



Journal of Economics and Financial Analysis

Type: Double Blind Peer Reviewed Scientific Journal

Printed ISSN: 2521-6627 | Online ISSN: 2521-6619

Publisher: Tripal Publishing House | DOI:10.1991/jefa.v5i1.a40

Received: 19.02.2021 | Accepted: 25.06.2021 | Published: 30.07.2021

Journal homepage: ojs.tripaledu.com/jefa



Real Gross Domestic Product as Value Added Tax Base: Evidence from Ghana

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Abstract

Total Private Consumption is the ideal Valued Added Tax base for Valued Added Tax revenue modelling and forecasting. However, data on private consumption expenditure is not available in most developing countries. With this reason, this study aims to study the appropriateness of real Gross Domestic Product as a Valued Added Tax base by testing the correlation between Valued Added Tax Revenue and Real Gross Domestic Product. It further examines the elasticity of Valued Added Tax revenue to changes in real Gross Domestic Product of Ghana. It is realized from the study that a one percent increase in real Gross Domestic Product results in a 3.73373 percent increase in Total Valued Added Tax revenue. Also, a high correlation of 0.9365 is realized between real Gross Domestic Product and Total Valued Added Tax revenue. Since monthly and/or quarterly data on private consumption expenditure is not available in Ghana, real Gross Domestic Product can be used as VAT base (especially in VAT revenue modelling and forecasting) because of the high correlation and elasticity between Value Added Tax revenue and real Gross Domestic Product. Sequel to these, the study recommends that the government of Ghana implements supply-side policies that will boost investment and production, reduce imports and encourage import substitution, and also demand-side policies that will increase aggregate demand. These policies will expedite rapid economic growth, and an increase in Value Added Tax revenue will be a consequent result.

Keywords: Valued Added Tax (VAT); Real Gross Domestic Product; VAT Base; Elasticity; Private Consumption Expenditure; Correlation.

JEL Classification: C02, H20.

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1. Introduction

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. In recent decades, Value Added Tax (VAT) has evolved as the main workhorse of taxation in developing countries (Le et al., 2016). Almost unknown in 1960, VAT is at the present found in over 140 countries around the globe.

Table 1. Contribution of VAT to total Tax Revenue in Ghana

Year	VAT Revenue	Total Indirect Tax Revenue	Total Tax Revenue	% of VAT to Total Tax Revenue
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

Note: Numbers are in Ghc'000

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

According to Heady (2002), though most member countries of the Organization of Economic Co-operation and Development (OECD) 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. Many 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. Ghana is no exception.

A critical analysis of revenue mobilization of the tax system of Ghana over the years reveals that indirect taxes mobilize more revenues for the government than direct taxes. Table 1 below shows revenues received from VAT for the period 2002 to 2017 and the percentage of these VAT receipts of total tax revenue for the time series.

It is observed from Table 1 that over the years, VAT in Ghana has been a major source of government revenue for the government of Ghana. Value Added Tax (VAT) is thus a major indirect tax to the economy of Ghana.

2. Literature Review

2.1. Theoretical Literature

Musgrave and Musgrave (1989) and Bhartia (2009) recommend certain measures and standards for evaluating a tax structure. These include: Equity, Certainty, Convenience, Economy, Simplicity, Productivity, Flexibility, and Diversity. To assess the tax performance (i.e. the proportion of actual tax collected from potential tax/tax capacity) of a country, Hindrichs (1966) and Musgrave (1969) suggest four main approaches, namely; ability to give up approach, efficient resource use approach, ability to collect approach and comparison with average performance (stochastic) approach. Regressing the tax revenue to output ratio with other variables that affect tax revenue, is a method usually employed to measure tax performance (Bahl, 1971). In such cases, the regression coefficients act as average effective rates on the tax base. This tax performance method suggested by Hindrichs (1966) and Musgrave (1969) though very useful, is considered as static as its major strength is to reveal the potential of an economy for a tax increase at a given point. Nonetheless, the sensitivity and responsiveness of tax revenue to changes in income/GDP will be a better measure of the efforts a country has made to increase its tax revenue over some time. In the case of VAT, the responsiveness of VAT revenue to changes in the VAT base

will be a better measure of efforts made to increase the VAT revenue of a country. Musgrave (1959), explains that the tax revenue elasticity coefficient depends on the tax base, which is also determined significantly by changes in income. Thus, Musgrave (1959) suggests that the value of elasticity should be divided into two components, namely; (a) elasticity of the tax base to change in income; (b) elasticity of tax revenue to change in the tax base.

