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The Effect of Foreign Direct Investment (FDI) on Climate Change, Empirical Evidence from the Manufacturing Sector of Ghana

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ABSTRACT : Foreign direct investment (FDI) has been argued to be a blessing and curse to most economies of the world, especially developing economies. Despite its growth enhancing attributes, FDI also serves as an avenue for dumping with subsequent effects on environmental quality. The current study examined the effect of manufacturing FDI and its effects on climate change. Measuring climate change by changes in carbon dioxide emissions, the study employed a time series data spanning years (1975 to 2014).
Examination of the time series properties of the model revealed that all variables become stationary after first differencing, an I(1) process which warranted the construction the Johansen-Juselius test for cointegration. A long run association was established between the explanatory and carbon dioxide emissions. This warranted the use of the Vector Error Correction model as the main model of analysis and specifically in estimating the short run effect.
The Vector error correction model revealed a significant short run relationship between previous year's emissions and present emissions in the manufacturing sector. The study results were discussed in relation to literature and the directional effects are also checked against theoretical assumptions. In the short run, carbon dioxide and manufacturing FDI were the only variables in the model that proved significant.
Generally, manufacturing FDI was found to have negative effect on carbon dioxide emissions in the short run, but positive effect in the long run. Following from the study findings, some constructive recommendations were made.

Keywords: FDI, Carbon dioxide emissions, Manufacturing sector

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1. INTRODUCTION

Background to the Study

Foreign direct investment constitutes the most important form of foreign capital investment (Kilic and Ates, 2009) and it entails the establishment of production plants, the buying of existing production facilities or installment of those facilities abroad, as well as the manufacturing of products among others by a company in foreign countries (Seyidoglu, 2001). In most countries, especially developing economies, foreign direct investment (FDI) has been viewed as an important catalyst to economic growth and development. One of the major policy aims of Ghana's Economic Recovery Program (ERP) has been the attraction of foreign direct investment (FDI) into the Ghanaian economy (Abdulai, 2005). The significance of FDI to the economic development of host receiving nations cannot be under-emphasized. It has become the center of attention to researchers, policy makers, and most developing host economies (Peng et al., 2016) due to its ability to tackle issues of financial resource shortages, and skills and technological needs and/or advancement (Abdulai, 2005). During the last three decades, FDI inflows had seen great increases across various regions of the world with high concentration in Africa. Since 2004, the global economy has experienced increases in FDI. In 2007, the annual FDI reached about $1,833 billion of what should showed in an increase of 30%(Yachum, 2011). Many Sub-Sahara African (SSA) countries have benefited enormously from FDI inflows (Fauzel et al., 2015; Saqib et al., 2013; Walfure and Nurudeen, 2010). It has been recognized as a critical growth catalyst in developing countries like Ghana (Aveh et al., 2013; Ugwuegbe, 2014). In 2015, Global FDI inflows to receiving economies on the globe experienced its highest due to the 2008 global economic and financial crisis. The period saw a rise in global FDI flows by about 40% from to $1.8 trillion (UNCTAD/WIR, 2016). Global inward FDI stock for 2014 showed the service sector to be the major FDI contributor or receiver across the various sectors of the world. The world records and FDI distribution for developed economies, developing economies, Africa, Latin America and the Caribbean, developing Asia and traditional economies all show much largest concentration in the service sector, accounting for almost two thirds of global FDI stock of $26 trillion (UNCTAD/WIR, 2016). This was followed by the manufacturing sector as the second largest which accounted for 27% in global FDI stock and second across all the various region and then the primary (7%) and other unspecified sectors (2%).

In Ghana, FDI inflows has served as a great source of finance to various sectors of the economy. Various investment policies have been adopted and implemented by many governments since independence in 1957 (Anokye and Tweneboah, 2009). According to the 2008 World Investment Report, Ghana's share of FDI quadrupled from its 2005 value to $636 million in 2006. This represented 19.4% of gross capital formation. In Ghana, most of the FDI inflows are in the mining sector. The sector has experienced the largest proportion of total FDI with the gold sector benefiting the most (Abdulai, 2005). The sector in 2005 accounted for a total of $5 billion in FDI inflows with a little over $200 million annual inflow and still continue to dominate in the share of FDI inflow. The Ghana Investment Promotion Centre (GIPC) in the first quarter of 2013 recorded a total of 199 newly registered projects with an estimated project amount of GH¢1,099.44 million (US$578.65 million) out of the FDI component amounted to GH¢1,067.93 million (US$562.07 million), representing 77.7% decrease in value for corresponding period in 2012. Also, the sectorial composition within the second quarter showed the service sector to dominate in both number of registered projects and value. This was followed by the manufacturing sector registering 19 new projects amounting to $ 26.63 million (GIPC, 2013). Despite a decline in FDI to Ghana in 2011 by 4.9% according to the UNCTAD 2016 report (Dogbevi, 2016), the 2016 sectorial breakdown was not different from that of 2013 (Eduku,

