Exchange Rates and Stock Prices in Ghana

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Using daily data spanning from January 2, 1998 to December 20, 2011, the study investigated the cointegration and the Granger causality relationships between exchange rates and stock prices in Ghana. Augmented Dickey-Fuller test was used to test for unit root process in the data series and the results show that both variables are integrated at order one, I (1). The Engle-Granger (1987) two-step cointegration test was used to test for cointegration between the two variables. The results show that there is no cointegration relationship between the two. Also, a structural break in the relationship between the two variables after the redenomination of the Ghana's currency (Cedi) on July 3, 2007 was noticed. In effect, VAR between the stock price and exchange rate returns for pre-redenomination and post-redenomination sub-sample periods and consequently test for Granger causality. Unidirectional causality from exchange rates to stock prices before the redenomination but no causality between the two after the redenomination of the cedi.

INTRODUCTION

The effects of globalization and the continuous deepening of financial integration among economies coupled with the economic role that stock markets play in the allocation of resources to productive sectors has generated a lot of research interest in the relationship between exchange rates and stock prices. Liberalization of foreign capital controls and the adoption of floating exchange rate regimes by many countries especially emerging economies in Asia and Africa have increased the traffic of funds among economies unleashing its concomitant effects on the foreign exchange rates. The dynamic interactions between exchange rate and stock prices are explained from two theoretical standpoints, namely, the flow-oriented model and the stock-oriented model. More than three decades ago Dornbusch and Fischer (1980) propounded the flow-oriented model and argue that changes in exchange rates lead to changes in stock prices. Thus, if the domestic currency depreciates, the country's global competitiveness is improved. This implies that domestic firms that export have a strategic competitive edge and all things being equal implies more cash flows for the domestic firms and therefore this development may influence the stock prices of these firms positively and the opposite holds for import-oriented companies in case the domestic currency appreciates. However, the stock-oriented theory pioneered by Frankson (1983) and Branson

(1993) posits that stock price changes lead to exchange rate changes. The stock-oriented model theorizes that if the prices of domestic stocks rise, investors will be influenced to augment the weight of the domestic assets in their portfolio by selling-off foreign assets to obtain domestic assets. Consequently, increase in the demand for domestic currency will lead to an appreciation in the value of the domestic currency.

In the conclusion of Bodnar et al. (1993), movements in the exchange rates can essentially affect the values of firms especially if the cost of input for their operations and the values of their assets are denominated in foreign currencies. Also, Kim (2003) reports that the S&P 500 stock price is causally and negatively related to exchange rate in a study conducted on the relationship among some key macroeconomic variables of the United States of America. It was further argued that the consistent increases in the global trade volume and the growing traffic in capital across economies have positioned the exchange rates as one of the cardinal determinants of both business and equity performance.

This study is motivated to provide empirical relationship between stock price performance and exchange rate volatility in Ghana to guide well-informed policy framework in the financial market.

THE RELATIONSHIP BETWEEN EXCHANGE RATES AND STOCK PRICES

There is a large body of literature on the relationship between stock prices and exchange rates with a lot of mixed results. Ghana has gone through cycles of exchange rate volatility even when the fixed rate regime was practiced. After the structural adjustment programme and the financial sector adjustment programme that led to financial sector reforms, the exchange rate regime has changed to a liberalized one allowing demand and supply and speculation to thrive. The dynamic interactions between exchange rate and stock prices are explained from the two theoretical positions, namely, the flow-oriented model and the stock-oriented model. Dornbusch and Fischer (1980) who propounded the flow-oriented model argue that changes in exchange rates lead to changes in stock prices. Thus, if the domestic currency depreciates, companies that principally rely on exports to generate revenues will gain a competitive advantage since the value of their exports will be cheaper comparatively. This positive development may influence the stock prices of these firms positively and the opposite holds for import-oriented companies in case the domestic currency appreciates. On the contrary, in the case of firms that use imported raw materials and components in the their production, the depreciation of the local currency will augment their cost of production thereby negatively affecting their performance which will reflect in their stock prices all things being equal. However, the stock-oriented theory pioneered by Frankson (1983) and Branson (1993) posits that stock price changes lead to exchange rate changes. Thus, if the prices of domestic stocks rise, investors will be enticed to increase the weight of the domestic assets in their portfolio by selling-off foreign assets to obtain domestic assets. Consequently, increase in the demand for domestic currency will lead to an appreciation in the value of it.

