# The impact of exchange rate volatility on foreign direct investment inflows in Ghana.

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**Abstract**

This paper analyzed the effect of exchange rate volatility and its interaction on the foreign direct investment inflow into Ghana. The unit root of the series was checked using Augmented Dickey-Fuller (ADF), Phillps-Parron (PP) and Kwaiatkpwski-Phillps-Schmidt-Shin (KPSS) tests. According to the results of the unit root tests all the variables were stationary at 5 percent level of significance in their first difference. Therefore, the Dynamic Ordinary Least Square regression model was used for the analysis. It was found that the depreciation of the real exchange rate, the degree of openness of the economy and interaction term do not encourage the inflows of foreign direct investment. However, size of economy and volatility do attract foreign direct investment inflows. Based on the above findings the following recommendations are made. Since volatility of the real exchange rate attracts FDI inflows, the Government should encourage import substitute FDIs to help Ghana industrialized.

**Keywords:** exchange rate volatility; foreign direct investment; DOLS;

**JEL Classification Codes:** B26, B27, C01, C30, F65

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## 1 Introduction

The inflow of foreign direct investment among other factors is regarded as the engine of growth in less developed or developing countries. Most at times investors look for developing countries that need more capital investment and technological improvement to reach their economic development goals. The inflow of foreign direct investment into those countries turns to improve the economy assuming that the political climate and other macroeconomic factors are relatively stable. The inflow of foreign direct investment in the long run have positively influence on most Africa and Latin American countries as well as other less developed nations in the world. In addition, according to Havi *et al* (2013), the inflows of foreign direct investment to Ghana in a long run affect positively on economic performance.

The collapse of the Breton Woods Agreements had introduced fluctuation or uncertainty into the exchange rate; this is due to flexible exchange rate regime. This fluctuation or uncertainty in the exchange rate referred to as volatility may influence foreign direct investment either positively or negatively as small but open economy tries to manage their exchange rate. As a result, the exchange rate volatility has become a factor that the foreign investors do consider. According to Osinubi *et al* (2009) and Choudhry (2005) exchange rate volatility influence foreign direct investment positively while Bryne and Davis (2003) and Aizenmann (2001) also showed in their study that exchange rate volatility influence foreign direct investment negatively.

The part played by exchange rate volatility in encouraging or discouraging foreign direct investment had been explored in advance economy and some developing ones all over the world. However, the issue of interaction between the exchange rate volatility and degree of economic openness was not given or given less attention. Also, the issue of impact of exchange rate volatility on foreign direct investment is not conclusive. In addition, how the exchange rate volatility impact foreign direct investment in Ghana had not been explored extensively. Therefore, this paper tries to investigate the impact of exchange rate volatility and its interaction with degree of economic openness on foreign direct investment in Ghana. This study will contribute to knowledge and fill the gap in the empirical literature on issues of the impact of exchange rate volatility on foreign direct investment in Ghana and the world at large.

The main objective of this study is to find out how exchange rate volatility and its interaction with the degree of openness of the economy impact on the inward foreign direct investment in Ghana. To guide the study the following questions will be explored. Does exchange rate volatility deters foreign direct investment inflows in Ghana? Does interaction between exchange rate volatility and degree of openness of the economy influence inward foreign direct investment?

In addition, this paper will verified whether volatility and interaction term significantly affect the foreign direct investment inflows. The findings of this study will help Ghana and other FDI receiving countries to position themselves well in managing their exchange rate to attract more FDIs. It will inform the World Bank, IMF, other institutions and private investors in their operations as far as foreign direct investment is concern. The study will use data from World Development Indicators and appropriate regression technique to explore the research questions to achieve the objectives set.

The rest of the paper is presented as follows. The section two will cover literature review while section three and four will cover methodology and analysis, respectively. Finally, section five will cover the summary, conclusion and policy recommendations.

## 2 Literature Review

There are two theoretical arguments that linking exchange rate volatility to foreign direct investment inflows; that is, production flexibility arguments and risk aversion arguments. From production flexibility arguments perspective increase in exchange rate volatility causes increase in foreign direct investment because firms can adjust the use of one of the variable factors following the realization of nominal or real shocks in exchange rate. This argument assumed that the firms operate in the long run where inputs can be varied. However, the argument does not hold when firms operate in the short run where all inputs are fixed. From risk aversion arguments perspective as exchange rate volatility increases foreign direct investment decreases because higher volatility in exchange rate lower the certainty equivalent expected exchange rate. Certainty equivalent levels are used in the expected profit functions of firms that make investment decisions today in order to realize profits in future periods (Goldberg and Kolstad, 1995).

In support of this risk aversion theory, Campa (1993) re-examined risk aversion arguments claim and extended it to cover risk-neutral firms using the argument of future expected profits. It was postulated that as investors are concerned with future expected profits, firms would postpone their decision to enter the foreign market as the exchange rate becomes more volatile. It was also stated that risk-neutral firms would consequently be deterred from entering foreign markets in the presence of high level of exchange rate uncertainty. This theoretical result was confirmed empirically for inward investment to the US in the wholesale industry especially in case where the sunk cost of entry were high.