Despite the growth enhancing advantages of FDI through the transfer of skills and technology, there are some negative aspects to poor countries that is worth emphasizing. In some cases, FDI has brought about dumping of foreign goods into the local economy. It puts workers under foreign control and promotes foreign appropriation of profits amongst others. Also, the full benefit from FDI promoted activities in the host economies are usually affected by a variety of leakages, prominent of which is the global warming and climate change. Apart from the benefits of FDI, there exsit some environmental and health related effects through climate change. A special case is the FDI activities of the manufacturing sector of most countries, particularly LDCs.

The industrial sector of Ghana plays a vital role in the composition of the country's gross domestic product (GDP) and results in the provision of jobs to the people. In 2011 for instance, the sector contributed more than a quarter (25.6%) of Ghana's GDP and by the end of 2014 the sector contributed 28.4% of the country's GDP as per Ghana Statistical Service's revised 2014 figures (GSS, 2015). The industrial sector in Ghana, according to the composition by Ghana Statistical Service (GSS), is made up of the mining & quarrying, oil & gas, manufacturing, electricity, water & sewerage and construction sub sectors (GSS, 2015), these are the major conttibutors to carbon dioxide emissions which causes the climate to change.

Climate Change and global warming has in recent times become one of the main issues of concern in the world. It has become of great concern to governments and environmentalists due to their impact on human activities and the environment. This global concern on climate change and carbon emissions was cited by the International Climate Conference in Copenhagen (Yanchum, 2011).

The issue of climate change and its impact are beginning to manifest on the entire globe with its relatively higher level of vulnerability on developing economies. In Ghana, it is evident that all the ecological zones are experiencing rising temperatures with gradual decreases in rainfall levels and patterns which is increasingly becoming erratic (UNEP/UNDP, 2016). Over the past 30 years, average annual temperature has been on the rising side. Minia et al. (2004) has estimated a similar weather pattern of increasing temperature and reducing rainfall in all agro-ecological zones. The average annual temperature is projected to rise by between 0.8oC and 5.4oC for the years 2020 and 2080 respectively. The average annual rainfall is also estimated to decline by between 1.1% and 20.5% within the same period (UNEP/UNDP, 2016). This has great economic implications for the country. For many decades, agriculture has been the back-bone of Ghana's economy with about 70% of the country's population depending on the activities of crop and animal farmers, fisheries and the forest sector. These economic activities are highly dependent on the weather conditions at the various ecological zones in the country. However, the activities of other economic sectors, especially the manufacturing sector also posed some level of threat on the weather and atmospheric conditions in the country. The manufacturing sector in Ghana happens to be the second largest contributor to FDI inflows.

Most FDIs are usually undertaken in mining, and manufacturing sub-sectors of developing economies (Mahmood and Chaudhary, 2012). Increases in FDI means transfer of skills and technology, increases in employment opportunities, and boost in productivity among others ceteris paribus. Implicitly, inflows of FDI have growth implications for host economies. It results in various projects and business venture, setting up of factories, which means increases in economic and/or production activities in the host economy. With increases in production, there could be pressure on limited natural resources and environmental implications. In a simple stylized production function, an increase in investment in new factories and/or existing ones in the form of capital formation through FDI, increases production through increases in plant size or scale of production all things being equal. This results in increasing pressure on the environment. Several studies have explored the FDI-growth nexus (Iddrisu et al., 2015; Acharyaa, 2009; Baisheng and Deyong, 2008). Others have also examined the environmental impacts of FDI on various economies including LDCs (Liang, 2006; Bao et al., 2010; Doytcb and Uctum, 2012). While most of these studies revealed positive effect of FDI on growth, some produced unambiguous results for FDI and the environmental impacts (especially CO2 emission).