A vast array of empirical work has been done on the relationship between exchange rates and stock prices. Abdalla and Murinde (1997) employed a bivariate vector autoregressive model to analyse the nexus between stock prices and exchange rates for four Asian countries, Philippines, India, South Korea and Pakistan for a period ranging from 1985:01- 1994:07. The findings from the Granger-causality test showed that there was a uni-directional causality from exchange rates to stock prices in all the respective countries except Philippines where stock prices Granger-cause exchange rates. Adjasi et el. (2008) studied the effect of the exchange rate volatility on the Ghana stock exchange with data spanning from 1995 to 2005 by employing the Exponential Generalised Autoregressive Conditional Heteroskedascity (EGARCH). They reported that there was an inverse relationship between exchange rates volatility and stock market returns with volatility transmission running from exchange rates to stock prices.

On the contrary, Ajayi et al. (1998) employed daily stock indices and exchange rates for a set of developed and developing economies by employing a Granger causality test to investigate the causal relations between stock returns and changes in the exchanges rates using data spanning from 1985 to 1991. The findings indicated a uni-directional Granger causality from the stock market to the currency market in all the developed economies however, no consistent causal relations were observed in the developing economies. Lee et al.(2011) employed Smooth Transition Conditional Correlation-GeneralisedHeteroskedasticity (STCC-GARCH) model to investigate the relationship between exchange rates and stock prices of six Asian countries, namely, Korea, Malaysia, Indonesia, Taiwan, Philippines and Thailand. The results showed that there was a significant spillover from stock market to foreign exchange market for Indonesia, Korea, Malaysia, Thailand and Taiwan except in Philippines. Chien-Hsiu (2011) investigated the comovement between the exchange rates and stock prices in the Asian emerging markets by adopting the Autoregressive Distributed Lag (ARDL) model developed by Pesaran et al. (2001). He concluded that the comovement between the exchange rates and stock prices during the crises period was more pronounced than during the stable period. He further argued that most of the causality ran from stock prices to exchange rates. Thus, the economic slowdown affected equity prices which prompted international investors to withdraw their investment which consequently affected the exchange rates. Moreover, Athanasios and Costas (2013) investigated the existence of the long-run relationship between exchange rates and stock prices in the European Union (EU) and United States of America (USA) during the recent financial crises using daily data ranging from January 2008 to April 2012 by employing a more recent advanced model, the structural nonparametric cointegration regression. They reported that there was a uni-directional Granger causality from stock prices to exchange rates in the long run with respect to EU and in the short –run in the case of USA.

Furthermore, in other related studies, the researchers found feedback and no causal interactions between the two variables. Usman and Aliyu (2008) examined the short-run and long-run interactions between the exchange rates and stock prices in Nigeria based on the sample from February 1, 2001 to December 31, 2008. They divided the data into pre-crises and post-crises period (after the 2007 global financial crises). The Granger (1969) causality model was employed to establish bidirectional causality between the exchange rates and stock prices within these periods. Also, it was found that there was no causality between the exchange rates and stock prices in the pre- crises period, however there was a bidirectional causality between the exchange rates and stock prices in the post-crises model as well as the entire period model. Zhao (2009) analyzed the dynamic relationship between the exchange rates and stock prices of China using monthly data from January 1991 to June 2009. He concluded that there was a bidirectional volatility spillover effect between the two markets, indicating that past innovations in stock market have great effect on the future volatilities in foreign exchange market and vice versa. Liu and Wan (2012) investigated the relationship between the Shanghai stock market and the foreign exchange rates. They reported that there was a cross correlation between the stock prices and exchange rates. Furthermore, by employing both the linear and non-linear Granger causality tests, they found no causality between the exchange rates and stock prices before the financial crises. However, they found a uni-directional causality from the exchange rates to stock prices after the financial crises.

