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# An Assessment of the Efficiency in the Collection of Value Added Tax Revenue in Tarkwa-Nsuaem Municipality (Ghana) Using Time Series Model

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**Abstract**

The collection of Value Added Tax revenue has become a source of worry not only to the Government but to the nation as a whole. Various techniques have been employed to determine the efficiency in the mode of collection of Value Added Tax revenue to ascertain the true volume of revenue generated in the VAT sector within a given period. Unfortunately, the expected annual revenue from VAT has never been realized, a reason being ineffective mode of collection. In this paper, questionnaire administration and interviews were used to study five hundred and twenty businesses in the Tarkwa-Nsuaem Municipality in the Western Region of Ghana. The interview centered on the business that always issue VAT receipts to the customers and the business which does not often issue VAT receipts. The revenue data of four years from January 2007 to December 2010 for the analysis was obtained from the VAT head office in the Tarkwa –Nsuaem Municipality in the Western Region of Ghana. The rate of increase in VAT revenue in each year is compared with the results from the interview to assess the efficiency in the mode of collection. SPSS was used to investigate the autocorrelation and partial autocorrelation graphs to establish the appropriate model. The paper established that the efficiency in the mode of collection of VAT revenue in the Tarkwa-Nsuaem Municipality was beyond average.

***Keywords:*** *ARIMA models, Time Series, Linear regression, VAT Revenue, Businesses issuing VAT receipts,*

## Introduction

Under the Value Added Tax (VAT) Act 1998, Act 546, VAT is a general tax on consumption expenditure. It is a consumption tax that taxes the value added by businesses at each point in the production chain and applicable to both manufactured goods and services. Value Added Tax revenue is one of the most promising incomes that the government depends largely on for its budgets. As it stands Government cannot ascertain the true volume of revenue generated in the VAT sector within a given period. It is therefore prudent for the government to ascertain the volume of revenue that can be generated in the VAT sector within a given period in other to factor it into its budgets proposals. It has undoubtedly become imperative to put forth some quantitative arrangements or measures that would help to assess the efficient and prudent way of collection of VAT revenue.

Time series and regression analysis are widely applied techniques and are of great interest for use in business problems in mathematics. Regression analysis is used since it is one of the statistical tools which can be used to solve common business problems and provides a very powerful means of ascertaining whether or not there is association between the separate events. The concept of time series and regression analysis is not new. These concepts have gained importance and popularity during the past four decades or more as a result of their demonstrated applications in many diverse fields of business mathematics and econometrics. Research works by many Mathematicians such as Box and Jenkins (1984), Borghers and Wessa (2009) have demonstrated that Time series model has the largest literature and number of application of any approach to forecasting, indeed, production, planning, inventory management, sales marketing and distribution all depends on the accurate, short term time series model. The Box-Jenkins classical ARMA models were used to tests the stationarity of the time series. This method was necessary as a result of the previous works carried out by some researchers who employed the same techniques. For instance, in United State of America policymakers were asked whether the strength in federal revenue was likely to continue. Andrew et al., (2007), addressed U.S. policy makers question through an econometric analysis of the determinants of tax revenue, using time series that were adjusted for tax policy changes. Their results suggested that growth in corporate profits and capital gains each contributed fourty percent of the increase in the revenue-to-GDP ratio from 2004-2006. Revenue data frequently arise in the form of concurrent time series. Jeffery et al., (1991) presented a general framework for simultaneous modeling and fitting of such series using the class of Box - Jenkins models. This framework was an exchangeable hierarchical Bayesian model incorporating dependence among the series.

Autoregressive Integrated Moving Average (ARIMA) models normally describe the current behaviour of variables in terms of linear relationships with their past values. An ARIMA model is classified an "ARIMA (p,d,q)" model. These models are called Box-Jenkins (1984) models as results of the authors' pioneering work regarding time-series forecasting techniques. An ARIMA model can be decomposed in two parts. First, it has an Integrated (I) component (d), which represents the amount of differencing to be performed on the series to make it stationary. The second component of an ARIMA consists of an ARMA model for the series rendered stationary through differentiation. The ARMA component is further decomposed into AR and MA components. The autoregressive (AR) component captures the correlation between the current value of the time series and some of its past values. The Autocorrelation Function (ACF) and Partial Autocorrelation Function (PCF) are used to estimate the values of p and q. Where p is the number of autoregressive terms and q the number of lagged forecast errors in the prediction equation.

