, machinery and equipment used in industries are exempted from Import VAT in Ghana according to the provisions of the VAT amendment Act 948, 2017.

Figure 5.8 is the plot of both the observed and fitted domestic VAT using the time series intervention model. The fitted values for 2017 are presented in Table A10 in Appendix A.

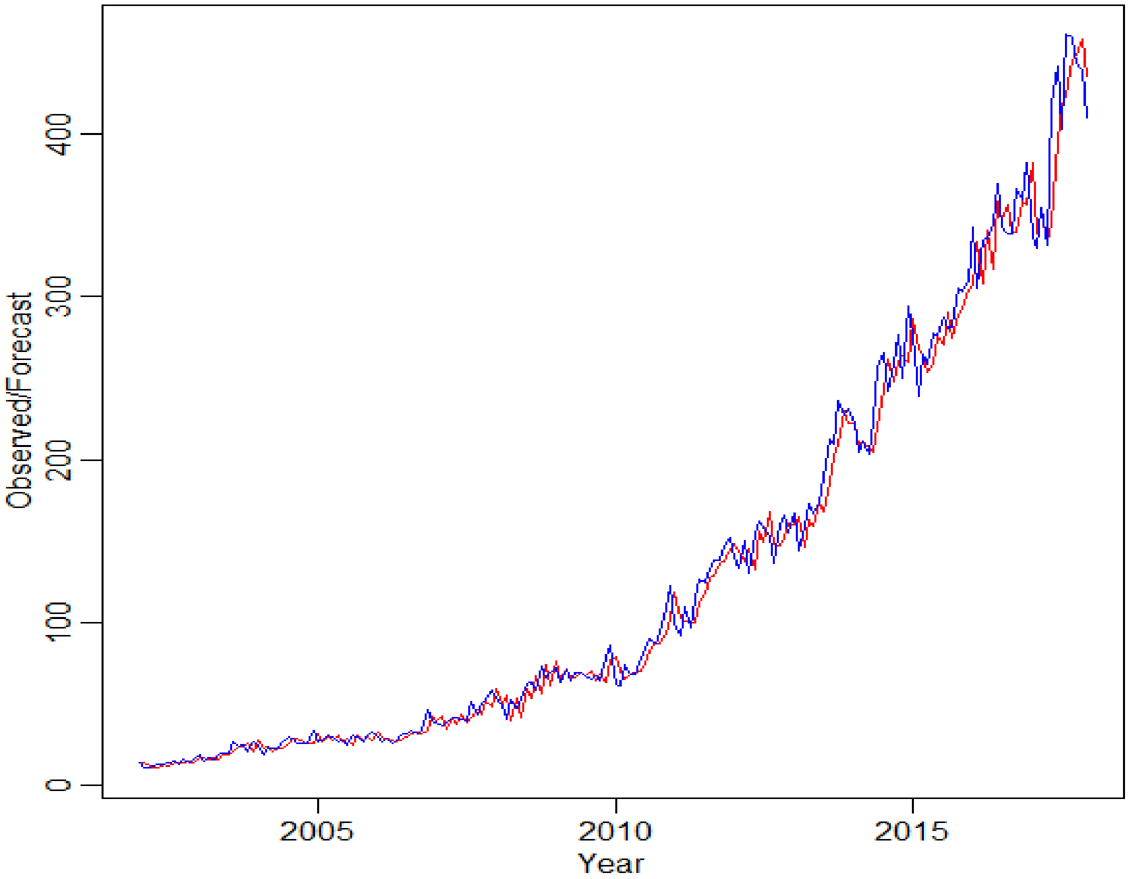

Figure 5. 8: Plot of Observed and Fitted Import VAT Revenue from Intervention Model

From Figure 5.8, fitted values follow the pattern of the observed values indicating a goodness of fit.

5.3 Trend Analysis

The VAT revenue data (Total VAT, Domestic VAT and Import VAT) exhibits an increasingly rise and fall trend, however, it is not seasonal. Thus, in choosing the trend model for forecasting and taking the features of the data into consideration, it was very necessary to explore beyond the linear trend, logarithmic trend, polynomial trend, power trend and the exponential trend models. With reference to the taxonomy in Table 4.1 since the VAT revenue data (Total VAT, Domestic VAT and Import VAT) is additive but non-seasonal, the best modelling and forecasting method for this research is the Holt's linear trend method.

5.3.1 Holt Linear Trend Model

The increasing trend in the series is modeled using the Holt's linear trend method. The trend model for Total VAT, Import VAT, and Domestic VAT was fitted. Figure 5.9 is the plot of the original series (black) and the fitted series (red) using the Holt linear trend method.

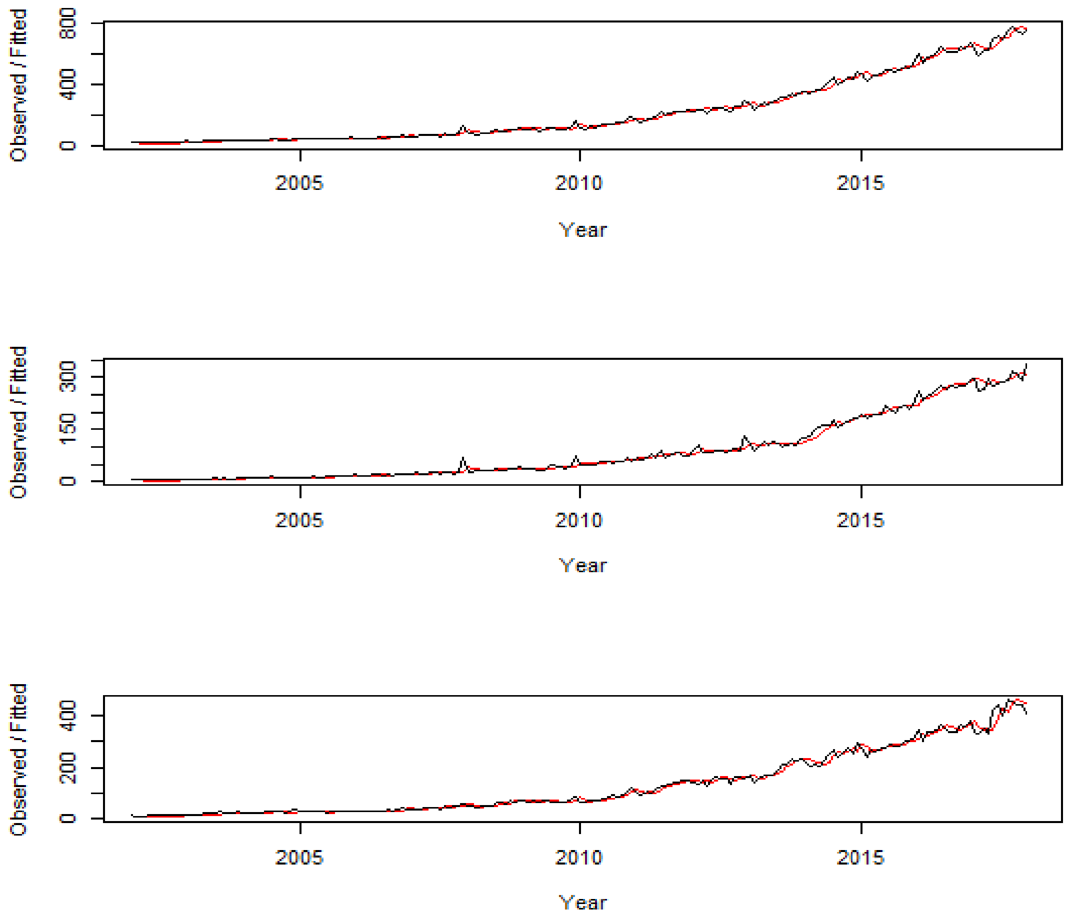

Figure 5. 9: Plot of Observed and Fitted values of Holt Linear Trend Method

From Figure 5.9, fitted values follow the pattern of the observed values indicating a goodness of fit. The estimate of the parameters for fitting Holt linear trend equations, that is the forecast equation and the two smoothing equations (i.e. the level equation and the trend equation) are presented in Table 5.114. Here, ℓ_t denotes an estimate of the level of the series at time *t*. b_t also denotes the estimate of the trend (slope) of the series at time *t*. For the smoothing parameters of the level and trend, α denotes the smoothing parameter for the level while β denotes the smoothing parameter for the trend.

Table 5.1 14: Estimate of Holt's linear trend Parameters

	Total VAT	Domestic VAT	Import VAT
Smoothing Parameters			
Alpha (α)	0.4813	0.3601	0.5847
Beta (β)	0.0527	0.5841	0.0351
Coefficients			
Level (ℓ_t)	756.5771	320.1854	427.2283
Slope (b_t)	8.6874	3.79795	4.22997

From Table 5.114, the trend equation, level equation, and forecast equation for total, domestic, and import VAT are deduced as follows;

Trend Equation; $b_t = \beta(\ell_t - \ell_{t-1}) + (1-\beta)b_{t-1}$

Level Equation; $\ell_t = \alpha x_t + (1-\alpha)(\ell_{t-1} + b_{t-1})$

Forecast Equation; $\hat{x}_{t+h|t} = \ell_t + hb_t$

From Table 5.114, the weighted average of the observed Total, Domestic, and Import VAT Revenues are respectively 756.5771, 320.1854, and 427.2283. Also, the weighted average of the estimated trend for total, domestic, and import VAT are 8.6874, 3.798, and 4.22997 respectively. Forecast for total, domestic, and import VAT recorded in 2017 was obtained and is depicted in Figures 5.18, 5.19, and 5.20, and presented in Tables B1, B2, and B3, Appendix B.

5.4 Cross-Validation of Intervention ARIMA Model and Holt Linear Trend Model

From the 2017 forecast using the ARIMA model with Intervention effect and Holt linear trend analysis, both models predicted with a small margin of error. On the average, the forecast by ARIMA model with Intervention effect was below what was observed values in 2017 whiles that of Holt's linear trend technique exceeded observed values in 2017. As both the Holt linear trend model and the ARIMA with intervention analysis model were used to predict the monthly VAT (Total VAT, Domestic VAT and Import VAT) revenues in 2017, the RMSE, MAPE and MAD were used to compare the prediction accuracy of both models. The RMSE, MAPE and MAD were computed using the predicted values and the observed values in 2017 for both models.