DATA SOURCES AND DEFINITION OF VARIABLES

Data used for these studies are the daily stock prices of the Ghana Stock Exchange and the daily exchange rates[1] between the Ghana cedi and the US dollar. The principal stock indices on the Ghana Stock Exchange were used as proxy for stock prices. The data series start from January 2, 1998 to December 20, 2011 and could not go further due to data gathering difficulties. The data are taken from the Ghana Stock Exchange and the Central Bank of Ghana data bases. The US dollar to Ghana cedi is chosen as a proxy for the exchange rate principally because it is the most largely traded currency on the forex market of Ghana and also according to the IMF's Direction of Trade Statistics (DOTS, 2011)[2], the United States ranks as one of the major trading partners of Ghana. Both the exchange rate series and the stock prices are expressed in their natural logarithm. Many researchers data of different frequencies in conducting studies on this topic, namely, daily, weekly, monthly, quarterly and yearly observations. Daily observations was chosen over the monthly and yearly ones based on the argument put forward by Granger et al. (2000) that studies based on daily observations are more likely to find Granger- causality and also be able to capture capital movements. In order to capture the effect of the redenomination of the cedi on the interactions between the variables, the sample period was divided into two, the pre-redenomination and post-redenomination periods. In effect, three models are estimated, the basic model which refers to the entire sample period, pre-redenomination model which is the model estimated based on the sub-sample period before the redenomination and finally the post-redenomination model which is based on sub-sample period after the redenomination. The summary statistics (See Table1) shows a negative mean and skewness in the case of the stock price returns but positive mean and skewness with respect to exchange rate returns. The return series for both stock index and the exchange rates are obtained as follows:

R_t=ln (P_t/P_{t-1})*100.

TABLE 1
STATISTICAL PROPERTIES OF THE RETURN SERIES

Statistic	ΔlnSI	ΔlnER
Mean	-0.039586	0.064282
Median	0.056867	0.013872
Maximum	19.53734	5.254275
Minimum	-18.77655	-5.071232
Std. Dev.	1.275029	0.240571
Skewness	-4.514463	1.276291
Kurtosis	91.58829	151.0140
Jarque-Bera	1174874	3247024

Note: ***indicates rejection

Estimation Techniques

Researches on the causal relationship between equity prices and exchange rates have been conducted with various econometric methods. In this study, the vector autoregressive model and dynamic Granger (1969) causality test were used to examine the relationship between the variables under study. Empirical studies which are premised on time series data assume that the underlying time series is stationary. On the contrary, many empirical studies have shown that this assumption is not always true and that a significant number of time series variables are non-stationary (Engle and Granger, 1987). Thus, employing a non-stationary time series data in a regression analysis may result in spurious results (Granger and Newbold (1974)). Therefore, embarking on studies involving time series data necessitates that stationary test is conducted to establish the underlying process of the data series.

Test for Stationary

A data generating process is considered stationary if it has time-invariant first and second moments, and the covariance of two time periods is constant notwithstanding which time periods are used and the distance between them, Gujarati (1995). The process is said to be weakly stationary if the two first conditions are fulfilled but the covariance between two time periods depends on the distance between the time periods, but not on when it is calculated. If the process is stationary around a trend, it is said to be trend-stationary. There are a variety of unit root tests used in the econometric literature principally Augmented Dickey-Fuller (ADF), Dickey-Fuller, Phillip-Perron, Ng-Perron tests, etc. to investigate whether the time series data used in a study are stationary or not. The study employed the Augmented Dickey-Fuller to examine the stationarity of the variables.

Augmented Dickey-Fuller (ADF) Test

The ADF model tests the null hypothesis that there is unit root against the alternative hypothesis that there is no unit root in the regression. The regression for the ADF test is estimated as follows:

$$\Delta Y_t = \lambda + \phi t + \eta Y_{t-1} + \phi_1 \Delta Y_{t-1} + \phi_2 \Delta Y_{t-1} + \ldots + \phi_p \Delta Y_{t-p} + \varepsilon_t \qquad (1)$$

where Y_t represents the variable that we are examining its properties, Δ is the difference operator, λ, η and ϕ are the coefficients to be estimated, p is the chosen lag length, *t* is the time trend, and ε_t is the white-noise error term. Y_t has a stochastic trend under the null hypothesis but under the alternative hypothesis Y_t is stationary. Generally, the lag length for conducting the ADF test is unknown but can be estimated using information criteria such as the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) applied to the regressions of the form in equation (1). If the Data Generating Process (DGP) is stationary in the data series at levels, then it will be concluded to be integrated of order zero, I (0). On the contrary, it is not always the case and the underlying process of the data series may be non-stationary. In effect, the original series need to be transformed into a stationary state by taking difference (d) times. If after taking first difference of the series, it is found that they are all stationary then we can conclude that the DGP is integrated at order one, I (1). Moreover, if the original series used in the study are found out to be integrated of the same order, it is useful to test for cointegration relationship between the integrated variables.