This study was done at Tarkwa a town situated in the southwest of Ghana, located about 120 miles west of Accra with an estimated population of 40,397 as at 2005 and the largest gold mine in Ghana. *(www.ghanadistrict.com/districts)*. This paper therefore investigates efficiency of the mechanism for collection of VAT revenue in Tarkwa-Nsuaem Municipality using time series and regression analysis. To help government ascertain the true volume of revenue generated in the VAT sector, the paper establishes the fitted model that will help the government to forecast the volume of

VAT revenue that can be generated within any period. This however, can only be achieved if discrepancies that occur in the revenue are carefully monitored by the officers at the helm of affairs. The purpose of this paper is to establish the sanity and efficiency in the collection of VAT revenue using time series and regression analysis as a result of its many applications. The study is of the view that VAT is a major source of tax revenue in the country (Ghana) therefore proper studies and analysis must be carried on its operation to assist the authorities to play proper supervisory role.

The motivating data set consists of VAT revenue available monthly for only one Municipality. The Box-Jenkins methodology that serves a statistical way of analyzing and building a forecasting model which best represents time series was utilized as it has a number of advantages over other methods of time series analysis. An ARMA model that predicts the value of the target variable as a linear function of lag values plus an effect from recent random shock values was also used. The SPSS was later used to investigate the autocorrelation and partial autocorrelation correlograms and this help in the identification of the exact model.

**Field Investigations**

The study was conducted in Tarkwa a town situated in the southwest of Ghana, located about 120 miles west of Accra. As of 2005, it was estimated to have a population of 40,397. Its geographical coordinates are 5° 18' 0" North, 1° 59' 0" West and is the largest gold mine in Ghana.


Fig. 0, A map of Tarkwa-Nsuaem Municipality.

**Materials and Method**

The data for this study was obtained from the VAT head office in the Tarkwa- Nsuaem Municipality in the Western Region of Ghana. The data collected was on the VAT revenue generated on the monthly basis for the period of four years from January 2007 to December 2010. A simple random technique was used to select the businesses. Five hundred and twenty businesses were interviewed on how often they issue VAT invoices to the customers for the period of four years. Hundred businesses were interviewed in 2007, one hundred and twenty in 2008. One hundred and fourty in 2009 and one hundred and sixty in 2010. The study increased the number of businesses by twenty percent (20%) each year. The objective of this constant value was to establish the consistency in the revenue generated each year. In this method, the observations of the variables are used to calculate the line of best fit so that one can make estimates and predictions about the variables. The study considered the revenue accrued from VAT as the dependent variable and the businesses issuing the VAT as the independent variable. The relationship between one dependent variable and one

independent variable however, paved way for simple regression. Thus, the possible effects of other independent variables were ignored but how the VAT revenue generated was related to the number of businesses issuing VAT receipts to assess efficiency in the mode of collection. The estimation of regression coefficient and coefficient of determination were dealt with. The regression coefficient indicates the change in the estimated value of dependent variable for a unit change in the independent variable. The positive regression coefficient indicates positive relationship between VAT revenue and the number of businesses issuing VAT receipts which portrays proper efficiency in the mode of collection. Indeed, regression is based on the assumption that the functional relationship between two or more events can be identified and quantified. This functional relationship between the two events was however, represented by a straight line. It holds that as the independent variable changes, the dependent variable changes by a constant. The coefficient of determination measures the percentage of the total variation in the dependent variable that is explained by the variation in the independent variable. The regression analysis was supported by ARMA model in time series. The time series showed the inconsistencies or the fluctuations in the VAT revenue generated each year. Time series and regression analysis were used as the statistical tool for analyzing the data. The data was later tested for stationarity and Box-Jenkins classical ARMA models were fitted to the series. SPSS was used to investigate the autocorrelation and partial autocorrelation correlograms to help in the identification of the exact model.

**Results and Discussions**

A total of five hundred and twenty businesses were interviewed on how often they issue VAT receipts to the customers for the period of four years. A randomly selected particular number of businesses were interviewed for the study. In 2007 one hundred businesses were interviewed, one hundred and twenty businesses in 2008, one hundred and fourty in 2009 and one hundred and sixty in 2010. The study increased the number of businesses by 20% in each corresponding year to access the consistency in the revenue generated. The results were analysed using time series and regression model as shown in the tables below.

