# Impact of Foreign Direct Investment and Economic Growth in Ghana: A Cointegration Analysis

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**ABSTRACT**

*Foreign direct investment (FDI) has been an important source of economic growth for Ghana, bringing in capital investment, technology and management knowledge needed for economic growth. This paper aims to study the relationship between FDI and economic growth in Ghana for the period 1980-2010 using time series data. The data used in this study was mainly secondary data collected from the period, 1980 to 2010 consisting of yearly observations for each variable. The real GDP growth and foreign direct investment net inflows as percent of GDP (FDI ratio) data were taken from the World Banks World Development Indicators 2011 CD Rom. Yearly time series data covering the period 1980-2010 for which data was available was used. The cointegration methodology is applied on yearly data of FDI, GDP and GNI to determine the extent to which these variables are related. The study establishes that a long-run equilibrium and causal relationship exists between the dependent variable; FDI and the two independent variables under consideration namely, GDP and GNI. It was determined that in the short-run, effects of GDP and GNI volatility on FDI are nearly imaginary. These findings hold practical implications for policy makers, government and investors.*

**Keywords**: Economic Growth, FDI inflows, GDP, GNI, Ghana

## 1.0 Introduction

Foreign direct investment (FDI) has played a leading role in many of the economies of the region. There is a widespread belief among policymakers that foreign direct investment (FDI) enhances the productivity of host countries and promotes development. There are several studies done on FDI and economic growth. Their findings vary from different methods used on their research, some of the researchers found that FDI has a positive effect on economic growth. For example is Balasubramanyam et al (1996) analyzes how FDI affects economic growth in developing economies. Using cross-section data and OLS regressions he finds that FDI has a positive effect on economic growth in host countries using an export promoting strategy but not in countries using an import substitution strategy. Olofsdotter (1998) provides a similar analysis. Using cross sectional data she finds that an increase in the stock of FDI is positively related to growth and that the effect is stronger for host countries with a higher level of institutional capability as measured by the degree of property rights protection and bureaucratic efficiency in the host country. De Mello (1999) only finds weak indications of a positive relationship between FDI and economic growth despite using both time series and panel data fixed effects estimations for a sample of 32 developed and developing countries. On the other hand, Zhang (2001) and Choe (2003) analyses the causality between FDI and economic growth. Zhang uses data for 11 developing countries in East Asia and Latin America. Using cointegration and Granger causality tests, Zhang (2001) finds that in five cases economic growth is enhanced by FDI but that host country conditions such as trade regime and macroeconomic stability are important. According to the findings of Choe (2003), causality between economic growth and FDI runs in either direction but with a tendency towards growth causing FDI; there is little evidence that FDI causes host country growth. Rapid economic growth could result in an increase in FDI inflows. There is further study done by Chowdhury and Mavrotas (2003) which examine the causal relationship between FDI and economic growth by using an innovative econometric methodology to study the direction of causality between the two variables. The study involves time series data covering the period from 1969 to 2000 for three developing countries, namely Chile, Malaysia and Thailand, all of them major recipients of FDI with different history of macroeconomic episodes, policy regimes and growth patterns. Their empirical findings clearly suggest that it is GDP that causes FDI in the case of Chile and not vice versa while for both Malaysia and Thailand, there is a strong evidence of a bi-directional causality between the two variables. The robustness of the above findings is confirmed by the use of a bootstrap test employed to test the validity of the result. In addition, Frimpong and Abayie (2006) examine the causal link between FDI and GDP growth for Ghana for the pre and post structural adjustment program (SAP) periods and the direction of the causality between two variables. Annual time series data covering the period from 1970 to 2005 was used. The study finds no causality between FDI and growth for the total sample period and the pre-SAP period. FDI however caused GDP growth during the post –SAP period. This paper aims to study the relationship between FDI and economic growth in Ghana for the period 1980-2010 using time series data.