In addition, Goldberg and Kolstad (1995) commented on the above arguments that when assessing risk aversion argument verse production flexibility argument it is important to distinguish between short-term exchange rate volatility and long term misalignments. According to him, risk aversion argument is more convincing under the short-term volatility as firms are not likely to adjust factors in the short run. Also, in the short run, factors of production are usually fixed and as a result, firms will only be risk averse to the volatility and their future profit. According to Jayaratnam (2003) the production flexibility argument, however, appears more convincing under the long term misalignments as firms are now able to adjust their variable factors.

From the existing theoretical literature, there is no conclusive notion about the effect of exchange rate volatility on foreign direct investment inflows. The literature survey of the past empirical studies on this issue yielded positive, negative and indeterminate results. The reason that justified the positive effect of exchange rate volatility on foreign direct investment inflows can be attributed to export substituting FDIs. In this case, an increase in exchange rate volatility between the giving nation and the receiving country induce a multinational firms to serve the receiving country through a local production facilities rather than export hence protecting against the currency risk. Pain and Van Welsum (2003) and Foad (2005) findings supported this argument. Also, the argument of Markusen (1995) was in line with export substituting FDIs which postulate that firms engaged in FDI to avoid the cost of international trade including currency risk. As exchange rate becomes more volatile, more firms will choose to serve the foreign markets through a local production facilities rather than exports.

Also, the reason that justified the negative effect of exchange rate volatility on foreign direct investment inflows can be attributed to irreversibility literature pioneered by Dixit and Pindyck (1994). A foreign direct investment in a country with high degree of exchange rate volatility will have a riskier stream of profits, all other things being equal. The findings of Bryne and Davis (2003), Benassy-Quere *et al* (2001) and Darby *et al* (1999) supported this negative

relationship. However, the finding of Alaba (2003) on effect of exchange rate volatility on inward foreign direct investment in Nigeria could not determine whether this impact was positive or negative. Some of these empirical studies were reviewed on the issue being investigated; these empirical works will be organized according to the effects; positive, negative and undetermined.

From the empirical studies, Soyoung *el al* (2013) explored the determinants of international capital flow in Korea using push verses pull factors from 1980 to 2010. General Method of Moment was used on time series data to estimate the relationship among the variables. It was found that there is a positive relationship between exchange rate volatility and foreign portfolio investment in Korea.

In addition, Osinubi *et al* (2009) explored the possible effect of exchange rate volatility on inward foreign direct investment in Nigeria. In this study, it was found that exchange rate volatility influence inward foreign direct investment positively.

Also, Chowdhury and Wheeler (2008) examined the impact of exchange rate volatility on foreign direct investment in Canada, Japan, United Kingdom and United States. Vector Autoregressive model was used with the following variables the price level, real output, real exchange rate, real exchange rate volatility, interest rate and foreign direct investment. The impulse response functions indicated that exchange rate volatility had positive impact on foreign direct investment.

Finally, Choudhry (2005) study the relationship between exchange rate volatility and inward foreign direct investment using data from bilateral foreign direct investment flows across USA, Canada, UK and Japan with vector autoregressive analysis. It was found that exchange rate shock varied and sometimes positive with the effects showing in the lags.

Beside the positive relationship between foreign direct investment and the exchange rate volatility, there are some empirical studies, which showed that the negative relationship between FDI and exchange rate volatility. The first to be consider is Teddy (2015) who investigated the effect of exchange rate volatility on private capital inflows in Zambia. The GARCH model was used to generate the volatility in the exchange rate. Using Johansen Cointegration Test and error correction model it was found that volatility of nominal exchange rate exerted significant negative impact on the inflow of foreign portfolio investment in Zambia.

Also, Chonnikara (2010) also examined the effect of exchange rate volatility on inward foreign direct investment and portfolio inflows to Thailand with the use of monthly panel data from 2005 – 2009. The result showed that the relationship between exchange rate volatility and foreign portfolio investment is negative; indicating that high exchange rate risk lowers each firm-specific portfolio flow to Thailand.

Finally, Foad (2005) noted that one possible explanation for the conflicting results is that most studies ignore the relevance of export oriented FDI. He argued that a multi-national's foreign affiliate is likely to operate in both the host country and local export markets. According to the author, this tendency is magnified when considering FDI within customs union like EU. As such ignoring local export market creates an omitted variable bias, which could overestimate or underestimate the effect of exchange rate volatility on inward foreign direct investment. Using the details of foreign affiliate of USA multinationals across seventeen European countries from 1983 – 2002, accounting for foreign affiliate exports it was found that exchange rate volatility between the US and the host country has a significantly negative effect on the level of FDI.

Despite the above effects, some studies could not determine whether the relationship is positive or negative. Olubunmi *et al* (2018) investigated the effects of exchange rate volatility on foreign portfolio investment in Nigeria. This effect was captured through monthly official exchange rate and bureau-de exchange rate from the Central Bank of Nigeria. General Autoregressive Conditional Heteroscedasticity, GARCH(1,1) model was used to generate volatility in both official exchange rate and bureau-de exchange rate. A two-stage least square (TSLS) method was used and the result showed that official exchange rate volatility had significant positive effect on foreign portfolio investment while bureau-de exchange rate volatility had significant negative effect on the foreign portfolio investment in Nigeria.