**Table 1. Number of businesses interviewed and the responses.**

| Year | Number of business interviewed | Business that always issue VAT receipts | Business that does not often issue VAT receipts | ean |
|---|---|---|---|---|
| 2007 | 100 | 65 | 35 | 0 |
| 2008 | 120 | 81 | 39 | 0 |
| 2009 | 140 | 85 | 55 | 0 |
| 2010 | 160 | 112 | 48 | 0 |

| | | | | |
|---|---|---|---|---|
| **Total** | **520** | **343** | **177** | **60** |

**Table 2. VAT revenue generated in four years**

| | **2007** | **2008** | **2009** | **2010** |
|---|---|---|---|---|
| **January** | 232023.75 | 325510.87 | 351759.68 | 613528.32 |
| **February** | 300958.53 | 225746.87 | 350180.45 | 520170.35 |
| **March** | 296821.83 | 554293.35 | 510173.59 | 840522.58 |
| **April** | 292075.12 | 348612.71 | 686449.69 | 572570.37 |
| **May** | 271279.49 | 634437.55 | 571346.03 | 601126.82 |
| **June** | 239409.81 | 448244.28 | 733019.19 | 629637.54 |
| **July** | 237087.23 | 512006.55 | 468393.50 | 600608.82 |
| **August** | 161622.77 | 584524.13 | 462267.89 | 781699.45 |
| **September** | 368609.24 | 404901.40 | 419054.81 | 756963.96 |
| **October** | 314100.50 | 633804.36 | 665329.29 | 827263.11 |
| **November** | 311095.07 | 360256.97 | 697995.17 | 645177.37 |
| **December** | 409019.22 | 384106.68 | 433613.71 | 582293.80 |
| **Total** | **3454102.56** | **5416445.72** | **6349583** | **7971562.49** |
| **Mean** | **286175.21** | **451370.48** | **529131.92** | **664296.87** |

**Table 2. VAT revenue generated in four years**

| | **Minimum** | **Maximum** | **Mean** | **Standard deviation** |
|---|---|---|---|---|
| **VAT** | **161622.77** | **840522.58** | **566285.29** | **175043.8** |

The analysis conducted on the data collected as shown in Table 2 revealed that between Jan. 2007 to December 2010, Tarkwa Municipality generated an average VAT revenue of GH¢ 566285.29. This indicates that the expected VAT revenue per month in Tarkwa Municipality should hover around GH¢566,285.29.The values GH¢ 161622.77and GH¢840522.58 which served as the minimum and the maximum VAT revenue returns respectively in Table 3 during the period under study show the worst and highest VAT revenue that were generated in Tarkwa Municipality within a particular month in the year. The recorded values of minimum and maximum revenue occurred in August 2007 and March 2010 respectively. The standard deviation of GH¢ 175043.8 indicates how monthly revenue generated

fluctuates around the average or mean returns. The value GH¢ 175043.8 is the total variation and it's include other factors which were not considered for the revenue generated. The standard deviation is too large to have occured by chance. These indicate that there may be some problems in the collection of VAT revenue. Figure1 shows a graph in which the slope is greater than zero thus, from Table 4,R = 0.991 indicating the positive relationship that exists between VAT revenue and the number of businesses issuing VAT receipts. The value of 0.991 is fairly close to one, indicating how strong the association is. Thus as the number of businesses increases VAT revenue also increases. Indeed, when the number of businesses issuing VAT receipts was increased at constant interval, VAT revenue exhibits some degree of randomness. Thus there were some errors in the VAT revenue. In other words, VAT revenue yielded different values at different points.