Despite the various studies on climate change, specifically in the areas of carbon dioxide emission (CO2) emissions and foreign direct investment, review of literature apparently shows little evidence on the impact of FDI on carbon dioxide emission in the manufacturing sector of Ghana. Although studies by Opoku (2013) examined the effect of economic activities on carbon dioxide emissions in Ghana, the study focused on the effect of trade and economic growth. Just as Roy and Berg (2006) posit that the examination of the growth effect of all the components of globalization is a necessary requirement for the complete assessment of the importance of globalization for economic growth, it is equally important to also examine the back-drop effects of FDI on the environment or climate change in order to better understand and appreciate the growth hampering aspect of FDI to host economies.

Putting together the argument that FDI to Africa is driven by extractive minerals which are at the heart of the industrial sector in Ghana and the argument of FDI's spillover effect of technology to sectors such as manufacturing, the study of the impact of FDI on climate change in Ghana could not be more imperative. Peng et al. (2016) also posit that foreign direct investment and CO2 emissions are the two major factors interacting with economic growth. These and many arguments espoused above explain the nature of climate change in the context of economic globalization. It is therefore imperative to examine the effect of Manufacturing FDI on climate change despite the growth associated benefit to host economies.

Review of literature also show little evidence or no evidence of an empirical study on FDI-CO2 emissions nexus in Ghana. The study therefore adds to several related works and also creates a platform which arouse some interest for further studies in this regards, serving as a source of reference for future studies in the area.
The study is also equally relevant to policy makers and environmentalists. CO2 emission poses great danger on human health, both in the short and long term. It has been described by Opoku (2012) as the most arduous and problematic of the greenhouse gas effects to manage. The bulk of CO2 emission is produced from the consumption of fossil fuels, hence forms an integral part of industrial activities and consumption. Findings from the study will help policy makers, and environmentalist gain a better and practical understanding of the environment response to the activities of the manufacturing sector and specifically, FDI related activities.

2. LITERATURE REVIEW

Theoretical Review

The Pollution Haven Hypothesis (PHH)

The Pollution Haven Hypothesis (PHH) is based on the assumption of different environmental regulations in different countries. The PHH depicts the trade-environment nexus within trading partners or countries within the international market. According to the PHH, stringent environmental regulations distorts the extent of utilization of comparative advantage by influencing decisions of plant location and trade flows (Copeland and Taylor, 2004; McCarney and Adamowicz, 2005). According to Eskeland and Harrison (2003), the PHH hypothesizes that, stringent environmental regulations in countries (especially developed countries) will influence the move of pollution-prone economic activities to poorer countries who are usually known to have relaxed environmental regulation (i.e. developing economies).

PHH postulates that, trade openness or trade liberalization as a result of economic integrations or globalization will influenced multinational firms in developed countries where environmental policies are stringent to move their production of pollution intensive products to regions with lxer environmental laws or regulations. The hypothesis therefore perceive pollution as an imported emission from developed countries to the less-developed ones as a result of regulatory gaps and trade liberalization. Implicitly, it argues that due to the differences in environmental protection and regulatory frameworks in the developed and developing countries, most corporations in the developed countries are compelled to undertake production of dirty or pollution-prone activities in the developing country where they find it comparatively less expensive to produce such products since the environmental laws are related and the cost involved is relatively less.
Field and Field (2009) argue that with trade openness, developing countries tend to act as “pollution havens”, for developed countries. According to them, the PHH essentially has two parts; first, the stringent environmental control standards are causing pollution intensive firms to relocate to countries with less strict environmental standards, and secondly, some developing countries have also put in much effort, with some success, to attract pollution-intensive firm with the promise of production incentives, and lower environmental/pollution standards, with the aim of accelerating economic growth.
In contradiction to the pollution haven hypothesis, Leonard and Duerksen (1980) find that trade and investment data suggest pollution-intensive industries relocate to other industrial countries instead of to less developed nations (LDCs). They concludes that there are other factors like infrastructure, labor training, and political stability, as opposed to cost-savings from pollution regulations, that play critical roles in the relocation decisions of multinational firms.
Aldaba and Cororaton (2002) made use of the general equilibrium model simulation to examine the relationship between trade and environmental pollution in Philippine. They found trade liberalization to have no effect on basic pollution, but rather increases the output and revenue base.
The PHH has theoretically been shown to be intriguing in theory, albeit inconsistencies in imperial finings. Evidently, the debate on the validity of the PHH is still inconclusive and the argument is however far from closure.