In addition, Omororunwa and Ikponnwosa (2014) explored the exchange rate volatility and foreign portfolio investment in Nigeria, 1980 – 2011. The stationarity of the series was checked using Augmented Dickey-Fuller test, Engel and Granger two-step cointegration procedure and error correction model were used for the analysis. It was found that exchange rate volatility has a very weak effect on foreign portfolio investment in the short run and strong positive effect on the long run.

Also, Guglielmo *et al* (2013) examined the impact of exchange rate uncertainty on different components of portfolio flows. The study included Australia, Japan, UK, Canada and Sweden from 1988 to 2011. GARCH-BEKK model was used and it was found that negative relationship exist in some countries while positive relationship also exist between exchange rate volatility and foreign portfolio investment.

From the above empirical studies, the relationship between the exchange rate volatility and foreign direct investment is not conclusive. Also, the common variables used in the most of the studies included the price level, real output (market size), political stability, infrastructure development, real exchange rate, real exchange rate volatility, interest rate, degree of economic openness and foreign direct investment among others. This study will use real exchange rate and its volatility, degree of economic openness, real output (market size), economic growth as well as the interaction between real exchange rate volatility and degree of economic openness to investigate the effect of exchange rate volatility on foreign direct investment inflows.

From the literature, attention has not been given to interaction between real exchange rate volatility and degree of economic openness. However, according to Enu *et al* (2014), the degree of economic openness is significant determinant of the economic performance in Ghana, hence may serve as an intermediary to attract foreign direct investment inflows. Therefore, the interaction between volatility and degree of economic openness will be used to find out if the degree of economic openness serves as intermediary for exchange rate volatility to influence FDI. According to Havi (2019), exchange rate volatility significantly influence the export of goods and services in Ghana. Therefore, any study that investigate the effect of exchange rate volatility on the major macroeconomics factors, as foreign direct investment in the Ghanaian economy will contribute immensely to economics and financial economics literature as well as exchange rate management issues in Ghana specifically and the world as a whole.

## 3 Methodology

The aim of this paper is to find out how real exchange rate volatility and its interaction with the degree of openness of the economy impact on the inward foreign direct investment in Ghana from 1970 to 2018. The data was obtained from World Development Indicators from the World Bank data base. In order to avoid estimation being spurious regression the time series properties of all the variable under consideration will be determined. This will inform about the choice of estimation procedure. For the stationarity of the variables, Augumented-Dickey_Fuller (ADF),

Phillps-Parron (PP) and Kwaiatkpwski-Phillps-Schmidt-Shin (KPSS) unit root tests will be conducted to determine the order of integration and estimation procedure.

The ADF unit root test procedure as shown in [1] below will be carried out for all variables under consideration. In the ADF unit root test the null and alternative hypotheses are stated as:

$H_0: \alpha = 0$, the variable is not stationary
$H_1: \alpha < 0$, the variable is stationary.

The test result is built on the t-ratio for $\alpha$, Fuller (1976), Dickey and Fuller (1979). However, the t-statistics does not follow the t-distribution under the null; hence, critical values are stimulated for each regression specification and the sample size, MacKinnon (1996).

$$\Delta y_t = \alpha y_{t-1} + x_t^{'}\delta + \sum_{p=1}^{p} \Delta y_{t-p} + \varepsilon_t \qquad [1]$$

Where $x_t^{'}$ - exogenous regressors that include a constant term only, a constant and trend or none; terms included to correct for higher-order correlation. $\Delta y_{t-p}$ - terms included to correct for higher-order correlation.

The Phillps-Parron (PP) unit root test includes the estimation of non-augmented version of ADF test in [1], that is, without the lagged difference terms. The PP unit root test uses non-parametric method to control for serial correlation under the null and alternative hypotheses stated as:

$H_0: \alpha = 0$, the series is not stationary
$H_1: \alpha < 0$, the series is stationary.

However, the PP unit root test is built on its own statistics and corresponding distribution, Phillps (1987), Phillps-Parron (1988). In the case of ADF and PP tests, alternative hypotheses are accepted when the p-value associated with t-statistics is less or equal to 0.05, otherwise it is reject.

The final unit root test to be considered is Kwaiatkpwski-Phillps-Schmidt-Shin (KPSS) unit root tests under the null hypothesis assumed that the variable is stationary against the alternative hypothesis that the variable is not stationary.

$H_0$: The series is stationary
$H_1$: The series is not stationary.

In KPSS tests, the residuals got from the OLS in [2] where $x_t$ is defined as in ADF. The KPSS test is based on the LM statistics. In the case of KPSS test, the null hypothesis is accepted when the t- statistics less than t-critical, otherwise null hypothesis is reject.

$$y_t = x_t^{'}\delta + \varepsilon_t \qquad [2]$$

Finally, when all the variables are integrated of order zero, I(0), then ordinary least square (OLS) will be used; but when all the variables are integrated of order one, I(1), then dynamic ordinary least square (DOLS) or VAR will be used for the estimation. However, if the variables

are integrated of order zero, one or two; I(0), I(1) or I(2), then Autoregressive Distributed lag (ARDL) will be used. However, in this particular study all the variables are integrated of order one, I(1) and DOLS most fit the data under consideration. Therefore, DOLS technique is used to estimate the single cointegrating vector that will show the long run relationship among the variables.

