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Stochastic Time Series Analysis of Major Trading Currencies in Ghana

Eunice Osei-Asibey[1], Ezekiel N. N. Nortey[1*], & Ebenezer Okyere [2]
[1]Department of Statistics, University of Ghana, P. O. Box LG 115, Legon-Accra, Ghana
[2]Bank of Ghana, Research Department, P. O. Box GP 2674, Accra, Ghana
*Corresponding Author

Abstract

Most central banks' policy initiatives throughout the world have been aimed at achieving and maintaining price stability and in Ghana; the Bank of Ghana is no exception. The exchange rate of the GH cedi to the U.S. Dollar, Japanese Yen, C.F.A., Pound Sterling and the Euro (major trading currencies) are not normalized (i.e. it fluctuates with upward tendencies) in the country. In recent years, a number of related formal models for time-varying methodologies have been developed. The study uses Box-Jenkins Autoregressive Integrated Moving Average (ARIMA) approach to mathematically fit models that describe the monthly trading currencies between the Ghana Cedi against the major trading currencies. We then forecast one year ahead and compare the predictive powers of the models. This study attempts to outline the practical steps which need to be undertaken, in order to use the ARIMA model for forecasting changes/variabilities in the major trading currencies in Ghana which then helps in predicting inflation to near perfection. All the five major trading currencies used were ARIMA (1, 1, 0). They all fitted well with the exception of the C.F.A. This may be attributable to the re-denomination of the Cedi in July, 2007. Also none of the models were seasonal and the predominant components were trend and random variation.

Keywords: Stochastic Models; Autoregressive Integrated Moving Average (ARIMA) Models; Forecasting.

INTRODUCTION

Foreign exchange has been the focal point of the global community since trading has developed from batter system, through to goods and service etc. Foreign exchange is now a worldwide decentralized financial market for trading currencies. Financial centers around the world function as anchors of trading between a wide range of different types of buyers and sellers around the clock in which the foreign exchange market determines the relative values of different currencies.

During the colonial era, the colonial government restricted itself to monetary stability and monetary growth. Banking was established with the object of providing banking services for the British trading enterprises and the British Colonial Administration.

The West African Currency Board (WACB) was operated as a central bank operating a Sterling Exchange Standard through a guaranteed convertibility of the West African pound to sterling in the year 1912 to 1957. Though the WACB was not having any central banking functions, nor exercise control over the volume of currency issue and supplied, the WACB operated as a bureau exchanging West African currency for sterling and vice versa and accounting for such activities (Mensah et al 1997).

Foreign exchange market was modernized and formed during the 1970's after three decades of government restrictions on foreign exchange transactions. The foreign exchange assisted international trade and investments and also support direct speculation in the value of currencies as well as the change in interest rates in two currencies.

An appropriate exchange rate has been one of the most important factors for the economic growth in the economies of most developed countries whereas a high volatility or inappropriate exchange rate has been a major obstacle to economic growth of many African countries like Ghana.

Some previous studies suggest that variations in an exchange rate has the potential to affect a country's economic performance, LDC's (Less Developed Countries') have received less attention compared to industrialized or developed economies (Osei - Assibey, 2010) though the volatile nature of exchange rates has been the focus of many researchers. Again,(Richard, 2007), in his own Report, said "Volatility plays a very important role in any financial market around the world, and it has become an indispensable topic in financial markets for risk managers, portfolio managers, investors, academicians and almost all that have something to do with the financial markets.

Many researchers attribute interest in exchange rate volatility to the fact that it is empirically difficult to predict future exchange rate values (Mishra et al, 2001). Past behaviours of the Cedi to major trading currencies thus U.S.Dollar, Pound Sterling and Euro is crucial and this has been linked largely to the financial system underdeveloped and the exchange rates market. The bilateral trade deficit between Ghana and the other countries or in the context of global imbalances has been the focal point of the global community in the exchange rate regime of the country.

Ghana being one of West Africa's most popular tourist destinations is filled with interesting historical sights, lots of culture, colorful festivals, good beaches and decent wildlife parks. Due to this, people move from all walks of life to the country. These people have to change their currency to the GH¢ in order to enjoy their stay since they cannot use their currency in Ghana here. And this paves way ending up in currency trading.

It is interesting therefore to investigate whether correcting the exchange rate system could solve some of the structure rigidities, trade imbalances, slow growth performance of the Ghanaian economy, this is because inappropriate exchange rate policies negatively affect imports, exports, investment, technology transfer and the ultimately economic growth.

The liquidity of the market, especially which of the major currencies, helps ensure price stability and narrow spreads. The liquidity comes mainly from banks that provide liquidity to investors, companies, institutions and other currency market players.

The combination used in the buying of one currency and selling of another one simultaneously on a currency trade is known as a ‘cross’ (e.g. The Euro against the U.S.Dollar, Great Britain Pound sterling against the Japanese Yen). And the currencies commonly traded with are the so – called ‘majors’ – U.S.Dollar against the Japanese Yen, U.S.Dollar against the Ghana Cedi, Great Britain Pound sterling against the U.S.Dollar, etc.

Trading the “majors” is cheaper than trading other “cross” because of the high level of liquidity. The liquidity of the market, especially which of the major currencies, helps ensure price stability and narrow spreads. The liquidity comes mainly from banks that provide liquidity to investors, companies, institutions and other currency market players.

The interest rate differential doesn't usually affect trade considerations unless you plan on holding a position with a large differential for a long period of time. The interest rate differential varies according to the ‘cross’ you are trading. For example, the interest rate differential is quite small, whereas the differential on Great Britain Pound sterling against the Japanese Yen is large. It may work for or against you when you make a trade which has both a positive and a negative interest rate differential. Many banks and forex bureaus in the country hold foreign currencies, enabling them to continue to be trade since the majority of trading on a particular currency occurs when its main market is open.

Certain currencies have very low rates of demand for exchange purposes. As a result, these currencies can be difficult to trade and are usually traded in specific banks. Because currency trading does not take place on a regulated exchange, there is no assurance that there will be someone who will match the specifications of your trade. However, the major currencies in Ghana, such as the American dollar, the euro and the Japanese yen, pound sterling, CFA are the most widely available.

Exchange rate changes affect the competitiveness of firms through their impact on input and output price, Joseph, (2002). He said when the exchange rate appreciates, since exporters will lose their competitiveness in international market, the sales and profits of exporters will shrink and the stock prices will decline.

Aggarwal, (1981) also stated that the currency appreciation has both a negative and a positive effect on the domestic stock market. He explained that exchange rates can affect stock prices not only for multinational and export oriented firms but also for domestic firms. For a multinational company, changes in exchange rates will result in both an immediate change in value of its foreign operations and a continuing change in the profitability of its foreign operations reflected in successive income statements. Again, he said the changes in economic value of firm’s foreign operations may influence stock prices. Domestic firms can also be influenced by changes in exchange rates since they may import a part of their inputs and export their outputs. Therefore he concluded that a devaluation of its currency makes imported inputs more expensive and exported outputs cheaper for a firm.

Devaluation will make positive effect for export firms and increase the income of these firms consequently, Wu (2000) said, boosting the average level of stock prices for an export-dominant and an import-dominated country, respectively likewise Ma and Kao (1990).

Historical efforts regarding the exchange rate are more focused on the effect from announcement. Anderson et al (2002) added up in their paper by used of a newly constructed dataset consisting of six years of real time exchange rate quotations, macroeconomic expectations, and macroeconomic realizations. They characterized the conditional mean of the US dollar spot exchange rate for the German mark, British pound, Japanese yen, Swiss franc, and the euro. They stated that the important finding indicated conditional mean adjustments of exchange rates to news occur quickly compare to conditional variance adjustment. Besides, an announcement’s impact depends on its timing relative to other related announcement, on whether the announcement time is known in advance. Moreover, the adjustment response pattern is characterized by a sign effect. They concluded that the sign effect refers to the fact that the market reacts to news in an asymmetric fashion. So in general, bad news has greater impact than good news.

Geweke and Feige (1979) provided some indications of why foreign exchange markets are not efficient (due to market participants’ risk adverse behavior combined with the existence of transaction costs). Whilst Hansen and Hodrick (1980) also rejected the EMH from the 1970s and the 1920s; likewise the semi-strong-form tests undertaken by Longworth et al (1986) have rejected the joint null hypothesis of an efficient exchange market and no risk premium for the period ending in October 1976.

OBJECTIVE (S) OF THE STUDY

The main objective of the study was to identify a model that can be used to describe the observations of major trading currencies in Ghana. Specifically, it seeks to:

- Fit an ARIMA optimal model of order (p, d, q) for the study in question.
- Use the ARIMA to describe the major trading currencies in Ghana.
- Give recommendations to researchers, investors and policy makers on the appropriate conditions for using ARIMA under study.

The study focused on the use of ARIMA models to forecast the exchange rate between the Ghana Cedi and the major trading currencies in Ghana. This will help appreciate, normalise and bring about improvement in trade imbalance in the Ghanaian economy because forecasting a variable in the financial markets is a matter of imperative importance.