Engle-Granger Two Step Cointegration Test

It is generally accepted that regression which involves non-stationary time series will lead to spurious results. However, Engle-Granger (1987) proposed that a linear combination of these non-stationary series may be stationary in which case we can say that the series are cointegrated. The concept here is to determine whether the stochastic trends in the variables of interest that contain unit roots have long-run relationships. Thus this method is a two-step procedure which involves an ordinary least square (OLS) estimation of the specified cointegration regression.

The cointegration regression is specified as follows:

$$SP_t = \alpha + \beta ER_t + u_t \qquad (2)$$

Where SP_t and ER_t represent stock prices and exchange rates respectively, α and β are the parameters to be estimated and u_t is the error term. With respect to this regression, it is assumed that all the variables are I (1) and might cointegrate to form a stationary relationship, and thus will result in a stationary residual term. The null hypothesis of non-cointegration is that the residual term is non-stationary. Unit root test is conducted on the residuals to find out whether they are stationary or otherwise. To this end, the ADF test is employed to conduct the unit root test. If the residuals are stationary, then one rejects the null hypothesis of non-cointegration. However, if they are non-stationary, then one accepts the null hypothesis of non-cointegration.

Vector Autoregressive (VAR) Model

A vector autoregression is a set of k series of regressions in which the regressors are lagged values of all the k series. The underlying assumption of the model is that all variables are endogenous a priori, and allowance is made for rich dynamics. VAR models offer some level of flexibility and therefore easy to use for analysing multiple time series. This is against the backdrop that one needs not to specify which variables are exogenous or endogenous. However, there are still some difficulties associated with VAR models. In the first place, it is not easy to identify which variables have significant effect on the dependent variable. Also, there is a strict condition that all the data series in the VAR should be stationary. However, most financial time series are non-stationarity. In case the variables are found not to be stationary at levels, then according to Granger (1969), it is more appropriate to estimate VAR or Vector Error Correction Model depending on whether the series are cointegrated or not.

If the variables are found not to be cointegrated, then the following standard VAR will be estimated and the Granger causality test is consequently conducted:

$$\Delta \ln SI_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} \Delta \ln SI_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta \ln ER_{t-i} + u_t \quad (3)$$

$$\Delta \ln ER_t = \beta_0 + \sum_{i=1}^{m} \beta_{1i} \Delta \ln SI_{t-i} + \sum_{i=1}^{n} \beta_{2i} \ln \Delta ER_{t-i} + v_t \quad (4)$$

where SI is the stock price, ER is the exchange rate of the Ghana cedi to the US dollar u_t and v_t are uncorrelated white noise terms, ln represents the natural log, Δ difference operator and t denotes the time period. If the lagged coefficient of vector α_2 in equation (3) is significant but that of vector β_1 in equation (4) is not significant then the results imply that there is unidirectional causality from exchange rate to stock price returns. However, if the lagged coefficient vector β_1 in equation (4) is statistically significant but the lagged coefficient vector α_2 in equation (3) is not statistically significant then the results imply that there is unidirectional causality from stock prices returns to exchange rate returns. Moreover, if the lagged coefficient vectors of both equations (3 and 4) are statistically significant then the results imply that there is a bidirectional causality from the stock returns and exchange rate returns. Finally, if both lagged coefficient vectors are statistically insignificant, then this implies that there is no causality between these variables.

According to Engle and Granger (1987), the VECM is a preferable model to the standard VAR in equations (3 and 4) if it is found that there is cointegration relation between and or among the data series. The VECM discriminates between both the dynamic short-run and long-run Granger causality. The VECM equations are written as follows:

$$\Delta \ln SI_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} \Delta \ln SI_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta \ln ER_{t-i} + \alpha_3 \varsigma_{t-1} + u_t \quad (5)$$

$$\Delta \ln ER_t = \beta_0 + \sum_{i=1}^{m} \beta_{1i} \Delta \ln SI_{t-i} + \sum_{i=1}^{n} \beta_{2i} \ln \Delta ER_{t-i} + \beta_3 \varsigma_{t-1} + v_t \quad (6)$$