### 3.1 Dynamic Ordinary Least Square

According to Stock and Watson, (1983) "one simply regress one of the variables (in this case FDI) onto contemporaneous levels of the remaining variables , leads, lags of their first differences and a constant, using" OLS. The Stock-Watson DOLS model is specified as follows:

$$Y_t = \beta_0 + \overline{\beta} X + \sum_{j=q}^{p} d_j \Delta X_{t-j} + \mu_t \qquad [3]$$

Where $Y_t$ – dependent variable (FDI inflows), $X_t$ – matrix of explanatory variables (real exchange rate, volatility, degree of economic openness, real output, economic growth and interaction term), $\overline{\beta}$ cointegrating vector that represent the long run cumulative multiplier or the long run effects of a change in Xs on Y, p-lag length, q-lead length. The lag and the lead terms are included in the DOLS regression for the purpose of making its stochastic error term independent of all past innovations in stochastic regressors.

Finally, the residuals of the DOLS estimation will be tested for unit root. If the residuals of the DOLS estimation is unit root non-stationary then the regression equation estimated is spurious one, Choi *et al* (2008). The Eviews 7 will be used to perform the following; summary statistics, unit root test, estimation of DOLS and follow-up tests.

### 3.2 Definition of Variables

Foreign direct investment (FDI): This variable is real inward foreign direct investment. The size of this variable is a good indicator of the relative attractiveness of the economy to foreign investment. It is also a channel of economic growth. It is calculated as foreign direct investment as a percentage of GDP. It served as the dependent variable in the study.

Exchange rate (EXC): This is log of real exchange rate of GHS/USD. It measures the worth of the domestic currency (GHS) to another currency (USD). It shows Ghana's competitiveness in the international market. It is measured as the log of real exchange rate. It is important in order to show how the strength of a nation's currency affects its FDI inflows.

Volatility (VOLA): This is the log of volatility in the real exchange rate and it was captured by GARCH(1,1) with the assumption that the error term follows student's - t distribution. It may have positive or negative effect on FDI.

Goss Domestic Product (GDP): This is the log of real GDP, which measure the size of the economy. It is assumed that the growth of domestic economy will attract more foreign direct investment. It is expected to have positive effect on FDI.

Economic growth (GDPG): This is the growth of the real GDP. It is expected to have positive effect on FDI.

Openness (OPEN): This is the degree of economics openness of a country. It is measured as ratio of export and import to the GDP. The economy is termed, closed if the ratio is less than

100 percent; however, the economy is termed, opened if the ratio is more than 100 percent. It is expected to have positive or negative effect on the foreign direct investment inflows.

Interaction term (INTERACTION): This term is the interaction between real exchange rate volatility and degree of economic openness of the economy. It was measured as the product of openness and volatility. This, if significant will show that the degree of economic openness of the economy served as an intermediary for real exchange rate volatility to influence the FDI. It may have positive or negative effect on FDI.

## 4 Results and Discussion

This section showed the discussion of the results; time series properties of the data, the result of the model estimated and its explanations. The table 1 below showed the summary statistics of the variables used. From the table, the mean of foreign direct investment inflows was 2.5, the mean of exchange rate was -3.3, the mean of gross domestic product was 23.5, the mean of economic growth was 3.9, the mean of openness was 56.5, the mean of volatility was -0.907 and that of interaction term was 8.23. With respective standard deviation of 2.8, 3.3, 0.6, 4.6, 28.3, 3.3 and 184.2. The mean of openness showed that the economy over the period under consideration is much closed. In exception of GFPG and interaction term, which Kurtosis were above three, the rest of the variables had their Kurtosis below three but volatility has Kurtosis equal to three. In exception of exchange rate and economic growth, all the variables were positively skewed but closed to one. From the Jarque-Bera statistics, in exception of openness and volatility, the variables are not normally distributed. This called for the examination of the order of integration of the variables.

**Table 1: The Summary Statistics of the Variables under Consideration**

| | FDI | LEXC | LGDP | GDPG | OPEN | LVOLA | inter |
|---|---|---|---|---|---|---|---|
| Mean | 2.53 | -3.35 | 23.53 | 3.92 | 56.55 | -0.91 | 8.23 |
| Median | 1.57 | -2.35 | 23.38 | 4.70 | 57.42 | -1.02 | -42.44 |
| Maximum | 9.52 | 1.52 | 24.71 | 14.05 | 116.05 | 7.68 | 578.81 |
| Minimum | -0.66 | -9.19 | 22.84 | -12.43 | 6.32 | -6.16 | -219.95 |
| Std. Dev. | 2.81 | 3.82 | 0.58 | 4.55 | 28.32 | 3.25 | 184.21 |
| Skewness | 1.05 | -0.40 | 0.64 | -1.26 | 0.13 | 0.40 | 1.48 |
| Kurtosis | 2.90 | 1.63 | 2.08 | 5.70 | 2.12 | 3.06 | 4.81 |
| Jarque-Bera | 9.03 | 5.13 | 5.02 | 27.95 | 1.70 | 1.32 | 24.51 |
| Probability | 0.01 | 0.08 | 0.08 | 0 | 0.43 | 0.52 | 0 |
| Sum | 124 | -164.13 | 1152.96 | 192.17 | 2770.79 | -44.44 | 403.44 |
| Sum Sq. Dev. | 377.9 | 700.2 | 15.94 | 995.39 | 38510.24 | 506.46 | 1628804. |
| Observations | 49 | 49 | 49 | 49 | 49 | 49 | 49 |