The effect of foreign direct investment on host nations has been one of the hottest debates in economic and finance research over the years (Sothan, 2017). In developing countries FDI has been argued and empirically found to contribute to growth of economies (Yao and Wei, 2007; Vu et al., 2008; Pegkas, 2015) at both the firm and macro levels. At the firm level, several studies have established the technology spillover effect as well as the enhancement of productivity from FDI inflows (Zhou et al., 2002). Zhao and Zhang (2010), and Wang (2010) among other studies have also shown the positive contribution of FDI to positive productivity externalities, industrial productivity and higher per capita GDP. Despite the growth enhancing impact of FDI, there are some negatives, paramount of which is the depletion of natural resources and pollution of the environment (Yang et al., 2008; Acharyya, 2009) which subsequent effect on climate change (Sothan, 2017).

Some Empirical Review

Dean (2009) employed 2889 manufacturing JV projects in China for the period 1993 to 1996 and found evidence in support of the PHH for investors in Chin but not necessary for foreign investors from high income countries. Cave and Blomquist (2008) also investigated the PHH between European Union (EU) energy intensive trade and toxic intensive trade with Organizations for Economic Co-operation and Development (OECD) for 29 year period (1970 to 1999). They found evidence of PHH for energy intensive trade, but otherwise for toxic intensive trade between the countries.

In Vietnam, Dinh and Lin (2014) also employed 1980 to 2010 time series data to examine the relationship between FDI flows and CO_2 emissions. The study found FDI inflows to impact on growth and the environment. They concluded that FDI inflow to Vietnam increases energy consumption which has implication for carbon CO_2 emission. However, Vietnam is able to further attract more FDI due to lax in its environmental regulation which worsens the consequences of FDI-promoted activities on the environment through emission of greenhouse gasses. Lee (2009) made similar conclusion for Malaysia where a one-way dimensional relationship was found between the two variables; FDI impacting on CO_2 emissions.

Some studies also employed the Pollution Haven Hypothesis (PHH) as the basis to justify the impact of FDI on climate change. Grimes and Kentor (2003) examined the emission impact of FDI dependence for 66 less developed countries (LDCs) between 1980 and 1996. Using a cross-sectional panel analysis of these countries, they found penetration of foreign capital in 1980 to significantly impact on the growth of carbon dioxide (CO_2) emissions between the years reviewed. They attributed this result to a couple of factors which included that fact that most of the industries with high FDI concentration are those that required more energy, and that foreign corporation with high polluting industries may relocate to countries with less protective environmental controls. Sha and Shi (2006) focused on the impact of FDI on the environment for China using the same time periods (1980-1996) and found negative impact on the environment through carbon dioxide emissions.

In the agriculture and fishing sector, Pazienza (2015) examine the environmental impact (estimated by the extent of carbon dioxide emission) of FDI of OECD countries. Specifically, it investigates the impact of FDI inflows of OECD countries exerts on level of carbon dioxide emission deriving from fuel combustion by the sectors. The study made use of the panel data analysis technique on a dataset comprising statistics of 30 OECD countries for a period of 25 years (1981 to 2005). Findings showed a negative relation for the scale, technique, and cumulative effect of FDI on CO_2 emissions. The implication is that FDI enhances the quality of the environment by reducing the extent of CO_2 emissions as a result of FID inflow.

Source of Data

For the purpose of this study however, the researcher employs secondary data from the World Development Indicator (WDI) database compiled annually by the World Bank. The study will make use of annual data for FDI, CO_2 emissions, manufacturing value added (MVA), gross domestic investment (GDI), trade openness (TOP), population growth (POP) and urbanization (URB) for the period 1975 to 2014.

Model Specification

The model for the study follows from the Environmental Kuznets Curve (EKC) hypothesis. According to Stern (2004), EKC is a hypothesized relationship between various environmental indicators and income per capita. It depicts an inverted U-shaped relationship between the two sets of variables (environmental indicator and income per capital). The EKC in its general form can be hypothesized mathematically following from Saboori et al., (2012) as below:

$$E = f(Y, X_i) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3.1)$$

E = Environmental indicator representing environmental degradation

Y= Income (real GDP per capita)

X_i= vector of variables that may contribute to or affect environmental degradation.