where SI is the stock price, ER is the exchange rate, ς_{t-1} is the error correction term lagged one period; u_t and v_t are uncorrelated white noise terms. The error correction term (ς_{t-1}) is derived from the long-run cointegration relationship between the variables. The estimates of the error correction term of (ς_{t-1}) also shows how much of the deviation from the equilibrium state is corrected in each short period. To find out the presence of long-run causality between the two data series, one will test for the significance of the coefficient of the error correction term in equations (5 and 6) by employing the t-test. Finally the Wald or F-statistic is used to test for the joint significance of both the error correction term and the various interactive terms in equations (5 and 6). If the lagged coefficient vector α_2 of equation (5) is statistically significant but the lagged coefficient vector β_1 in equation (6) is not significant then the results imply that there is a unidirectional causality from exchange rate to stock price returns. However, if the lagged coefficient vector β_1 in equation (6) is statistically significant but the lagged coefficient vector α_2 in equation (5) is not statistically significant then the results imply that there is a unidirectional causality from stock prices returns to exchange rate returns. Moreover, if the lagged coefficient vectors of both equations (5 and 6) are statistically significant then the results imply that there is bidirectional causality from the stock returns and exchange rate returns. Finally, if both lagged coefficient vectors are statistically insignificant, then this implies that there is no causality between these variables.

Test for Structural Breaks

To test for structural breaks in the regression coefficients, an autoregressive distributed lag (ADL) with dummy variables to represent the periods before and after the redenomination of the cedi were estimated. Moreover, to choose the appropriate lag length for both the dependent and independent variables to include in the ADL, an estimate the regression equations with different lag lengths was conducted and compare the resulting BICs. In effect, the lag length that resulted in the lowest BIC is chosen to estimate the ADL and then the structural break test is conducted. The ADL is estimated as below:

$$\Delta \ln SI_t = \beta_0 + \sum_{i=1}^{m} \delta_i \Delta \ln SI_{t-1} + \sum_{i=1}^{n} \lambda_i \Delta \ln ER_{t-1} + \alpha_0 D_t + \sum_{i=1}^{m} \alpha_{1i} D_t \Delta \ln SI_{t-1} + \sum_{i=1}^{n} \alpha_{2i} D_t \Delta \ln ER_{t-1} + u_t \quad (7)$$

where

SI_t= stock price returns

ER_t= exchange rate returns

D_t = Dummy variable where D_t= 1 if t ≥ 3 July, 2007; D_t= 0 if t ≤ 3 July, 2007

Δ = difference operator

T = time period; $\alpha, \beta, \delta, \lambda$ are the coefficients of the parameters

Chow (1960) model tests for structural break in which case the break dates must be known a priori and the decision is made on the F-statistic that tests the null hypothesis of no break; $\alpha_0 = \alpha_{1i} = ... = \alpha_{1m} = \alpha_{2i} = ...\alpha_{2n} = 0$ against the alternate hypothesis that at least one of α 'sis nonzero. Thus, in case of the Chow (1960) test, the investigator has to pick an arbitrary break date or pick a known date based on the feature of the data series. In effect, the results can be highly sensitive to these arbitrary choices and as the true break date can be missed. However, in this study, the break date is identified by the redenomination of the cedi.

The CUSUM of Squares Test

In an attempt to test for the constancy of the variance, the CUSUM of square test was employed as in Brown et al. (1975). This test is principally based on the square of the residuals on the plot of the quantities. This test involves drawing a pair of critical lines on the diagram which is parallel to the mean value line so that the probability that the sample path crosses one or both critical lines is the significance level. If the sample path stays between the pair of critical lines without crossing any of the two lines, then one can conclude that the variance is constant over the period. However, movement outside of the critical lines implies parameter or variance instability.

RESULTS AND DISCUSSION

Unit Root Tests

The unit root test is conducted with different lag lengths and then the resultant BICs are compared to select the lag that yields the lowest BIC. According to Stock and Watson (2007) it is beneficial to use higher lag length than fewer lags to conduct the unit root test. Against this background, several lags were employed to carry out the stationary test and the lag that yields the lowest BIC was chosen. Therefore, stationary test is carried out on the data at log levels and also in returns using the ADF test with constant only and then constant and trend with lags 22 and 11 respectively for stock price index and exchange rate. With respect to the log levels, the t-statistic are less than all the critical values at all the conventional levels of significance and therefore we fail to reject the null hypothesis that they are non-stationary. However, the t-statistic are greater than all the critical values at 5% levels of significance in terms of returns (after taking first difference) and consequently, we reject the null hypothesis that there is unit root in the data series. Therefore, both series follow an I (1) process (see table 2).