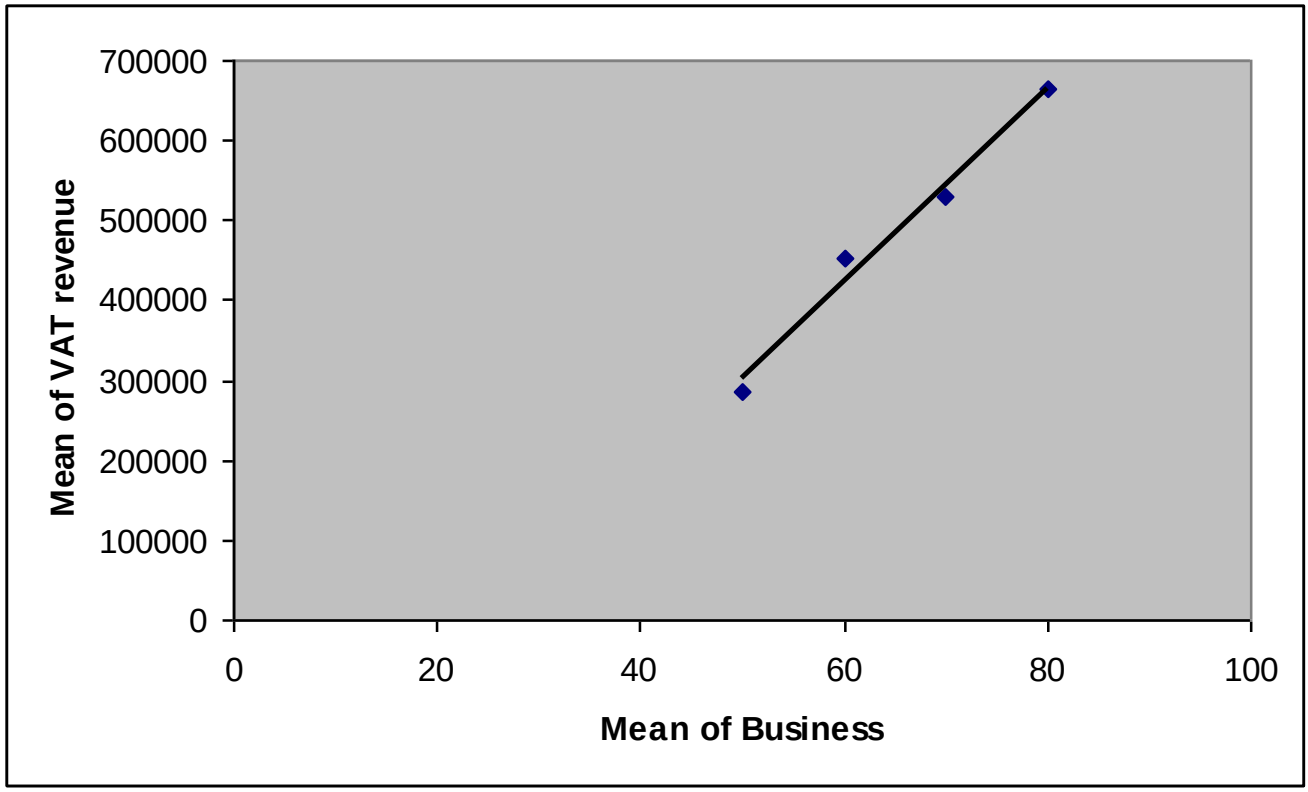


**Fig 1. Mean of VAT Revenue Versus Mean of Business**

## Table 4. Model Summary -Predictors: (Constant), Mean of Business

| Mode | R | R Square | Adjusted Square | Std. Error of th Estimate |
|---|---|---|---|---|
| 1 | .991[a] | .983 | 974 | 25242.30361 |

These errors, measured by the standard error of the estimate showed a value of 25242.30361 as displayed in Table 4. The standard error of the estimate gauges the variation of VAT revenues above and below the regression line. The R-square = 0.983 is the coefficient of determination and it measures the percentage of total variation in the VAT revenue that is accounted for by the variation in the number of businesses issuing VAT receipts.

Figure 2 displays how the VAT revenue data generated behaves within equally spaced time interval. From the diagram it was observed that there was no form of seasonality nor periodicity but only an upwardly moving trend. The trend and the variance (amplitude) increase with time. This is nonseasonal time series consisting of VAT revenue data. There is no differencing therefore it suggests an ARIMA (0,0,0) model. An indication that greater portion of the monthly revenue specifically, from June 2008 generated alternates around the mean. Thus it fluctuates upwardly and downwardly around its long mean.