Since VAT is a tax on consumption and not on income, the VAT revenue elasticity will depend on the consumption or value of final goods and services only. This will mean that the VAT revenue coefficient will directly depend on the VAT Base – Total Personal Consumption or real GDP, whichever is selected as VAT base (Greene, 2014). Meanwhile, VAT is not a progressive tax. It is levied with a standard and flat rate, thus, a change in VAT base will easily cause VAT revenue to respond. In other words, there exists an elasticity of VAT revenue to changes in the VAT base (Musgrave, 1959).

2.2. Empirical Literature

Several research studies have been conducted to measure the elasticity of tax revenues. Osoro (1993) for the period 1979 to 1989 evaluated the implications of tax reforms on revenue productivity in Tanzania. Employing the proportional adjustment method, he estimated the tax revenue elasticity. The study revealing a tax revenue elasticity of 0.76 for Tanzania, concluded that tax reforms in Tanzania had failed in raising tax revenues. This failure was attributed to poor tax administration and government granting numerous tax exemptions within the aforementioned sample period.

Also, for a sample period, 1970 to 1980, Osoro (1995) in another study estimated the elasticity of the overall tax system and that of individual taxes. He found a decline from 0.85 in 1970 to 0.782 in 1980 of the overall tax system's elasticity. Osoro (1995) in his study further established that Import Duty though inelastic in the 1970s became elastic in the 1980s, and Income and Sales tax, though elastic in the 1970s also became elastic in the 1980s. These changes, Osoro (1995) attributed to two reasons; (a) steep depreciation of the exchange rate of Tanzania which altered the tax base, and (b) reduction in import duties which triggered a rise in imports.

The effects of tax reforms on tax yields in Malawi were studied by Chipeta (1998) for the period 1970 to 1994. The results of his study revealed an elasticity of 0.6. Chipeta (1998) thus concluded that the growth in the tax bases was less rapid than GDP.

Kusi (1998) also used the Proportional Adjustment method to evaluate the effect of tax reform on the revenue productivity of Ghana for the period 1970 to 1993. The result from his study indicated an elasticity of 0.71 for the pre-reform period (1970 to 1982) and 1.22 for the post-reform period (1983 to 1993). Laxity in tax collection, tax evasion, smuggling, and unrecorded trade was identified as the contributing factors to the inelasticity of the tax revenue to tax reform for the pre-reform period. Kusi (1998) concluded in his study that the reforms offered a significant contribution to the tax revenue productivity of Ghana for the period 1983 to 1993.

Twerefou et al. (2010) in their study, sought to estimate the elasticity of the Ghanaian tax system. Historical Annual 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. (2010) 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.

Basila (2010) in his study evaluated the relationship between VAT and GDP in Nigeria. He employed Pearson’s Product Moment Correlation (PPMC) using time series data set ranging from 1994 to 2008. The test revealed a strong positive correlation between VAT revenue and GDP (about 96% strength).

Irizepova (2016) used GDP as the base macroeconomic indicator to forecast annual Value Added Tax Revenues (Paid VAT and Invoiced VAT) for ten years (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), mentions that in selecting a proxy tax base, there should be a high correlation between observed tax revenue and the proxy tax base. Greene (2014) suggests that Private Consumption Expenditure, GDP, and Import Expenditure can be a proxy base for VAT. He adds that if significant VAT revenues are from the tourism sector, one must consider earnings from tourism. On this

basis of Greene's suggestion, this study explores the correlation between VAT revenue and Real GDP to determine the appropriateness of having Real GDP as VAT base for VAT revenue. A more appropriate benchmark or VAT base would be Total Private Consumption, which is an ideal VAT base for VAT revenue forecasting. However, since time series (monthly or quarterly) data on private consumption expenditure and data on monthly/quarterly purchases of exempt sectors are not available, any researcher who seeks a VAT base for VAT revenue modelling and forecasting (monthly or quarterly) may have to consider another variable with monthly or quarterly time series data available.