The vector of control variables in this study however has FDI, trade openness, gross domestic investment and population growth. The income (real GDP per capita) variables are also represented by the manufacturing value added (MVA).

Thus, in order to determine the effect of FDI on climate change (CO_2 emissions), the study employ the mathematical model as below:

$$CO_{2_t} = f(FDI_t, MVA_t, GDI_t, TOP_t, POP_t,) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . (3.2)$$

Where CO_2 = Carbon Dioxide Emission, an indicator for climate change

FDI = Foreign Direct Investment into Manufacturing

MVA = Manufacturing Value Added

GDI = Gross Domestic Investment

TOP = Trade Openness

POP = Population growth

Equation (3.2) can be rewritten in its multiplicative form as;

$$CO_{2_t} = \beta_0 + \beta_1 FDI_t + \beta_2 MVA_t + \beta_3 GDI_t + \beta_4 TOP_t + \beta_5 POP_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3.3)$$

The explicit empirical model for analysis is expressed in its logarithm form as follows:

$$\ln(CO2)_t = \beta_0 + \beta_1 \ln FDI_t + \beta_2 \ln MVA_t + \beta_3 \ln GDI_t + \beta_4 \ln TOP_t + \beta_5 \ln POP_t \quad \ldots\ldots\ldots (3.4)$$

All variables are as explained above,

ln natural logarithm, *t* denotes time, *μ* denotes the error term, and β_i (*i* = 0, 1, 2, … , 7) represent the elasticity coefficients.

β_i (*i* = 0, 1, 2, … , 7) > 0. Thus, all the elasticity coefficients are expected to be positive. Implicitly, the independent variables are expected to positively impact on CO_2 emission.

Equation (3.4) shows the long-run equilibrium relationship.

3. RESULTS AND DISCUSSION

Unit Root Test

The study employed the Augmented Dickey Fuller Test to examine the unit root properties of the variables before conducting the empirical regression analysis. Presented in table 4.2, the unit root test which was conducted under the null hypothesis of the presence of unit root at 5%. The raw variables are employed in the empirical model for this study hence, the test for stationarity was conducted on the logged variables. A log transformation of the raw variables are performed in order to ensure linearization and normalization of the data.

Evidence from the table, all the variables became stationary (attained stationarity) after first difference, producing an I(1) process. Implicitly, the critical values for LCO2, LMFDI, LMVA, LGDI, LTOP, and LPOP reported test statistics greater than their respective critical values. The test statistics for LTOP and LPOP (-3.301 and -3.147 respectively) were greater than their respective critical values at least 5% (-2.951 and -2.964

respectively) but less than the 1% critical values (3.639 and 3.670 respectively) in absolute terms. Hence, LTOP and LPOP show 5% stationarity. Following the same deduction, LCO2, LMVA and LGDI show stationarity at 1% whilst LMFDI is stationary at 10%. The former variables (LCO2, LMVA, and LGDI) had test statistics (-6.190, -4.151, and -6.214 respectively) greater in absolute terms than their corresponding 1% critical value (-3.639, -3.616, and -3.616), whilst the later produced a test statistic (-2.789) that was higher than the 10% critical value (-2.261) in absolute terms. This presence or absence of unit root can equally be explained using the corresponding probability values for the variables. A probability less than 1%, 5%, and 10% imply stationarity at 1, 5, and 10 percent respectively.

Given an I(1) process for all the study variables, the study proceeding to examine the cointegrating relationship among the variables using the Johansen-Juselius (J-J) test for cointegration.