## 2.0 Methods

### 2.1 Data Collection and Source

The data used in the empirical analysis was mainly secondary data collected from the period, 1980 to 2010 consisting of yearly observations for each variable. The real GDP growth and foreign direct investment net inflows as percent of GDP (FDI ratio) data were taken from the World Banks *World Development Indicators 2011* CD Rom. Annual time series data covering the period 1980-2010 for which data was available was used. The choice of these variables is as a result of the interrelationship and interdependence.

### 2.2 Analysis Plan

In analyzing the dataset the following tests are expected to be employed: Unit root test for stationarity, Augmented Dickey-Fuller Test (ADF), Ordinary Least Square (OLS) method, Cointegration test, Vector error correction model (VECM), etc. We rely on R statistical computing software to implement the time series methods that will be discussed and all statistical tests were carried out at 0.05 level of significance.

### 2.3 Model Specification and Estimation

The fundamental estimating equation in log-linear form is as follows:

$$\ln FDI_t = \beta_0 + \beta_1 \ln GDP_t + \beta_2 \ln GNI_t + \varepsilon_t, \qquad t = 1, 2, ..., 120 \qquad (3.1)$$

Where, $\ln GDP$ = natural log of Gross Domestic Product, $\ln GNI =$ natural log of Gross National Income and $\ln FDI =$ natural log of Foreign Direct Investment. The error term, $\varepsilon_t$ is assumed to be independent and identically distributed and $t =$ time subscript. The expected signs of the above equations are $\beta_0 > 0, \beta_1 < 0$ and $\beta_{2} \lessgtr 0$ (i.e. positive or negative).

If the unit root test confirm the stationarity in time series data of each variable, then equation (3.1) is estimated appropriately by the Ordinary Least Square (OLS) method. This is done to avoid misleading inferences in the presence of spurious correlation (Granger and Newbold, 1974). As a rule of thumb, (Granger and Newbold, 1974) suggested that one should be suspicious if $R^2$ is greater than Durbin-Watson statistic.

If the unit root test rejects the null hypothesis that the series has a unit root, it means that the series is stationary and thus can be used for VAR. But, if the unit root test cannot reject the null hypothesis, it means that the series are not stationary and we can apply difference operator to make the series stationary before testing for VAR.

#### 2.3.1 Cointegration

If the variables are found to have unit roots (nonstationarity), and are of the same order of integration, the cointegrating relationship among variables determined, that is the tendency of the variables to move together in the long run is studied either by the Engle-Granger (1987) procedure or the Johansen-Juselius procedure (Johansen 1988; Johansen-Juselius 1992, 1999) to overcome the associated problem of spurious correlation and misleading inferences. If the variables are found to be cointegrated, the relationship may be interpreted as a long run relationship. However, in this study the Johansen-Juselius procedure was used.

### 2.3.2 Johansen-Juselius Procedure

The Johansen procedure is applied at this point to test for cointegration and this can be done through the Vector Autoregressive (VAR) approach as outlined in Granger (1988). The appropriate lag-length (p) is selected with the aid of the Final Prediction Error (FPE) criterion (Akaike, 1969) and Akaike Information Criterion (AIC) to ensure that errors are white noise. A time series $H_t$ is called white noise if $\{H_t\}$ is a sequence of independent and identically distributed random variables with finite mean and variance. This is to help overcome the problem of over or under parameterization that may induce bias and inefficiency in the estimates.

The analysis then begins with a congruent statistical system of unrestricted reduced form as stated below:

$$Y_t = \alpha + \sum_{i=1}^{p} \Pi Y_{t-i} + \zeta_t; \qquad \zeta_t \sim N(0,\Omega); \qquad i = 1,2,\ldots 120. \qquad (3.2)$$

Where $Y_t$ is a $(3\times1)$ vector of order $I(1)$ and/or of order $I(0)$ variables, and α is a $(3\times1)$ vector of constraints, letting $\Delta Y_t = Y_t - Y_{t-i}$ then equation (3.2) then becomes

$$Y_t = \alpha + \sum_{i-1}^{p-1} \Psi \Delta Y_{t-i} + \Pi Y_{t-i} + \zeta_t; \qquad (3.3)$$