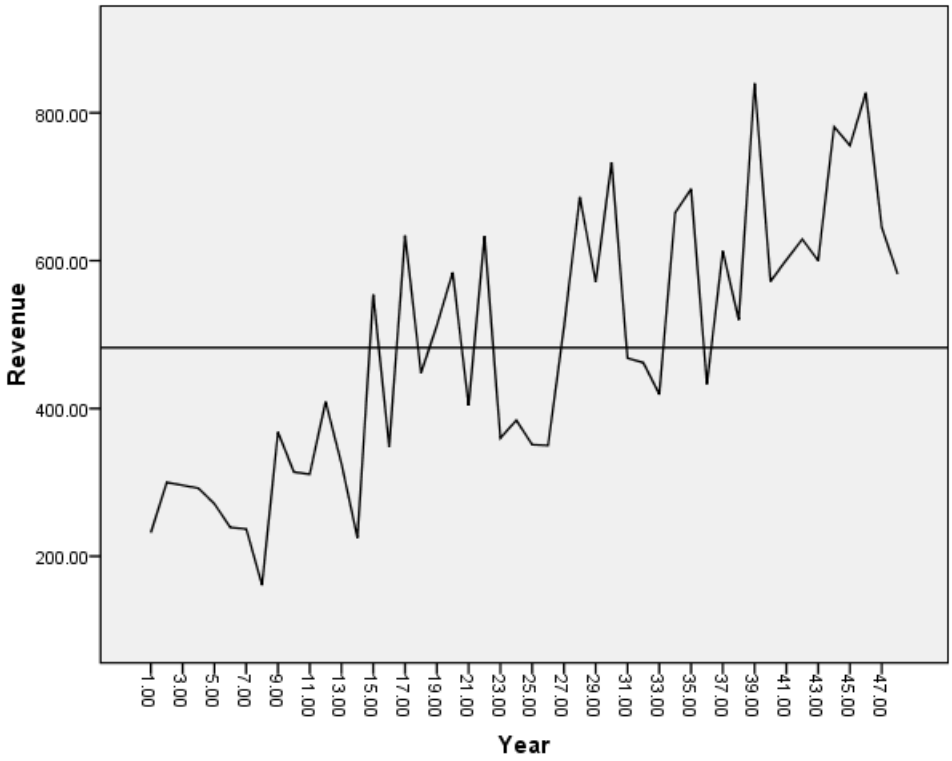


**Fig 2. Trajectory of VAT revenue generated in Tarkwa Municipality from Jan 2007 to Dec 2010**

To identify the appropriate ARIMA model for the VAT revenue there is the need to identify the orders of differencing needing to stationarize the series and remove the gross features of seasonality in conjunction with variance to stabilize the transformation. There is therefore the need to difference the data values to attain stationary or find the average value. The differenced diagram is shown in Fig 3.

