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Consequence of Exchange Rate Volatility on Economic Growth in Ghana

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Abstract: *The study investigates the relationship between exchange rate volatility and economic growth in Ghana using quarterly data from 1990 to 2012 by means of the Autoregressive Distributed Lag (ARDL) approach and the Granger causality test. The study found a unique cointegrating relationship between economic growth and exchange rate volatility. The regression results show that exchange rate volatility exerts negative and statistically significant effects on economic growth in both the short-run and long-run, suggesting that exchange rate volatility adversely influences economic growth in Ghana. The Granger causality test results revealed unidirectional causality between exchange rate volatility and economic growth, with the causality running from exchange rate volatility to economic growth. The existing literature primarily concentrates on the effects of exchange rate volatility on trade flows, investment, and inflation but fails to extensively examine its implications for Ghana's economic growth. Consequently, a comprehensive understanding of how exchange rate volatility influences the country's growth dynamics remains insufficiently explored. Therefore, there is a need for research that specifically investigates the relationship between exchange rate volatility and economic growth in Ghana, taking into account the unique characteristics of its economy, policy frameworks, and external sector dynamics.*

Keywords: economic, bank, exchange rate, economic growth, Ghana

I. INTRODUCTION

Exchange rate volatility is a significant aspect that needs to be taken into consideration for rising economies that largely rely on international commerce. Since exchange rate volatility is thought to signify uncertainty and impose costs on risk-averse commodity merchants, it has historically been suggested that exchange rate volatility may impede the flow of international commerce. Theoretically, there is no definite agreement on which exchange rate regime is better for macroeconomic performance (Prasad, 2007). Exchange rate stability, according to proponents of a fixed exchange rate regime, boosts macroeconomic stability and trade, which may encourage foreign investment and growth. This regime also affects investment and saving decisions (and therefore the current account balance) and financial development. In contrast, proponents of flexible exchange rate regimes emphasize the advantage of exchange rate flexibility to correct for domestic and external disequilibria in the face of real asymmetric shocks (Arratibel, Furceri, Martin, & Zdzienicka, 2011). Before the introduction of the economic recovery program in Ghana in 1983, exchange rate policy had involved the maintenance of a fixed exchange rate regime with occasional devaluation and exchange rationing. However, the country adopted a flexible exchange rate regime, i.e., managed float, and with this, the national currency has experienced instability for most of its existence (Mumuni & Owusu-Afriyie, 2004).

In Ghana, some studies have focused on the effects of exchange rate volatility on stock market performance (for example, Adjasi, Haervey, and Agyapong, 2008; Kyereboah-Coleman and Agyire-Tettey, 2008; and Frimpong and Adam, 2010). Studies that have specifically investigated the relationship between exchange rate volatility and economic growth in Ghana (for example, Adu-

Gyamfi, 2011) used annual data and employed models such as the ordinal least squares (OLS) and vector autoregressive (VAR) models in their analysis other than the autoregressive distributed lag (ARDL) approach. This study therefore uses quarterly data and employs the ARDL model to establish the long-run and short-run relationships between the variables of interest. This is because annual data does not adequately address the behavior of exchange rate volatility, so it is important to use high-frequency data, such as quarterly data, while the ARDL approach can establish long-run and short-run relationships between the variables (Peseran, Shin, & Smith, 2001).

2. METHODOLOGY

Research Design

The study followed the positivist paradigm within the framework of classical and neoclassical economics. The positivist philosophy favours the use of quantitative approach to research used in this study.

Model Specification

The study adopts the Solow growth model in a form of Cobb-Douglas production function to capture the relationship between exchange rate volatility and economic growth as shown in equation (1).

$$Y_t = K_t^{\alpha}(A_t L_t)^{\beta} \ell^{\varepsilon} \qquad (1)$$

For the purpose of the study and followingVieira et al. (2013), we define the total factor productivity (A) in equation (1) as;

$$A_t = f(Vol_t, TO_t, GE_t, CPI_t) = Vol_t^{\beta_1} TO_t^{\beta_2} GE_t^{\beta_3} CPI_t^{\beta_4} \qquad (2)$$

Where
Yt = per capita GDP,
Volt = exchange rate volatility,
TOt =TradeOpenness,
GEt =Government Expenditure,
CPIt =Consumer Price Index,
Lt = Labour force and
Kt = Gross Fixed Capital Formation.

Substituting equation (2) into (1) we get

$$Y_t = \eta K_t^{\alpha}(Vol_t^{\beta_1} TO_t^{\beta_2} GE_t^{\beta_3} CPI_t^{\beta_4} L_t^{\beta_5})\ell^{\varepsilon} \qquad (3)$$

Taking logarithm of the variables, differencing per capita GDP we get:

$$\ln Y_t = \beta_0 + \beta_1 Vol_t + \beta_2 \ln TO_t + \beta_3 \ln GE_t + \beta_4 \ln CPI_t + \beta_5 \ln L_t + \alpha \ln K_t + \varepsilon_t \qquad (4)$$

Where In = natural logarithm

Equation (4) is subsequently modelled with optimal lags of the variables to depict the ARDL representation.