Table 5 2: Results for Augmented Dickey-Fuller Test for Stationarity

Variables	Critical Values			Test Statistic	*p-value*	Order of Integration
	1%	*5%*	*10%*			
			Level Variables			
LCO2	-3.646	-2.954	-2.616	-0.057	0.9461	NS[1]
LMFDI	-3.611	-2.939	-2.608	-0.781	0.8133	NS
LMVA	-3.616	-2.941	-2.609	-1.435	0.5548	NS
LGDI	-3.610	-2.939	-2.608	0.107	0.9623	NS
LTOP	-3.639	-2.951	-2.614	-1.330	0.6042	NS
LPOP	-3.662	-2.960	-2.619	-2.179	0.2175	NS
			First Differenced Variables			
LCO2* **	-3.639	-2.951	-2.614	-6.190	**0.0000**	I(1)[2]
LMFDI*	-3.670	-2.964	-2.621	-2.780	**0.0731**	I(1)
LMVA***	-3.616	-2.941	-2.609	-4.151	**0.0024**	I(1)
LGDI***	-3.616	-2.941	-2.609	-6.214	**0.0000**	I(1)
LTOP**	-3.639	-2.951	-2.614	-3.301	**0.0227**	I(1)
LPOP**	-3.670	-2.964	-2.621	-3.147	**0.0336**	I(1)

Source: *Author's Computation from EViews 9*
****, **, & * represent stationarity at 1%, 5%, & 10% respectively*

Johansen Juselius Cointegration Test

The absence of unit root in all the variables after first difference (producing an I(1) process) warrants the construction of cointegration test using the J-J test. As explained under section 3.4, the construction of the J-J cointegration test requires that all the variables are I(1) process (i.e. integrated of the same order and of order 1). We therefore proceeded to estimate the cointegrating relationship existing among the variables by conducting the J-J Multivariate cointegration test. This examined the existence and the number of cointegrating relationships existing among the variables if any. The existence of a stationary linear combination or cointegration equation is proved with the presence of cointegration.

Table 4 3: Johansen-Juselius Cointegration Test Results.

Hypothesized No. of CE(s)[3]	Trace Test		Max-Eigen Test	
	Test Statistic	5% Critical Value	Test Statistic	5% Critical Value
None*	207.1571	95.75366	121.0458	40.07757
At most 1*	86.11123	69.81889	38.65929	33.87687
At most 2	47.45194	47.85613	27.43888	27.58434
At most 3	20.01306	29.79707	14.58289	21.13162
At most 4	5.430178	15.49471	3.935360	14.26460
At most 5	1.494818	3.841466	1.494818	3.841466

Source: *Author's Computation from EViews 9.*
** denotes rejection of null hypothesis at 5% level of significance.*
Decision is based on MacKinnon-Haug-Michelis (1990) p-values.

Evident from table 4.3 above, the result for trace and Max-Eigen tests rejects the null hypothesis that there is no cointegration at 5%. Thus, the value of test statistics for both tests were greater than their corresponding 5% critical values for the first two hypothesis, indicated with an asterisk showing the rejection of the respective null hypothesis. Both test therefore concluded the existence of two cointegrating equations. This is also explained by the probability values of both tests for the first two hypothesis (see appendix). The existence of cointegrating relationship among the variables from the J-J cointegration results warranted the construction of a vector error correction model to examine the relationship between the dependent and independent variables of the model.

Long-run Effect

The J-J cointegration revealed presence of two cointegrating equations in the model. This implied that carbon dioxide emissions and its determining variables, namely, manufacturing FDI, manufacturing value added, gross domestic investment, trade openness, and population growth share some common relationships in the long-run. We therefore employ the normalized cointegrating equations in order to establish the long run relationship or the long run effects of the variables on carbon dioxide emissions.

The first normalized cointegrating equation expresses the long relationship between the dependent and the independent variable. The results of the first normalized cointegrating equation is shown in table 5.4 below. The table shows an estimated long-run effect of approximately 0.22% in carbon dioxide given a 1% increase in FDI in manufacturing. The long run elasticity of a percentage change in manufacturing value addition (MVA) on carbon dioxide emission is approximately 2.17%. Gross domestic investment (GDI), trade openness (TOP) and population growth (POP) show elasticity of approximately 0.64%, 0.33% and 4.81% respectively on carbon dioxide emissions.

In addition, MVA and TOP reported negative long-run effects on carbon dioxide emissions, while MFDI, GDI and POP found positive long-run relationship with carbon dioxide emissions. The directional effect produced by MVA and TOP were contrary to apriori expectations. According to study findings, the indication is that in the long run, a percentage increase in MVA is expected to result in a decrease in carbon dioxide emissions by more than proportionate (double). Also a percentage increase in TOP is also shown to have a reducing effect in carbon-dioxide emission in the long-run.