2.3. Critical Contribution

This study, converse to other studies that investigate the elasticity of tax revenues to tax reform (Osoro, 1993; Osoro, 1995; Ariyo, 1997; Kusi, 1998), explores the appropriateness of real GDP as VAT base and further, examines the elasticity of VAT revenue to real GDP from 2006 first quarter to 2017 fourth quarter which can be very helpful in forecasting quarterly VAT revenue.

3. Research Methodology

3.1. Linear Regression Model

A 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:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \dots + \beta_p X_{ip} + \varepsilon_i, i = 1, 2, \dots, n. \quad (1)$$

where Y_i is the response variable on the i^{th} observation, $\beta_0, \beta_1, \dots, \beta_p$ 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, Peck, & Vining, 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:

$$VAT Rev_i = \beta_0 + \beta_1 RGDP_t + \beta_2 Ceffi_t + \beta_3 EffRate_t + \beta_4 Corr_t + \varepsilon_t \quad (2)$$

where t represents time, which is from the 2002 1st quarter to 2014 4th quarter. $VAT Rev_i$ which is independent variable represents VAT revenues collected quarterly throughout the study period.

RGDP stands for the 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 an increase in Real GDP means an increase in expenditure which will increase revenues collected from VAT as VAT is a 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 is a broadly used measure of the efficiency of VAT administration. According to Keen (2013), C-efficiency reveals the extent to which 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, Nam & Parsche (2007) and De Mello (2009) to explore the determinants of VAT compliance. Other researchers including Jack (1996) and also Bird & 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:

$$Ceffi = (VAT Revenue \div Consumption Expenditure) \div Statutory VAT Rate$$

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 VAT revenue since the improvement in tax administration efficiency has a positive impact on VAT Revenue by reducing tax evasion and increasing VAT revenue (Engel, Galetovic & Raddatz, 2001). $EffRate$ represents the Effective VAT Rate of Ghana for the sample period. Greene (2014) presents the calculation of the Effective Tax Rate as follows:

$$Effective Tax Rate = Total Tax Revenues \div Tax Base$$

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

$$\text{Effective VAT Rate} = \text{Total VAT Revenues} \div \text{Tax Base}$$

According to Alm & El-Ganainy (2013) an increase in tax rate is associated with an increase in tax revenue, even though there will be a welfare loss in terms of a 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 the implementation of VAT policy. The Effective VAT rate will increase if the VAT revenue 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 VAT revenue, *ceteris paribus*. The latter instance reveals that broadening the tax base is ineffectual if it does not increase 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 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 while 0 is the highest level of corruption. High levels of corruption will decrease tax revenues in a country (Bird, Martinez-Vazquez, & Torgler, 2008; Sokolovska, 2015). Therefore, it is expected that as the corruption index increases (which means a low level of corruption) VAT revenue will increase, which means a positive relationship between the corruption index and VAT revenue is anticipated. It is thus expected that there would be a negative relationship between the level of corruption and VAT revenue.

3.2. Assumptions of the Model

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

3.3. 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 VAT Revenue and Real GDP and to know if Real GDP can be used as a proxy VAT base in Ghana. Greene (2014), states that in selecting a proxy tax base, there should be a high correlation between observed tax revenue and the proxy tax base. He suggests private consumption expenditure and GDP as proxy tax bases for VAT. Thus, if the analysis reveals a high correlation between VAT revenue and Real GDP in this case, the Real GDP may be accepted and recommended to be a VAT base in VAT revenue modelling and 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 which when produced may result in imprecise predictions. Ways to check for multicollinearity is to examine bivariate correlations between each of the predictor variables. For example, multicollinearity exists if bivariate correlations between the two predictor variables are above 0.7. The Variance Inflation Factor (VIF) if it is above 4 also confirms the presence of multicollinearity (Dormann et al, 2013). Green, Tull, & Albaum (1988) suggest 0.9 as the threshold of bivariate correlations. Tull & Hawkins (1990) also suggest 0.35 while Lehmann, Gupta & Steckel (1988) also suggest 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. Thus, in this study, 0.9 is the threshold of bivariate correlations.