Since $\zeta_t$ is stationary, the rank, $r$ of the long-run matrix $\Pi$ determines how many linear combinations of $Y_t$ are stationary. If $r = n$ , all $Y_t$ are stationary, while if $r = 0$ so that, $\Pi = 0$ , $\Delta Y_t$ is stationary, as are all linear combinations if $Y_t$ is of order $I(1)$ .For $0 < 1 < n$ , there exist $r$ cointegrating vectors meaning $r$ stationary linear combinations of $Y_t$ . If this is the case since the study seeks to investigate the long-term relationship between foreign direct investment, gross domestic product and gross national income in Ghana, then the hypothesis for the cointegration vectors is stated as $H_0 : \Pi = \alpha\beta'$ where both $\alpha$ and $\beta$ are $n\times r$ matrices. The cointegration vectors of $\beta$ are the error-correlation mechanisms in the system, while $\alpha$ contains the adjustment parameters. In order to test the hypothesis, the order of the cointegration vector needs to be determined first.

The order (rank) of cointegration, $r$ is determined by constructing the trace statistics $(\lambda_{trace})$ and the estimated values of the characteristic roots or eigenvalues ( $\lambda_{\max}$ ). Since in practice the order of cointegration ( $r$ ) is not known,

Johansen (1991) proposes two ways to perform likelihood ratio tests for the value of ( $r$ ) which differ in assumptions of alternative hypothesis. These are computed as follows:

- $\lambda_{trace} = -T\sum_{t=r+1}^{n} \ln(1-\hat{\lambda}_i)$ Where the null is $r = q$ against the more general alternative $r \le 1$ .
- $\lambda_{\max} = -T\ln(1-\hat{\lambda}_{r+1})$ , where the appropriate null is $r = q$ cointegrating vectors with $(q = 0,1,2,3,\ldots)$ against the alternative that there exists only one additional cointegrating vector i.e. $(r \le q+1)$ .

In the Johansen-Juselius procedure $\lambda_{trace}$ and $\lambda_{\max}$ tests are conducted. For any conflict between these tests, the $\lambda_{\max}$ test should prevail for inferences (Johansen and Juselius, 1992).

### 2.3.3 Vector Error Correction Model

The vector error correction model (VECM) is estimated to find out long-run causality and short-term dynamics if there is an evidence of cointegration relationship among the variables. The VECM is estimated as shown below

$$\Delta \ln FDI_t = \alpha + \lambda \varepsilon_{t-1} + \sum_{i=1}^{n} u_i \Delta \ln FDI_{t-i} + \sum_{i=1}^{m} v_i \Delta \ln GDP_{t-i} + \sum_{i=1}^{k} w_i \Delta \ln GNI_{t-i} + \xi_t \,, \quad (3,4)$$

Where $\varepsilon_{t-1}$ is the error correction term which reflects the deviation from the long-run equilibrium path. This allows causality to be determined in two ways namely:

- Short run causality, which is determined by the lagged differences of the variables and;
- Long-run causality, which is determined by the significance of the coefficient of the error-correction term.

The null hypothesis that GDP or GNI does not Granger cause FDI is rejected if $v_i$ or $w_i \neq 0$ are jointly significant and / or the coefficient of the error-correction term $\lambda$ is significant. This implies that the variable GDP or GNI can Granger cause FDI even if the coefficients on the lagged changes in variables GDP or GNI are not jointly significant. Equation (3.4) shows that the variables are cointegrated if the estimate of $\lambda$ is negative and statistically significant in terms of the associated t-value. This thus will indicate unidirectional long-run causal flows from changes in Gross Domestic Product and Gross National Income to change of the Foreign Direct Investment as well as long-run convergence.

Changes in GDP and GNI Granger cause the changes in FDI when $v_i$ 's and $w_i$ 's jointly significant in terms of the joint F-test as determined by Bahamani and Payesteh (1993). However if $\lambda$ is positive and statistically significant, there will still be an existence of long-run causality, but with divergence.