Expected Sign of the variables

The coefficients β1, β 2 , β 3 , β 4 , β 5 and α in equation (4) are the various elasticities of the respective variables. β 0 , t and ε are the drift components, time and error terms. The a priori signs for the coefficient in equation (4) are $\beta 1 < 0$, $\beta 2 > 0$, $\beta 3 > 0$, $\beta 4 < 0$, $\beta 5 > 0$ and $\alpha > 0$. The choice of the variables included in the above model is based on the literature, economic theory, data availability and their significance in the model chosen for the study.

Definition and measurement of variables

Economic Growth (Y)

Economic Growth refers to steady increases in the economy's real gross domestic product or national product overtime. Following standard practice, we use real per capita GDP growth as the measure for economic growth (Levine et al., 2000). Real GDP per capita is real gross domestic product divided by population.

Exchange rate volatility (Vol)

Following Heidari & Hashemi Pourvaladani (2011), we use generalized autoregressive conditional heteroscedasticity (GARCH) models to generate time varying conditional variance of exchange rate as a standard measure of exchange rate volatility. This is because the study used quarterly data, which is high frequency data hence, the use of GARCH. GARCH (1, 1) model can be defined as follows:

$$\ln RER_t = a + a_1 \ln RER_{t-1} + \varepsilon_t \quad (5)$$

$$\varepsilon_t \sim iid\,(0, \delta^2)$$

$$\delta^2 = \gamma_0 + \gamma_1 \varepsilon^2_{t-1} + \varphi \delta^2_{t-1} \quad (6)$$

The above conditional variance of *RER* is a function of three terms (i) the mean, γ_0 , (ii) news about volatility from the previous period, measured as the lag of the squared residual from the mean equation, $\varepsilon_t^2{}_{-1}$ (ARCH term), and (iii) the last period's forecast error variance, $\varphi\delta_t^2{}_{-1}$ (the GARCH term) as shown in equation (6).The basis for the use of GARCH for this study is the fact that there exists exchange rate volatility in Ghana as found by Insah (2013) noting that a GARCH (1,1) model explained real exchange rate.

Trade Openness (TO)

Trade openness was measured as the sum of value of exports and imports to nominal GDP.

Government Expenditure (GE)

Government Expenditure was measured as ratio of government expenditure to GDP. It is commonly used as an indicator of macroeconomic stability. Government expenditure, according to the Keynesian proposition, is expected to raise economic growth. It could, however, reduce economic growth because of the crowding out effect on private investment and the inflationary pressures it can lead to (Allen & Ndikumana, 2000).

Consumer Price Index

CPI is the index of prices used to measure the change in the cost of basic goods and services in comparison with a fixed base period. The annual percentage change in the cost to the average consumer of acquiring a fixed basket of goods and services that may be fixed or changed at specified intervals, such as yearly is used to measure inflation. It is a reflection of macroeconomic instability. A high rate of inflation is generally unattractive to foreign investors because it raises the cost of borrowing and thus lowers the rate of capital investment. Inflation is therefore used as an indicator to capture macroeconomic instability, (Asiedu & Lien, 2004; Asiedu, 2006).

Capital (K)

Capital stock was measured as the ratio of gross fixed capital formation to GDP.

Labour (L)

Labour force was measured as the proportion of the population aged between 15 years and 65 years and is active and productive.

Estimation Technique
This study first investigates the time series properties of the data using the Augmented Dickey-Fuller (ADF) and the Philip-Perron (PP) tests. The unit root test was used to check the stationarity properties of the data. The study then proceeded to test for the long-run and short-run relationships among the variables using the Autoregressive Distributed Lag (ARDL) approach.

Sources of Data
This study relied strongly on secondary data coming from the World Bank database, and the Bank of Ghana quarterly bulletins and annual reports. This study employed quarterly data on the chosen variables from the period 1990:Q1 – 2012:Q4. Ghana's exchange rate values against the U.S dollar were obtained from both the Bank of Ghana website and World Development Indicators. Data on growth rates and control variables were equally obtained from the World Development Indicators. Quarterly series of the control variables – trade openness, government expenditure, CPI, capital stock and labour force were generated from annual series using Gandolf (1981) algorithm.

Unit Root Tests
Since macroeconomic time series data are usually non-stationary (Nelson &Plosser, 1982) it is very important to test for the stationarity properties of the data. This testing requires the test of the order of integration of the data set which is the unit root tests. A time series is stationary if its moments such as the mean, variance, and autocovariances are independent of time (Gujarati, 2012). A stationary series is said to be integrated of order (d) if it achieves stationarity after being differenced (d) times. Many studies have shown that models with non-stationary variables tend to produce spurious regressions and make the usual test statistics (t, F, DW, and R^2) unreliable (Al-Yousif, 2002). So, if the non-stationary variables are differenced properly, they become stationary. The appropriate number of differencing is called the order of integration. Therefore, if a time series, for example, Y becomes stationary after being differenced d times, Y is said to be integrated of order d, denoted by $YI(d)$.