Source: Author's own computations

The results of Augmented Dickey-Fuller (ADF), Phillps-Parron (PP) and Kwaiatkpwski-Phillps-Schmidt-Shin (KPSS) unit root tests statistic for the variables are shown in Table 2 below. From the table, considering ADF test for exchange rate (*log(exc*)), economic growth (*gdpg*), volatility (*log(vola*)) and interaction term the variables are not stationary in level. The PP unit root test also confirmed that the variables are not stationary in level. In addition, the KPSS unit root test, which assumed stationary for the null hypothesis also confirmed that the variables are not stationary in level except volatility.

Considering the first difference, according to ADF, PP and KPSS unit root tests all the variables are stationary at 5 percent level of significance. That is, all the variables; foreign direct investment inflows (*fdi*), exchange rate (*log(exc*)), gross domestic product (*log(gdp*)), economic growth (*gdpg*), openness (*open*), volatility (*log(vola*)), interaction term were integrated of order one, I(1). Hence, the Dynamic Ordinary Least Square regression is applicable to the data under consideration.

**Table 2: Augmented Dickey-Fuller (ADF), Phillps-Parron (PP) and Kwaiatkpwski-Phillps-Schmidt-Shin (KPSS) Unit Root Test Statistic**

| Variables | Level | | | | | | First Difference | | | | | | order of integration |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | none | | intercept | | inter & trend | | none | | intercept | | inter & trend | | |
| **ADF** | **t-Stat** | **Prob** | **t-Stat** | **Prob** | **t-Stat** | **Prob** | **t-Stat** | **Prob** | **t-Stat** | **Prob** | **t-Stat** | **Prob** | |
| fdipgdp | -1.01 | 0.28 | -1.5 | 0.52 | -2.7 | 0.23 | -6.91 | 0 | -6.86 | 0 | -6.76 | 0 | I(1) |
| lexc | -1.81 | 0.07 | -0.3 | 0.91 | -2.0 | 0.58 | -2.06 | 0.04 | -4.38 | 0 | -4.33 | 0.01 | I(0), I(1) |
| lgdp | 3.22 | 1 | 1.98 | 1 | -0.6 | 0.98 | -0.36 | 0.55 | -4.93 | 0 | -5.66 | 0 | I(1) |
| gdpg | -0.35 | 0.55 | -4.9 | 0 | -4.3 | 0.01 | -5.9 | 0 | -5.87 | 0 | -5.81 | 0 | I(0), I(1) |
| open | -0.0006 | 0.68 | -1.5 | 0.53 | -2.2 | 0.47 | -2.52 | 0.01 | -2.54 | 0.11 | -2.48 | 0.34 | I(1) |
| lvola | -1.93 | 0.05 | -1.9 | 0.35 | -4.7 | 0 | -6.82 | 0 | -6.8 | 0 | -5.63 | 0 | I(0), I(1) |
| interaction | -2.84 | 0.01 | -2.8 | 0.06 | -3.9 | 0.02 | -6.22 | 0 | -6.17 | 0 | -6.18 | 0 | I(0), I(1) |
| **PP** | | | | | | | | | | | | | |
| fdipgdp | -1.03 | 0.27 | -1.5 | 0.52 | -3.0 | 0.14 | -6.95 | 0 | -6.9 | 0 | -6.79 | 0 | I(1) |
| lexc | -2.15 | 0.03 | 0 | 0.95 | -1.9 | 0.63 | -3.13 | 0 | -4.15 | 0 | -4.1 | 0.01 | I(0), I(1) |
| lgdp | 4.8 | 1 | 3.07 | 1 | -0.1 | 0.99 | -3.52 | 0 | -4.93 | 0 | -5.5 | 0 | I(1) |
| gdpg | -3.43 | 0 | -4.9 | 0 | -5.5 | 0 | -28.23 | 0 | -31.0 | 0 | -33.9 | 0 | I(0), I(1) |
| open | -0.49 | 0.5 | -1.3 | 0.62 | -2.24 | 0.46 | -7.21 | 0 | -7.15 | 0 | -7.13 | 0 | I(1) |
| lvola | -1.84 | 0.06 | -1.9 | 0.34 | -2.95 | 0.16 | -7.64 | 0 | -8.71 | 0 | -8.99 | 0 | I(1) |
| interaction | -5.25 | 0 | -5.3 | 0 | -5.4 | 0 | -33.75 | 0 | -33.3 | 0 | -33 | 0 | I(0), I(1) |
| **KPSS** | | | **t-Stat** | **t-crit** | **t-Stat** | **t-crit** | | | **t-Stat** | **t-crit** | **t-Stat** | **t-crit** | |
| fdipgdp | | | 0.65 | 0.46 | 0.16 | 0.15 | | | 0.12 | 0.46 | 0.08 | 0.15 | I(1) |
| lexc | | | 0.92 | 0.46 | 0.12 | 0.15 | | | 0.19 | 0.46 | 0.18 | 0.15 | I(0), I(1) |
| lgdp | | | 0.88 | 0.46 | 0.23 | 0.15 | | | 0.61 | 0.46 | 0.11 | 0.15 | I(1) |
| gdpg | | | 0.61 | 0.46 | 0.08 | 0.15 | | | 0.31 | 0.46 | 0.3 | 0.15 | I(0), I(1) |
| open | | | 0.53 | 0.46 | 0.15 | 0.15 | | | 0.15 | 0.46 | 0.11 | 0.15 | I(1) |
| lvola | | | 0.91 | 0.46 | 0.08 | 0.15 | | | 0.24 | 0.46 | 0.21 | 0.15 | I(0), I(1) |
| interaction | | | 0.28 | 0.46 | 0.09 | 0.15 | | | 0.5 | 0.74 | 0.5 | 0.15 | I(0), I(1) |