### 2.3.4 Vector Autoregressive Model

The vector autoregressive (VAR) model is estimated in first-difference when there is absence of cointegrating relation among the variables by excluding the error correction term, $\lambda \varepsilon_{t-1}$ as stated in equation (3.4) for Granger causality with a short-term interactive feedback relationship following Granger (1988). Equation (3.4) then becomes:

$$\Delta \ln FDI_t = \alpha + \sum_{i=1}^{n} u_i \Delta \ln FDI_{t-1} + \sum_{i=1}^{m} v_i \Delta \ln GDP_{t-1} + \sum_{i=1}^{k} w_i \Delta \ln GNI_{t-1} + \xi_t \,,$$

Where $\Delta$ is the difference operator, $\xi_t$ = the white noise error term and $t-1$ = the time lags.

## 3.0 Empirical Results

### 3.1 Descriptive Statistics

**Table 1: Summary of Descriptive Statistics**

| | LnFDI | LnGDP | LnGNI |
|---|---|---|---|
| Mean | 8.158 | -0.080 | 2.978 |
| Median | 8.544 | -0.097 | 2.918 |
| Maximum | 9.298 | 0.396 | 3.850 |
| Minimum | 6.606 | -1.014 | 2.262 |
| Std.Deviation | 0.879 | 0.274 | 0.487 |
| Skewness | -0.598 | -0.351 | -0.095 |
| Kurtosis | -1.263 | -1.089 | -1.209 |
| Jarque-Bera | 16.465 | 10.073 | 7.879 |
| Probability | 0.0003 | 0.0065 | 0.0195 |

The descriptive statistics as evidenced in Table 1 reveals approximate normality in the data distribution of each variable in terms of skewness and kurtosis.

The FDI has a larger standard deviation among all the variables, which supports the general intuition that FDI is highly volatile. The coefficient of skewness is low and negatively skewed. The value for kurtosis in each variable is below the benchmark for normal distribution of 3 which confirms near normality. The mean-to-median ratio of each variable is approximately 1. The range of variation between maximum and minimum is quite logical. The Standard deviation, compared to the mean is low which indicates small coefficient of variation. The J-B statistics also indicate that the distributions of all the variables during the sample periods have long left tails and flat than the normal distribution. On the whole, by the J-B test the variables do not conform to normal distribution but display negative skewness and a flat distribution. These results are, however, based on the null hypothesis of normality and provide no information for the parametric distribution of the series.

### 3.2 A Formal Unit Root Test

Using the ADF test, this study performs unit root tests in log levels and first differences in order to determine univariate properties of the series being examined. That is, to test for the presence of unit roots or nonstationarity. The ADF test involves testing the null hypothesis of a unit root or nonstationarity of the series against the alternative of stationarity. From the results of the unit root test presented in Table 1, it is evident from the table that all the variables are log level nonstationary, since we cannot reject the null hypothesis of a unit root. The results further indicate that all the variables are integrated of order one, with linear deterministic trend. The variables are thus level nonstationary and exhibit unit roots, implying that the shock to them is permanent. The results in Table 1 again shows that the ADF statistics for the three variables imply first-difference stationary, as all the variables become stationary after being first differenced. Thus, the first difference of the series is integrated of order zero, I (0). The combined results from the entire test therefore suggest that all the variables are I (1) in the levels but I (0) in first differences.

**Table 2: Unit Root Test**

| ADF Test | | | | |
|---|---|---|---|---|
| | $H_0: Unit\ Roots\ I(1)$ | | $H_1: Trend\ Stationary\ I(0)$ | |
| Series | Log Level | | First Difference | |
| | Without Trend | With Trend | Without Trend | With Trend |
| FDI | -0.756984(1) | -2.182682(1) | -10.15257(0)*** | -10.12858(0)*** |
| GDP | -2.050889(9) | -1.317047(4) | -3.223596(3)** | -3.902743(8)** |
| GNI | -1.432253(12) | -1.768450(12) | -6.820765(11)*** | -6.848049 |

**NOTE:** Asterisks (**), (***) shows significant coefficients at the 5% and 1% significance level respectively. Figures in parentheses indicate lag length.