MATERIALS AND METHODS

Box-Jenkins methodology which they propounded called Autoregressive Integrated Moving Average (ARIMA) model was used for modelling the data. This is an advance forecasting technique that takes into account historical data, decomposes it into an Autoregressive (AR) process, where there is a memory of past values; an Integrated (I) process, which accounts for stabilizing or making the data stationary and a Moving-Average (MA) process, which accounts for previous error terms making it easier to forecast. In the forecasting process, data on trading Ghana Cedi against the

Pound Sterling, Euro and the Japanese Yen in Ghana are collected from the past years. The MINITAB statistical software was used to construct the ARIMA model based on data was used for the computation and analysis in the series.

Autoregressive (AR)

The autoregressive model with *p*th-order, or AR(p), takes the form:

$$X_t = \varphi_0 + \varphi_1 X_{t-1} + \varphi_2 X_{t-2} + \dots\dots\dots + \varphi_p X_{t-p} + \delta_t$$

Where X_t is the response variable at time t

X_{t-1} is the observation at time t – k

φ_p is the regression co efficient to be estimated

δ_t is the error term at time t

The Autoregressive models are appropriate for stationary time series, and the coefficient $\emptyset_0$ is related to the constant level of the series. The ACF dies out as the PACF cut off after the order p of the process.

Moving Average (MA)

The Moving Average model with *q*th-order moving average model, or MA(q), takes the form:

$$X = \mu + \delta_t - \varphi_1 \delta_{t-1} - \varphi_2 \delta_{t-2} - \dots\dots\dots \varphi_q \delta_{t-q}$$

Where Y_t is the response variable at time t

φ_t is the regression co efficient to be estimated

δ_{t-q} is the error at time t – k

μ is the constant mean of the process

The Moving Average models are appropriate for stationary time series. The weights μ_i do not necessarily sum to 1 and may be positive or negative. The ACF cuts off after the order q of the process whilst the PACF dies out

Autoregressive Moving Average (ARMA)

The ARMA process is an amalgam of its two basic elements AR and MA model of order (p, q) and is in the form:

$$X_t = \varphi_0 + \varphi_1 X_{t-1} + \varphi_2 X_{t-2} + \dots + \varphi_p X_{t-p} + \delta_t - \varphi_1 \delta_{t-1} - \varphi_2 \delta_{t-2} - \dots - \varphi_q \delta_{t-q}$$

ARMA (p, q) models can describe a wide variety of behaviors for stationary time series. the ACF and PACF of the ARMA dies out thus tends to zero.

Autoregressive Integrated Moving Average (ARIMA)

Box-Jenkins methodology; the Autoregressive Integrated Moving Average (ARIMA) models, are a class of linear models that is capable of representing stationary as well as non stationary time series.

A process, X_t is said to be ARIMA (p, d, q) if $\nabla^d X_t = (1-B)^d X_t$, is ARMA (p, q).

In general, we will write the model as $\varphi(B)(1-B)^d X_t = \theta(B) W_t$

If E $(\nabla^d X_t) = \mu$, we write the model as $\varphi(B)(1-B)^d X_t = \alpha + \theta(B) W_t$

Where $\alpha = \mu\left(1 - \varphi_1 - \dots - \varphi_p\right)$.

ARIMA models rely heavily on autocorrelation patterns in data: both ACF and PACF are used to select an initial model.

The Box and Jenkins methodology involves the following steps: model identification, model estimation, model diagnostic and forecasting (Box and Jenkins, 1976).

The first step in modeling is to determine whether the series is stationary. It is useful to look at a plot of the series along with the sample autocorrelation function or autocorrelation and the partial autocorrelation functions to check for stationary (Makridakis *et al*, 1998).

If the series is not stationary, it can often be converted to a stationary series by differencing: the original series is replaced by a series of differences and an ARMA model is then specified for the differenced series.

Models for non stationary series are called Autoregressive Integrated Moving Average models, or ARIMA (p,d,q), where d indicates the amount of differencing.

The sample ACF and PACF are compared to the theoretical ACF and PACF for the various ARIMA models once a stationary has been obtained.

Before a model can be used for forecasting, it must be checked for adequacy. Basically, a model is adequate if the residuals cannot be used to improve the forecasts, i.e., The residuals should be random and normally distributed. The individual residual autocorrelations should be small. Significant residual autocorrelations at low lags or seasonal lags suggest the model is inadequate (Nortey, 2007).

After an adequate model has been found, forecasts can be made, as prediction intervals based on the forecasts can also be constructed. But if the specified model is not satisfactory, the process is repeated using a new model designed to improve on the original one. Once a satisfactory model is found, it can be used for forecasting.

The Box and Jenkins (1970) methodology of ARIMA model is shown in Figure 1.1.

STUDY POPULATION

The population under study was the trading (buying) of the Ghana Cedi against the British Pound Sterling, Euro and Japanese Yen between January 1999 to December 2010.

SOURCES OF DATA

The data was obtained from the Bank of Ghana (BoG) Research Department, Accra The data on monthly basis consists of the buying, selling and mid-rate of the Pound Sterling, Japanese Yen and the Euro from the period January 1999 to December 2010.

RESULTS AND DISCUSSION

Figure 2.1 shows the time series plot of the Ghana Cedi against the Euro as figure 2.2 and 2.3 which is the ACF and the PACF, describes the features of the data A close look at the time series graph suggests that there is a trend. It looks almost like the slope of a mountain and there is an increasing trend in the data and there is no similarities existing within the months of the years. The study indicates of no possible presence of seasonality. But there was a slight increase from the latter part of 1999 and a sharp increase in middle of July 2008, which brought a significant peak in 2009. The cedi was stabilized except these two years and it was attributed to the economic crisis which occurred in those years.

The ACF of the observed data was high and declined slowly in a decreasing trend which indicates that it tails off to zero. This shows its non stationary and the PACF of the observed data shown in figure 2.3 cuts off at lag 1. Therefore an AR (1) model is suspected.

The parameters were checked if the models it contained were significant in the analysis. There are no extra parameters present in the model and the parameters used in the model have significant contribution, which can provide the best forecast. The estimate of autoregressive labelled AR (1) is 0.4382 and a constant of 59.80 respectively. Based on 95% confidence level we conclude that all the coefficients of the ARIMA (1, 1, 0) model are significantly different from zero as shown on table 1.3. The fitted model for the Ghana Cedi against the Euro prediction was used for a validation period (January 2010 to December, 2010) to evaluate the time series model

$$\widehat{X_t} = \varphi_0 + (1+\varphi_1)X_{t-1} - \varphi_1 X_{t-2}$$

Where $\widehat{X_t}$ is the exchange rate of the Ghana Cedi against the Euro

φ_0 is the constant

φ_1 is the co – efficient of the 1st order AR

X_{t-1} is the random shock (white noise) term

Furthermore the p-values for the Ljung-Box statistic clearly all exceed 5% for all lag orders, indicating that there is no significant departure from white noise for the residuals. We then proceed to the next step after parameter estimation which is the Diagnostic Checking or model validation.

The constant and the coefficients of AR (1) were not significantly different from zero with values 59.80 and 0.4382 respectively. This equation for the exchange rate was enabled by the model:

$$\widehat{X_t} = 59.80 + 1.4382X_{t-1} - 0.4382X_{t-2}$$

Ghana Cedi against the Japanese Yen

Figure 3.1 shows the time series plot of the Ghana Cedi against the Japanese Yen as figure 3.2, 3.3 which is the ACF and the PACF, describes the features of the data.

Looking at the time series plot in figure 3.1 suggests that the series is non stationary. The trend exhibits an upward movement which shows it was not periodic. But in 2009, there was an increase in depreciation which was due to the world economic crisis.

Figure 3.2 and 3.3 describes the ACF and PACF of the observed data. The ACF was high and declined slowly in a decreasing trend which indicates that it tails off to zero. This shows its non stationary and the PACF cuts off at lag 1, and AR (1) model is suspected.

The ACF and PACF of the residuals, the result of estimates of each of the iteration and the estimates of parameters are shown in figure 3.4, 3.5, and 3.6, and table 2.1, 2.2 and 2.3 respectively with the MINITAB.

The parameters were checked if the models it contained were significant in the analysis. There are no extra parameters present in the model and the parameters used in the model have significant contribution, which can provide the best forecast. The estimate of autoregressive labelled AR (1) is 0.3965 and a constant of 0.6357 respectively. Based on 95% confidence level we conclude that all the coefficients of the ARIMA (1, 1, 0) model are significantly different from zero as shown on table 2.3. The fitted model for the Ghana Cedi against the Japanese Yen prediction was used for a validation period (January 2010 to December, 2010) to evaluate the time series model

$$\widehat{X_t} = \varphi_0 + (1+\varphi_1)X_{t-1} - \varphi_1 X_{t-2}$$

Where $\widehat{X_t}$ is the exchange rate of the Ghana Cedi against the Japanese Yen

φ_0 is the constant

φ_1 is the co – efficient of the 1st order AR

X_{t-1} is the random shock (white noise) term

Furthermore the p-values for the Ljung-Box statistic clearly all exceed 5% for all lag orders, indicating that there is no significant departure from white noise for the residuals. We then proceed to the next step after parameter estimation which is the Diagnostic Checking or model validation.