The result of Dynamic Ordinary Least Square regression with one lead, one lag and computed elasticities for respective coefficients are shown in table 3 below. The computation of the elasticity was important as some of the variables were in logarithms while some are not. Therefore, to interpret the result correctly there is the need to convent the estimated coefficients into elasticity. The computation of the elasticity is shown below the table. From the table, the R-square adjusted was 0.8886 showed that about 88.86 percent of the variation in the foreign direct investment inflows were explained by the variables under consideration. The Durbin-Watson statistics of 1.899 showed that the error term of the regression was homoscedastic.

From the appendix A, the unit root tests on the error term of DOLS showed that the residual was integrated of order zero, I(0). That is, the residual is stationary in level; therefore, the model estimated is not spurious. From the correlogram in appendix B, the residual had no serial correlation; also, the histogram test showed that the residuals of DOLS are normally distributed as shown in appendix C. The cointegration test - Hansen Parameter Instability and Park Added Variables in appendix D, also showed that the series used in the estimation were cointegrated. Therefore, the DOLS model estimated fit this data and appropriate for this analysis.

From the table 3, the coefficient of the exchange rate was negative with t-statistics of 2.5 and p-value of 0.019. Since the p-value is less than 0.05, the exchange rate is significant in explaining the variation in foreign direct investment inflows. Considering the elasticity, when exchange rate increases by one percent the inflow of foreign direct investment declines by 0.22 percent. This means that the depreciation of the Ghana Cedi to US Dollar exchange rate discourage the inflows of foreign direct investment.

Secondly, the coefficient of gross domestic product was positive with t-statistics of 8.5 and p-value of zero. Since the p-value is less than 0.05, the gross domestic product is significant in explaining the variation in foreign direct investment. Considering the elasticity, when gross domestic product increases by one percent the inflow of foreign direct investment will increase by 2.47 percent. This means that the size of economy do attract foreign direct investment inflows.

The coefficient of economic growth had expected sign of positive with t-statistics of 1.2 and p-value of 0.2236. Since the p-value is greater than 0.05, the economic growth is not significant in explaining the variation in foreign direct investment inflows. Considering the elasticity, when economic growth increases by one percent the inflow of foreign direct investment will increase by 22 percent.

In addition, the coefficient of openness was negative with t-statistics of 2.9 and p-value of 0.007. Since the p-value is less than 0.05, the degree of economic openness is significant in explaining the variation in foreign direct investment inflows. Considering the elasticity, when the degree of economic openness increases by one percent the inflow of foreign direct investment will decrease by 0.65 percent. This mean that as the economy is closed it deters foreign direct investment inflows.

From the table, the coefficient of volatility was positive with t-statistics of 2.7 and p-value of 0.013. Since the p-value is less than 0.05, showing that the volatility is significant in explaining the variation in foreign direct investment inflow. Considering the elasticity, when volatility increases by one percent the inflow of foreign direct investment will increase by 0.531 percent. This means that the volatility do attract foreign direct investment inflows. This finding support the argument that most of the FDI inflows are export substitution and also confirmed the findings of Pain and Van Welsum (2003), Soyoung *et al* (2013), Osinubi *et al* (2009),

Choudhry (2005) and Chowdhury and Wheeler (2008) who found positive relationship between foreign direct investment inflows and volatility. It also confirmed that most of the firms engaged in FDI inflows in Ghana to avoid the risk of international trade including exchange rate volatility. In addition, it confirmed production flexibility argument that firms operate in the long run and adjust at least one of their variable inputs as they realized a normal or real shock of exchange rare. However, this finding contradicted the following studies Teddy (2015), Chonnikara (2010) and Foad (2005) which asserted that volatility negatively impact the FDI inflows.