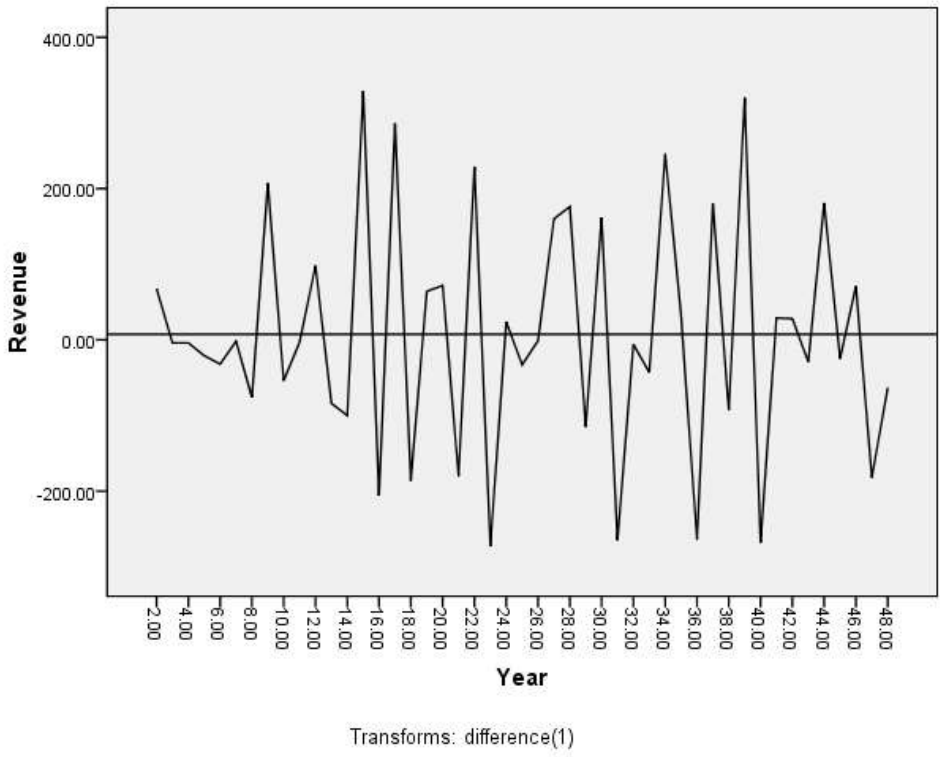


**Fig 3.Trajectory of Differenced VAT revenue generated in Tarkwa Municipality from Jan 2007 to Dec 2010**

Figure 3.is the trajectory of the stationary differenced VAT revenue data set. This has no form of periodicity or seasonality but only mimics the pattern of a random sequence. The Autocorrelation function (ACF) and Partial Autocorrelation function (PACF) graphs of the differenced data are shown below. .

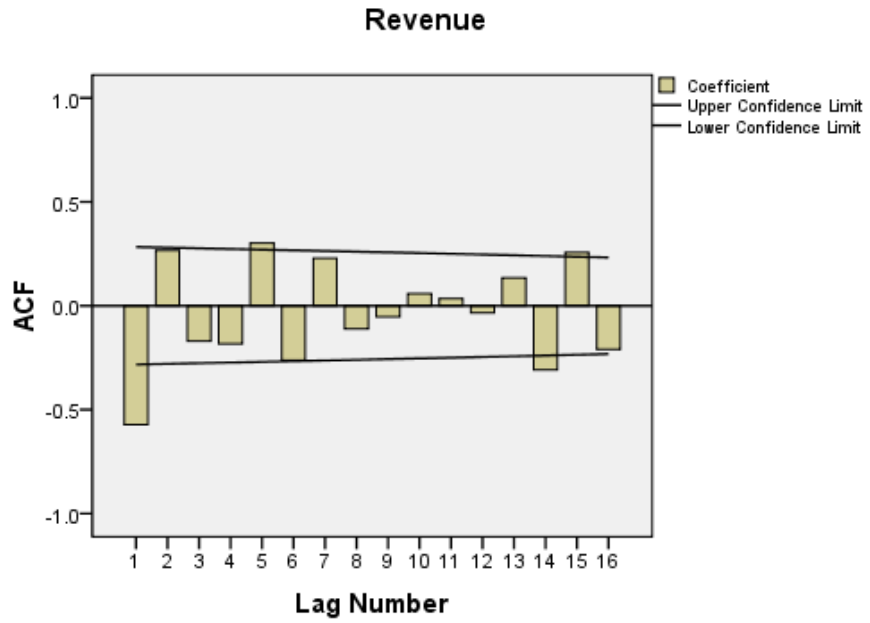


**Fig. 4**

ACF of differenced data of revenue generated in Tarkwa Municipality from Jan 2007 to Dec. 2010