### 3.3 Cointegration Test

The study then proceeds with the Johansen multivariate cointegration test having established that all the series are integrated of the same order, I (1). This cointegration test as already indicated allows for the testing of the long-run equilibrium relationships (cointegration) among the series. The results obtained from the Johansen and Juselius (1988, 1990) method is presented in Table 2. Table 2A presents the results based on the trace test to determine the number of cointegrating vectors (r) for this specification, suggested by selection criteria while Table 2B presents the results based on the maximum eigenvalue test also to determine the number of cointegrating vectors.

**Table 2: The results of Johansen's Cointegration Test for Cointegrating Vectors**
**Table 2A: The Trace Test**

| Hypothesis | | Eigen value | Trace Statistic | 5% Critical Value | Probability | Number of lags |
|---|---|---|---|---|---|---|
| $H_0$ | $H_1$ | | | | | |
| r=0* | r$\geq 1$ | 0.181523 | 80.80249 | 69.81889 | 0.0051 | 12 |
| r$\leq 1$ | r$\geq 2$ | 0.115982 | 44.54629 | 47.85613 | 0.0990 | 12 |
| r$\leq 2$ | r$\geq 3$ | 0.071205 | 8.863123 | 15.49471 | 0.3782 | 12 |

**Table 2B: The Maximum Eigenvalue Test**

| Hypothesis | | Eigen value | Max eigen statistic | 5% Critical Value | Prob.** | Number of lags |
|---|---|---|---|---|---|---|
| $H_0$ | $H_1$ | | | | | |
| r=0* | r=1 | 0.181523 | 36.25620 | 33.87687 | 0.255 | 12 |
| r$\leq 1$ | r=2 | 0.115982 | 22.31329 | 27.58434 | 0.2047 | 12 |
| r$\leq 2$ | r=3 | 0.071205 | 13.36987 | 21.13162 | 0.4188 | 12 |

**Note:** * denotes rejection of the null hypothesis at 5% significance level
**mackinon-Haug-michelis (1999) p-values
r stands for the number of cointegrating vectors
Critical values are obtained from Mackinnon (1996)
Numbers of lags are determined by using AIC

The AIC suggests twelve (12) lag length of vector autoregression (VAR) model. The trace test tests the null hypothesis that the number of cointegrating vectors is less than or equal to r, where r is 0, 1, or 2. In each case, the null hypothesis is tested against a general alternative. The maximum eigenvalue test on the other hand, tests the null hypothesis r =0 against the alternative that r =1, r =1 against the alternative r =2, etc.

The reported trace test statistic for the null hypothesis of no cointegration ($H_0$: r =0) is 80.80249 which is well above the critical value of 69.81889 at the 5 per cent (5%) significance level. Thus, it rejects the null hypothesis of no cointegration (r =0) in favour of the general alternative r≥ 1. However, the null hypothesis of r ≤ 1, that the system contains at most one (1) cointegrating vector cannot be rejected at the 5% significance level since the reported trace statistic of 44.54629 is less than the critical value of 47.85613 at the 5% significance level. This test thus, concludes that there is only one cointegrating relationship among the FDI, GDP and GNI.

On the other hand, the maximum eigenvalue statistic testing the null hypothesis of no cointegration ($H_0$: r = 0) is rejected at the 5% significance level as the reported maximum eigen statistic of 36.25620 exceeds the critical value at the 5% significance level. The test however, fails to reject the null hypothesis of r≤ 1, as the reported maximum eigen statistic of 22.31329 is less than the critical value of 27.58434 at the 5% significance level. This result provides additional evidence in favour of the above conclusion that there exists only one cointegrating relationship among the three variables under investigation.