Finally, the coefficient of interaction term was negative with t-statistics of 2.9 and p-value of 0.009. Since the p-value is less than 0.05, the interaction is significant in explaining the variation in foreign direct investment inflows. Considering the elasticity, when interaction term increases by one percent the inflow of foreign direct investment will decrease by 0.053 percent. Since the economy is closed the interaction between openness and volatility deter foreign direct investment inflows. From this, it can be inferred that when the economy is open the interaction term will attract FDI. Since, this is significant, it showed that the degree of economic openness of the economy served as an intermediary for volatility to influence the FDI.

**Table 3: Dynamic Ordinary Least Square Regression Output with Elasticity**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. | Elasticity |
|---|---|---|---|---|---|
| LOG(EXC) | -0.56162 | 0.223459 | -2.5133 | 0.0194 | -0.2219 |
| LOG(GDP) | 6.240056 | 0.73152 | 8.530255 | 0 | 2.466032 |
| GDPG | 2.365557 | 1.942559 | 1.217753 | 0.2357 | 21.99723 |
| OPEN | -0.02926 | 0.009904 | -2.95474 | 0.0071 | -0.65476 |
| LOG(VOLA) | 1.344977 | 0.497076 | 2.705777 | 0.0126 | 0.531532 |
| interaction | -0.01632 | 0.00571 | -2.85769 | 0.0089 | -0.05304 |
| C | -143.446 | 17.74418 | -8.0841 | 0 | 0 |

| | | | |
|---|---|---|---|
| R-squared | 0.945501 | Mean dependent var | 2.488149 |
| Adjusted R-squared | 0.888632 | S.D. dependent var | 2.819589 |
| S.E. of regression | 0.940949 | Sum squared resid | 20.36384 |
| Durbin-Watson stat | 1.89931 | Long-run variance | 0.618321 |

NOTE:

$$fdi = a*\log exc + b*\log gdp + c*gdpg + d*openness + e*\log volatility + f*\text{int}eraction.$$

$$\varepsilon_{exc} = \frac{\partial fdi}{\partial exc}*\frac{\overline{exc}}{\overline{fdi}} = \frac{a}{fdi} = \frac{-0.5616}{2.53} = -0.2219,\ \varepsilon_{gdp} = \frac{\partial fdi}{\partial gdp}*\frac{\overline{gdp}}{\overline{fdi}} = \frac{b}{fdi} = \frac{6.24}{2.53} = 2.466$$

$$\varepsilon_{gdpg} = \frac{\partial fdi}{\partial gdpg}*\frac{\overline{gdpg}}{\overline{fdi}} = c*\frac{gdpg}{fdi} = 2.366*\frac{3.92}{2.53} = 21.997$$

$$\varepsilon_{openness} = \frac{\partial fdi}{\partial openness}*\frac{\overline{openness}}{\overline{fdi}} = d*\frac{\overline{openness}}{\overline{fdi}} = -0.02926*\frac{56.5467}{2.53} = -0.6547$$

$$\varepsilon_{volatility} = \frac{\partial fdi}{\partial volatility} * \frac{\overline{volatility}}{\overline{fdi}} = \frac{e}{fdi} = \frac{1.344977}{2.53} = 0.5315$$

$$\varepsilon_{\text{int}eraction} = \frac{\partial fdi}{\partial \text{int}eractin} * \frac{\overline{\text{int}eractin}}{\overline{fdi}} = f * \frac{\overline{\text{int}eractin}}{\overline{fdi}} = -0.01632 * \frac{8.233}{2.53} = -0.053$$

## 5 Conclusion

This paper examined the effect of exchange rate volatility and its interaction with the degree of economic openness on the foreign direct investment inflow in Ghana. The unit root of the series was checked using Augmented Dickey-Fuller (ADF), Phillps-Parron (PP) and Kwaiatkpwski-Phillps-Schmidt-Shin (KPSS) tests. According to ADF, PP and KPSS unit root tests all the variables were stationary at 5 percent level of significance in their first difference; that is, the series were integrated of order one, I(1). Hence, the Dynamic Ordinary Least Square regression model was applicable. From the DOLS estimation, it was found that the depreciation of the real exchange rate, the degree of openness of the economy and interaction term do deter the inflows of foreign direct investment. However, size of economy and volatility do attract foreign direct investment inflows.

Based on the above findings the following recommendations are made. Since volatility of the real exchange rate attracts FDI inflows the Government should encourage import substitute FDIs to help Ghana industrialized. The openness of the economy as an intermediary for FDI inflows is deterring foreign direct investment, therefore, Ghana need to open up the economy by improving upon the value of export and import value (encourage the import of industrial inputs to boost output for export in favour of import of consumables) and encourage the consumption of local goods. In addition, a study should be conducted to check how volatility and interaction term behave towards foreign direct investment inflows in the economies that are relatively open.