Table 5.4: Estimated Long-Run Effect on Carbon Dioxide Emissions : Normalized Cointegrating Coefficients

LCO2	LMFDI	LMVA	LGDI	LTOP	LPOP
1.000000	0.219980	-2.169165	0.964161	-0.331062	4.810916
	(0.06732)	(0.19424)	(0.15844)	(0.16851)	(0.24724)
		Log Likelihood = 315.3367			

Source: *Author's Computation from EViews 9*
Standard errors are in parenthesis.

The long run increasing or adverse effect of FDI on climate change (emission) falls in line with findings of Grime and Kentor (2003), Lee (2009), Dinh and Lin (2014), among other studies who found inflow of FDI to have damaging effect on host countries. This supports the argument by Lin (2014) that countries with high levels of FDI, especially in pollution-prone ventures should ensure a robust system of quality control for FDI.

Short-run Effects between FDI and Climate Change

Presented in table 5.5 is the short-run effects of the regressors on climate change (carbon dioxide emission). First of all, the table reports an R-square and adjusted R-square of 0.744 and 0.556 respectively which is an indication that more than 50% of the deviation in the dependent variable is explained for by the model. Thus, the independent variables account for more than 50% of the changes in climate change which is measured by the amount of carbon dioxide emission. Also probability value of 0.003131 for the F-statistic is also an indication of model significance at 1%. Thus, the model is a good one.
As indicated by the stars (** and ***), apart from the lag of carbon dioxide (CO2), and the second lag of foreign direct investment into manufacturing (MFDI), the other variables in the model, manufacturing value

added (MVA), gross domestic investment (GDI), trade openness (TOP), population growth (POP) are found not to be significant in the model. The first and second lags of carbon dioxide emission showed high significant and negative impact on emissions. At 1% and 5% level of significance for the first and second lag of CO2, the corresponding coefficients of -0.5061 and -0.4785 show that emissions in the immediate previous years reduces current emissions by approximately 50.16% and 47.85% respectively. Thus, previous years emissions have significant reducing effect on current levels of emission. The intuition is that, the manufacturing sector tried to improve on environmental quality by ensuring that the pollution levels (carbon dioxide emissions) are reduced every year. The coefficient of the second and first lag for CO2 means that past years emission influences current year's emissions negatively, hence, improving environmental quality. Another plausible explanation to this is the level of activity or economic concentration in the manufacturing sector has reduced drastically such that the levels of emission continue to experience drastic reduction over the years, showing almost 47.85% and 50.61% reduction in current levels of CO2 emission as a result immediate previous years' emissions respectively. Again, this could also be due to conscious efforts of the sector to meet some targeted level of emission. It is possible that stakeholders within the sector upon examining the levels of emissions in a particular year try to reduce this level not necessarily by cutting production but by devising various production approaches that are less polluting, or by aiming at some minimum annual levels over time.

FDI into manufacturing also reported significant negative impact on CO2 emissions. With a probability (p-value) of 0.0141, MFDI show a significant effect on carbon dioxide emission at 5%. Also a coefficient of -0.127069 show a negative effect of MFDI on CO2 emission in the short run. Implicitly, a percentage increase in manufacturing FDI reduces emissions by about 12.71% in the short run. Hence, FDI into manufacturing show significant negative effect on climate change. The plausible intuition is that most FDI into the manufacturing sector are into pollution-reducing or environment-enhancing technologies that turn to enhance productivity whilst promoting quality environment. This relates from the findings by Yachum (2010) that FDI inflows reduces the pressure of carbon dioxide emissions in China due to the technology spillover effects. This is similar to most recent study, Pazienza (2015) who also found a reducing effect of FDI on CO2 emissions attributive to the scale, technical and cumulative effects. This finding is also in consonance with findings by Vinh (2015) who found the environmental impact of FDI into the manufacturing sector to be relative less compared to other sectors in Vietnam. Similarly, Deng and Song (2008) found enhancement in environmental quality following FDI inflows.

The results from this current study on FDI however contradicts most findings in literature such as Acharyya (2009) and Jalil (2014) among many others who found defying results. Jalil (2014) for instance found FDI inflows to results in increases in carbon dioxide emission in Northern Africa and the Middle East, while Acharyya (2009) also found the same relationship for 18 countries.