It was observed that ARIMA with intervention analysis model had a lessor RMSE, MAPE and MAD for the predicted values of Total VAT Revenue, Domestic VAT Revenue and Import VAT Revenue. As shown in Appendix A tables A7, A8, A9, using the ARIMA with intervention analysis model to predict VAT revenues in 2017, the RMSE for Total VAT Revenue, Domestic VAT Revenue and Import VAT Revenue was 37.22, 17.02 and 32.20 respectively whiles the MAD for Total VAT Revenue, Domestic VAT Revenue and Import VAT Revenue was 30.25, 14.80 and 24.41 respectively and the MAPE for Total VAT Revenue, Domestic VAT Revenue and Import VAT Revenue was 4.37, 5.01 and 5.97 respectively as shown in Appendix A tables A7, A8, A9. Using the Holt linear trend model on the other hand to predict VAT Revenues in 2017, the RMSE for Total VAT Revenue, Domestic VAT Revenue and Import VAT Revenue is 43.65, 27.83 and 37.70 respectively whiles the MAD for Total VAT Revenue, Domestic VAT

Revenue and Import VAT Revenue was 35.70, 24.05 and 33.82 respectively and the MAPE for Total VAT Revenue, Domestic VAT Revenue and Import VAT Revenue was 5.45, 8.49 and 8.74 respectively as shown in Appendix B tables B1, B2, B3.

This result thus, agrees with the studies of Marcellino and Favero (2005) and Nazmi and Leuthold (1988) that found that ARIMA outperforms other models in terms of forecast accuracy in the short run. Since ARIMA with intervention analysis was adjudged the better in terms of accuracy in prediction, it was selected to forecast VAT (Total VAT, Domestic VAT and Import VAT) revenues revenue to be expected in the next 24 months (i.e. for 2018 and 2019). This is presented in Tables 5.115, 5.116, and 5.117.

Table 5.1 15: Forecast of Total VAT Revenue for 2018 and 2019 using ARIMA with Intervention Analysis Model

MONTH	YEAR	FORECAST	95% CONFIDENCE INTERVAL		80% CONFIDENCE INTERVAL	
			LOWER	UPPER	LOWER	UPPER
Jan	2018	343.8837	332.4761	355.2913	326.4372	361.3301
Feb	2018	325.7069	313.2931	338.1208	306.7216	344.6923
Mar	2018	331.9659	319.1954	344.7365	312.435	351.4968
Apr	2018	345.5822	331.6222	359.5423	324.2321	366.9323
May	2018	348.2617	332.4367	364.0867	324.0594	372.464
Jun	2018	351.1511	333.8622	368.4399	324.71	377.5921
Jul	2018	350.6522	332.2851	369.0192	322.5621	378.7422
Aug	2018	359.5273	340.0725	378.982	329.7738	389.2808
Sep	2018	362.9296	342.245	383.6142	331.2953	394.5639
Oct	2018	365.712	343.7755	387.6486	332.163	399.2611
Nov	2018	365.3185	342.1966	388.4404	329.9566	400.6804
Dec	2018	379.8026	355.5297	404.0755	342.6804	416.9248
Jan	2019	379.2308	353.1122	405.3494	339.2858	419.1757
Feb	2019	371.9888	344.4546	399.523	329.8789	414.0988
Mar	2019	377.2749	348.4457	406.1042	333.1844	421.3654
Apr	2019	389.1325	358.8831	419.3819	342.87	435.3949
May	2019	385.0443	353.2924	416.7962	336.4839	433.6047
Jun	2019	387.6236	354.4084	420.8387	336.8254	438.4217
Jul	2019	393.705	359.0762	428.3338	340.7449	446.6652
Aug	2019	398.6673	362.6231	434.7114	343.5425	453.792
Sep	2019	408.0674	370.5858	445.549	350.7442	465.3905
Oct	2019	409.8737	370.9479	448.7995	350.3418	469.4056
Nov	2019	407.408	367.0434	447.7727	345.6757	469.1404
Dec	2019	423.1789	381.3766	464.9812	359.2478	487.11

Table 5.1 16: Forecast of Domestic VAT Revenue for 2018 and 2019

MONTH	YEAR	FORECAST	95% CONFIDENCE INTERVAL		80% CONFIDENCE INTERVAL	
			LOWER	UPPER	LOWER	UPPER
Jan	2018	343.8837	332.4761	355.2913	326.4372	361.3301
Feb	2018	325.7069	313.2931	338.1208	306.7216	344.6923
Mar	2018	331.9659	319.1954	344.7365	312.435	351.4968
Apr	2018	345.5822	331.6222	359.5423	324.2321	366.9323
May	2018	348.2617	332.4367	364.0867	324.0594	372.464
Jun	2018	351.1511	333.8622	368.4399	324.71	377.5921
Jul	2018	350.6522	332.2851	369.0192	322.5621	378.7422
Aug	2018	359.5273	340.0725	378.982	329.7738	389.2808
Sep	2018	362.9296	342.245	383.6142	331.2953	394.5639
Oct	2018	365.712	343.7755	387.6486	332.163	399.2611
Nov	2018	365.3185	342.1966	388.4404	329.9566	400.6804
Dec	2018	379.8026	355.5297	404.0755	342.6804	416.9248
Jan	2019	379.2308	353.1122	405.3494	339.2858	419.1757
Feb	2019	371.9888	344.4546	399.523	329.8789	414.0988
Mar	2019	377.2749	348.4457	406.1042	333.1844	421.3654
Apr	2019	389.1325	358.8831	419.3819	342.87	435.3949
May	2019	385.0443	353.2924	416.7962	336.4839	433.6047
Jun	2019	387.6236	354.4084	420.8387	336.8254	438.4217
Jul	2019	393.705	359.0762	428.3338	340.7449	446.6652
Aug	2019	398.6673	362.6231	434.7114	343.5425	453.792
Sep	2019	408.0674	370.5858	445.549	350.7442	465.3905
Oct	2019	409.8737	370.9479	448.7995	350.3418	469.4056
Nov	2019	407.408	367.0434	447.7727	345.6757	469.1404
Dec	2019	423.1789	381.3766	464.9812	359.2478	487.11

Table 5.1 17: Forecast of Import VAT Revenue for 2018 and 2019

MONTH	YEAR	FORECAST	95% CONFIDENCE INTERVAL		80% CONFIDENCE INTERVAL	
			LOWER	UPPER	LOWER	UPPER
Jan	2018	343.8837	332.4761	355.2913	326.4372	361.3301
Feb	2018	325.7069	313.2931	338.1208	306.7216	344.6923
Mar	2018	331.9659	319.1954	344.7365	312.435	351.4968
Apr	2018	345.5822	331.6222	359.5423	324.2321	366.9323
May	2018	348.2617	332.4367	364.0867	324.0594	372.464
Jun	2018	351.1511	333.8622	368.4399	324.71	377.5921
Jul	2018	350.6522	332.2851	369.0192	322.5621	378.7422
Aug	2018	359.5273	340.0725	378.982	329.7738	389.2808
Sep	2018	362.9296	342.245	383.6142	331.2953	394.5639
Oct	2018	365.712	343.7755	387.6486	332.163	399.2611
Nov	2018	365.3185	342.1966	388.4404	329.9566	400.6804
Dec	2018	379.8026	355.5297	404.0755	342.6804	416.9248
Jan	2019	379.2308	353.1122	405.3494	339.2858	419.1757
Feb	2019	371.9888	344.4546	399.523	329.8789	414.0988
Mar	2019	377.2749	348.4457	406.1042	333.1844	421.3654
Apr	2019	389.1325	358.8831	419.3819	342.87	435.3949
May	2019	385.0443	353.2924	416.7962	336.4839	433.6047
Jun	2019	387.6236	354.4084	420.8387	336.8254	438.4217
Jul	2019	393.705	359.0762	428.3338	340.7449	446.6652
Aug	2019	398.6673	362.6231	434.7114	343.5425	453.792
Sep	2019	408.0674	370.5858	445.549	350.7442	465.3905
Oct	2019	409.8737	370.9479	448.7995	350.3418	469.4056
Nov	2019	407.408	367.0434	447.7727	345.6757	469.1404
Dec	2019	423.1789	381.3766	464.9812	359.2478	487.1100

Forecast using the best-fitted model is made for the next 24 months. This is shown in Figures 5.10, 5.11 and 5.12.

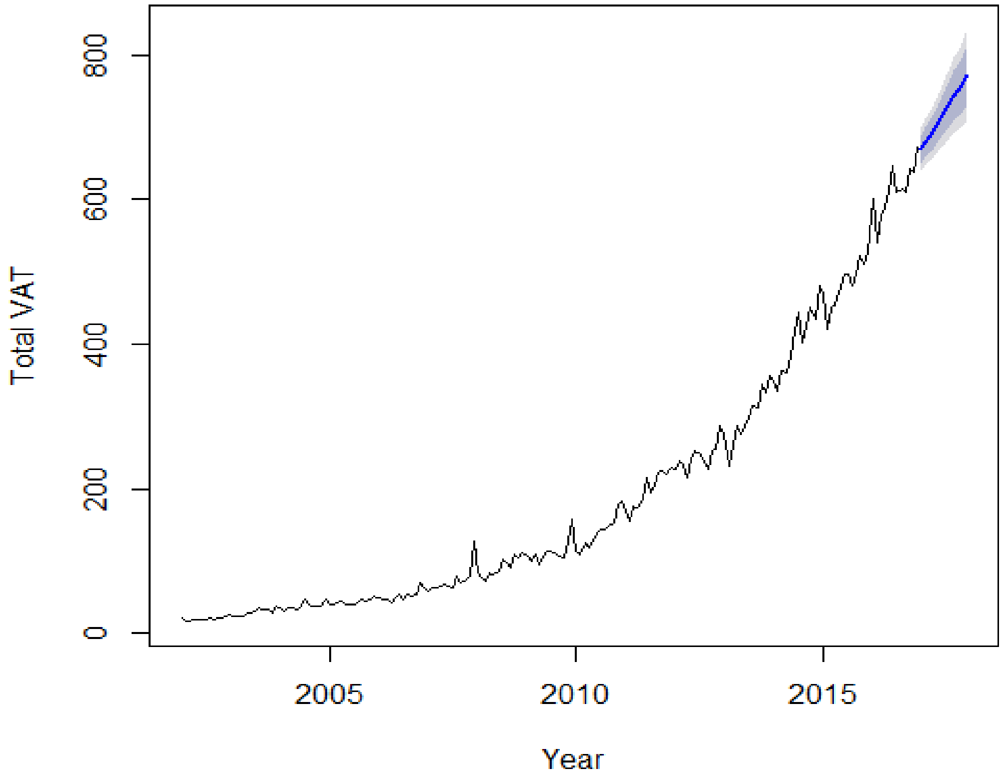

Figure 5. 10: Intervention ARIMA Forecast of Total VAT Revenue for 2018 and 2019

In Figure 5.10, the forecasted Total VAT (in millions) is shown by the blue line, whilst the blue-gray and gray shaded areas show 80% and 95% prediction intervals respectively.