In line with empirical literature, the study employed the ADF and PP tests to inspect the stationarity properties of the variables included in the model. These tests actually involve two separate steps. First, they test the model with constant but no linear time trend, and second, with both constant and linear trend in order to determine the degree of integration of the data series. The main reason for conducting these two tests is to be sure that, the series enter the model to be estimated in non-explosive form and to address the issue of tests with low power. The ADF and PP tests are similar except that they differ with regard to the way they correct for autocorrelation in the residuals. For instance, the PP (non-parametric) test generalizes the ADF procedure, allowing for less restrictive assumptions for the time series in questions. That is, it relates the assumptions pertaining to autocorrelation and heteroskedasticity. Both ADF and PP tests test the null hypothesis that the variables under investigation have unit root against the alternative hypothesis of no unit root. Moreover, in each of these tests, the optimal lag length is chosen using the Swartz Information Criterion (SIC). Here, the sensitivity of the ADF test to lag selection renders the PP test an important and essential additional tool for making inferences about unit roots. The basic formulation of the ADF is given as:

$$\Delta Y_t = \mu + \delta_t + \rho Y_{t-1} + \sum_{i=1}^{p} \psi_i \Delta Y_{t-i} + \varepsilon_t \;..... \quad (7)$$

Where Y_t denotes the series at time t, Δ is the difference operator, μ, δ, ρ, and are the parameters to be estimated and ε is the stochastic disturbance term.

Cointegration Test

In the face of non-stationary series with unit roots, first differencing appears to provide the appropriate solution to the problems. However, first differencing tends to eliminate all the long- run information which economists are invariably interested in. Thus, such differencing may result in a loss of low frequency information or long-run characteristics of the series data. Nevertheless, Engle and Granger (1987) disclosed that, if there is an equilibrium relationship between such variables, then for this relationship to have any meaning, a linear combination of these variables, the disequilibrium error should fluctuate around zero (that is, it should be stationary). Thus, two time series integrated of the same order d are said to be co-integrated if one unique linear combination of these series exists which is integrated in an order inferior to (d-b) with ≥ 1 . After establishing that variables are stationary, it is necessary to determine whether there is any long-run relationship between them, and this leads to co-integration testing.

The Bounds Testing/ARDL Procedure

Series of studies by Peseran and Peseran (1997), Peseran and Shin (1999), and Peseran et al. (2001) introduced the co-integration technique known as the Autoregressive Distributed Lag (ARDL) bounds test. This technique has a number of advantages over Johansen's co-integration technique. First, the ARDL Approach is the more statistically significant technique to determine the co-integration relations in small samples (Ghatak & Siddiki, 2001), while Johansen's co-integration technique requires large data samples for validity. Second, while other techniques require all the regressors to be integrated of the same order, the ARDL approach can be applied whether the regressors are I (1) or I (0). This means that the ARDL approach avoids the pre-testing problems associated with standard co-integration, which requires that the variables already be classified into I (1) or I (0) (Peseran et al., 2001). In addition, Tang, (2006) stated that the ARDL approach is also applicable when the explanatory variables are endogenous and is sufficient to simultaneously correct for residual serial correlation. According to Peseran and Peseran (1997), the ARDL approach requires the following two steps. In the first step, the existence of any long-run relationship among the variables of interest is determined using an F-test. The second step of the analysis is to estimate the coefficients of the long-run relationship and determine their values, followed by the estimation of the short-run parameters of the variables with the error correction representation of the ARDL model. By applying the error correction model (ECM) version of ARDL, the speed of adjustment to equilibrium will be determined. In order to apply the bounds test procedure for co-integration, the following restricted (conditional) version of the ARDL models are estimated to test the long-run relationships between exchange rate volatility and economic growth. This framework is implemented by modeling equation (3) as a conditional ARDL as:

$$\Delta \text{In}Y_t = \alpha 0\text{-}i + \sum_{i=1}^{p} \lambda 1i\, \Delta \text{In}Y_{t-i} + \sum_{i=1}^{p} \lambda 2i\, \Delta Vol_{t-i} + \sum_{i=1}^{p} \lambda 3i\, \Delta \text{In}T_{t-i} + \sum_{i=1}^{p} \lambda 4i\, \Delta \text{In}G_{t-i} +$$

$$\sum_{i=1}^{p} \lambda 5i\, \Delta \text{In}CPI_{t-i} + \sum_{i=1}^{p} \lambda 6i\, \Delta \text{In}L_{t-i} + \sum_{i=1}^{p} \lambda 7i\, \Delta \text{In}K_{t-i} + \eta 1\, \text{In}Y_{t-i} + \eta_2 Vol_{t-i} +$$

$$\eta_3 \text{In}T_{t-i} + \eta_4 \text{In}G_{t-i} + \eta_5 \text{In}CPI_{t-i} + \eta_6 \text{In}L_{t-i} + \eta_7 \text{In}K_{t-i} + \nu_t \;\ldots\ldots\ldots\ldots(8)$$

Where

Δ' s are the first difference operators and

η1 ....η7 are the long run

Granger Causality Test

The study of causal relationships among economic variables has been one of the main objectives of empirical econometrics. According to Engle and Granger (1987), cointegrated variables must have an error correction representation. One of the implications of Granger representation theorem is that if non-stationary series are cointegrated, then one of the series must granger because of the other (Gujarati, 2012). To examine the direction of causality in the presence of co-integrating vectors, Granger causality is conducted based on the following specifications:

$$\Delta Y_t = \delta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta Y_{t-i} + \sum_{i=0}^{p} \varphi_{1i} \Delta Vol_{t-i} + \nu_t \text{ .... } (12)$$

$$\Delta Vol_t = \delta_0 + \sum_{i=1}^{p} \beta_{2i} \Delta Vol_{t-i} + \sum_{i=0}^{p} \varphi_{2i} \Delta Y_{t-i} + u_t \text{ .... } (13)$$

Where

ΔY and ΔVol are our non-stationary dependent and independent variables; p is the optimal lag order while the subscripts t and t-i denote the current and lagged values. To find out whether the independent variable (Vol) granger-causes the dependent variable (Y) in equation (12), we examine the joint significance of the lagged dynamic terms by testing the null hypothesis:

$H_0 : \varphi_{1i} = 0$, implying that the independent variable (Vol) does not granger- cause the dependent variable (Y), against the alternative hypothesis that

$H_1 : \varphi_{1i} \neq 0$, implying that the independent variable (Vol) granger-causes the dependent variable (Y).