The constant and the coefficients of AR (1) were not significantly different from zero with values 0.6357 and 0.3965 respectively. This equation for the exchange rate was enabled by the model:

$$\widehat{X_t} = 0.6357 + 1.3965X_{t-1} - 0.3965X_{t-2}$$

Ghana Cedi against the Pound Sterling

Figure 4.1 above shows the time series plot of the Ghana Cedi against the Pound Sterling as figure 4.2 and 4.3 which is the ACF and the PACF, describes the features of the data. A look at the graph shows a tremendous increase in the exchange rate of the Ghana Cedi against the Pound Sterling from months to months. There appears to be a trend which is becomes a steep. The study indicates of no possible presence of seasonality. But there was a sharp increase from the latter part of 1999 and in middle of July 2008, which brought a significant peak in 2009. The cedi was stabilized except these two years and it was attributed to the economic crisis which occurred in those years. But there was depreciation at the early stage in 2008 but shot up.

The ACF declined slowly showing its non stationary and PACF of the observed data shown in figure 4.2 and figure 4.3 indicate that it tails off to zero and cuts off at lag 1 respectively.

The estimates at each iteration, estimates of parameters, Modified Box-Pierce (Ljung-Box) Chi-Square statistic, the residual plot, the graph of ACF and PACF of the residuals and the residuals plots are shown in figure 4.4, 4.5, and 4.6, and table 4.1, 4.2, and 4.3 respectively.

The parameters were checked if the models it contained were significant in the analysis. There are no extra parameters present in the model and the parameters used in the model have significant contribution, which can provide the best forecast. The estimate of autoregressive labelled AR (1) is 0.4027 and a constant of 75.97 respectively. Based on 95% confidence level we conclude that all the coefficients of the ARIMA (1, 1, 0) model are significantly different from zero as shown on table 4.3. The fitted model for the Ghana Cedi against the British Pound Sterling prediction was used for a validation period (January 2010 to December, 2010) to evaluate the time series model

$$\widehat{X_t} = \varphi_0 + (1+\varphi_1)X_{t-1} - \varphi_1 X_{t-2}$$

Where $\widehat{X_t}$ is the exchange rate of the Ghana Cedi against the Japanese Yen

φ_0 is the constant

φ_1 is the co – efficient of the 1st order AR

X_{t-1} is the random shock (white noise) term

Furthermore the p-values for the Ljung-Box statistic clearly all exceed 5% for all lag orders, indicating that there is no significant departure from white noise for the residuals. We then proceed to the next step after parameter estimation which is the Diagnostic Checking or model validation.

The constant and the coefficients of AR (1) were not significantly different from zero with values 0.6357 and 0.3965 respectively. This equation for the exchange rate was enabled by the model:

$$\widehat{X_t} = 75.97 + 1.4027X_{t-1} - 0.4027X_{t-2}$$

Diagnostic Checking and Model Validation

The model verification is concerned with checking the residuals of the model to determine if the model contains any systematic pattern which can be removed to improve on the selected ARIMA model. Although the selected model may appear to be the best among a number of models considered, it is also necessary to do diagnostic checking to verify that the model is adequate. Verification of an ARIMA model is tested (i) by verifying the ACF of the residuals, (ii) by verifying the normal probability plot of the residuals. Figure 2.4 and 2.5 are the graph ACF and PACF of the residuals. With a critical look at figure 2.6 which is the residual plot, the normal probability plot shows normality only that there was a separate distant plot and this was due to the significant peak in 2009. Almost all have a standard deviation of one. With the versus fits plot, as the time increases, it is spread thus is not stationary in time. Again, with the histogram plot, the error terms are normal with mean zero with almost all in one standard deviation. Therefore, the model fit, so prediction was made.

All the three trading currencies thus the Euro, Japanese Yen and the British pound Sterling's model fits for forecasting.

Model Forecast

From all the tables of the forecasted model, it was found that the Ghana Cedi is going to depreciate against the Euro, Japanese Yen and the British Pound Sterling after model was fitted for one year period after the diagnostic test.

Tables 1.4, 2.4, and 3.4 summarizes 12 months forecast of the trading currencies under used for the year 2010 starting from January to December 2010 along side the existing actual values from January to December, 2010 with 95% confidence interval. Comparing the predicted rates from January to December with the actual rates, we can see that the predicted values are close to the actual values. Also, all the actual values fall inside the confidence interval. Hence, we say that, ARIMA (1, 1, 0) model is adequate to be used to forecast monthly trading currencies thus the Japanese Yen, British Pound Sterling and the Euro against the Ghana Cedi.

Concluding Remarks

The time series components found in the model were trend and random variation. The data was found to be non stationary and was differenced to attain stationarity. The model was found to have a good fit hence appropriate for the study. The forecast was found to have and upwards trend for the period of two years. Thus the Cedi will depreciate against the Dollar for the period forecasted.

CONCLUSIONS

The forecast results came to light one significant point. The forecast values for all the three were in a trend had slight increase in 2009 which was due to the world economic crisis. The Ghana Cedi trading against the Euro, Japanese Yen, and British Pound Sterling was found to be non stationary. And from the findings it was seen that the model fitted was perfect. It is therefore worth to say that per the model fitted is stable. In conclusion, the Ghana Cedi is going to have an upward trend against the Euro, Japanese Yen, and the British Pound Sterling.