3.4. 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.

H_0 : *The residuals exhibit no autocorrelation*

H_1 : *The residuals exhibit autocorrelation*

The rule of thumb is, fail to reject H_0 if $1.5 < DW < 2.5$ or $p\text{-value} > 0.05$. In the case where no autocorrelation is exhibited among the residuals, the OLS estimators are efficient in concluding the estimates of the linear regression. However, if the residuals exhibit autocorrelation, the OLS estimators are not efficient in concluding the estimates of the linear regression since there will be a need to include a dummy variable, estimate generalized least squares, or include a linear (trend) term if the residuals show a consistent increasing or decreasing pattern.

3.5. 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, there may be a need to investigate 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:

$$\ln Y_i = \ln(\alpha) + \beta \ln X_i$$

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

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

Therefore, instead of 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:

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

By differentiating the model above, we obtain

$$\frac{\partial Y}{Y} = \beta_1 \frac{\partial X}{X}$$

From the above, $\frac{\partial Y}{Y}$ is interpreted as the percentage change in Y while $\frac{\partial X}{X}$ it 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 the interpretations that may be given β_1 .

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

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 (fairly inelastic).

If $\hat{\beta}_1 = 1$, it means a percentage change of the independent variable will result in an equal percentage change in the dependent variable (unitary elastic).

Therefore, the magnitude of $|\hat{\beta}_1|$ is the level of elasticity between the dependent and independent variables.

3.6. Data Source for the Study

Quarterly VAT revenue data spanning from January 2006 to December 2017 was 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 the corruption index of Ghana was retrieved from the 2018 Transparency International's corruption perceptions index results table. Data on Effective VAT Rate was computed from the values of VAT Revenues and Final Consumption Expenditure, while C-efficiency data was also computed from VAT Revenue, Final Consumption Expenditure, and the Statutory VAT Rate over the sample period.

4. Results and Discussion

Simple regression analysis is fitted to explore the effect of Real GDP on VAT revenue.

4.1. Regression Analysis

In this section of the study, the effect of Real GDP, CEFF, CORR, and EFFVATRATE on Total VAT revenue received is 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 2 is the correlation matrix among the variables considered.

Table 2. Correlation Matrix

	VAT Revenue	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

From Table 2, Real GDP (0.9365), CEFF (0.9929), CORR (0.7373), and EFFVATRATE (0.9964) are all positively, strongly, and linearly related to VAT Revenue. However, there is a 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, and 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. This may be misleading and large standard errors may be produced in the related independent variables. The scatter plot showing the strength of the correlation is presented in Table A1 in the Appendix. To ascertain the presence of

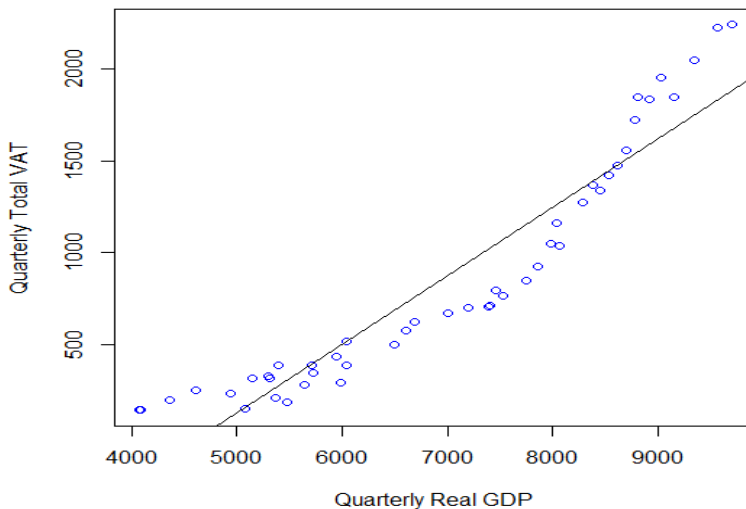
multicollinearity, the variance inflation factors of the variables are explored. This is presented in Table 3 below:

Table 3. Variance Inflation Factor (VIF)

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

Multicollinearity is confirmed by the presence of high VIF amongst variables. From Table 3, 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 are dropped. However, to explore the effect of real GDP on VAT Revenue, real GDP is retained, and the other variables with high collinearity are dropped. A simple regression analysis where VAT Revenue is the dependent variable with the Real GDP being the independent variable is therefore fitted. The estimate of the coefficient is presented in Table 3.

Figure 1. Scatter Plot of Real GDP and Total VAT Revenue



From Figure 1 above, there is a strong positive linear correlation between VAT Revenue and Real GDP. The correlation coefficient between VAT Revenue and Real GDP is assessed and it is presented in Table 2. Indeed, there is a strong positive correlation between VAT Revenue and Real GDP indicated by a correlation coefficient of 0.9365 (Table 2). This is analogous to the study conducted by Basila (2010) on the relationship between VAT and GDP in Nigeria which also revealed a strong positive correlation between VAT revenue and GDP (about 96% strength).

The strong positive correlation between VAT Revenue and Real GDP of Ghana justifies using GDP as VAT base in VAT revenue modelling and forecasting as it agrees with Greene (2014), that there should be a high correlation between observed tax revenue and the proxy tax base.

A simple regression analysis where VAT Revenue is the dependent variable with the Real GDP being the independent variable was therefore fitted. The estimate of the model coefficient is presented in Table 4.

Table 4. Regression Model and Diagnostics

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

Note: $R^2=0.8913$, F-statistic=377.3, p-value=0.0000

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

$$VAT\ Revenue = -1738.00 + 0.3728RealGDP$$

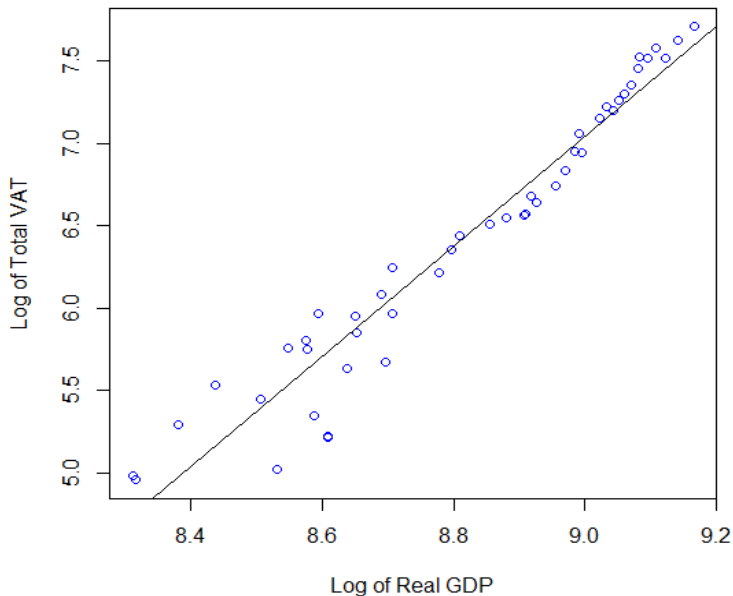
From the model, it is estimated that on the average, a unit change in Real GDP, will trigger a 0.3728 increase in the VAT Revenue. Furthermore, the model explains about 89.1% of the changes in VAT Revenue. From the residual plot (Figure A2, Appendix), the normal Q-Q plot appears to be approximately linear indicating goodness-of-fit. Also, the residual appears to be on a horizontal band (from the residual vs fitted plot), thus, there is a constancy of variance. Besides, the standardized residual plot indicates that there are no outliers. There is no observation beyond the bounds of the cook's distance which implies there are no influential outliers. Furthermore, a formal test on normality and constancy of variance was performed and presented in Table A1 (Appendix). From this test, the Lilliefors normality test indicates that the residuals follow the normal distribution (p-value greater than 5%). Also, the constancy of variance is confirmed through

the Breusch Pagan test (p-value greater than 5%). Therefore, the model is appropriate for prediction purposes.