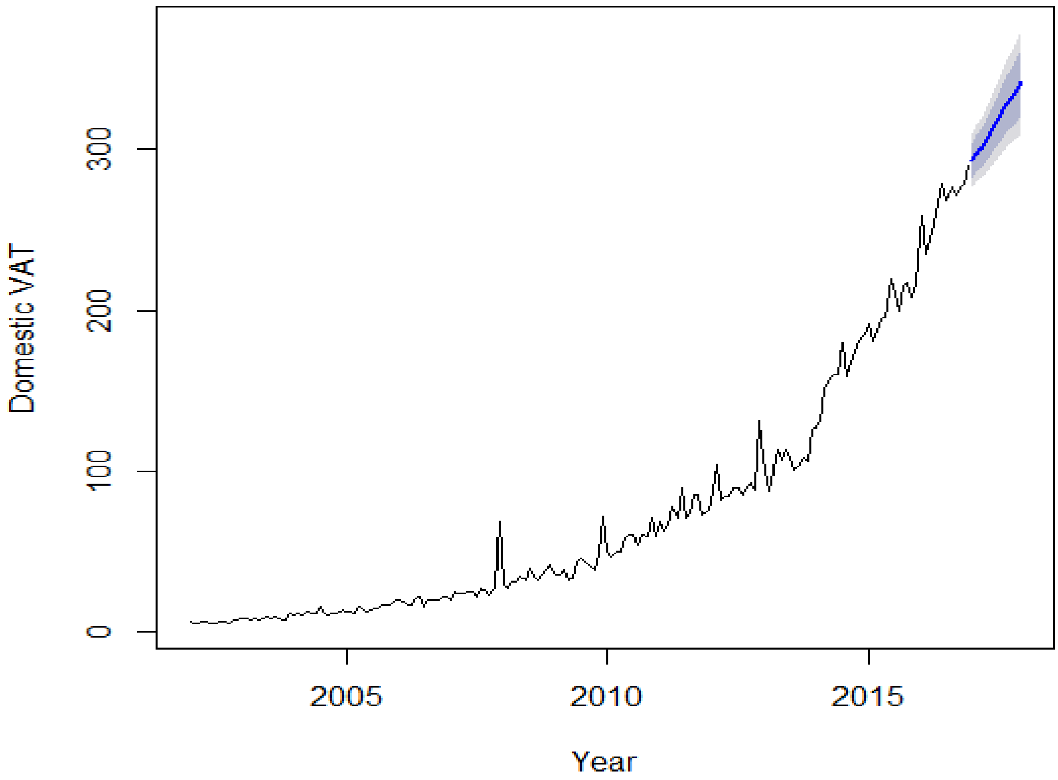

Figure 5. 11: Intervention ARIMA Forecast of Domestic VAT Revenue for 2018 and 2019

In Figure 5.11, the forecasted Total VAT (in millions) is shown by the blue line, whilst the blue-gray and gray shaded areas show 80% and 95% prediction intervals respectively.

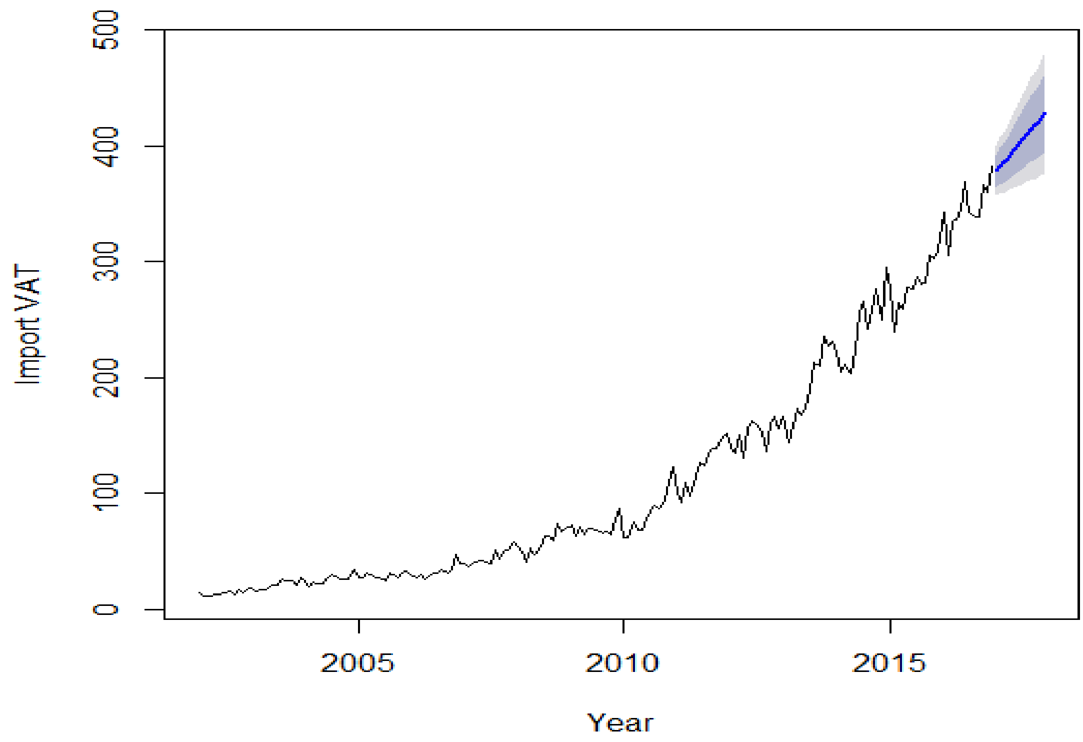

Figure 5. 12: Intervention ARIMA Forecast of Import VAT Revenue for 2018 and 2019

In Figure 5.12, the forecasted Total VAT (in millions) is shown by the blue line, whilst the blue-gray and gray shaded areas show 80% and 95% prediction intervals respectively.

5.5 Regression Analysis

In this section of the study, the effect of Real GDP, CEFF, CORR, and EFFVATRATE on Total VAT revenue received was explored through scatter plot, Pearson correlation coefficient, and multiple linear regression analysis. The data used in this analysis is quarterly Real GDP, CEFF, CORR, EFFVATRATE, and Total VAT and it spans the period 2006 to 2016. Table 5.118 is the correlation matrix among the variables considered.

Table 5.1 18**: Correlation Matrix**

	Total VAT	Real GDP	CEFF	CORR	EFFVATRATE
Total VAT	1.0000				
Real GDP	0.9365	1.0000			
CEFF	0.9929	0.9465	1.0000		
CORR	0.7373	0.8492	0.7514	1.0000	
EFFVATRATE	0.9964	0.9280	0.9280	0.7270	1.0000

Source: Author's own computation

From Table 5.118 Real GDP (0.9365), CEFF (0.9929), CORR (0.7373), and EFFVATRATE (0.9964) are all positively and strongly linearly related to Total VAT Revenue. However, there is high correlation amongst the predictor variables as well. For instance, there is a strong positive linear correlation between real GDP and CEFF (0.9465), CORR (0.8492), and EFFVATRATE (0.9280). Also, CEFF is strongly positively linearly correlated with CORR (0.7514), and EFFVATRATE (0.9280). This is an indication of the presence of multicollinearity which is an unpleasant situation in regression analysis. This is because multicollinearity has consequences such as: Impreciseness of coefficient values (the estimate of the impact of an independent variable on the dependent variable whiles controlling for the other independent variables) which may then result in imprecise out-of-sample predictions, small changes in a regressor leading to large changes in the dependent variable which can even result in changes in the sign of parameter estimates that may be misleading and large standard errors that may be produced in the related independent variables. The scatter plot showing the strength of the correlation is presented in Table C1 in Appendix C. To ascertain the presence of multicollinearity, the variance inflation factors of the variables were explored. This is presented in Table 5.119.

Table 5.1 19: Variance Inflation Factor (VIF)

Variable	VIF	Square Root of VIF
Real GDP	18.2527	4.2723
CEFF	157.4089	12.5463
CORR	3.9710	1.9927
EFFVATRATE	118.1694	10.8706

Source: Author's own computation

Multicollinearity is confirmed by the presence of high VIF amongst variables. From Table 5.119, the square root of the VIF associated with real GDP, CEFF, and EFFVATRATE is greater than 2.0 thus influential. To address this collinearity, the variables real GDP, CEFF, and EFFVATRATE were dropped. However, one of the main objectives of this study is to explore the effect of real GDP on Total VAT Revenue, thus, real GDP was retained and the other variables due to the high collinearity were dropped. A simple regression analysis where Total VAT was the dependent variables with the Real GDP being the independent variable was therefore fitted. The estimate of the coefficient is presented in Table 5.120

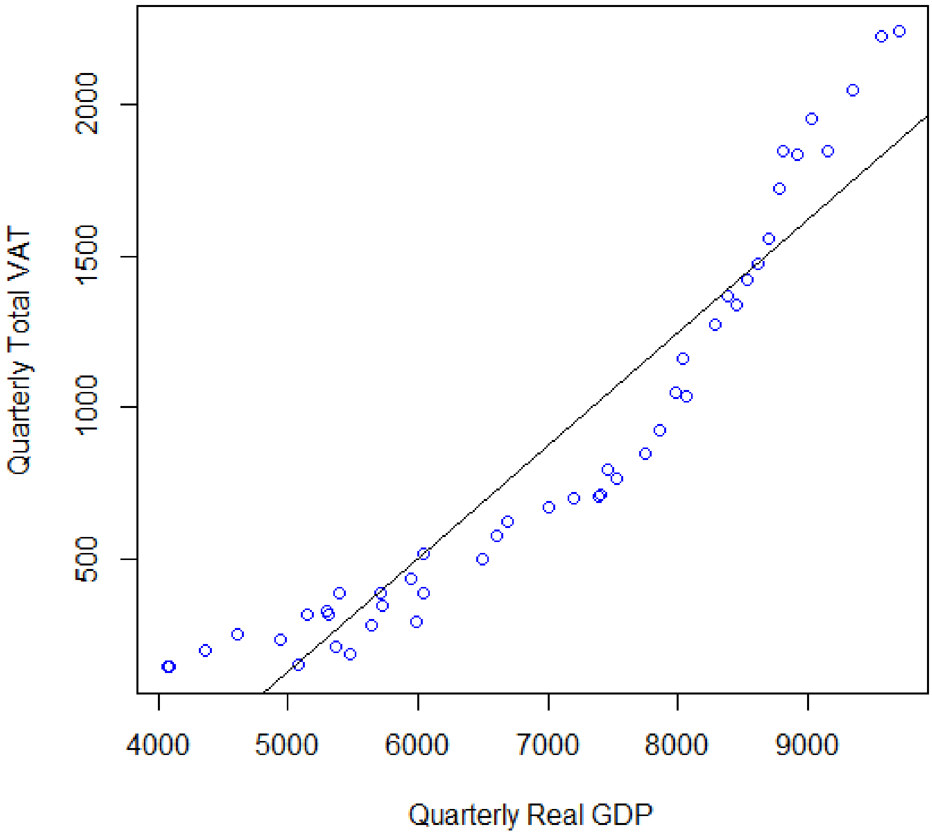

Figure 5. 13: Scatter Plot of Real GDP and Total VAT Revenue

From Figure 5.13, there is a strong positive linear correlation between Total VAT Revenue and Real GDP. The correlation coefficient between Total VAT Revenue and Real GDP was assessed and is presented in Table 5.118. Indeed, there is a strong positive correlation between VAT Revenue and Real GDP indicated by a correlation coefficient of 0.9365 (Table 5.118). This strong positive correlation between VAT Revenue and Real GDP agrees with the suggestion of Greene (2014) that GDP can be used as a proxy tax base for VAT in Tax Revenue Forecasting. Thus, if Real GDP is used as a VAT Base in VAT Revenue forecasting in Ghana, it conforms to the principle of Greene (2014) that there should be a high correlation between observed tax revenue and the proxy tax.