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TABLE CAPTIONS

Figures

Tables

Figures and Tables

Figure 1.1: The Box and Jenkins methodology of ARIMA model

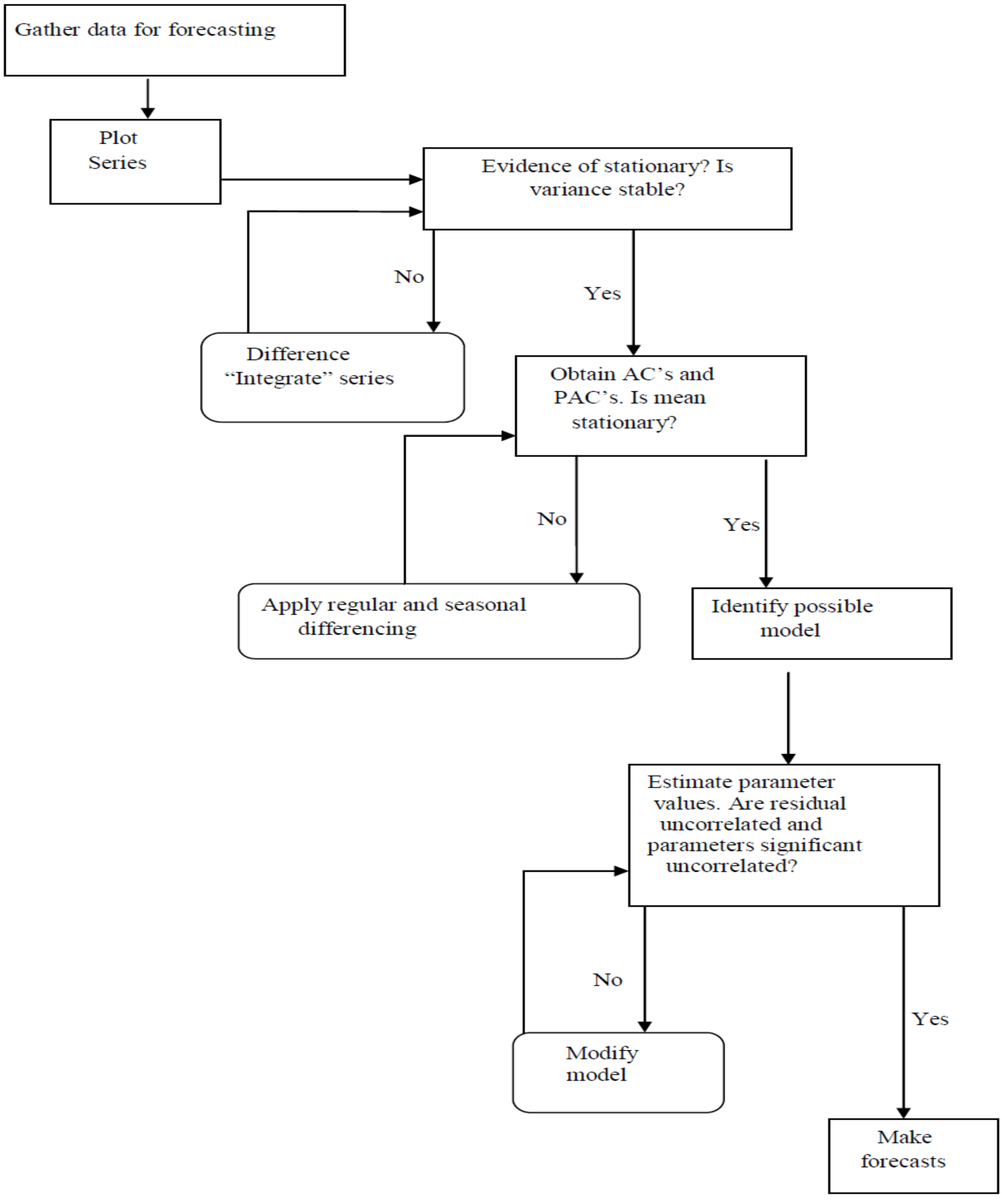

Figure 2.1: Time Series Plot of the Ghana Cedi against the Euro

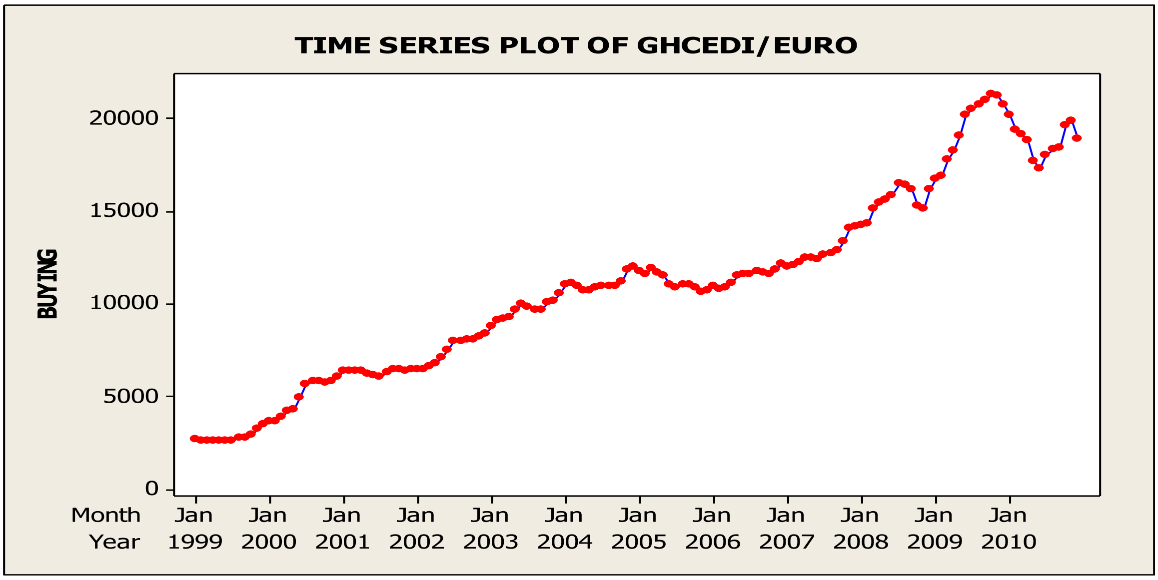

Figure 2.2: Autocorrelation Plot of the Ghana Cedi against the Euro

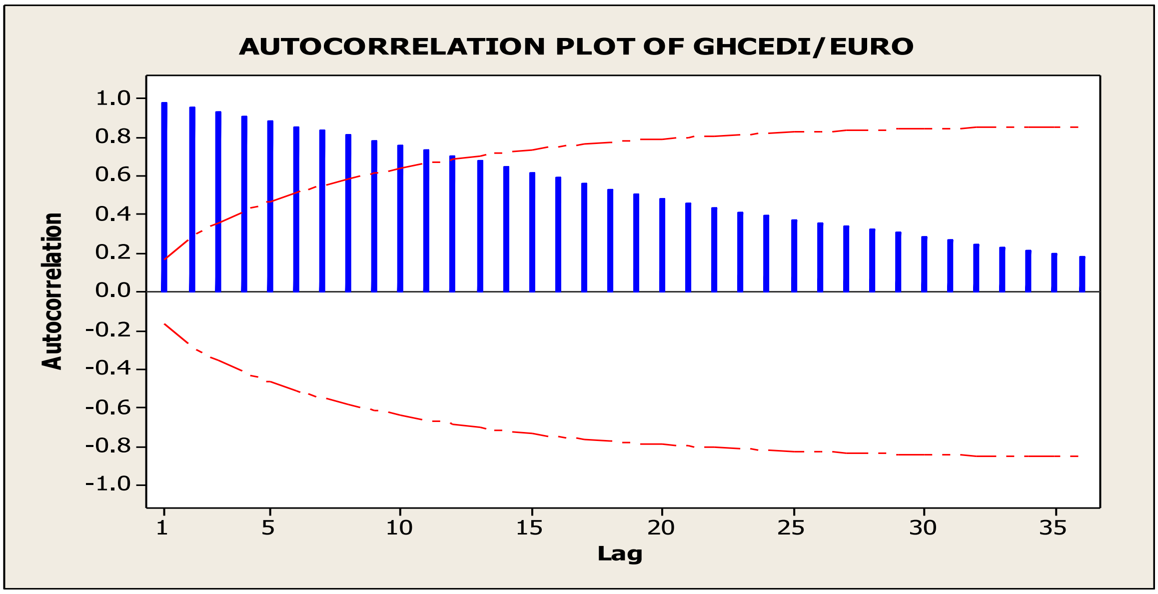

Figure 2.3: Partial Autocorrelation Plot of the Ghana Cedi against the Euro

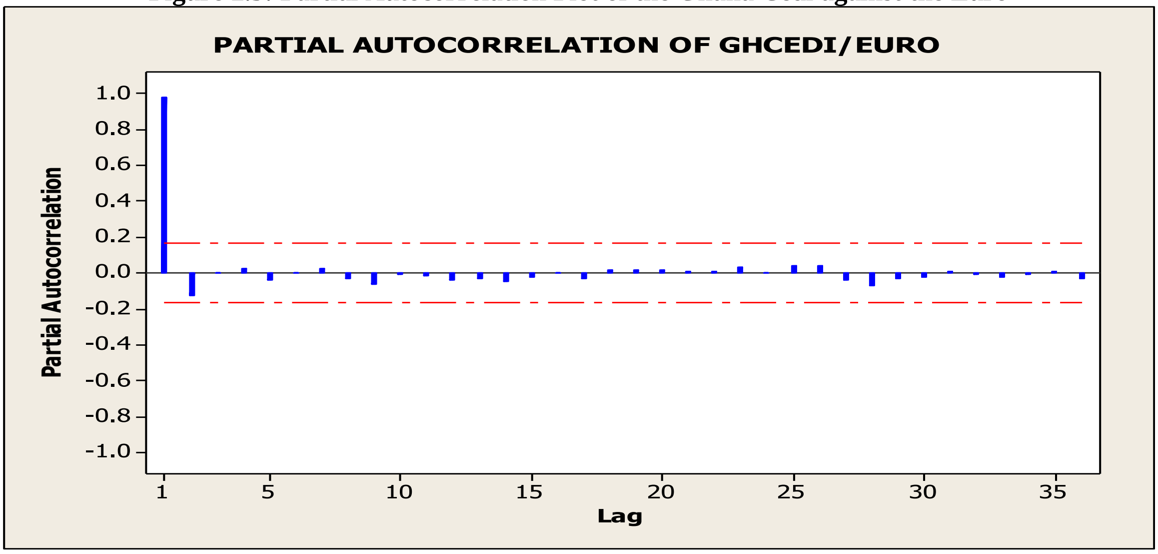

Table 1.1: Estimates at each iteration

Estimates at each iteration			
Iteration	SSE	Parameters	
0	15884170	0.100	102.060
1	14627903	0.250	83.778
2	14087457	0.400	65.335
3	14064169	0.436	60.249
4	14064092	0.438	59.824
5	14064091	0.438	59.796

Relative change in each estimate less than 0.0010

Table 1.2: Estimate of Parameters for AR (1) Model of GHCedi against Euro

Final estimate of Parameters for AR (1) Model of GHCedi against Euro				
Type	Coef	SECoef	T	P
AR 1	0.4382	0.0790	5.54	0.000
Constant	59.80	26.43	2.26	0.025

Number of observations: Original series 144, after differencing 143
Residuals: SS = 14058714 (backforecasts excluded)
MS = 99707 DF = 141

Table 1.3: Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Modified Box-Pierce (Ljung-Box) Chi-Square statistic				
Lag	12	24	36	48
Chi-Square	20.7	32.8	45.7	55.4
DF	10	22	34	46
P-Value	0.024	0.065	0.086	0.161