In essence, both test statistics - the trace and the maximum eigenvalue test statics -reject the null hypothesis of $H_0$: r = 0 at the 5% significance level and suggest that there is a unique cointegrating vector. Therefore, our yearly data from 1980-2010 appears to support the existence of long-run relationship among FDI and economic growth indicators (GDP, GNI) based on the Johansen's cointegration procedure. This further implies that, FDI maintain a stable equilibrium with economic growth in the long-run for the entire period of the study.

**3.4 The Long-Run Relationship**
Table 3 below presents the normalized long-run relationship based on the model in the equation.

Table 3:Estimates of Long-Run Cointegration Model (1980-2010)

| Dependent Variable : LnFDI | | | |
|---|---|---|---|
| Regressors | Coefficients | Std.Error | t-Statistics |
| Constant | 7.196870 | | |
| LnGDP | -0.606974*** | 0.18979 | -3.19808 |
| LnGNI | 1.561014*** | 0.45293 | 3.44644 |

**NOTE: (***)** denotes statistical significance at 1% significance level.

The results show that all the coefficients are highly statistically significant at the 1 percent (1%) significance level. Theoretically, the model reveals correct signs for such explanatory variables as GDP and GNI. The results in our case revealed a statistically significant negative relationship between FDI and economic growth. The coefficients in the long-run relationship are long-run elasticities. Each coefficient measures the corresponding magnitude or extent of change in the dependent variable following a unit or a percentage change in a particular explanatory variable. The measure of elasticity in GDP is inelastic with that of GNI being elastic.

### 3.5 Granger Causality Test

The study now turns to examine the Granger-causality relationship between the FDI and each of the economic growth variables. From the results in Table 4, we have been able to establish the cointegrating relationship among FDI and economic growth variables. The main interest of this test lies in examining the Granger-Causality between the economic growth variables and the FDI. Granger-causality may have more to do with precedence, or prediction, than with causation in the usual sense. It suggests that while the past can cause/predict the future, the future cannot cause/predict the past. According to Granger, X causes Y if the past values of X can be used to predict Y more accurately than simply using the past values of Y.

The results of Granger-causality test as presented in Table 4 were estimated from the equations to determine whether or not a feedback relationship exists between FDI and economic growth indicators. Over here, we use the first log difference of the variables because the Granger-Causality test works on the assumption of stationary variables and as already discussed, these first log differences are stationary.

**Table 4: The results of Granger Causality Test**

| Null Hypothesis | F-Statistic | Probability |
|---|---|---|
| DLN_GDP does not Granger cause DLN_FDI | 2.74162 | 0.0021 |
| DLN_FDI does not Granger cause DLN_GDP | 0.75424 | 0.6964 |
| DLN_GNI does not Granger cause DLN_FDI | 1.26816 | 0.2426 |
| DLN_FDI does not Granger cause DLN_GNI | 0.71295 | 0.7373 |
| DLN_GDP does not Granger cause DLN_GNI | 0.54672 | 0.8811 |
| DLN_GNI does not Granger cause DLN_GDP | 5.20534 | 0.0003 |

**NOTE:** DLN represents the first log difference of the respective series. Number of lags used is 12 and are determined by using AIC.

As can be seen in Table 4, the F-statistic used to test causality is significant at 5% significance level in the case of the null hypothesis that, GDP Granger cause FDI. Thus, the F-statistic is sufficient enough to reject the null hypothesis in favour of the alternative that GDP Granger causes FDI. Therefore, the results indicate that GDP Granger causes FDI implying that past values of GDP significantly contribute to the prediction of current FDI even in the presence of past values of FDI. This further implies that causality runs unidirectional from GDP to the FDI. Thus, GDP is found to lead FDI in the long run and can stir movements in FDI, suggesting that, the FDI is not efficient with regard to information contained in GDP. It is also indicated in Table 4 that while GDP Granger causes FDI no reverse causality was observed, because the F-statistic was not sufficient to reject the null hypothesis that FDI do not Granger-cause GDP. This result shows that over the period, 1980-2010, for the study, past values of FDI do not significantly contribute to the prediction of the current GDP in Ghana. Thus, no feedback relationship exists between FDI and GDP in Ghana over the period 1980-2010. It is also evident from Table 4 that an independent relationship or no causal relationship was identified between FDI and GNI. This was because the F-statistics in both cases were statistically insignificant and as such were insufficient enough to reject any of the null hypotheses in both cases. This result therefore implies that the FDI is efficient with regard to information contained in the GNI. Besides, the results reveal that GNI Granger causes GDP as the null hypothesis of 'GNI does not Granger cause GDP' is rejected at 1% significance level. This implies that the past values of GNI drive GDP which is important enough to guide the central bank in its policy decisions. However, no reverse causality was found between GNI and GDP implying that causality runs unidirectional from GNI to GDP.