A simple regression analysis where Total VAT was the dependent variables with the Real GDP being the independent variable was therefore fitted. The estimate of the model coefficient is presented in Table 5.120.

Table 5.1 20: Regression Model and Diagnostics

	Estimate	Standard Error	T value	p value
Intercept	-1738.00	136.80	-12.70	0.0000
Real GDP	0.3728	0.0192	19.42	0.0000

$R^2 = 0.8913, \quad F - statistic = 377.3, p - value = 0.0000$

Source: Author's own computation

The regression model is given by: $y = \alpha + \beta x$

$$Total\,VAT = -1738.00 + 0.3728 RealGDP$$

From the model, it is estimated that on the average, a unit change in Real GDP, will trigger a 0.3728 increase in the Total VAT. Furthermore, the model explains about 89.1% of the changes in total VAT. From the residual plot (Figure C2, Appendix C), the normal Q-Q plot appears to be approximately linear indicating of goodness-of-fit. Also, the residual appears to be on a horizontal band (from the residual vs fitted plot), thus, there is constancy of variance. In addition, the standardized residual plot indicates that the there are no outliers. There was no observation beyond the bounds of the cook's distance which implies there are no influential outliers. Furthermore, formal test on normality and constancy of variance was performed and presented in Table C1 (Appendix C). From this test, Lilliefors normality test indicated that the residuals follow the normal distribution (p-value greater than 5%). Also, the constancy of variance was confirmed through the Breusch pagan test (p-value greater than 5%). Therefore, the model is appropriate for prediction purposes.

5.5.1 Test for Autocorrelation

The Durbin Watson test (test of autocorrelation) was performed. The Durbin-Watson Test Statistic is 2.1050 which is between 1.5 and 2.5 (1.5 <2.1050 <2.5) this indicates that we do not reject H0 as there is sufficient evidence to suggest that there is no first order autocorrelation as evident from the Durban Watson analysis as well. See Table C4 of Appendix C.

5.5.2 Elasticity

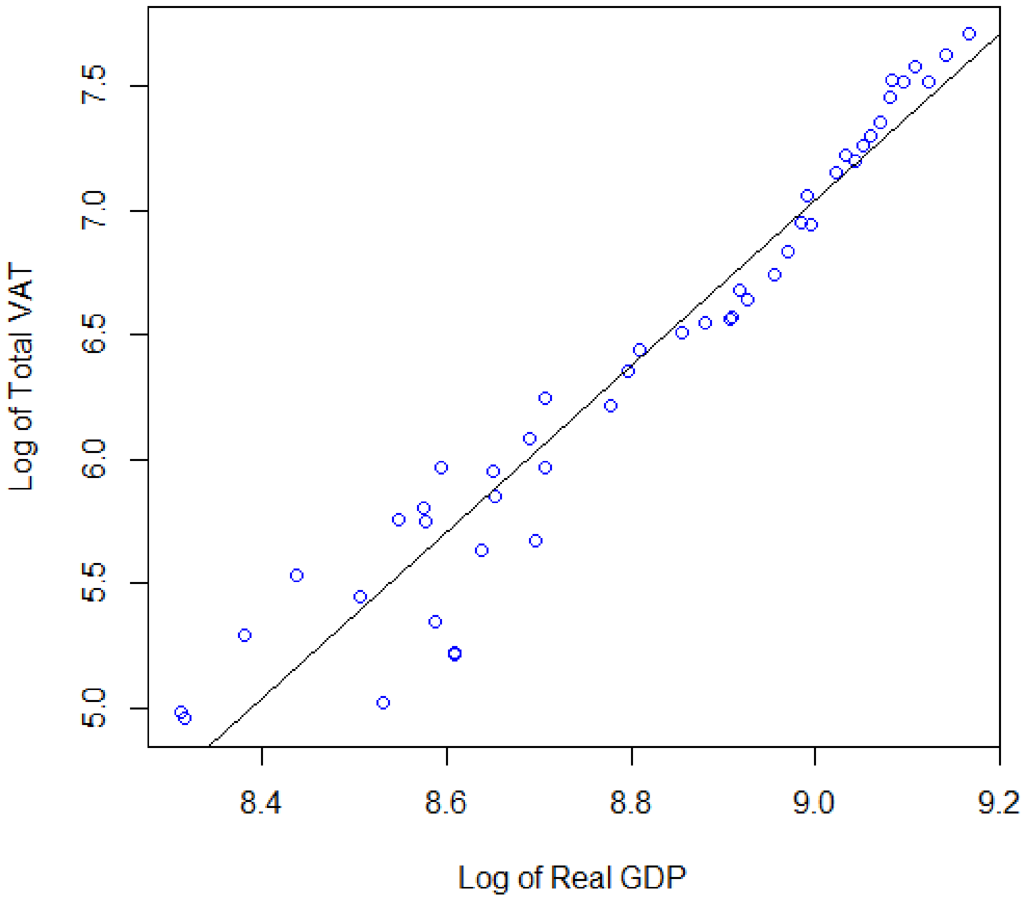

Figure 5. 14: Scatter Plot of log of Real GDP and log of Total VAT Revenue

From Figure 5.14, there is a fairly high elasticity between Total VAT Revenue and Real GDP. The level of elasticity is confirmed by the elasticity coefficient in Table 5.121 below.

Table 5.1 21: Regression Coefficient of Log-Log Model

	Estimate	Standard Error	T value	p value
Intercept	-22.996	1.1066	-20.78	0.0000
Log Real GDP	3.3373	0.1256	26.58	0.0000

$R^2 = 0.9401, \quad F - statistic = 706.5, p - value = 0.0000$

Source: Author's own computation

The simple log-log model is given by:

$\ln y = \beta_o + \beta_1 \ln x$

$$\ln(VAT) = -22.996 + 3.3373\ln(RGDP)$$

Here, the elasticity is 3.3373, thus, for a one percent increase in Real GDP, there is an associated 3.73373 percent increase in Total VAT Revenue on the average. This implies that VAT is fairly elastic to change in Real GDP in Ghana. This result agrees with the study of Twerefou *et al* (2010) which found out that the overall tax system in Ghana is elastic (i.e. the responsiveness of the tax system in Ghana to a unit change in GDP is more than unity).

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

In this chapter, a summary and conclusions of the research based on the analysis and findings are given. Based on the findings from the study, recommendations are also given for consideration. Limitations of the study are discussed and finally, suggestions for further research are stated for the attention of researchers.

6.1 Summary

The general objective of this study was to evaluate the pattern of the VAT revenue collections over the study period and to know the most accurate VAT revenue forecasting technique for the economy of Ghana.

The specific objectives of the study were:

i. To evaluate the forecasting approach that gives the most accurate prediction of Ghana's monthly VAT (Total VAT, Domestic VAT and, Import VAT) revenue.

ii. To access the effect of the 2.5% increment of VAT rate in 2014 on monthly VAT (Total VAT, Domestic VAT and, Import VAT) revenue in Ghana.

iii. To establish whether or not Real GDP can be an appropriate proxy VAT base in VAT revenue forecasting.

iv. To make a forecast of monthly VAT (Total VAT, Domestic VAT and, Import VAT) revenue in Ghana for the next twenty-four months (two years).

The study presented an overview of the VAT system in Ghana with a series that shows the pattern of VAT revenues collected over the study period. Both theoretical and empirical literature on taxation and VAT were reviewed. The theoretical literature review focused on the concept of taxation and VAT, theories of taxation, how VAT is administered, the operation of VAT in other jurisdictions, the consequences of adopting VAT and the realized contributions of VAT to domestic government revenues. The study also reviewed empirical studies on government revenue generation and impact analysis of VAT on GDP. Empirical studies on Fiscal (Tax revenue) forecasting and the various forecasting techniques that were employed were also reviewed. Also reviewed were empirical works on specifically VAT Revenue modelling and forecasting. Based on knowledge gained from review of the literature, a methodology was developed, and analysis made to achieve the stated objectives of the study.

It was realized from the analysis that both Domestic VAT Revenue and Import VAT Revenue and hence Total VAT Revenue exhibited increasing trends and no seasonality was observed in all the VAT Revenue data throughout the period of study. Only two forecasting techniques namely; Holt linear trend model and the ARIMA with intervention analysis model proved applicable to achieve the stated objectives of the study. In comparing forecast accuracy and precision of the Holt linear trend model and the ARIMA with intervention analysis model, the latter model outperformed the former in forecasting Total VAT, Domestic VAT and Import VAT Revenues. It was also observed from the intervention analysis that the 2.5% increase in the standard VAT rate in January 2014 had no significant effect on the Import VAT Revenue and as well the Total VAT Revenue. However, for Domestic VAT Revenue, a significant positive effect (increase in Domestic VAT Revenue) was realized. Domestic VAT Revenue increased steadily in February 2014 and has maintained the steady increase to date. This steady increase in Domestic VAT Revenue is thus attributed to the intervention (i.e. the 2.5% increase in VAT rate) in January 2014.

With the analysis of the effect of real GDP on VAT revenue and the correlation that exists between them, it was realized that a unit change in Real GDP, will trigger a change of 0.3728 in the Total VAT. In terms of elasticity, it was realized that a one percent increase in RGDP will result in a 3.73373 percent increase in Total VAT Revenue on the average. The R^2 of the model was 0.89. Therefore, the regression model explained about 89.1% of the changes in Total VAT

Revenue in Ghana. Also, a, very high correlation of 0.9365 was realized between Real GDP and Total VAT Revenue as shown in the correlation of matrix of table 5.26. Finally, because the ARIMA with intervention analysis model outperformed the Holt linear trend model in terms of forecast accuracy and precision, the ARIMA with intervention analysis model was used to forecast monthly Total VAT, Domestic VAT and Import VAT Revenues for the next 24 months (2018 and 2019) as shown in tables 5.23, 5.24 and 5.25 respectably.

6.2 Conclusion

- Results from the analysis of the trends of all various VAT Revenues permits the researcher to conclude that Domestic VAT Revenue, Import VAT Revenue and hence Total VAT Revenue in Ghana have increasing trends and are without seasonality.
- Also, the results of the analysis prove that ARIMA with intervention analysis model is a better forecasting approach that gives a more accurate prediction of Ghana's monthly Total VAT revenue, Domestic VAT Revenue and, Import VAT Revenue. On this basis, ARIMA with intervention analysis model is adjudged a better forecasting approach for Ghana's monthly Total VAT revenue, Domestic VAT Revenue and, Import VAT Revenue in terms of forecast accuracy and precision.
- The increase in the standard VAT rate in January, 2014 by 2.5% did not have a significant effect on Total VAT revenue though some significant effect was realized in the Domestic VAT revenues that were collected from the time February 2014 to date. The overall insignificant response of Total VAT revenue to the change in VAT rate is as a result of revenue leakages in the VAT system. The researcher therefore, concludes that increasing the VAT rate without sealing the VAT revenue leakages will always result in an insignificant response of VAT revenue to the change in VAT rate. However, sealing the VAT revenue leakages will result in a significant increase in VAT revenue when the VAT rate is increased.