Similarly, to find out whether the dependent variable (Y) granger-causes the independent variable (Vol) in equation (13), we examine the joint significance of the lagged dynamic terms by testing the null hypothesis:

$H_0 : \varphi_{2i} = 0$, implying that the independent variable (Y) does not granger- cause the dependent variable (X), against the alternative hypothesis that

$H_1 : \varphi_{2i} \neq 0$, implying that the independent variable (Y) granger-causes the dependent variable (X).

Using the standard F-test or Wald statistic, four possibilities exist: First, rejection of the null hypothesis in equation (12) but failing to reject the null in equation (13) at the same time implies unidirectional causality running from Vol to Y. Second, a rejection of the null hypothesis in equation (13) but at the same time failing to reject the null in equation (12) implies unidirectional causality running from Y to Vol. Third, simultaneous rejection of the two null hypotheses in equations (12) and (13) indicates bi-directional causality. Fourth, simultaneous failure to reject the two null hypotheses in both equations indicates independence or no causality between the variables of interest.

3. RESULTS AND DISCUSSION

Table 1: Summary Statistics of the Variables

	lnY	Vol	lnTO	lnGE	CPI	lnL	lnK
Mean	0.813	-0.127	5.320	5.233	0.924	3.977	5.359
Median	0.838	0.020	4.255	5.139	0.983	3.983	5.289
Maximum	1.270	1.912	16.939	6.537	1.568	4.708	6.652
Minimum	0.428	-5.798	1.664	4.025	0.343	2.912	4.109
Std. Dev.	0.173	0.908	3.278	0.290	0.327	0.161	0.288
Skewness	0.058	-3.125	1.475	1.175	-0.302	1.448	1.019
Kurtosis	2.807	19.313	4.988	11.312	1.985	28.517	11.731
Sum	74.81	-11.682	489.465	481.425	84.993	365.909	493.016
Sum Sq. Dev.	2.709	75.093	977.856	7.669	9.7188	2.364	7.587
Observations	92	92	92	92	92	92	92

Note: Std. Dev. represents Standard Deviation while Sum Sq. Dev. represents Sum of Squared Deviation.

Source: (computed by the author using Eviews 6.0 Package 42)

It can be seen from Table 1 that all the variables have positive average values (means) with the exception of exchange rate volatility. The minimal deviation of the variables from their means as shown by the standard deviation gives indication of slow growth rate (fluctuation) of these variables over the period. Most of the variables were positively skewed implying that the majority of the values are less than their means.

Unit Root Tests

Table 2: Results of Unit Root Test with constant only: ADF Test

Levels			First Difference			
Variables	ADF-Statistic	Lag	Variables	ADF-Statistic	Lag	*I(0)*
lnY	-3.163[0.256]	1	ΔlnY	-5.001[0.000]***	0	*I*(1)
Vol	-1.877 [0.336]	0	ΔVol	-4.102[0.000]***	2	*I*(1)
lnTO	-2.825 [0.588]	1	ΔlnTO	-6.452[0.000]***	0	*I*(1)
lnGE	-0.508 [0.986]	5	ΔlnGE	-4.592[0.000]***	1	*I*(1)
CPI	-2.776[0.658]	4	ΔCPI	-7.263[0.000]***	3	*I*(1)
lnL	-3.251 [0.205]	5	ΔlnL	-7.551[0.000]***	4	*I*(1)
lnK	-0.437 [0.983]	4	ΔlnK	-14.228[0.004]***	3	*I*(1)

Note: *** indicate the rejection of the null hypothesis of non-stationary at 1% level of significance, Δ denotes the first difference, and *I(0)* is the order of integration. The values in parenthesis are the P-values.

Source: computed by the author using Eviews 6.0 Package

Although the bounds test (ARDL) approach to cointegration does not necessitate the pretesting of the variables for unit roots, it is however vital to perform this test to verify that the variables are not integrated of an order higher than one. The aim is to ascertain the absence or otherwise of I(2) variables to extricate the result from spurious regression. Thus, in order to ensure that some variables are not integrated at higher order, there is the need to complement the estimated process with unit root tests.

For this reason, before applying Autoregressive Distributed Lags approach to cointegration and Granger-causality test, unit root test was conducted in order to investigate the stationarity properties of the data. As a result, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were applied to all variables in levels and in the first difference in order to formally establish their order of integration. In order to be sure of the order of integration of the variables, the test was conducted first with intercept and no time trend, and second with intercept and time trend in the model. Schwarz-Bayesian Criterion (SBC) based the optimal number of lags included in the test on automatic selection. The study used the P-values in the parenthesis in tables 2 and 3 to make the unit root decision, (that is, rejection or acceptance of the null hypothesis that the series contains unit root) which arrived at a similar conclusion with the critical values.