**3.6 The Short Run (VECM) model**
The short run dynamic results are provided under the vector error correction model as shown in Table 5 below.

These results were obtained with a lag length of 12 for each variable using the
**Table 5: Estimates of the Short Run (VECM) equation (1980-2010)**

| Variable | Coefficient | Std Error | t-statistic |
|---|---|---|---|
| C | 0.014153 | 0.00940 | 1.50463 |
| Res | -0.043247 | 0.01966 | -2.19942 |
| $\Delta InFDI_{t-1}$ | 0.202192** | 0.08681 | 2.32901 |
| $\Delta InFDI_{t-2}$ | 0.254774*** | 0.08587 | -2.96692 |
| $\Delta InFDI_{t-3}$ | 0.808591** | 0.36339 | 2.22510 |
| $\Delta InFDI_{t-4}$ | -0.628398* | 0.33388 | -1.88209 |
| $\Delta InFDI_{t-5}$ | 0.119073* | 0.06841 | 1.74054 |
| $\Delta InGDP_{t-1}$ | 0.190284*** | 0.06748 | 2.81974 |
| $\Delta InGDP_{t-2}$ | -0.228557* | 0.13297 | 1.71548 |
| $\Delta InGDP_{t-3}$ | -0.272725*** | 0.12620 | -2.16098 |
| $\Delta InGDP_{t-4}$ | -0.326432** | 0.13064 | -2.49875 |
| $\Delta InGDP_{t-5}$ | -0.058570*** | 0.01253 | -4.67619 |
| $\Delta InGNI_{t-1}$ | -0.017889* | 0.00994 | -1.79951 |
| $\Delta InGNI_{t-2}$ | -0.606974 | 0.18979 | -3.19808 |
| $\Delta InGNI_{t-3}$ | 1.561014*** | 0.45293 | -4.06087 |
| $\Delta InGNI_{t-4}$ | -3.252486*** | 0.80093 | 3.44644 |
| $\Delta InGNI_{t-5}$ | 0.305574*** | 0.10881 | -2.80839 |
| Multiple $R^2$ 0.459451 | Mean dependent variable 0.017448 | | |
| Adjusted $R^2$ 0.182362 | S.D dependent variable 0.084151 | | |
| Akaike info criterion (AIC) -260.2873 | | | |
| Log likelihood 1263.012 | F-statistic 1.658137 | | |
| Durbin-Watson Stat 1.9435 | Prob (F-statistic) 0.04426 | | |
| Residual Std Error 0.08028 | Bayesian Info criterion (BIC) -209.2343 | | |