4.2. 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 H_0 as there is sufficient evidence to suggest that there is no first-order autocorrelation as evident from the Durbin Watson analysis as well. See Table A4 of the Appendix.

Figure 2. Scatter Plot of the log of Real GDP and the log of Total VAT Revenue



From Figure 2, 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 below.

Table 5. Regression Coefficient of Log-Log Model

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

Note: $R^2=0.9401$, F-statistic=706.5, p-value=0.0000

Here, the elasticity is 3.3373, thus, for a one percent increase in Real GDP, there is an associated 3.73373 percent increase in VAT Revenue on the average. This implies that VAT is fairly elastic to changes 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).

4.3. Summary

In the analysis of the effect of real GDP on VAT revenue and the correlation that exists between them, it is realized that a unit change in Real GDP, will trigger a change of 0.3728 in the Total VAT. In terms of elasticity, it is 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 is 0.89. Therefore, the regression model explains about 89.1% of the variation in VAT Revenue in Ghana. Also, a very high correlation of 0.9365 is realized between Real GDP and Total VAT Revenue as shown in the correlation of matrix of table 1.

5. Conclusion and Policy Suggestions

Realizing the significant effect of Real GDP on VAT Revenue and the high correlation that exists between the two variables, the study concludes that it is appropriate to use Real GDP as a VAT Base in VAT Revenue modelling and forecasting. Also, since the elasticity coefficient of 3.73373 realized from the results is greater than 1, we conclude that VAT revenue is fairly elastic to changes in Real GDP/economic growth.

The appropriateness of using real GDP as VAT base has been bolstered by its strong correlation with VAT revenue revealed in this study. This will thus make forecasting quarterly VAT revenue for short-term planning and preparation of half-year budgets feasible, to reduce the recurring budget deficit and to bring the fiscal profile of the economy of Ghana to an acceptable level. The elasticity of VAT revenue revealed in the results of the study (fairly elastic) implies that the percentage increase in tax revenue will be greater than any increase in real GDP in Ghana. In other words, economic growth in Ghana will result in greater growth in VAT revenue. This suggests to the government of Ghana to implement policies that will expedite rapid economic growth.

Since monthly and/or quarterly data on private consumption expenditure is not available in Ghana, to make quarterly forecasts of VAT revenue with a model that requires a VAT base, real GDP should be considered and used as VAT base. This is because there is a high correlation between Real GDP and VAT Revenue. Also, because VAT revenue is fairly elastic to changes in Real GDP/economic growth, the government of Ghana should implement supply-side policies that will boost investment and production, reduce imports and encourage import substitution and also demand-side policies that will increase aggregate demand. These policies will expedite rapid economic growth, and an increase in Value Added Tax revenue will be a consequent result.