The results of ADF test and PP test for unit root with constant only in the model for all the variables are presented in Table 2and Table 3 respectively. The null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of the null hypothesis for the test is based on the MacKinnon (1991) critical and probability values.

Table 3: Results of Unit Root Test with constant only: PP Test

Levels		First Difference		
Variables	PP-StatisticBwd	Variables	PP-StatisticBwd	*I(0)*
lnY	-2.542[0.109]	2ΔlnY	-5.010[0.000]***	1*I*(1)
Vol	-1.192 [0.321]1	ΔVol	-4.093[0.005]***	2*I*(1)
lnTO	-2.573[0.102]	4ΔlnTO	-6.485[0.000]***	2*I*(1)
lnGE	-2.444 [0.133]	5ΔlnGE	-3.791[0.009]***1	*I*(1)
CPI	-1.792 [0.382]	4ΔCPI	-5.143[0.006]***1	*I*(1)
lnL	-1.658 [0.438]1	ΔlnL	-4.063[0.005]***	0*I*(1)
lnK	-0.083 [0.957]	2ΔlnK	-5.245[0.004]***2	*I*(1)

Note: *** indicate the rejection of the null hypothesis of non stationary at 1% significance levels, Δ denotes the first difference, Bwd is the Band Width, and *I(0)* is the order of integration. The values in parenthesis are the P-values.

Source: Computed by the author using Eviews 6.0 Package.

Table 4: Results of Unit Root Test with constant and trend: ADF Test

Levels			First Difference			
Variables	ADF-Statistic	Lag	Variables	ADF-Statistic	Lag	*I(0)*
lnY	-2.322[0.137]	1	ΔlnY	-6.144[0.000]***	0	*I*(1)
Vol	-2.869[0.178]	1	ΔVol	-4.713[0.001]***	0	I(1)
lnTO	-2.529[0.313]	1	ΔlnTO	-6.589 [0.000]***	0	*I*(1)
lnGE	-1.752 [0.719]	1	ΔlnGE	-4.565 [0.002]***	0	*I*(1)
CPI	-1.905 [0.641]	5	ΔCPI	-7.133[0.000]***	3	*I*(1)
lnL	-2.858 [0.181]	3	ΔlnL	-4.083 [0.000]***	2	*I*(1)
lnK	-2.981 [0.143]	0	ΔlnK	-7.558[0.000]***	3	*I*(1)

Note: *** indicate the rejection of the null hypothesis of non stationary at 1% significance level, Δ denotes first difference, and *I(0)* is the order of integration. The values in parenthesis are the P-values. Source: computed by the author using Eviews 6.0 Package

From the unit root test results in Table 4, it can be seen that all the variables are non-stationary at levels. This is because the P-values of the ADF statistic are not statistically significant. However, when the variables are different for the first time they become stationary. This is because the null hypothesis of the presence of unit root (non-stationary) is rejected at 1 percent significant levels. Table 5 presents the unit root test results obtained for the PP test with both constant and trend in the model.

Table 5: Results of Unit Root Test with constant and trend: PP Test

Levels			First Difference			
Variables	ADF-Statistic	Lag	Variables	ADF-Statistic	Lag	*I(0)*
lnY	-2.269 [0.243]	3	ΔlnY	-6.129 [0.000]***	1	*I*(1)
Vol	-1.941 [0.624]	4	ΔVol	-4.678 [0.002]***	2	*I*(1)
lnTO	-1.109 [0.921]	5	ΔlnTO	-6.471[0.000]***	2	*I*(1)
lnGE	-2.047 [0.568]	2	ΔlnGE	-3.156 [0.012]***	1	*I*(1)
CPI	-2.809 [0.198]	5	ΔCPI	-11.493[0.000]***	13	*I*(1)
lnL	-2.692 [0.242]	6	ΔlnL	-4.566 [0.002]***	2	*I*(1)
lnK	-2.364 [0.299]	4	ΔlnK	-6.687 [0.000]***	3	*I*(1)

Note: *** indicate the rejection of the null hypothesis of non stationary at 1% significance level, Δ denotes first difference, and *I(0)* is the order of integration. The values in parenthesis are the P-values.

The calculated F-statistic value of 4.676 (i. e. $F_{\ln Y}$

$F_{\ln Y} = F_{\ln Y}(Vol, \ln TO, \ln GE, \ln CPI, \ln L, \ln K)$

Dependent Variable

lnY

Upper bound critical value of 4.450 at 99% level. Because of the existence of Cointegration among the variables in Table 6, the long run and short run estimates of the ARDL models were estimated to obtain the long and short run coefficients and their standard errors. The estimation was done using Schwarz Bayesian Criterion (SBC).

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(.) = 4.676) exceeds the
F-Statistic
4.676
K is the number of regressors. Note: Critical values were obtained from Pesaran and Pesaran (1997).
Source: Computed by Author using Microfit 4.1

As indicated in Table 6, the joint null hypothesis of lagged level variables (that is, variable addition test) of the coefficients being zero (no cointegration) is rejected at 1 percent significance level when the intercept without trend is included in the model. This rejection is necessitated by the fact

Bounds Test for Cointegration
It is important to establish the existence of a long run relationship between the variables by employing the bounds testing approach to cointegration (Pesaran, Shin, & Smith, 2001). Cointegration test helps to verify the long run and short-run relationships among the variables of interest. The results are presented in Table 6 below.