Differencing: 1 regular difference

Figure 2.4: Autocorrelation Residuals Plot of Ghana Cedi against the Euro

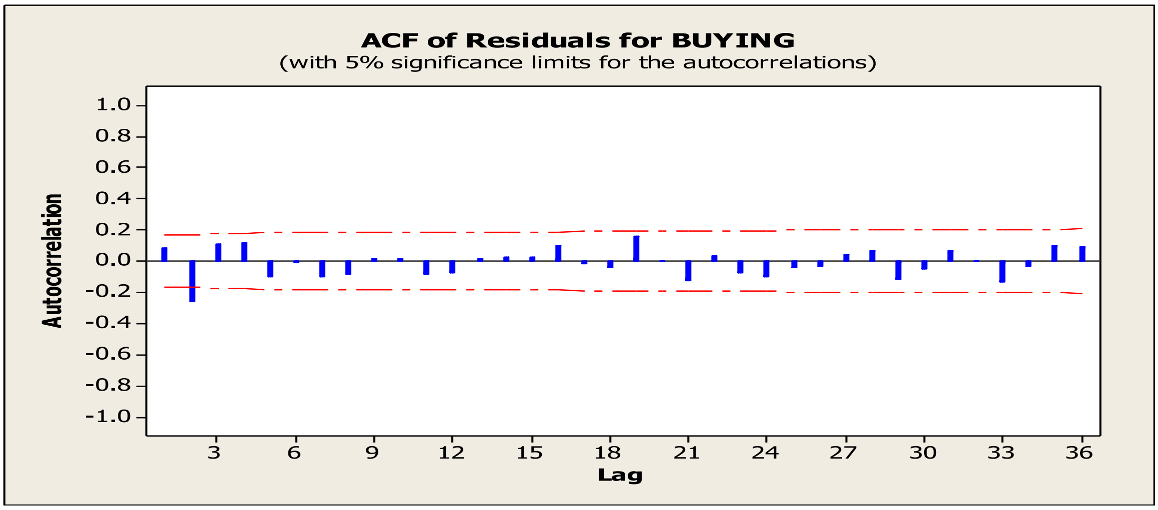

Figure 2.5: Partial Autocorrelation Residuals Plot of Ghana Cedi against the Euro

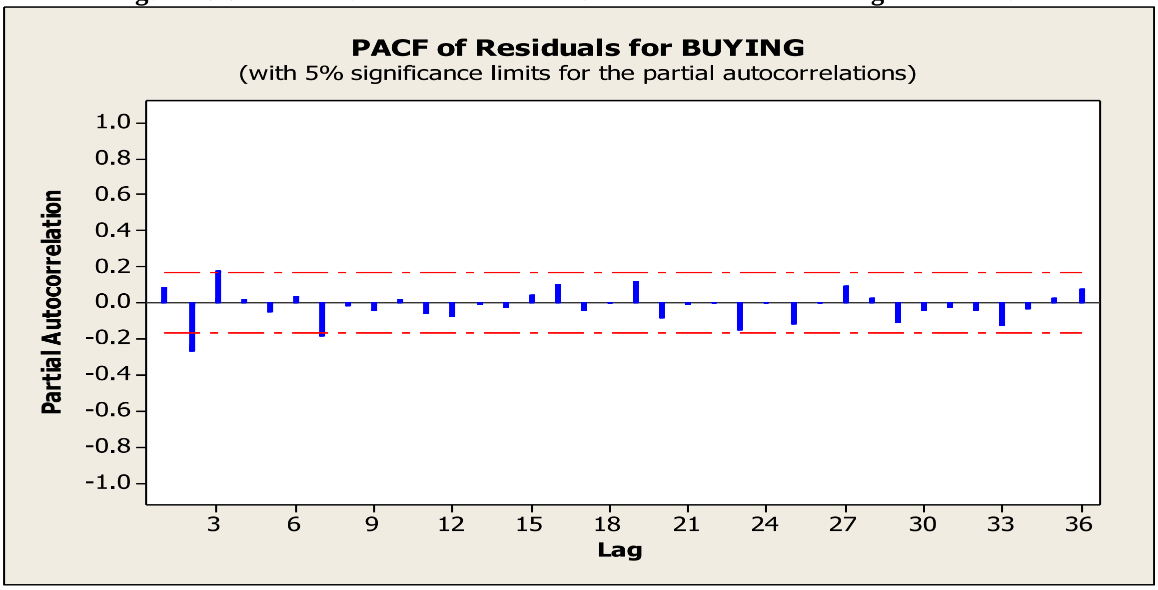

Figure 2.6: Residual Plot of Ghana Cedi against the Euro

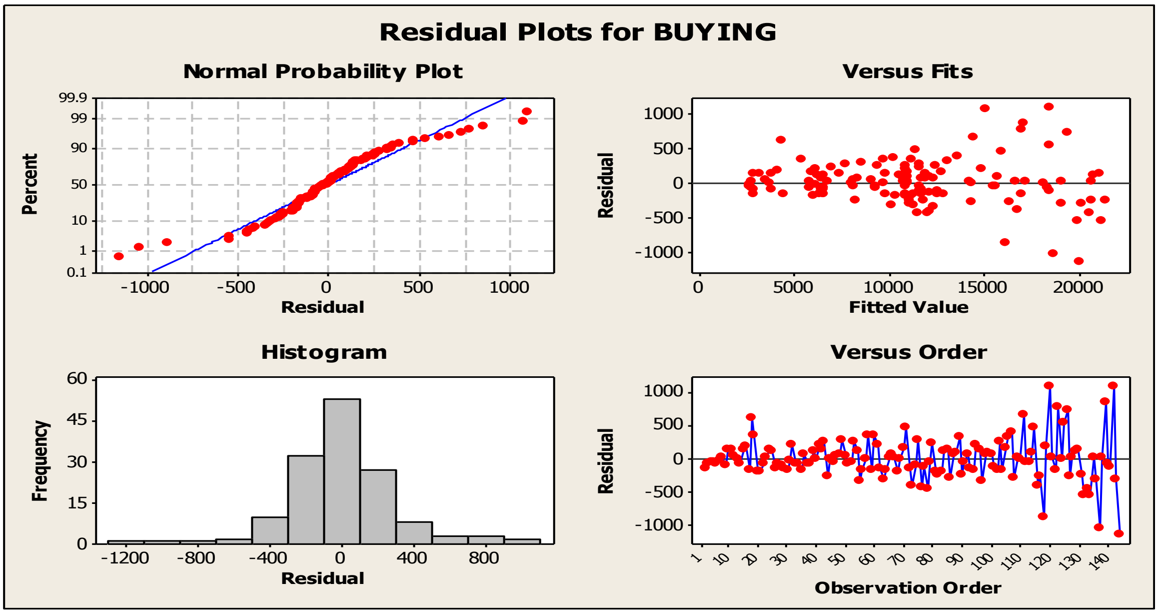

Table 1.4: 12- Months Forecasted of Ghana Cedi against the Euro for 2010 (January-December)

Forecasts from period 132

			95% limits		
Months	Period	Forecast	Lower	Upper	Actual
January	133	20634.4	20116.8	21152.0	20161.0
February	134	20656.5	19757.7	21555.3	19413.0
March	135	20743.0	19522.4	21963.6	19174.0
April	136	20856.6	19361.2	22352.1	18822.0
May	137	20981.6	19246.4	22716.8	17690.0
June	138	21111.3	19162.6	23060.0	17275.0
July	139	21243.0	19100.8	23385.2	18011.0
August	140	21375.5	19055.5	23695.5	18324.0
September	141	21508.4	19023.1	23993.8	18410.0
October	142	21641.5	19001.1	24281.9	19605.0
November	143	21774.6	18987.7	24561.4	19881.0
December	144	21907.7	18981.7	24833.7	18916.0