- Finally, realizing the significant effect of Real GDP on Total VAT Revenue and the high correlation that exists between the two variables, the researcher concludes that it is appropriate to employ Real GDP as a proxy VAT Base in VAT revenue forecasting.

6.3 Recommendations

- The ARIMA (2, 1, 0), ARIMA (1, 1, 4) and ARIMA (2, 1, 1) models are recommended for forecasting Total VAT, Domestic VAT and, Import VAT respectively in Ghana.
- ARIMA with intervention analysis model is a better forecasting model than Holt linear trend model. ARIMA with intervention analysis model should be compared with the in-house model used at Ghana Revenue Authority for forecast accuracy and prediction and if it outperforms the in-house model, it should be adopted by the Ghana Revenue Authority in forecasting monthly VAT revenues for the purpose of planning, drawing half year and full year government budgets so that the ministry of finance budgets approximately expenditure based on accurately forecasted revenue.
- The effect of interventions (e.g. discretionary vat policy change) should be analyzed using the ARIMA with intervention for accurate forecasting of monthly VAT revenue by the Ghana Revenue Authority.
- The Ministry of finance should be guided by the forecast figures and with their degrees of freedom in order to set realistic VAT revenue targets for the Domestic Tax Revenue Division of the Ghana Revenue Authority.
- Since monthly and/or quarterly data on private consumption expenditure is not reported on in Ghana but only annual data available, to make quarterly forecasts of VAT revenue for Ghana when using a forecasting approach that requires a VAT base, real GDP should be considered and used as proxy VAT base. This is because there is a high correlation between Real GDP and VAT Revenue.

6.4 Limitations of the Study

The major limitations of the study in the attempt to achieve the objective of adjudicating between various forecasting techniques, to establish the forecasting technique that is most accurate in forecasting VAT revenue for the economy of Ghana were as follows:

- Input-Output data to test Input-output modelling for VAT Revenue forecasting were not available. Thus, the input-output approach could not be tested with the other models that were tested for the most accurate VAT revenue forecasting technique to be used for the economy of Ghana.
- Real GDP data is only reported annually and quarterly but not monthly. Thus, other forecasting models namely; Vector Autoregressive (VAR) model and Correlation-Regression analysis model could not be compared with the ARIMA with intervention analysis and Holt linear trend models that were employed and tested in the study for forecasting monthly VAT revenues.
- There are no available quarterly real GDP data in time periods preceding 2006. This limited the data points that could be used for the regression and correlation analysis between VAT revenue and real GDP in the attempt to establish whether or not Real GDP can be an appropriate proxy VAT base in VAT revenue forecasting.

6.5 Suggestions for Further Research

This research was focused on adjudicating between various forecasting techniques, to establish the forecasting technique that is most accurate in forecasting monthly VAT revenue for the economy of Ghana. Since the researcher's focus was on forecasting monthly VAT revenues, other forecasting techniques namely; the Vector Auto-Regressive model (VAR), Correlation-Regression analysis and Error Correction Model (ECM), were not tested to compare with the Holt linear trend model and the ARIMA with intervention model that were tested because regressors such as real GDP and Total

Private Consumption are not reported monthly in Ghana. Further research can be conducted to test the aforementioned forecasting approaches (VAR, ECM and, Correlation-Regression analysis) to test their accuracy in predicting quarterly or annual VAT revenue in Ghana and in any other country. Also, since the study revealed a high correlation between VAT revenue and real GDP, further research can be conducted to test the Effective Rate Approach of quarterly or annual VAT revenue forecasting and compare with the aforementioned techniques of forecasting VAT revenues in Ghana and in any other country. Nevertheless, any further research that may employ the Effective Rate Approach to forecast VAT revenue must be sure there exists a high correlation between VAT revenue and real GDP or any proxy VAT base that may be under consideration before proceeding to use the Effective Rate Approach to make predictions.

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APPENDICES

APPENDIX A

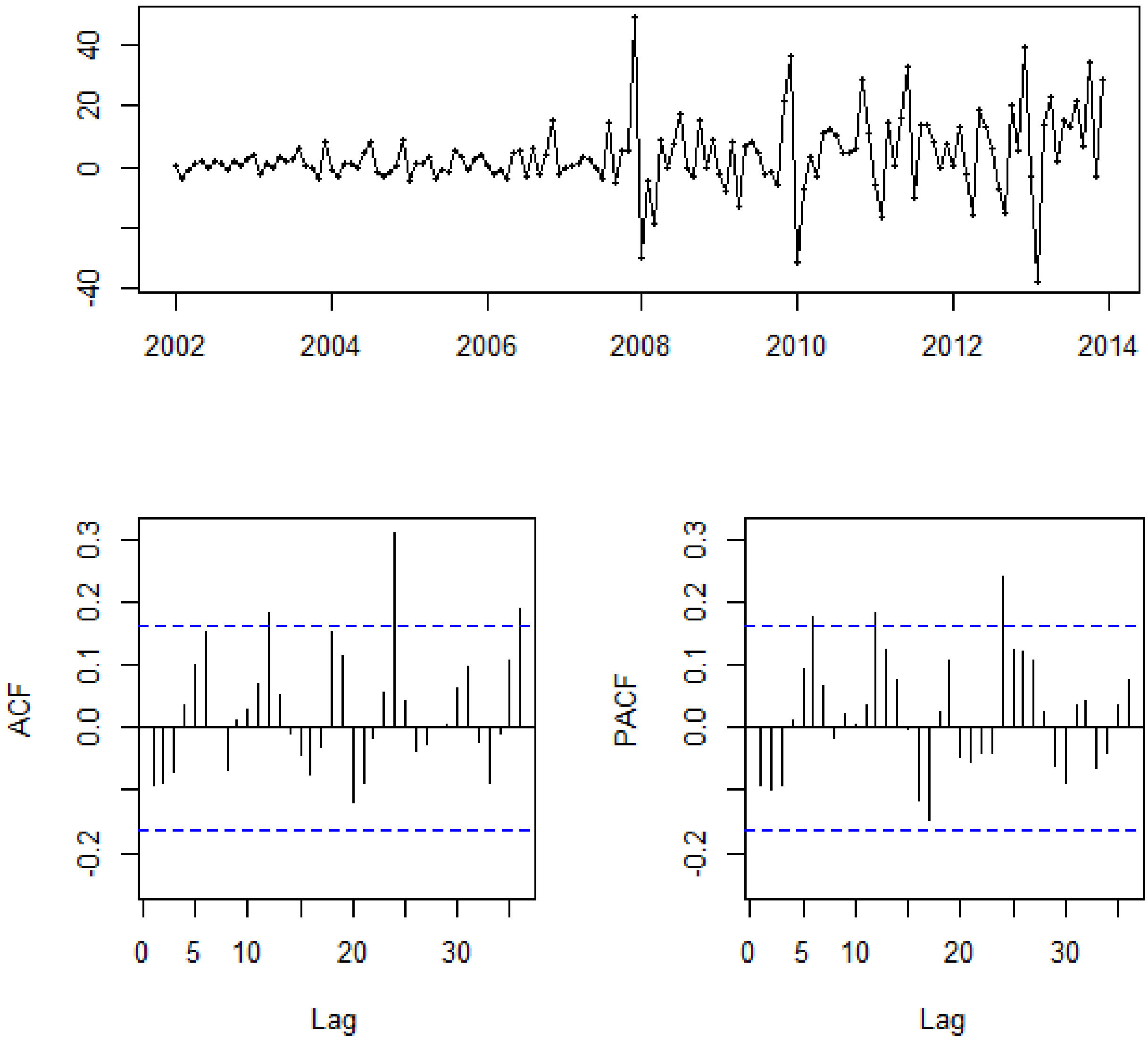

Figure A1: Plot of Residual Diagnostics for $ARIMA(2,1,0)$ Model

Table A1: Ljung-Box Test for $ARIMA(2,1,0)$ Residuals

Lag	Test Statistic	p – value
4	3.27	0.5139
8	8.65	0.3726
12	14.18	0.2892
16	15.60	0.4813
20	22.93	0.2925
24	38.30	0.0323

Table A2: ARCH-LM Test for $ARIMA(2,1,0)$ Residuals

Lag	Test Statistic	p – value
4	15.0	0.0047
8	18.5	0.0178
12	25.9	0.0112
16	26.1	0.0533
20	31.9	0.0443
24	39.0	0.0272