Table 6: Bounds Test for Cointegration

Critical value Bounds	90%Level		95% Level		99% Level	
Intercept with no trend	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
K=6	2.141	3.250	2.476	3.646	3.267	4.450

As shown in Table 7, all the estimated coefficients have their a priori expected signs except trade openness and labour force. From the results, the coefficient of exchange rate volatility is statistically significant at 10 percent significance level implying that 1 percent increase in volatility will decrease economic growth by approximately 0.02 percent. This result confirms theoretical literature and most findings in much empirical literature.

The coefficient of trade openness is statistically significant at 1 percent level, indicating that if Ghana were to increase her trade openness by 1 percent, economic growth will decrease by approximately 0.05 percent in the end. This means that Ghana imported more than it exported over the study period. This negative effect of trade openness on economic growth lends support to the argument that with an import inelastic country like Ghana greater openness to trade is likely to hurt economic growth.

In addition, the coefficient of government expenditure is statistically significant at 10 percent level, indicating that if government expenditure were to increase by 1 percent economic growth will increase by approximately 0.3 percent in the end. This means that government expenditure positively affect economic growth in Ghana.

Furthermore, the coefficient of inflation carried the expected negative sign and is statistically significant at 1 percent significance level. Thus, if the country's rate of inflation increases by 1 percent, economic growth will reduce by approximately 0.04 percent in the end. That is, inflation, which captures macroeconomic instability, has had a significant adverse effect on economic growth in Ghana. This result is in line with theory and empirical literature.

Finally, even though the coefficient of labour force had it expected positive sign, it is not statistically significant. This means that labour force do not significantly affect economic growth in the end in Ghana. The coefficient of capital had it expected positive sign and is statistically significant at 5 percent level. This means that capital positively affect economic growth in Ghana.

Having established the existence of long-run relationship between economic growth and exchange rate volatility, the ARDL cointegration method is then used to estimate long-run parameters of equation (9) in methods.

Table 7: Long-Run Coefficients Estimates using the ARDL Approach

ARDL(2, 0, 2, 2, 2, 0, 2) selected based on SBC   Dependent Variable: lnY

Regressor	Coefficient	Standard Error	T-Ratio	P-values
Constant	-1.8835	0.7572	-2.4872**	[0.015]
Vol	-0.0163	0.0083	-1.9643*	[0.053]
LnTO	-0.0454	0.0154	-10.467***	[0.000]
LnGE	0.2980	0.1541	1.9333*	[0.057]
CPI	-0.0442	0.0033	-13.314***	[0.000]
LnL	0.0664	0.1784	0.3723*	[0.068]
LnK	0.3226	0.1561	2.0668**	[0.042]

Note: ***, ** and * denote significance levels at 1%, 5% and 10% respectively

Source: Computed by the author using Microfit 4.1

The long-run results indicate that any disequilibrium in the system as a result of a shock can be corrected in the long-run by the error correction term. Hence, the error correction term that estimated the short-run adjustments to equilibrium is generated as follows:

$$ECM = \ln Y + 0.0163*Vol + 0.0454*\ln TO - 0.0393*\ln GE + 0.0442*CPI - 0.0664*\ln L - 0.3226*\ln K + 1.8835*Constant$$

Short Run Relationship

Once the long-run cointegrating model has been estimated, the next step is to model the short-run dynamic relationship among the variables within the ARDL framework. Thus, the lagged value of all level variables (a linear combination is denoted by the error-correction term, ECMt-1 is retained in the ARDL model. Table 8 presents the results of the estimated error-correction model of economic growth for Ghana using the ARDL technique. The model is selected based on the Schwarz Bayesian Criterion.

Table 8: Estimated Short-Run Error Correction Model using the ARDL Approach

ARDL(2, 0, 2, 2, 2, 0, 2) selected based on SBC — Dependent Variable: ΔlnY

Regressor	Coefficient	Standard Error	T-Ratio	P-values
Constant	-0.5830	0.26166	-2.2283**	[0.029]
ΔlnY(-1)	0.8117	0.0604	13.4315***	[0.000]
ΔVol	-0.0431	0.0010	-42.481***	[0.000]
ΔlnTO	-0.0357	0.0025	-0.0502***	[0.000]
ΔlnGE	0.3037	0.0501	6.0531***	[0.000]
ΔCPI	-1.4307	0.1254	-11.404***	[0.000]
ΔlnL	0.2939	0.0685	4.2915***	[0.000]
ΔlnK	0.0554	0.0258	2.1497**	[0.035]
ECM(-1)	-0.1718	0.0289	-5.9432***	[0.000]

Note: ***, **, and * denote significance level at 1%, 5% and 10% respectively
Source: Computed by the author using Microfit 4.1

The results from the ARDL model as displayed in Table 8 suggest that the ultimate effect of previous period value of economic growth on current values of economic growth in the short-run is positive and statistically significant at 1 percent significant level. The implication is that current values of economic growth are affected by previous quarters' values of economic growth in Ghana. This is expected in that previous growth and expansion in the economy serves as an indication of prosperity and may attract more investment leading to more growth. This result is in line with findings in the empirical studies by Levine et al. (2000) as well as Vieira et al. (2013).