Ghana Cedi against the Japanese Yen

Figure 3.1: Time Series Plot of the Ghana Cedi against the Japanese Yen

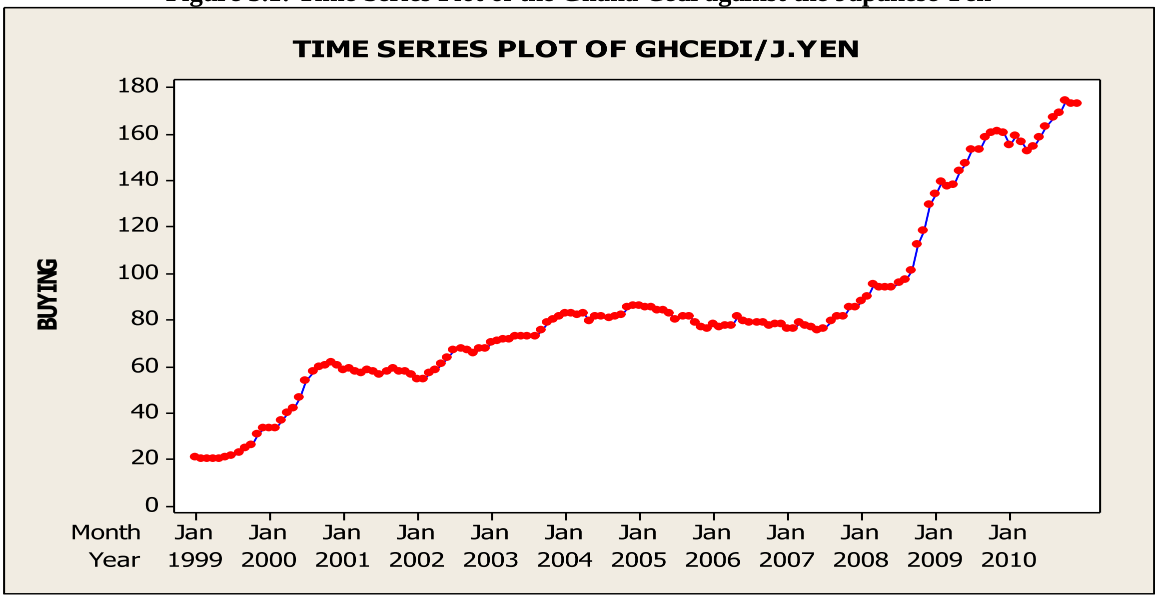

Figure 3.2: Autocorrelation Plot of the GHCedi against the Japanese Yen

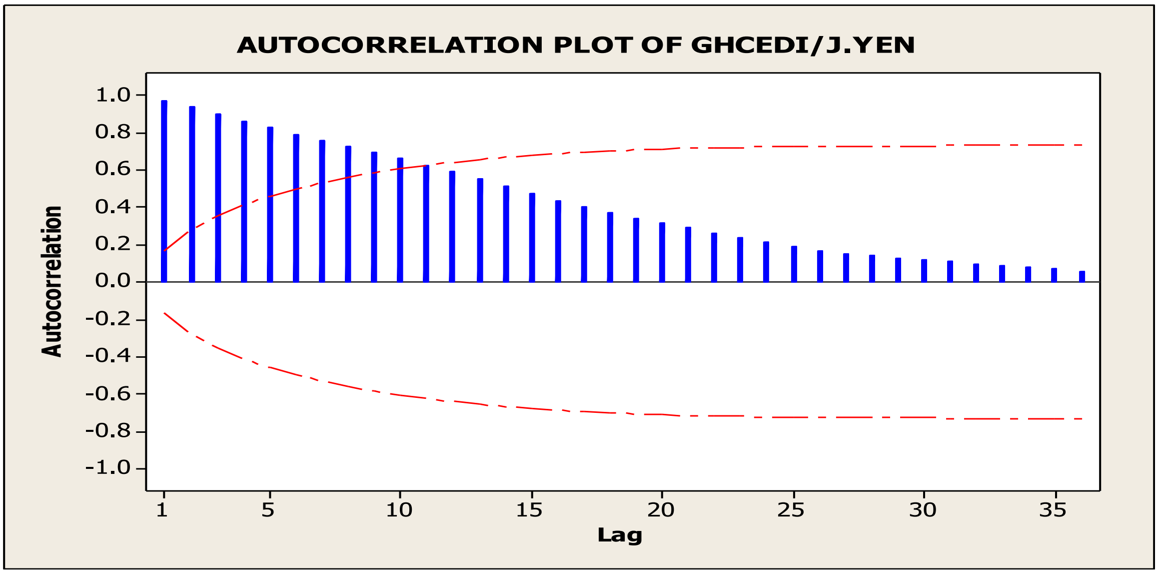

Figure 3.3: Partial Autocorrelation Plot of the Ghana Cedi against the Japanese Yen

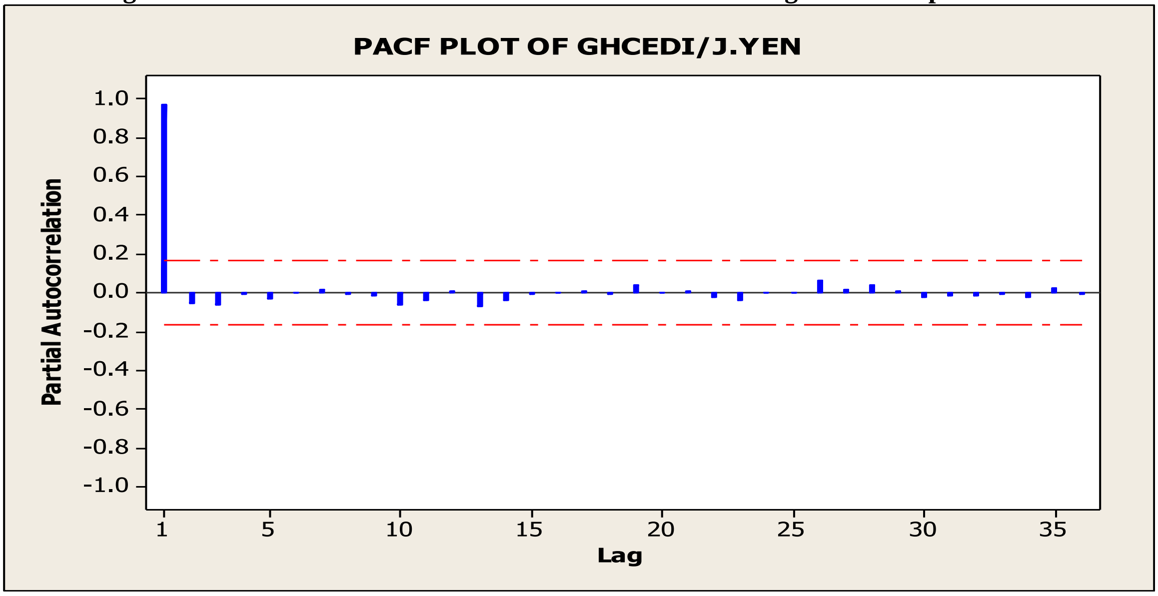

Figure 3.4: Autocorrelation Residuals Plot of the Ghana Cedi against the Japanese Yen

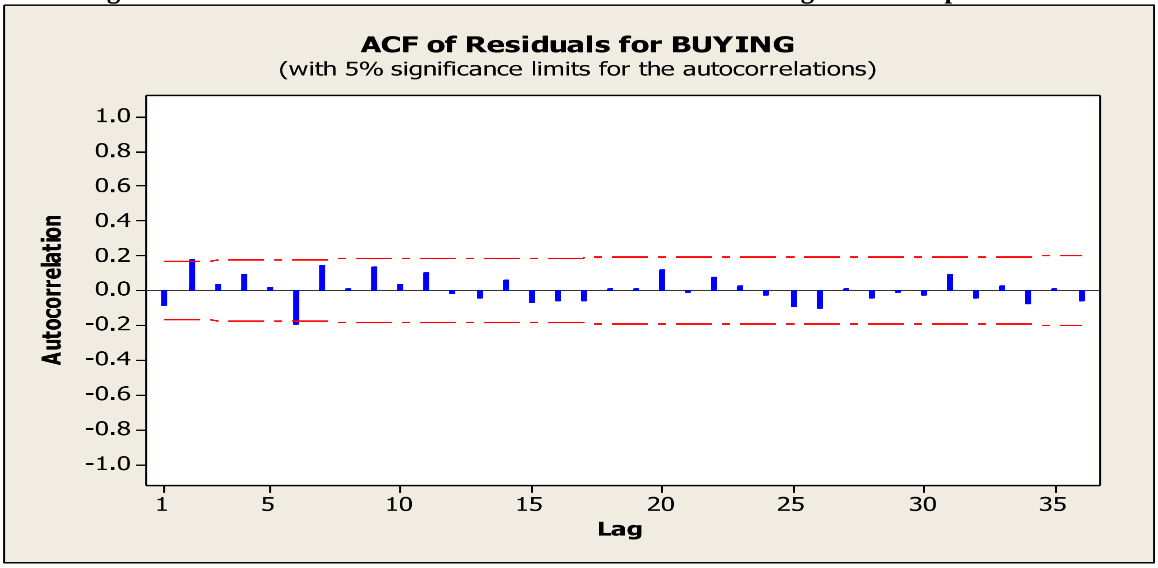

Figure 3.5: Partial Autocorrelation Residuals Plot of the Ghana Cedi against the Japanese Yen