TABLE 2
UNIT ROOT TEST FOR THE STOCK PRICES RETURNS AND NOMINAL EXCHANGE RATE SERIES

	Constant Only			**Constant and Trend**		
Levels	t-static	p-value	Decision	t-static	p-value	Decision
ln(SI)	-2.0016	0.2863	Accept	-1.7967	0.7064	Accept
ln(ER)	-1.7571	0.4023	Accept	-1.4001	0.8611	Accept
Differences						
Δ ln(SI)	-7.6166	0.0000	Reject	-7.6634	0.0000	Reject
Δ ln(ER)	-6.5389	0.0000	Reject	-6.6859	0.0000	Reject

Critical Values: Constant:10% (-2.56714), 5% (-2.86216) and 1% (-3.432013)
Constant and Trend: 10% (-3.12735), 5% (-3.41107) and 1% (-3.960636)

Cointegration Test

The results of stationary test shown in Table 1 confirm that both return series follow an I (1) process and therefore according to Engle-Granger (1987) it is essential to further test for cointegration relation between the variables. The cointegration test is conducted using Engle-Granger (1987) cointegration test. The two- step cointegration test is employed as discussed earlier and find the residuals of the cointegration regression are not stationary since the t-statistics are less than the critical values (see Table 3). Therefore the null hypothesis that the series are not cointegrated at 5% significance level was accepted.

TABLE 3
ENGLE-GRANGER TWO- STEP COINTEGRATION TEST

	t-statistic	P-value	Decision
ADF Test	-1.163446	0.9165	Accept

Critical Values: 1%(-3.90); 5%(-3.40); 10%(-3.04)[3]

Tests for Structural Break

The Chow (1960) test was employed to test for structural break in the data series principally because of the redenomination of the cedi. Based on Chow (1960) test, the F-statistic is greater than the critical value at 5% and therefore, we fail to accept the null hypothesis of no structural break in the data series (see table 4). This implies that the redenomination of the cedi did have some effect on the relationship between the exchange rate returns and stock price returns.

TABLE 4
CHOW (1960) TEST

	F-statistic	P-value	Decision
Value	1.8959	0.0144	Reject

Critical Values are: 10% (1.46), 5% (1.62) and 1% (1.97)

Granger Causality Test

Based on the results of the structural break test we divided the sample period into the basic model, pre-denomination and post-redenomination sample periods. Based on the standard VAR using the full sample, we examine the direction of causality between the foreign exchange rates returns and the stock price returns by employing the Granger (1969) causality model. We choose the Granger causality test above the other methods because of its favourable response to both small and large sample sizes (Odhiambo, 2008). We fail to accept the null hypothesis that exchange rate returns do not Granger-cause stock price returns because the F-statistic is bigger than the critical values. However, we accept the null hypothesis that stock returns do not Granger-cause exchange rate returns since the F-statistic is less than the critical value (see table 5). In the case of the pre-redenomination model, the F-statistic of the Granger causality test is greater than the critical value and therefore, we fail to accept the null hypothesis that exchange rate changes do not Granger cause stock price returns. However, we accept the null hypothesis that stock price returns do not Granger-cause exchange rate since the F-statistic is less than the critical value. Moreover, with respect to the post-redenomination model, there is no Granger causality between the exchange rates and stock price returns since the F-statistics in both cases are less than the critical values.

TABLE 5
GRANGER CAUSALITY TEST

Null Hypothesis	**F-statistic**	**P-value**	**Decision**
BASIC MODEL			
Δ ln(ER) does not Granger cause Δ ln(SI)	3.20433	0.0007	Reject
Δ ln(SI) does not Granger cause Δ ln(ER)	1.07954	0.3743	Accept
BEFORE THE REDENOMINATION			
Δ ln(ER) does not Granger cause Δ ln(SI)	3.42958	0.0003	Reject
Δ ln(SI) does not Granger cause Δ ln(ER)	0.83537	0.5834	Accept
AFTER THE REDENOMINATION			
Δ ln(ER) does not Granger cause Δ ln(SI)	0.40608	0.9323	Accept
Δ ln(SI) does not Granger cause Δ ln(ER)	0.96357	0.4687	Accept

Critical Values are: 10% (1.63), 5% (1.88) and 1% (2.41)

Robustness Check

In order to verify the reliability of the findings based on the daily data series, we conducted the same analyses using weekly data with specific focus on the structural break period and Granger causality between the two variables to find out whether the results are consistent notwithstanding the frequency of the data series.