The results also showed the expected negative sign of error correction term lagged one period (ECMt-1) and it is highly significant at 1 percent significant level. This confirms the existence of the cointegration relationship among the variables in the model yet again. The ECM stands for the rate of adjustment to restore equilibrium in the dynamic model following a disturbance. The coefficient of the error correction term (ECM) is around − 0.1718. In other words, the significant error correction term suggests that a deviation from the long-run equilibrium subsequent to a short-run shock is corrected by about 17% at the end of each quarter in a year. The rule of thumb is that, the larger the error correction coefficient, that is, in absolute terms, the faster the variables equilibrate in the long-run when shocked.

Consistent with the long-run results, the coefficient of exchange rate volatility has the theorized negative impact on economic growth in the short-run. From the results, a 1 percentage point increase in volatility will reduce economic growth by approximately 0.04 percent in the short-run. We realise that volatility has a higher impact in the short than long run.

With the control variables, the coefficient of trade openness has a negative impact on economic growth in the short-run. The coefficient of trade openness is statistically significant at 1 percent significance level. From the results, a 1 percentage point increase in trade openness will reduce economic growth by approximately 0.04 percent in the short-run. This confirms the results in the end model. In addition, the coefficient of government expenditure is statistically significant at 1 percent level, indicating that if government expenditure were to increase by 1 percent economic growth will increase by approximately 0.3 percent in the short run. This also corroborates the long run model results.

Again, the coefficient of inflation also maintained its negative sign and is statistically significant at 1 percent significant level, which is consistent with the long-run results. The result therefore suggests that if inflation goes up by 1 percent, economic growth will decrease by approximately 1.4 percent in the short-run. Thus, the short-run and long run results indicate that inflation has been a discouragement for economic growth in Ghana. The negative effect of inflation on economic growth seems more severe in the short-run (-1.4) than in the long run (-0.04). The results indicate how important it is to control inflation in the Ghanaian economy by putting in the appropriate policies. Its impact in both the short and long run appears to be debilitating as inflation generally proxy macroeconomic instability. This result is consistent with empirical literature.

Finally, inconsistent with the long-run estimate, the coefficient of labour force maintained its positive sign but statistically significant at 1 percent significance level. The results indicate that a 1-percentage point increase in the labour force will increase economic growth by about 0.3 percentage points in the short run. The results suggest that the labour force is more important for economic growth in the short-run than in the long-run. The coefficient of capital had its expected positive sign and is statistically significant at 5 percent level. This means that capital positively affects economic growth in both the short and long run in Ghana. The R-Square shows that the regressors in the model explain around 72 percent of the variations in economic growth. It can be seen that the R-Square value 0.72 is less than the Durbin DW-statistic value of 2.07 indicating that the results are not spurious.

Model Diagnostics and Stability Tests

In order to check for the estimated ARDL model, the significance of the variables and other diagnostic tests such as serial correlation, functional form, normality, heteroskedasticity and structural stability of the model are considered. As shown in Table 9, the model generally passes all diagnostic tests in the first stage. The diagnostic test shows that there is no evidence of autocorrelation and the model passes the normality test indicating that the error is normally distributed. Additionally, the model passes the white test for heteroskedasticity as well as the RESET test for correct specification based on the probability values in parentheses.

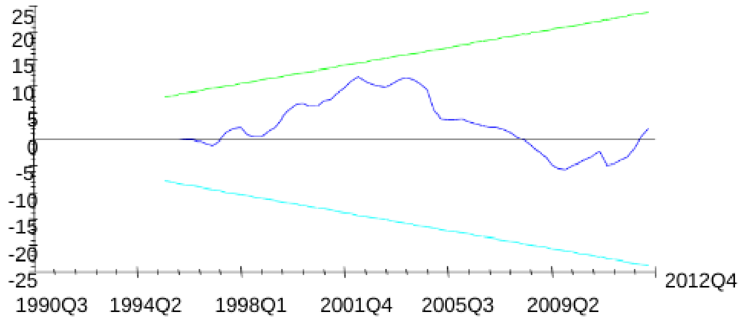
Table 9: Model diagnostics

Diagnostics	LM-Version	F-Version
Serial correlation	$\chi^2_{Auto\,(4)}$ 2.597 [0.627]	F(4, 68)=1.624[.178]
Functional Form	χ^2_{RESET} (1) 0.547 [0.459]	F(1,71) =7.019[0.207]
Normality	χ^2_{Norm} (2) 0. 536[0.765]	Not Applicable
Heteroskedasticity	χ^2_{White} (1) 2.500[.114]	F(1,88)= 2.514[.116]

Source: Computed by Author using Microfit 4.1

Finally, when analyzing the stability of the coefficients, the Cumulative Sum (*CUSUM*) and Cumulative Sum of Squares (*CUSUMQ*) are applied. Following Pesaran and Pesaran (as cited in Bahmani-Oskooee, 2004), the stability of the regression coefficients is evaluated by stability tests and they can show whether the parameter estimates are stable over time. This stability test is appropriate in time series data, especially when one is uncertain about when structural change might have taken place. The result for *CUSUM* and *CUSUMQ* are shown in Figures 1 and Figure 2.The null hypothesis is that the coefficient vector is the same in every period and the alternative is that it is not (Bahmani-Oskooee, 2004). The *CUSUM* and *CUSUMQ* statistics are plotted against the critical bound of 5 percent significance level. According to Bahmani-Oskooee (2004), if the plot of these statistics remains within the critical bound of the 5 percent significance level, the null hypothesis that all coefficients are stable cannot be rejected.