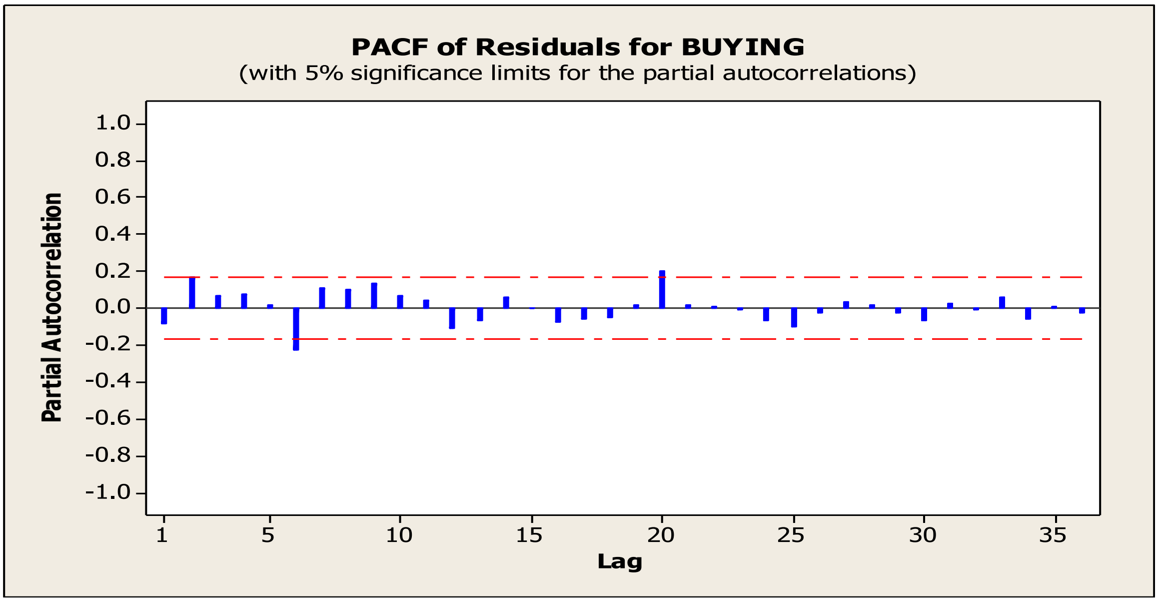

Figure 3.6: Residuals Plot of the Ghana Cedi against the Japanese Yen

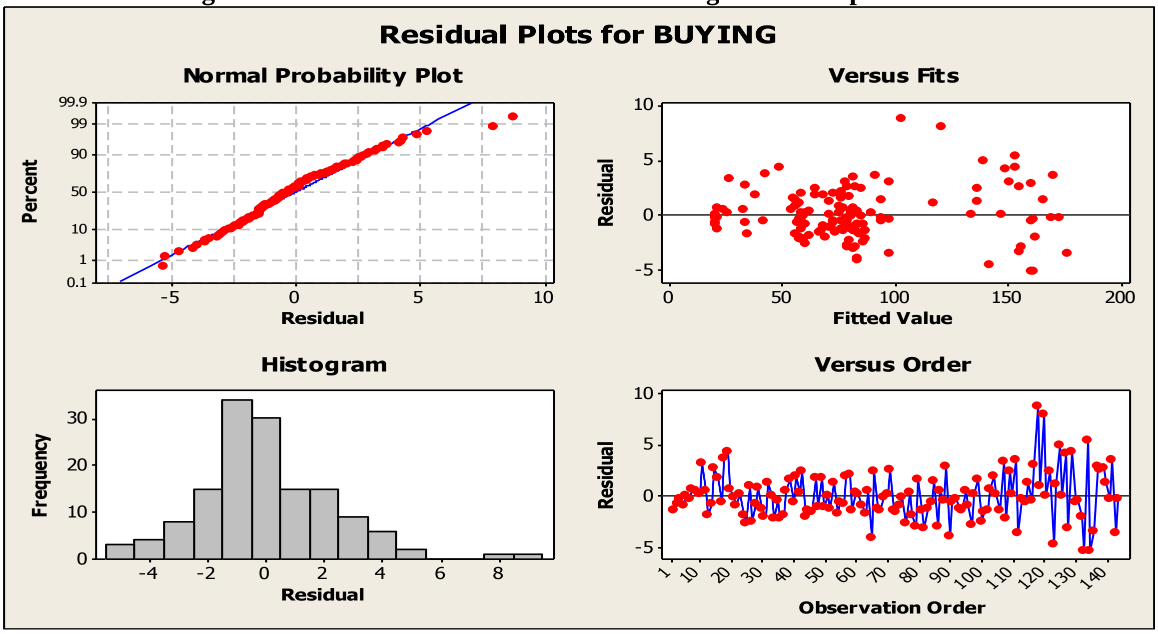

Table 2.1: Estimates at each iteration

Estimates at each iteration			
Iteration	SSE	Parameters	
0	820.315	0.100	1.049
1	761.277	0.250	0.847
2	742.163	0.388	0.657
3	742.081	0.396	0.637
4	742.081	0.396	0.636
5	742.081	0.396	0.636

Relative change in each estimate less than 0.0010

Table 2.2: Estimate of Parameters for AR (1) Model of GHCedi against Japanese Yen

Final estimate of Parameters for AR (1) Model of GHCedi against Japanese Yen				
Type	Coef	SECoef	T	P
AR 1	0.3965	0.0774	5.13	0.000
Constant	0.6357	0.1918	3.31	0.001

Number of observations: Original series 144, after differencing 143
Residuals: SS = 741.761 (backforecasts excluded)
MS = 5.261 DF = 141

Table 2.3: Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Modified Box-Pierce (Ljung-Box) Chi-Square statistic				
Lag	12	24	36	48
Chi-Square	20.3	26.4	34.1	47.3
DF	10	22	34	46
P-Value	0.026	0.234	0.463	0.420

Differencing: 1 regular difference

Table 2.4: 12- Months Forecasted of Ghana Cedi against the Japanese Yen for 2010 (January-December)

Forecasts from period 132

			95% limits		
Months	Period	Forecast	Lower	Upper	Actual
January	133	160.140	155.933	164.347	155
February	134	160.784	153.403	168.166	159
March	135	161.650	151.556	171.745	156
April	136	162.615	150.188	175.042	152
May	137	163.622	149.155	178.090	154
June	138	164.649	148.363	180.936	158
July	139	165.685	147.751	183.619	163
August	140	166.724	147.275	186.172	167
September	141	167.765	146.910	188.620	169
October	142	168.806	146.632	190.980	174
November	143	170.890	146.429	193.267	173
December	144	170.890	146.289	195.491	173

Ghana Cedi against the B. Pound Sterling

Figure 4.1: Time Series Plot of the Ghana Cedi against the B. Pound Sterling

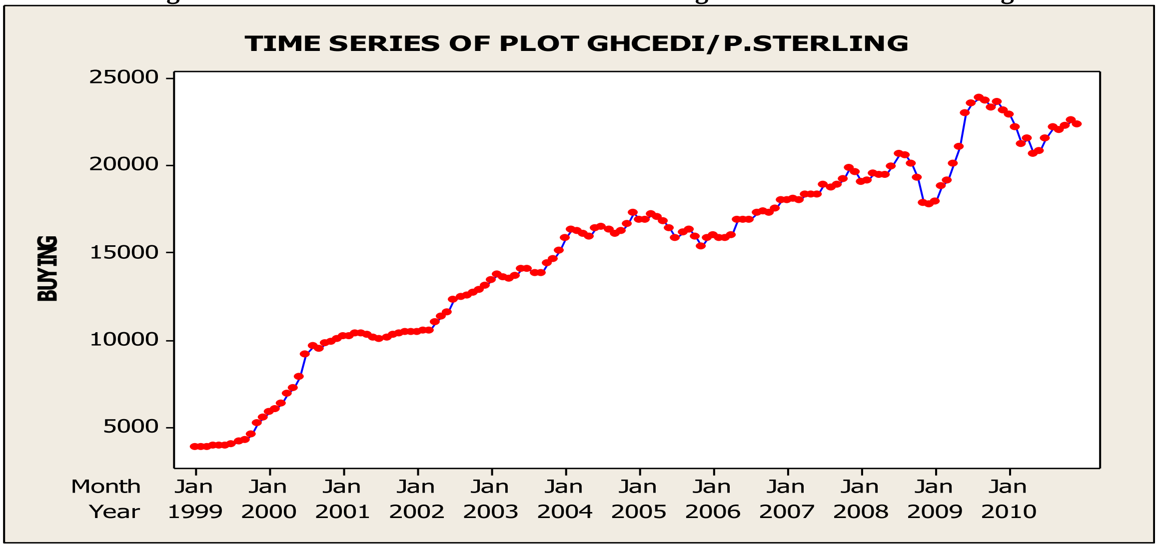

Figure 4.2: Autocorrelation Plot of the Ghana Cedi against the Pound Sterling

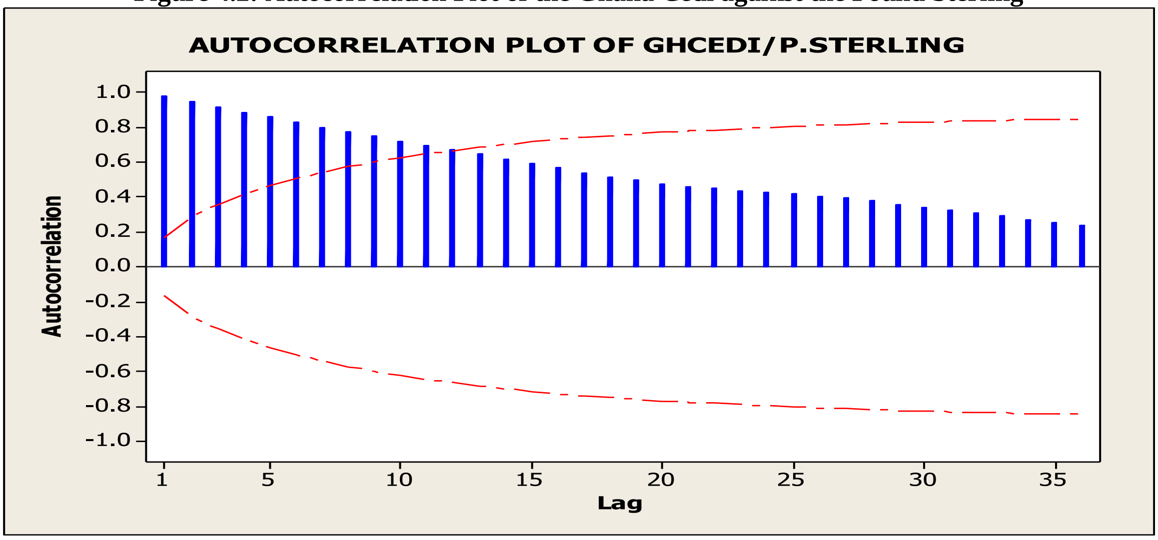

Figure 4.3: Partial Autocorrelation Plot of the Ghana Cedi against the Pound Sterling