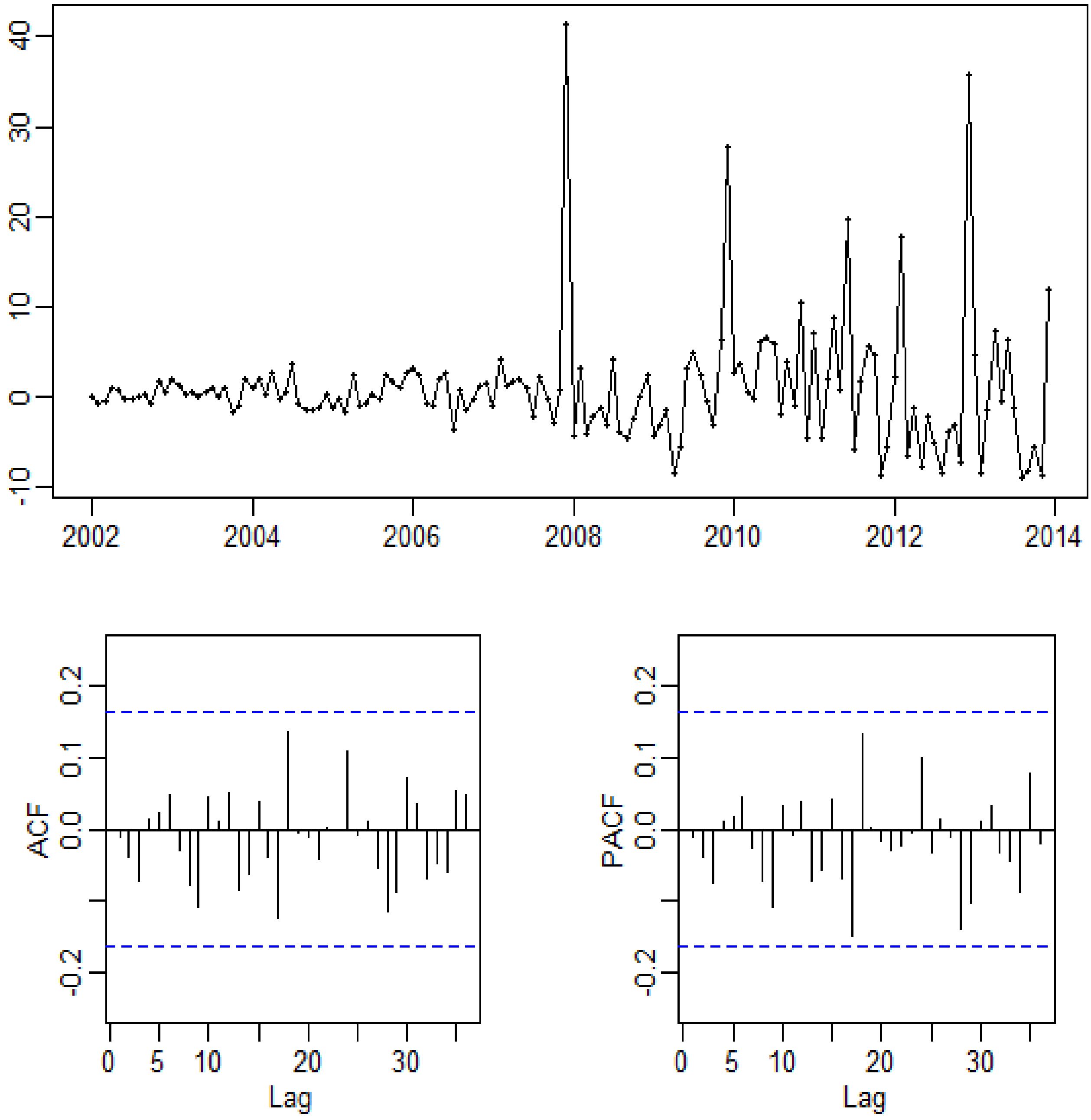

Figure A2: Plot of Residual Diagnostics for $ARIMA(1,1,4)$ Model

Table A3: Ljung-Box Test for $ARIMA(1,1,4)$ Residuals

Lag	Test Statistic	p – value
4	1.01	0.9080
8	2.38	0.9670
12	4.76	0.9650
16	6.81	0.9770
20	11.63	0.9280
24	13.59	0.9550

Table A4: ARCH-LM Test for $ARIMA(1,1,4)$ Residuals

Lag	Test Statistic	p – value
4	0.112	0.9980
8	0.220	1.0000
12	0.631	1.0000
16	0.722	1.0000
20	3.021	1.0000
24	10.910	0.9900

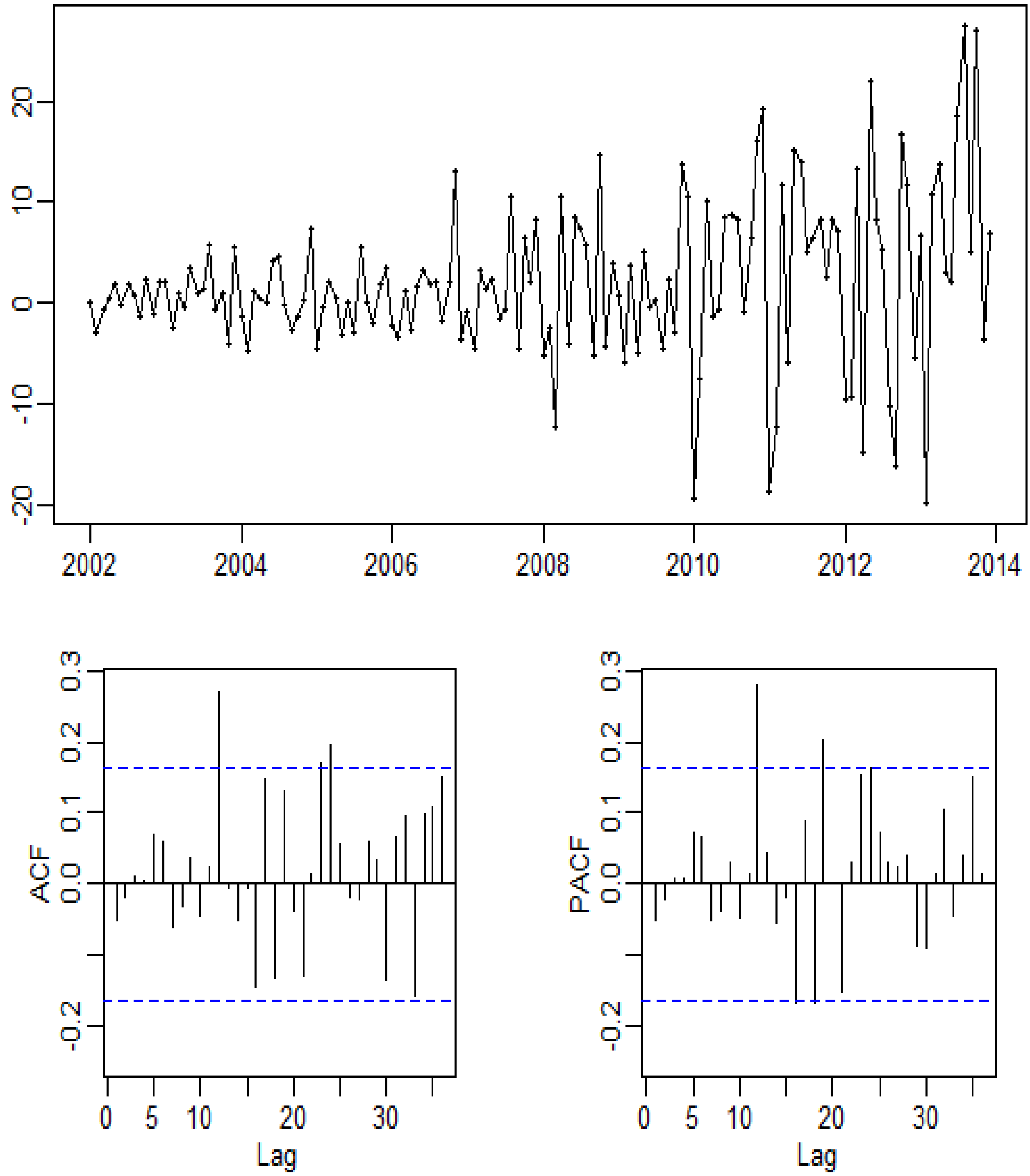

Figure A3: Plot of Residual Diagnostics for $ARIMA(2,1,1)$ Model

Table A5: Ljung-Box Test for $ARIMA(2,1,1)$ Residuals

Lag	Test Statistic	p – value
4	0.468	0.9765
8	2.341	0.9687
12	13.318	0.3463
16	16.748	0.4021
20	25.099	0.1977
24	37.069	0.0431

Table A6: ARCH-LM Test for $ARIMA(2,1,1)$ Residuals

Lag	Test Statistic	p – value
4	39.1	0.0000
8	63.5	0.0000
12	91.6	0.0000
16	120.0	0.0000
20	140.0	0.0000
24	144.9	0.0000

Table A7: Forecast for ARIMA with Intervention for 2017

Month	Total VAT		Domestic VAT		Import VAT	
	Observed	Predicted	Observed	Predicted	Observed	Predicted
January	632.80	665.27	294.68	285.21	338.13	382.52
February	590.59	636.44	260.62	288.86	329.97	338.99
March	620.93	607.39	266.51	279.31	354.42	350.42
April	627.52	620.83	295.48	283.57	332.04	334.21
May	693.76	620.82	274.58	285.68	419.17	344.46
June	724.05	678.86	283.01	274.48	441.04	396.56
July	690.42	705.64	287.01	284.32	403.41	417.40
August	755.72	693.31	294.41	284.04	461.30	423.69
September	777.37	745.84	317.60	290.67	459.77	445.74
October	757.95	761.17	314.15	304.18	443.80	448.50
November	732.81	758.92	293.20	308.52	439.61	458.16
December	749.94	742.08	340.06	309.82	409.89	435.15

Table A8: Observed and Predicted Monthly Total VAT revenue from intervention ARIMA model for 2017

Month	**Observed**	**Forecast**	**Difference**	**Absolute of Difference**	**Square of Difference**	**Absolute Values of Errors Divided by Actual Values.**
January	632.80	665.27	32.47	32.47	1054.30	0.05
February	590.59	636.44	45.85	45.85	2102.22	0.08
March	620.93	607.39	-13.54	13.54	183.33	0.02
April	627.52	620.83	-6.69	6.69	44.76	0.01
May	693.76	620.82	-72.94	72.94	5320.24	0.11
June	724.05	678.86	-45.19	45.19	2042.14	0.06
July	690.42	705.64	15.22	15.22	231.65	0.02
August	755.72	693.31	-62.41	62.41	3895.01	0.08
September	777.37	745.84	-31.53	31.53	994.14	0.04
October	757.95	761.17	3.22	3.22	10.37	0.00
November	732.81	758.92	26.11	26.11	681.73	0.04
December	749.94	742.08	-7.86	7.86	61.78	0.01
	Totals		-117.29	363.03	16621.67	0.52
	N	12.00				
	MAD	30.25				
	MSE	1385.14				
	RMSE	37.22				
	MAPE	4.37				

Table A9: Observed and Predicted Monthly Domestic VAT revenue from ARIMA intervention model for 2017

Month	**Observed**	**Forecast**	**Difference**	**Absolute of Difference**	**Square of Difference**	**Absolute Values of Errors Divided by Actual Values.**
January	294.68	285.21	-9.47	9.47	89.68	0.03
February	260.62	288.86	28.24	28.24	797.50	0.11
March	266.51	279.31	12.80	12.80	163.84	0.05
April	295.48	283.57	-11.91	11.91	141.85	0.04
May	274.58	285.68	11.10	11.10	123.21	0.04
June	283.01	274.48	-8.53	8.53	72.76	0.03
July	287.01	284.32	-2.69	2.69	7.24	0.01
August	294.41	284.04	-10.37	10.37	107.54	0.04
September	317.60	290.67	-26.93	26.93	725.22	0.08
October	314.15	304.18	-9.97	9.97	99.40	0.03
November	293.20	308.52	15.32	15.32	234.70	0.05
December	340.06	309.82	-30.24	30.24	914.46	0.09
	Totals		-42.65	177.57	3477.40	0.60
	N	12.00				
	MAD	14.80				
	MSE	289.78				
	RMSE	17.02				
	MAPE	5.01				

Table A10: Observed and Predicted Monthly Import VAT revenue from ARIMA intervention model for 2017