The Chow (1960) test is once again employed to test for structural break in the relationship between the two variables. The findings show that there is a structural break after the redenomination of the cedi. Thus, the F-statistic is greater than all the critical values at all the conventional levels of significance. In effect, we fail to accept the null hypothesis that there is no structural break in the relationship (see table 6).

To this end the Granger causality test is conducted on the full sample period, the sub-sample periods before and after the redenomination respectively. With respect to both full sample and the pre-redenomination sample, we fail to accept the null hypothesis that exchange rate changes do not Granger cause stock index returns since the F-statistic is greater than the critical value, however, we accept the null hypothesis that the stock index returns do not Granger cause exchange rate changes since the F-statistic is lower than the critical values. On the contrary, in the case of the post-redenomination model, we accept the null hypotheses that exchange rates do not Granger cause stock index returns and also that stock index returns do not Granger cause exchange rates because the F-statistic are lower than the critical values at all levels of significance (see table 7). Therefore, the results of the tests show again that there is unidirectional Granger causality from exchange rates changes to stock index returns with respect to the full sample and the sub-sample period before the redenomination of the cedi. However, there is no Granger causality between the two variables after the redenomination of the Cedi. Thus, the results imply that the frequency of the data series did not have any material impact on the conclusions of the studies.

TABLE 6
CHOW (1960) TEST

F-statistic	P-value	Decision
3.5779	0.0009	Reject

Critical Values are: 10% (1.46), 5% (1.62) and 1% (1.97)

TABLE 7
GRANGER CAUSALITY TEST

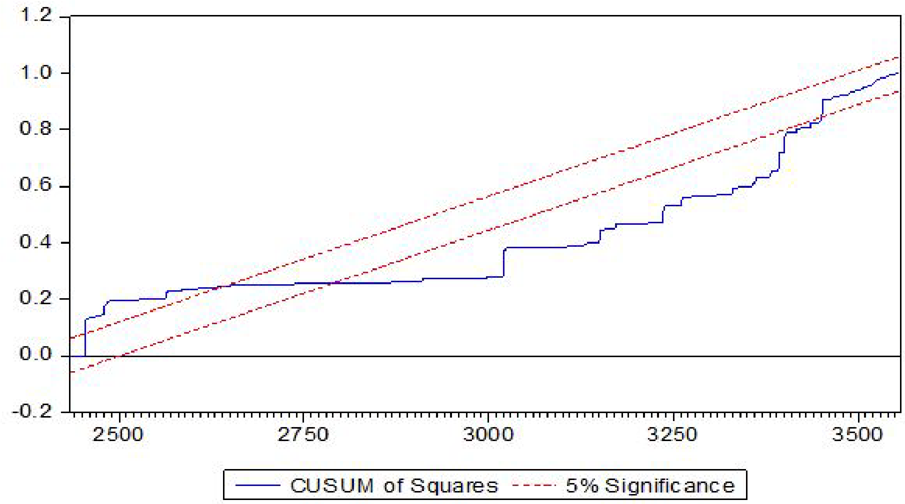
Null Hypothesis	**F-statistic**	**P-value**	**Decision**
BASIC MODEL			
Δ ln(ER) does not Granger cause Δ ln(SI)	5.1297	0.0004	Reject
Δ ln(SI) does not Granger cause Δ ln(ER)	0.6113	0.6545	Accept
BEFORE THE REDENOMINATION			
Δ ln(ER) does not Granger cause Δ ln(SI)	5.1865	0.0004	Reject
Δ ln(SI) does not Granger cause Δ ln(ER)	0.4448	0.7763	Accept
AFTER THE REDENOMINATION			
Δ ln(ER) does not Granger cause Δ ln(SI)	0.8938	0.4434	Accept
Δ ln(SI) does not Granger cause Δ ln(ER)	0.6344	0.5946	Accept

Critical Values are: 10% (1.63), 5% (1.88) and 1% (2.41)

CUSUM of Squares Test

We proceed to further test whether the redenomination of the cedi impacted the stability of the exchange rate and consequently its causal relationship with the stock prices returns. To this end, variance constancy was tested by employing the CUSUM of Squares test. The graph of the CUSUM of Squares test (see Figure 1) shows that the sample plot crosses both pair of critical lines (5%) which suggest that the variance is not constant over the period. Moreover, to further consolidate this statistical evidence, we notice based on the summary statistics of the pre-redenomination and post-redenomination sub-sample data that the variance{exchange rates returns (0.24); stock prices returns (1.45)} of the pre-redenomination sub-sample period is relatively higher than that of the post-redenomination{exchange rates returns (0.21); stock prices returns (0.79)}.