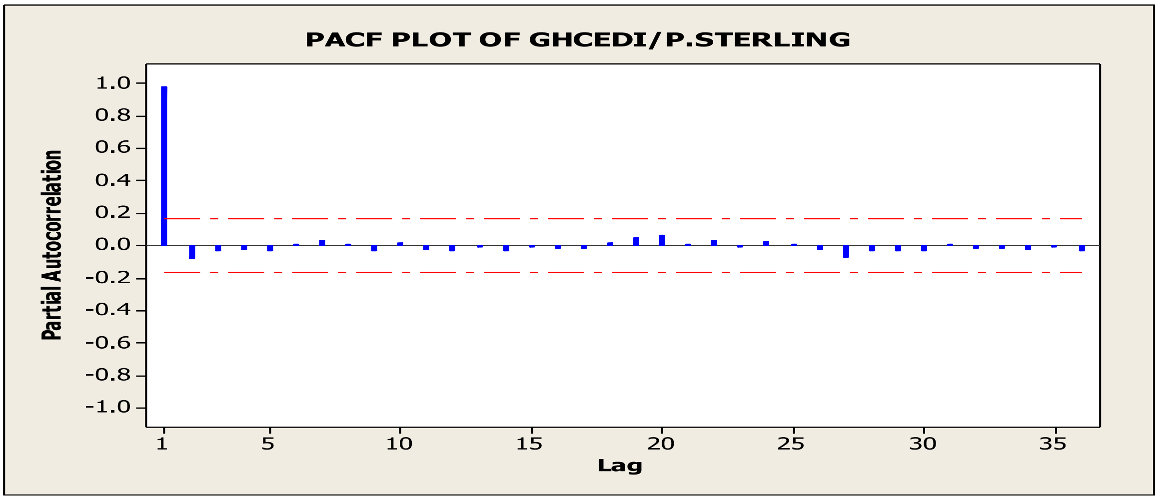

Table 3.1: Estimates at each iteration

Estimates at each iteration			
Iteration	SSE	Parameters	
0	22688154	0.100	116.588
1	21030221	0.250	96.727
2	20465725	0.395	77.415
3	20464158	0.402	76.058
4	20464153	0.403	75.970

Relative change in each estimate less than 0.0010

Table 3.2: Estimate of Parameters for AR (1) Model of GHCedi against the Pound Sterling

Final estimate of Parameters for AR (1) Model of GHCedi against the Pound Sterling				
Type	Coef	SECoef	T	P
AR 1	0.4027	0.0773	5.21	0.000
Constant	75.97	31.86	2.38	0.018

Number of observations: Original series 144, after differencing 143
Residuals: SS = 20460720 (backforecasts excluded)
MS = 145111 DF = 141

Table 3.3: Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Modified Box-Pierce (Ljung-Box) Chi-Square statistic				
Lag	12	24	36	48
Chi-Square	9.6	19.6	27.0	32.2
DF	10	22	34	46
P-Value	0.474	0.611	0.798	0.938

Differencing: 1 regular difference

Table 3.4: 12- Months Forecasted of Ghana Cedi against the British Pound Sterling for 2010 (January-December)

Forecasts from period 132

			95% limits		
Months	Period	Forecast	Lower	Upper	Actual
January	133	22965.4	22253.6	23677.2	22886
February	134	22988.1	21751.3	24224.9	22218
March	135	23080.1	21399.6	24760.5	21254
April	136	23201.1	21141.6	25260.7	21497
May	137	23334.5	20944.2	25724.7	20639
June	138	23473.0	20788.2	26157.7	20777
July	139	21613.6	20662.0	26565.2	21555
August	140	23755.2	20558.3	26952.1	22164
September	141	23897.2	20472.2	27332.1	22036
October	142	24039.3	20400.5	27678.1	22286
November	143	24181.5	20340.6	28022.4	22559
December	144	24323.7	20290.9	28356.5	22366

Figure 4.4: Autocorrelation Residual Plot of the Ghana Cedi against the Pound Sterling

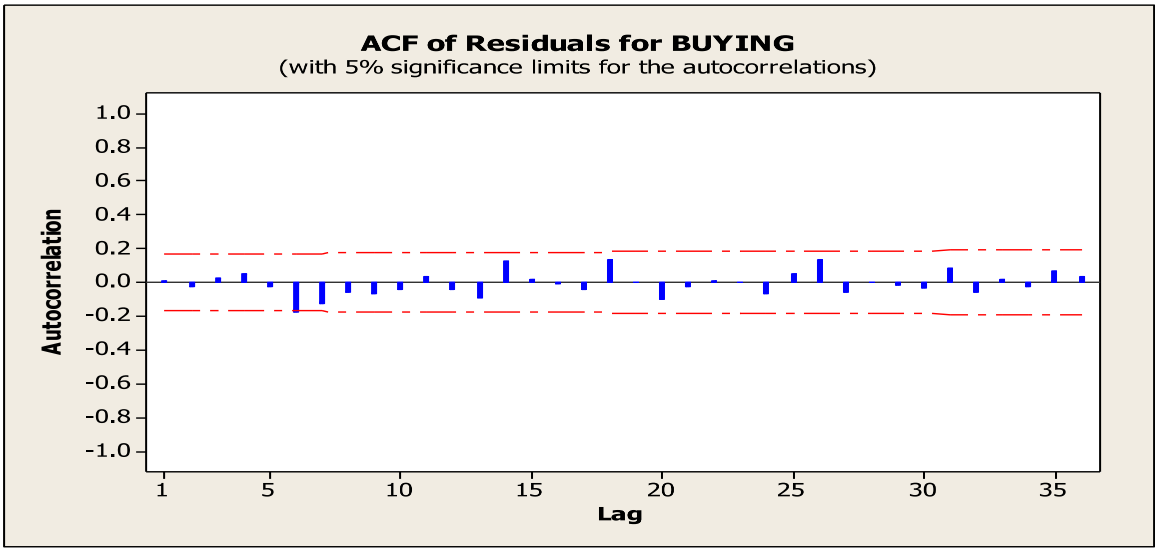

Figure 4.5: Partial Autocorrelation Residual Plot of the Ghana Cedi against the Pound Sterling

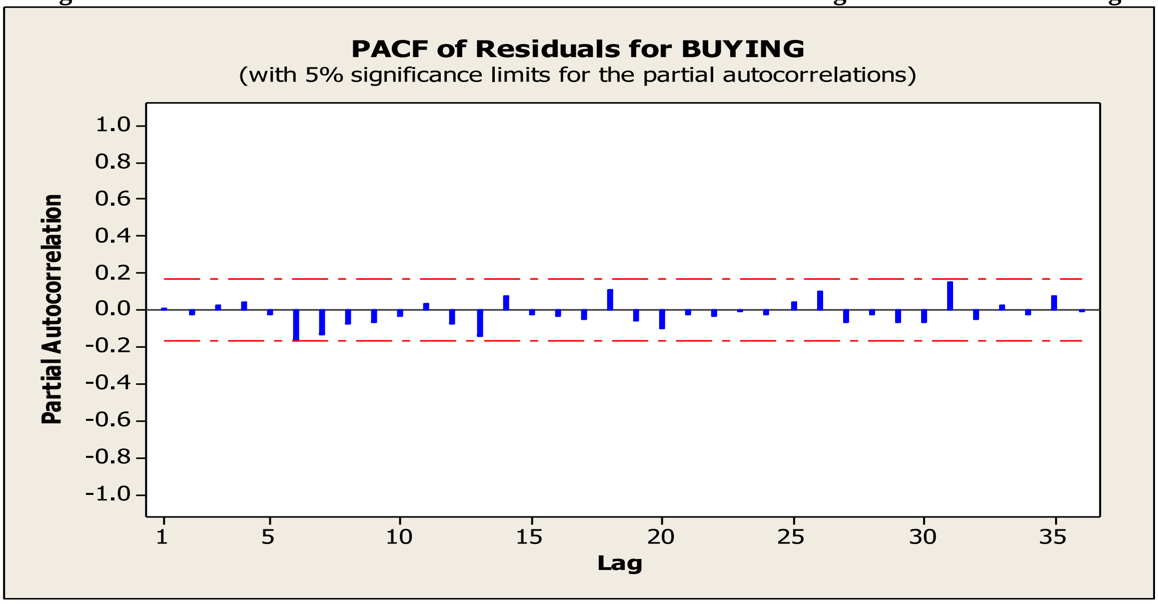

Figure 4.6: Residual Plot of the Ghana Cedi against the Pound Sterling