**Note:** (*) (**) (***) denotes significance at 10%, 5% and 1% significance level respectively

The R-squared of 0.459451 obtained from the short-run model suggests that all the explanatory variables thus, the economic growth variables (GDP and GNI) jointly account for approximately 45.9% of the variations in the FDI. The F-statistic of 1.658137 is relatively high and thus provides a good fit for the estimated model. The vector error correction (VEC) residual serial correlation LM test indicates that there is no autocorrelation. The variables jointly follow a normal distribution by the VEC Normality test using Jarque-Bera statistic/test. There is no presence of hetereoskedasticity. Based on these probability statistics from the regression, the model is good for analysis and policy interpretation. Quite interestingly, the VECM revealed mixed results with varying statistical significance level for some of the coefficients while most of them were also statistically insignificant. Similar to the long-run coefficients, the short run coefficients are short-run elasticities. In the case of the FDI, only two coefficients out of the 12 periods were found to be statistically significant. Precisely, in the first lag, a coefficient of 0.202192 was found to be statistically significant at the 5% significance level and it also exhibited a positive sign. However, after the first lag, all the other coefficients were statistically insignificant until at the eleventh lag. At this lag length, the coefficient on the FDI indicated a negative sign of -0.254774 at 1% significance level. The coefficient on the GNI variable showed a positive sign for two lag effect at 5% significance level implying a positive relationship between FDI and the GNI variable in the short-run. The coefficient of 0.808591 specifically suggests that a percentage increase in GNI will cause FDI to rise by approximately 0.8 per cent. Nevertheless, the identified positive relationship between FDI and GNI in the short run tends to provide support from the literature. The coefficients on the GDP on the other hand, showed a positive nine month and eleven month lag effect at the 10%and 1% significance level respectively, consistent with the long-run effect already discussed under section 4.3 of this study. In both cases, they exhibited a positive sign, implying a positive relationship with FDI in the short run. Out of the ten insignificant coefficients on GDP for the 12 lag period, six of them showed a negative sign but as indicated they were all statistically insignificant. Although, the statistically significant coefficient of 0.190284 at the eleventh lag period/month was higher than that of 0.119073 at the ninth lag period, they were both smaller than the significant coefficient of 1.561014 in the long-run relationship. The GNI showed a significant negative twelve month lag effect. Thus, the coefficient although showed a negative sign which was highly statistically significant at the 1% significance level. This result suggests an inverse relationship between FDI and the GNI in the short-run and it confirms the inverse relationship obtained in the long-run model already discussed in section 4.3. The magnitude of the error correction term indicates the speed of adjustment from short-run disequilibrium towards the long-run equilibrium state. From the results, the estimated coefficient of the error correction term was statistically significant at 10% significance level and yielded the expected negative sign. The negative coefficient of the error correction term also implies that the model is dynamically consistent and stable. Besides, the statistical significance of the error correction tem **(**ø**,** see equation 14**)** is also an indication of the joint significance of the long-run coefficients under the VECM framework. Also, from the results, the estimated coefficient of the error correction term ($ECT_{t-1}$), -0.0179, is less than one, suggesting that the system corrects its previous period's error/disequilibrium (or the short-run disequilibrium) towards the long-run equilibrium state in more than one year in the event of a shock. In essence, the results of the short-run model in almost all cases confirms and hence consolidate the results obtained in the long-run model as they maintain similar signs although at different statistical significance levels. These results therefore suggest that, to boost foreign direct investments, an economic growth policy that aims at increasing GDP both at the short and long run should be pursued. The short and long run results on both the GDP and GNI are somewhat confusing due to such reasons as discussed above.

## 4.0 Conclusion

This study has investigated the impact of FDI as well as some other selected economic growth variables in Ghana. The study further examined the causal relationships among the considered series. The empirical methodology uses the Johansen's multivariate cointegration test (Johansen and Juselius, 1990) together with the Granger Causality test to examine possible long-run and short-run effects among the involved series as well as the direction of these effects. The study used yearly data for the period 1980-2010 obtained mainly from the World Banks *World Development Indicators 2011* CD Rom. The augmented Dickey-Fuller (ADF) test - an econometric technique was used to examine the unit roots of the involved variables, which were all on the natural logarithm (Ln) scale. The study then proceeded to find whether there are any long and short run relationships after all the variables were found to have unit roots – integrated of order one I (1). The cointegration tests revealed that there is one unique cointegrating vector – implying there is one unique long-run relationship among FDI and the selected economic growth indicators for the period of study. Cointegration evidence indicated and thus confirmed a long-run negative relationship between GDP and FDI and also between GNI and FDI. The results of the Granger Causality test indicated a causal relationship between GDP and FDI, revealing that while GDP Granger-Causes FDI, no reverse causality was observed. Causality was also found to run unidirectional from GNI to GDP.

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