Month	**Observed**	**Forecast**	**Difference**	**Absolute of Difference**	**Square Of Difference**	**Absolute Values of Errors Divided by Actual Values.**
January	338.13	382.52	44.39	44.39	1970.47	0.13
February	329.97	338.99	9.02	9.02	81.36	0.03
March	354.42	350.42	-4.00	4.00	16.00	0.01
April	332.04	334.21	2.17	2.17	4.71	0.01
May	419.17	344.46	-74.71	74.71	5581.58	0.18
June	441.04	396.56	-44.48	44.48	1978.47	0.10
July	403.41	417.40	13.99	13.99	195.72	0.03
August	461.30	423.69	-37.61	37.61	1414.51	0.08
September	459.77	445.74	-14.03	14.03	196.84	0.03
October	443.80	448.50	4.70	4.70	22.09	0.01
November	439.61	458.16	18.55	18.55	344.10	0.04
December	409.89	435.15	25.26	25.26	638.07	0.06
	Totals		-56.75	292.91	12443.93	0.72
	N	12.00				
	MAD	24.41				
	MSE	1036.99				
	RMSE	32.20				
	MAPE	5.97				

APPENDIX B

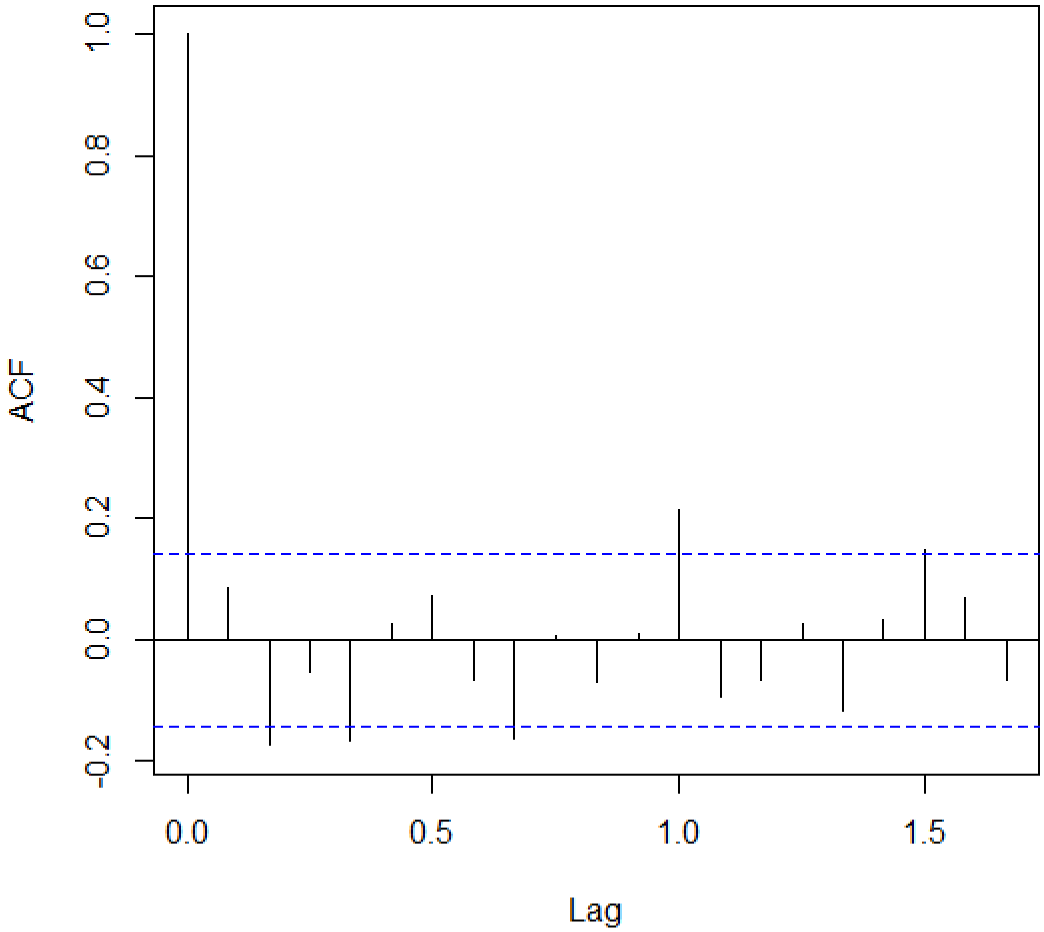

Figure B1: Residual Plot for Trend 1 (Total VAT)

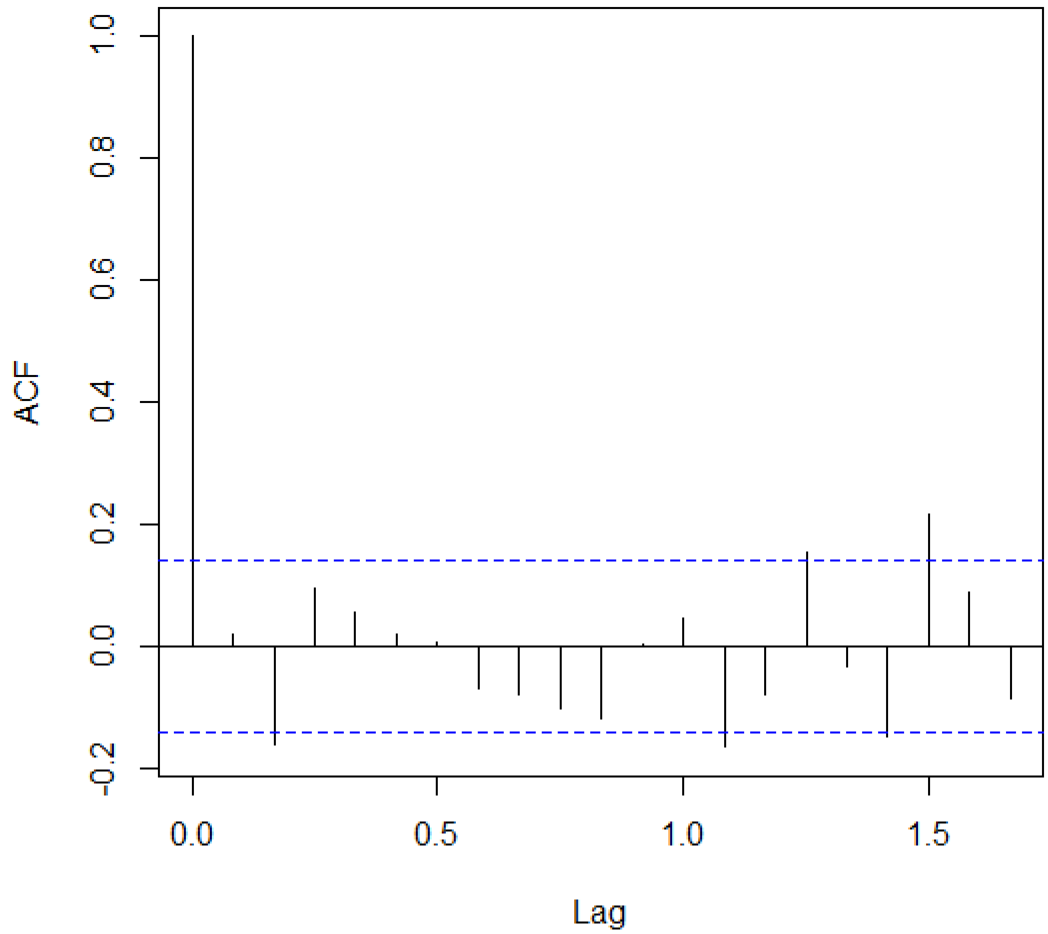

Figure B2: Residual Plot for Trend 2 (Domestic VAT)

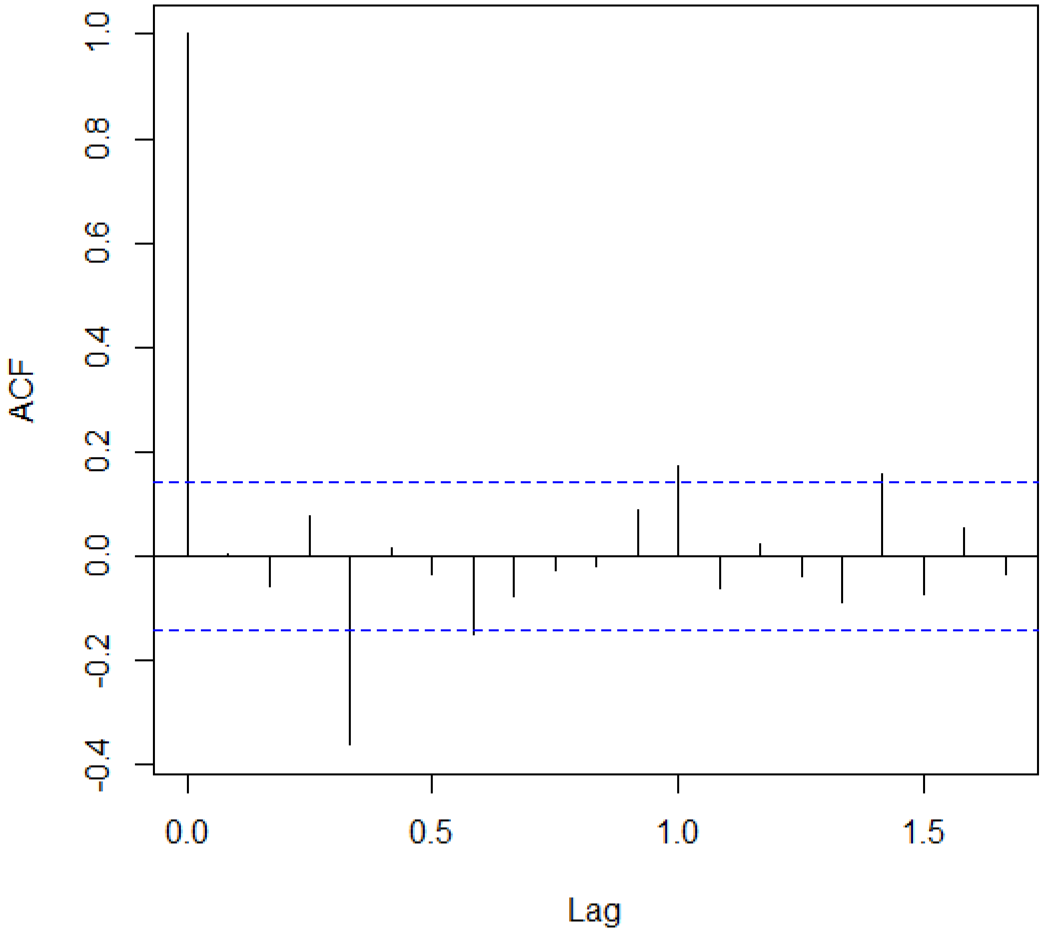

Figure B3: Residual Plot for Trend 3 (Import VAT)

Table B1: Observed and Predicted Monthly Total VAT revenue from Holt Linear Trend model for 2017