Figure 1: Plot of Cumulative Sum of Recursive Residuals

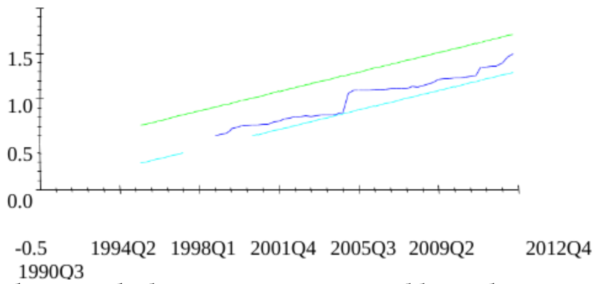


The straight lines represent critical bounds at 5% significance level

Note: The variable on the vertical axis is residuals while the variable on the horizontal axis is years in quarters.

Source: Generated by the author using Microfit 4.1

Figure 2: Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Note: The variable on the vertical axis is the square of the residuals while the variable on the horizontal axis is years in quarters. Source: Generated by the author using Microfit 4.1

As shown in Figures 1 and 2, the plot of both the *CUSUM* and *CUSUMSQ* residuals are within the 5 percent critical bound (boundaries). That is to say that the stability of the parameters has remained within its critical bounds of parameter stability. It is clear from both graphs in Figures 1 and 2 that both *CUSUM* and *CUSUMQ* tests confirm the stability of the coefficients.

Granger Causality Test (Results for the third objective)

After establishing cointegration among the variables, Granger causality test was then applied to measure the linear causation between economic growth and exchange rate volatility. The results of the test are presented in Table 10.

Table 10: Results of Bivariate Granger causality test

Null Hypothesis:	F-StatisticProb.
Vol does not Granger Cause Y	5.719850.0447**
Y does not Granger Cause Vol	1.953330.1481

Note: **, and * denote significance level at 1%, 5% and 10% respectively
Source: Estimated by the author using E-views 6.0

The bivariate Granger causality test results in Table 10 reject the null hypothesis that the Vol does not Granger cause real GDP at 5 percent level. The rejection of the null hypothesis indicates that exchange rate volatility causes growth in real GDP. However, the null hypothesis that real GDP does not Granger cause the exchange rate volatility cannot be rejected even at the conventional level. The results of Granger causality tests confirm causation from exchange rate volatility to economic growth.

4. CONCLUSION AND RECOMMENDATION

This study has examined the time series properties of the data used for estimation, presented and discussed the results. Unit root test employing both the ADF and the PP techniques essentially showed that all the series had to be different once to achieve stationarity. This implies that all the series are integrated of order one, *I*(1). The presence of non-stationary variables implied the possibility of the presence of a long-run relationship among the variables, which the study verified using ARDL bounds test. The results of the ARDL (2, 0, 2, 2, 2, 0, 2) model selected based on SBC show the presence of a long-run and short-run relationship between economic growth and exchange rate volatility while controlling for trade openness, government expenditure, inflation, labour force and capital. Whereas exchange rate volatility, trade openness and inflation exerted a negative and statistically significant impact on economic growth, a positive effect from government expenditure, labour force and capital to economic growth was found.

However, the labour force did not have any significant effect on economic growth in the end. The study's main conclusion, or takeaway lesson, is that Ghana's economic development is slowed or reduced by exchange rate fluctuation. As a result, policies need to be focused on lowering exchange rate volatility. The literature on the relationship between exchange rate volatility and economic growth in Ghana reveals a notable gap that warrants further investigation. While several studies have explored the impact of exchange rate volatility on economic growth in various countries and regions, there is a dearth of research specifically focused on Ghana. The existing literature primarily concentrates on the effects of exchange rate volatility on trade flows, investment, and inflation, but fails to extensively examine its implications for Ghana's economic growth. Consequently, a comprehensive understanding of how exchange rate volatility influences the country's growth dynamics remains insufficiently explored. Therefore, there is a need for research that specifically investigates the relationship between exchange rate volatility and economic growth in Ghana, taking into account the unique characteristics of its economy, policy frameworks, and external sector dynamics. Such an investigation could provide valuable insights for policymakers, businesses, and investors, enabling them to make informed decisions and design appropriate strategies to promote sustainable economic growth in Ghana.

In addition, the results of the ARDL (2, 0, 2, 2, 2, 0, 2) model selected based on SBC show that the error correction term (ECMt-1) for economic growth carried the expected negative sign. The significant error correction term suggests that a deviation from the long-run equilibrium subsequent to a short-run shock is corrected by about 17% at the end of each quarter in a year. The diagnostic and parameter stability tests revealed that the model passes the tests of serial correlation, functional form for misspecification, non-normal errors and heteroskedasticity at conventional levels of significance and the graphs of the CUSUM and CUSUMSQ indicate the absence of any instability of the coefficients because the plots of these graphs are confined within the 5 percent critical bounds of parameter stability suggesting that all the coefficients of the estimated ARDL model are stable over the study period. The Granger causality test results revealed a unidirectional causality from exchange rate volatility to economic growth.

5. SUGGESTIONS FOR FUTURE RESEARCH

Since exchange rate is a high frequency phenomenon, daily, weekly or monthly data must be used when investigating the effect of exchange rate on macroeconomic variables. Future research can also look at how exchange rate volatility affects directly on international trade and investment in Ghana.

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