FIGURE 1
GRAPH OF CUSUM OF SQUARES



RECOMMENDATIONS AND CONCLUSIONS

The study investigates the relationship between exchange rate and stock prices. The Augmented Dickey Fuller test is employed to test for a unit root process in the data series. Both series are found not to be stationary at levels but stationary after taking first difference. This implies that the two series are integrated of order one (1). Furthermore, test for a cointegrating relationship between the two variables was conducted by employing the Engle-Granger (1987) two-step cointegration test. It was established that there is no cointegrating relation between the two variables. In effect, vector autoregressive model was estimated on the returns of the series. The results of the Wald tests on the coefficients of the regressors of the VAR show that in the short-run, the lagged values of the exchange rates help predict changes in the stock prices. However, the Wald test shows the lagged values of the stock prices are not significant to explain changes in the exchange rate returns. Additional statistical evidence based on the Granger causality test shows that there is a uni-directional causality from the exchange rates to stock price returns before the redenomination of the cedi. This result is consistent with the flow-oriented model that posits that changes in exchange rates lead to changes in stock prices.

In addition, structural break test was conducted to examine whether the redenomination of the cedi had any structural impact on the relationship between the exchange rates and stock prices by employing the Chow (1960) test and the CUSUM of Squares test. The results of the Chow test show that there is a structural break in the relationship between the two. Moreover, the mean value in the CUSUM of squares graph crossed the critical lines at 5% significance level which implies that there is parameter and variance instability. Therefore, statistically inferred, it was noticed that the redenomination of the cedi had structural impact on the relationship between the exchange rates and the stock price returns. In effect, we estimate VAR models for the sample period before (pre-redenomination model) and after (post-redenomination model) of the Cedi and then test for Granger causality respectively. Thus, with respect to the basic and pre-redenomination, there is a uni-directional causality but no causality in the case of the post-redenomination model. Also, it was noticed that the variance of the exchange rate and stock price returns reduced after the redenomination of the cedi. Thus, statistically, we therefore infer that the redenomination policy helped to stabilize the cedi comparatively and therefore the fluctuations in exchange rates could not immediately cause significant changes in the stock prices after the redenomination of the cedi.

Investigating the mechanism by which the exchange rate policy change has influenced the relationship between the exchange rates and stock price returns is an area for future research.

ENDNOTES

1. The exchange rate is defined as Ghana cedi price of foreign currency so that a positive value for the exchange rate indicates a cedi depreciation whereas a negative value indicates a cedi appreciation
2. www.imf.org
3. Davidson and MacKinnon (1993) critical values for cointegration test

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APPENDIX

TABLE A1
WALD TEST: BASIC MODEL

Panel A: Stock Price as Dependent Variable

Test Statistic	Value	P-Value
F-statistic	3.2809	0.0005
Chi-square	29.5287	0.0005

Critical Values are: 10% (1.46), 5% (1.62) and 1% (1.97)

Panel B: Exchange Rate as Dependent Variable

Test Statistic	Value	P-Value
F-statistic	1.0669	0.3839
Chi-square	9.6023	0.3836

Critical Values are: 10% (1.46), 5% (1.62) and 1% (1.97)

TABLE A2
WALD TEST: PRE-REDENOMINATION MODEL

Panel A: Stock Price as Dependent Variable

Test Statistic	Value	P-Value
F-statistic	3.4295	0.0003
Chi-square	30.8662	0.0003

Critical Values are: 10% (1.46), 5% (1.62) and 1% (1.97)

Panel B: Exchange Rate as Dependent Variable

Test Statistic	Value	P-Value
F-statistic	1.4666	0.1030
Chi-square	23.4660	0.1018

Critical Values are: 10% (1.46), 5% (1.62) and 1% (1.97)

TABLE A3
WALD TEST: POST-REDENOMINATION MODEL

Panel A: Stock Price as Dependent Variable

Test Statistic	Value	P-Value
F-statistic	1.8617	0.1559
Chi-square	3.7234	0.1554

Critical Values are: 10% (2.08), 5% (2.6) and 1% (3.78)

Panel B: Exchange Rate as a Dependent Variable

Test Statistic	Value	P-Value
F-statistic	0.2478	0.6187
Chi-square	0.2478	0.6186

Critical Values are: 10% (2.08), 5% (2.6) and 1% (3.78)