Month	Observed	Forecast	Difference	Absolute of Difference	Square of Difference	Absolute Values of Errors Divided by Actual Values.
January	632.80	669.41	36.61	36.61	1340.61	0.06
February	590.59	678.71	88.12	88.12	7765.63	0.15
March	620.93	688.01	67.08	67.08	4499.90	0.11
April	627.52	697.31	69.79	69.79	4870.62	0.11
May	693.76	706.61	12.85	12.85	165.08	0.012
June	724.05	715.91	-8.14	8.14	66.31	0.01
July	690.42	725.21	34.79	34.79	1210.01	0.05
August	755.72	734.50	-21.22	21.22	450.13	0.03
September	777.37	743.80	-33.57	33.57	1126.80	0.04
October	757.95	753.10	-4.85	4.85	23.52	0.01
November	732.81	762.40	29.59	29.59	875.51	0.04
December	749.94	771.70	21.76	21.76	473.39	0.03
	Totals		292.81	428.37	22867.51	0.65
	N	12.00				
	MAD	35.70				
	MSE	1905.63				
	RMSE	43.65				
	MAPE	5.45				

Table B2: Observed and Predicted Monthly Domestic VAT revenue from Holt Linear Trend model for 2017

Month	**Observed**	**Forecast**	**Difference**	**Absolute of Difference**	**Square of Difference**	**Absolute Values of Errors Divided by Actual Values.**
January	294.68	292.70	-1.98	1.98	3.93	0.01
February	260.62	297.15	36.53	36.53	1334.10	0.14
March	266.51	301.59	35.08	35.08	1230.80	0.13
April	295.48	306.04	10.56	10.56	111.52	0.04
May	274.58	310.49	35.91	35.91	1289.35	0.13
June	283.01	314.93	31.92	31.92	1019.19	0.11
July	287.01	319.38	32.37	32.37	1047.96	0.11
August	294.41	323.83	29.42	29.42	865.51	0.10
September	317.60	328.28	10.68	10.68	114.00	0.03
October	314.15	332.72	18.57	18.57	345.00	0.06
November	293.20	337.17	43.97	43.97	1933.51	0.15
December	340.06	341.62	1.56	1.56	2.43	0.00
	Totals		284.59	288.56	9297.30	1.02
	N	12.00				
	MAD	24.05				
	MSE	774.77				
	RMSE	27.83				
	MAPE	8.48				

Table B3: Observed and Predicted Monthly Import VAT revenue from Holt Linear Trend model for 2017

Month	Observed	Forecast	Difference	Absolute of difference	Square of Difference	Absolute of Difference	Absolute Values of Errors Divided by Actual Values.
January	338.13	378.45	40.32	40.32	1626.06	1626.06	0.12
February	329.97	383.00	53.03	53.03	2812.45	2812.45	0.16
March	354.42	387.55	33.13	33.13	1097.64	1097.64	0.09
April	332.04	392.10	60.06	60.06	3607.06	3607.06	0.18
May	419.17	396.65	-22.52	22.52	507.29	507.29	0.05
June	441.04	401.20	-39.84	39.84	1587.62	1587.62	0.09
July	403.41	405.74	2.33	2.33	5.44	5.44	0.01
August	461.30	410.29	-51.01	51.01	2601.88	2601.88	0.11
September	459.77	414.84	-44.93	44.93	2018.74	2018.74	0.10
October	443.80	419.39	-24.41	24.41	595.96	595.96	0.06
November	439.61	423.94	-15.67	15.67	245.68	245.68	0.04
December	409.89	428.48	18.59	18.59	345.74	345.74	0.05
	Totals		9.08	405.87	17051.54	17051.54	1.05
	N	12.00					
	MAD	33.82					
	MSE	1420.96					
	RMSE	37.70					
	MAPE	8.74					

APPENDIX C

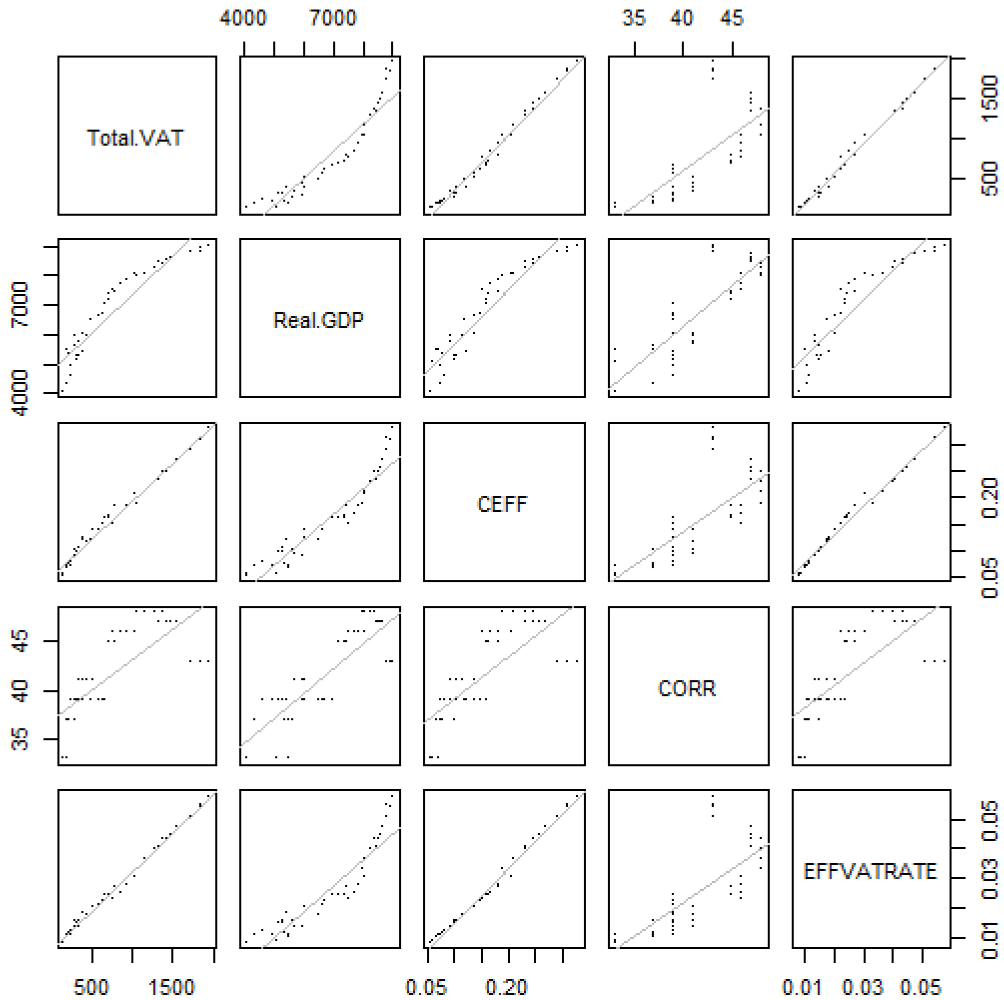

Figure CI: Scatter plot of variables

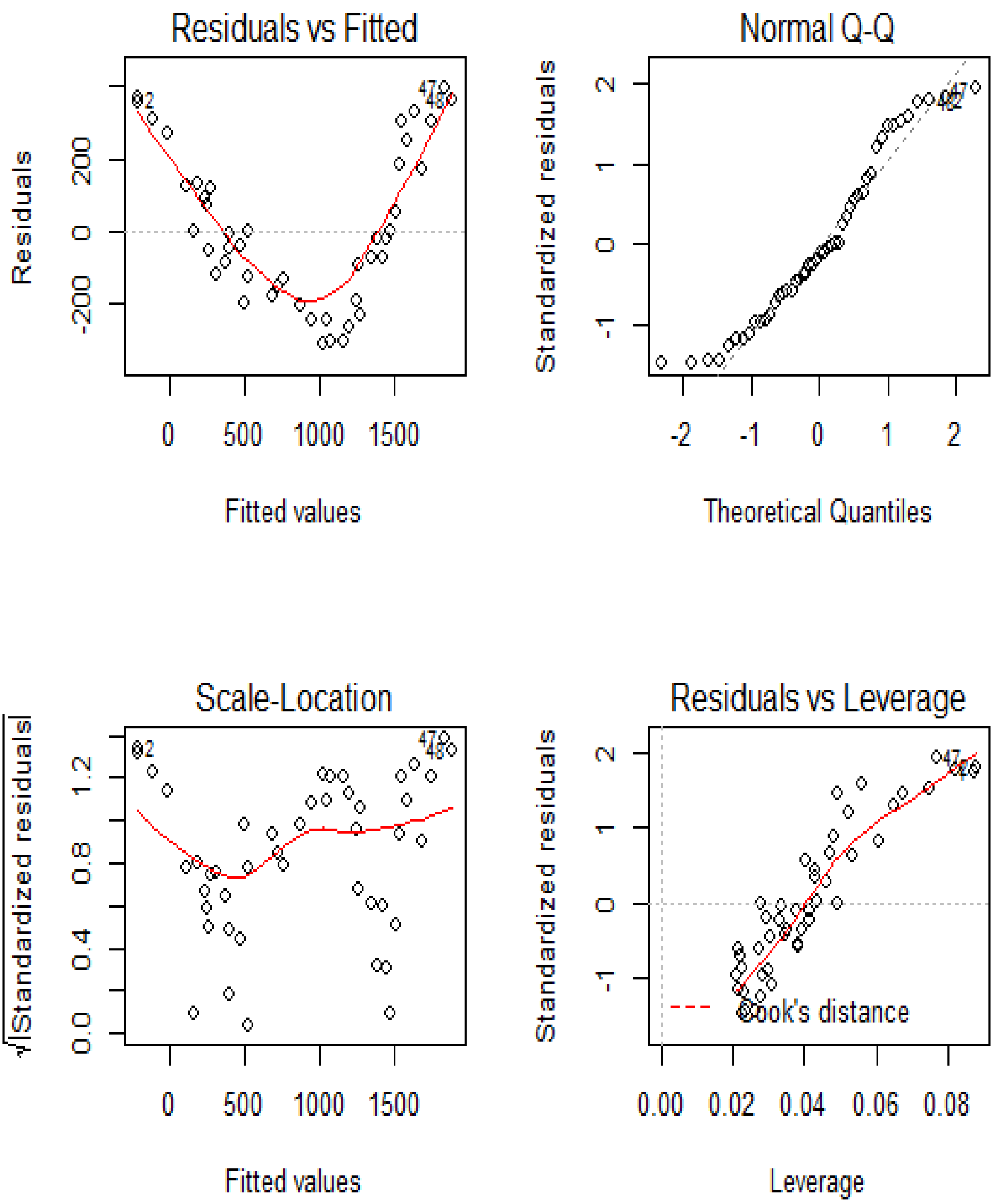

Figure C2: Residual Plot of the Regression model

Table C3: Test of Assumptions

Test	Test Statistic	P – value
Shapiro-Wilk normality test	0.9379	0.0198
Lilliefors (Kolmogorov-smirnov) normality test	0.10627	0.2428
Breusch-Pagan test	2.5147	0.1128

Table C4: Durbin-Watson Test for Autocorrelation

Durbin-Watson Test Statistic	p – value
2.1050	0.9765