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APPENDIX

Figure A1. Scatter plot of variables

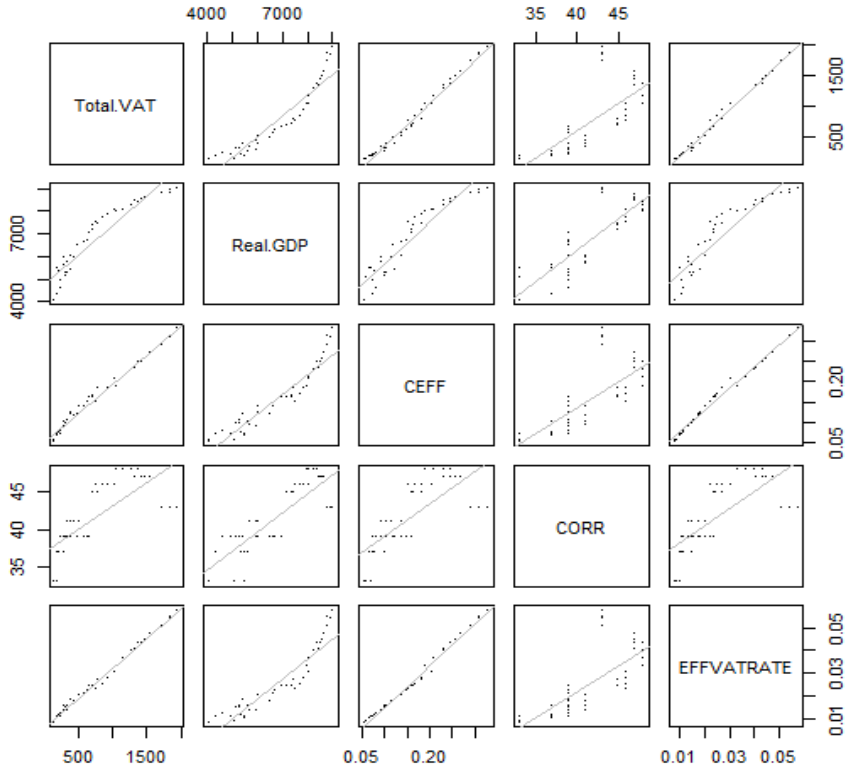
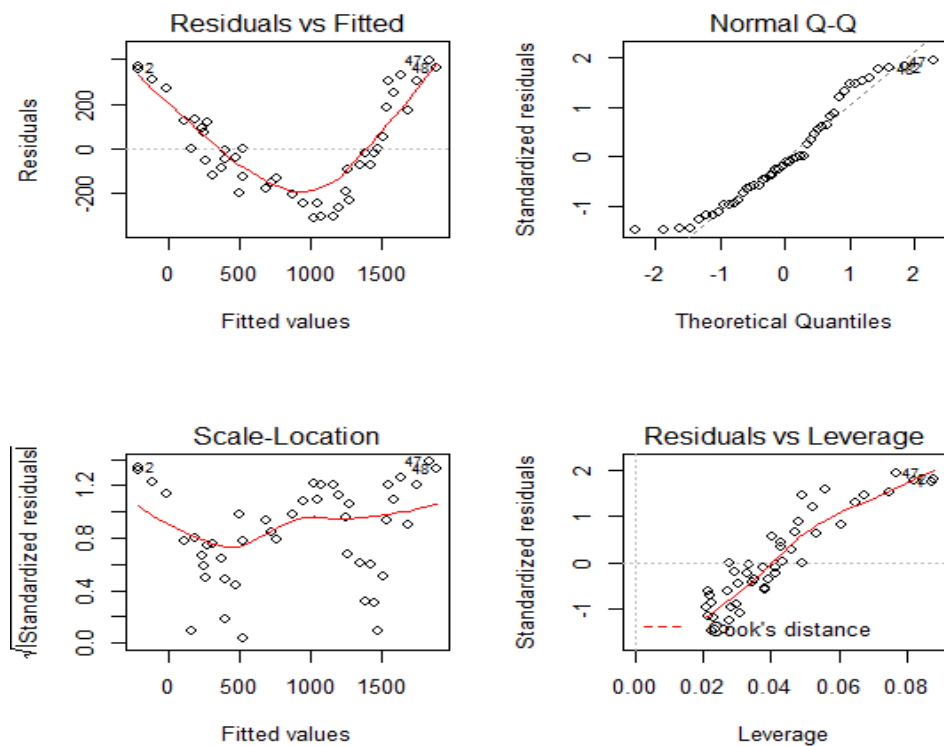


Table A1. Test of Assumptions

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

Figure A2. Residual Plot of the Regression model**Table A2.** Durbin-Watson Test for Autocorrelation

Durbin-Watson Test Statistic	P-value
2.1050	0.9765