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## Appendixes

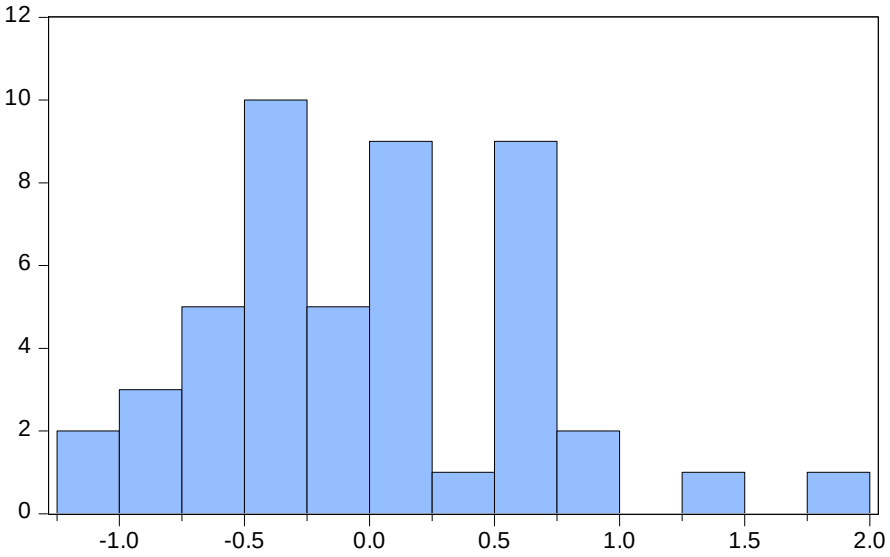
**Appendix A: The unit root test of the residuals of the DOLS**

| variables: Residual | Level | | | | | |
|---|---|---|---|---|---|---|
| | none | | intercept | | inter & trend | |
| | t-Stat | Prob | t-Stat | Prob | t-Stat | Prob |
| ADF | -3.981038 | 0.0002 | -3.925323 | 0.0043 | -3.945134 | 0.019 |
| PP | -8.126351 | 0 | -8.046334 | 0 | -8.583666 | 0 |
| | | | t-Stat | t-critical | t-Stat | t-critical |
| KPSS | | | 0.172504 | 0.463 | 0.172707 | 0.216 |

**Appendix B: The Serial Correlation test of the residuals of the DOLS**

| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|---|---|
| .*\| . \| | .*\| . \| | 1 | -0.157 | -0.157 | 1.2598 | 0.262 |
| .*\| . \| | .*\| . \| | 2 | -0.075 | -0.102 | 1.5553 | 0.459 |
| .*\| . \| | .*\| . \| | 3 | -0.119 | -0.153 | 2.3104 | 0.511 |
| . \| . \| | .*\| . \| | 4 | -0.060 | -0.123 | 2.5055 | 0.644 |
| . \|*. \| | . \| . \| | 5 | 0.110 | 0.051 | 3.1820 | 0.672 |
| .*\| . \| | .*\| . \| | 6 | -0.087 | -0.101 | 3.6176 | 0.728 |
| . \| . \| | .*\| . \| | 7 | -0.041 | -0.089 | 3.7145 | 0.812 |
| . \| . \| | . \| . \| | 8 | 0.002 | -0.029 | 3.7146 | 0.882 |
| . \| . \| | .*\| . \| | 9 | -0.044 | -0.084 | 3.8349 | 0.922 |
| . \| . \| | .*\| . \| | 10 | 0.005 | -0.070 | 3.8366 | 0.954 |
| . \| . \| | . \| . \| | 11 | 0.065 | 0.042 | 4.1145 | 0.966 |
| .*\| . \| | .*\| . \| | 12 | -0.112 | -0.132 | 4.9441 | 0.960 |
| . \|*. \| | . \| . \| | 13 | 0.112 | 0.055 | 5.8080 | 0.953 |
| . \| . \| | . \|*. \| | 14 | 0.046 | 0.075 | 5.9580 | 0.968 |
| . \|*. \| | . \|*. \| | 15 | 0.110 | 0.132 | 6.8322 | 0.962 |
| .*\| . \| | .*\| . \| | 16 | -0.117 | -0.074 | 7.8558 | 0.953 |
| .*\| . \| | .*\| . \| | 17 | -0.176 | -0.142 | 10.242 | 0.893 |
| . \|** \| | . \|** \| | 18 | 0.269 | 0.242 | 16.024 | 0.591 |
| . \| . \| | . \| . \| | 19 | -0.044 | 0.001 | 16.187 | 0.645 |
| .*\| . \| | .*\| . \| | 20 | -0.079 | -0.113 | 16.715 | 0.671 |

**Appendix C: The Normality test of the residuals of the DOLS**




Series: Residuals
Sample 1970 2017
Observations 48

| | |
|---|---|
| Mean | -2.99e-15 |
| Median | -0.119534 |
| Maximum | 1.961437 |
| Minimum | -1.206808 |
| Std. Dev. | 0.658235 |
| Skewness | 0.590601 |
| Kurtosis | 3.303903 |
| Jarque-Bera | 2.975194 |
| Probability | 0.225915 |

**Appendix D:**

Cointegration Test - Hansen Parameter Instability

| Lc statistic | Stochastic Trends (m) | Deterministic Trends (k) | Excluded Trends (p2) | Prob.* |
|---|---|---|---|---|
| 0.089108 | 6 | 0 | 0 | > 0.2 |

Cointegration Test - Park Added Variables

| | Value | df | Probability |
|---|---|---|---|
| Chi-square | 0.723060 | 2 | 0.6966 |