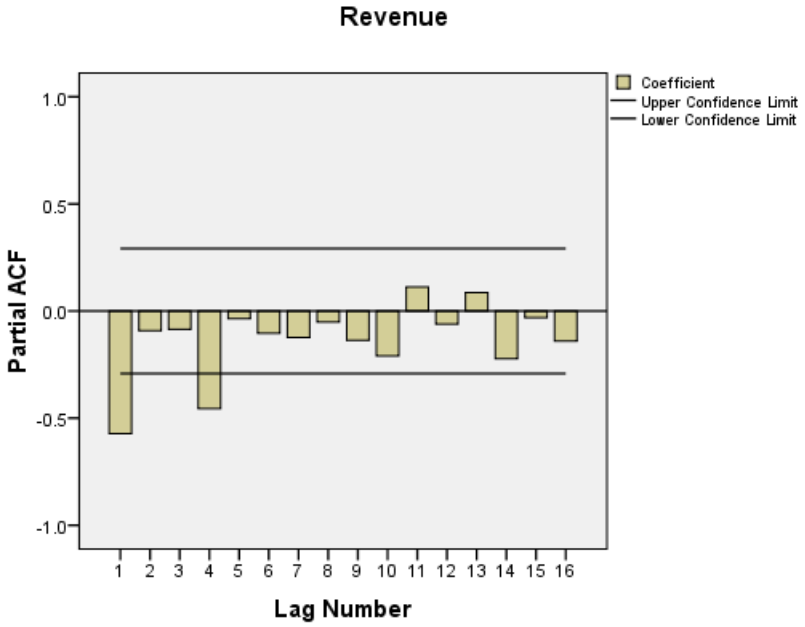


**Fig.5 PACF of differenced data of Revenue generated in the Tarkwa Municipality from Jan. 2001 to Dec. 2010**

From the above correlograms, it was observed that the Autocorrelation Function (ACF) of the differenced data set truncates or cut off after time lag one (1). Thus, the serial dependencies changes after the first differencing with lag one. That is, the sample ACF of VAT revenue decays very slowly, while the corresponding PACF shows only one very significant contribution at the first lag. At the same time, for the time series of the first difference, the ACF cuts off after the first lag, while the PACF cuts off after only two significant contributions. Since there is only one nonseasonal difference, the model is classified as an ARIMA ( 0,1,0) from Box-Jenkins (1984). The first order differenced autoregressive model therefore is ARIMA (1,1,0),an indication that there is close relation between the VAT revenue and the number of businesses issuing VAT receipts. Indeed, the autocorrelation for consecutive lags are supposed to be dependent. From Table 2, the first revenue is closely related to the second and the second also closely related to the third and so are the others. This implies that the pattern of serial dependencies can change considerably after removing the first order autocorrelation.. The Partial Autocorrelation Function (PACF) of the differenced data which enables observation of a clear picture of the serial dependencies for individual lags however seems to trail to zero (0) quickly. Indeed, lag one suggests that the partial autocorrelation is almost equal to autocorrelation. Since difference one was considered, the most preferable model might be obtained by choosing ARIMA (1,1,0) with respect to other highly probable practical models. Classical Box-Jenkins ARMA models only work satisfactorily with stationary time series. Therefore it was prudent to perform transformations on nonstationary time series to make it stationary from Box-Jenkins (1984).

**The Simple ARIMA Model**

From Fig 4 and Fig 5, the decaying pattern of ACF and the PACF of the first-differenced of VAT revenue was observed with reasonable cut-off points. The errors of the random walk are

correlated therefore the problems can be fixed by adding one lag of the dependent variable to the prediction equation. This suggests an ARIMA (1,1,0) structure. It implies the following evolution equation $Y_t = \mu + Y_{(t-1)} + \phi(Y_{(t-1)} - Y_{(t-2)})$ where $Y_t$ represents the VAT revenue, $\phi$ the autoregressive coefficient in keeping with the terminology for ARIMA models popularized by Box and Jenkins (1984) and $\mu$ the constant term is the average difference in $Y_t$. Thus, average difference in VAT revenue generated.

**Conclusion**

The collection of VAT revenue in the Tarkwa Municipality has been investigated..Linear regression was used to estimate linear relationship between VAT revenue and number of Businesses issuing VAT receipts. Indeed, there was positive relationship between VAT revenue and Businesses issuing VAT receipts which displays efficiency in the mode of collection of VAT revenue in Tarkwa-Nsuaem Municipality. The non zero value for the regression coefficient indicates that as the number of businesses issuing VAT receipts increases, VAT revenue also increases. It was realized that an increase in the number of businesses issuing VAT by one, leads to an estimated increase of GH¢ 0.991 in VAT revenue. Thus for each additional increase in the number of businesses issuing VAT receipts the revenue is expected to increase by GH¢ 0,991 per year. The study used constant interval of numbers for the Businesses issuing VAT receipts but observed disparities in the revenue generated, although the VAT rate remains the same. It was further justified by the standard error of the estimates of 25242.30361 which provided the dispersion about the regression line, an indication of the variation of VAT revenue above and below the regression line. The coefficient of determination provided a value of 0.983. This clearly showed that 98.3% of the total variation in VAT revenue is accounted for by the variation in the number of Businesses issuing VAT receipts. Since 98.3% of the total variation in the VAT revenue was accounted for by the variation in the number of Businesses issuing VAT receipts, the paper can therefore put out strong argument that there is strong efficiency in the collection of VAT revenue in Tarkwa-Nsuaem Municipality, although more can be done to improve the efficiency. The authorities concerned can therefore develop a strategy to step up their mode of collection to assist the Nation to generate huge revenue. It was also observed that the simple ARIMA model provided an evolution equation with a simple interpretation. Thus the VAT revenue at any time can be estimated before the actual collection is done. This however, will assist the revenue authorities in Tarkwa-Nsuaem Municipality to determine the relationship between the new and the preceding VAT revenues collected and assist them to predict in advance the expected revenue in order to check the efficiency in the mode of collection in the subsequent years.

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