Also evident in the table is the error correction term. This is represented by the first lag of the error correction model (ECMt-1 or ECM (-1)). The error correction term indicates the speed of adjustment and defined the speed with which any disturbance or disequilibrium in the model reacts towards the long-run equilibrium. Thus, the term specifies two: whether there is adjustment (convergence or divergence) towards or away from the long-run equilibrium, and the speed of adjustment. The significance of the error correction term with a negative coefficient imply long-run convergence, whilst a positive coefficient means divergence. From the table, the probability value of 0.0001 for the error correction term is an indication of high significance of 1%, and the negative sign for the coefficient (-0.66) indicates convergence. Also, the value of the coefficient of approximately 0.66 shows that the speed of adjustment is more than 50%. Implicitly, the result for the error correction term show the there is some long-run causality for the independent variables such that they move together in the long-run, converging to the long-run equilibrium state. Also approximately 66% of any disturbances in the model is corrected in a year.

Table 5 5: Vector Error Correction Results ($DLCO_2$ as Dependent Variable)

Variables	Coefficient	Standard Error	t-Statistic	*p-values*
ECM(-1)	**-0.660000*****	(0.12863)	[-5.13111]	0.0001
ECM(-2)	**0.251466*****	(0.05576)	[4.51009]	0.0002
D(LCO_2(-1))	**-0.506120*****	(0.15489)	[-3.26751]	0.0041
D(LCO_2(-2))	**-0.478462****	(0.17022)	[-2.81084]	0.0112
D(LMFDI(-1))	-0.049423	(0.04913)	[-1.00601]	0.3271
D(LMFDI(-2))	**-0.127069****	(0.04702)	[-2.70245]	0.0141
D(LMVA(-1))	0.132106	(0.15282)	[0.86448]	0.3981
D(LMVA(-2)	0.126918	(0.13675)	[0.92808]	0.3650
D(LGDI(-1))	-0.140808	(0.15816)	[-0.89032]	0.3488
D(LGDI(-2))	0.078228	(0.14696)	[0.53233]	0.6007
D(LTOP(-1))	-0.167668	(0.11699)	[-1.43322]	0.1680
D(LTOP(-2))	-0.194776	(0.13102)	[-1.48660]	0.1535
D(LPOP(-1))	0.329236	(0.88168)	[0.37342]	0.7130
D(LPOP(-2))	0.295037	(1.16629)	[0.25297]	0.8030
constant	**0.025076****	(0.01116)	[2.24707]	0.0367

R-Squared = 0.744399
Adj. R-Squared = 0.556062
F-statistic= 3.952479
Prob.(F-statistic) = 0.003131
Log Likelihood = 65.37596

Source: Author's Estimation from EViews 9.
*** & ** denote 1% and 5% level of significance respectively.

Diagnostic Testing

The efficiency of the model was examined by undertaking a residual diagnostic test. This included the test for normality, serial correlation and heteroscedasticity. Initially, the model was tested for normality by employing the Jarque-Bera (JB) p-value. A probability value (p-value) of 0.824589 for the JB statistics, which is less than 5% imply insignificance, hence we an indication that the VEC residuals are normally distributed. The heteroscedasticity test was also undertaking with the help of the Breusch-Pagan-Godfrey Test. With a chi-squared probability value of 0.9427 (i.e. $\mathcal{X}2$ (18) = 0.9427) which shows insignificant, we fail to reject the null hypothesis that there is no heteroskedasticity (the presence of homoscedasticity) and conclude that the VEC residuals is homoscedastic.

Finally, the model was also checked for serial correlation using the Q-statistics and confirming with the Durbin-Watson statistic from the regression analysis. Evident form the results from the graph of Correlogram of residuals, both AC (Autocorrelation) and PAC (Partial correlation) falls within the lower and upper bounds (left and right dotted line), hence showing the absence of serial correlation. This is confirmed by a Durbin-Watson statistic of 2.466657 which fall between the lower and upper limit (2 and 4). Thus, a Durbin-Watson value between 2 and 4 proves the absence of serial correlation.

Test for Causality

The Granger-Causality test result is presented in table 4.6 below, showing the defined null hypothesis under investigation, the F-statistics as well as the probability values (p-values). Of importance, is the causality between pairs consisting of the dependent variable and an independent variable, particularly MFDI and CO2 emissions (Climate change). From the table, it is evident that there is no Granger-Causality. That is, a probability value of 0.900 which is less than 5% (i.e. Prob. (F-Stats) < 5%) which insignificance of the null hypothesis that LMFDI does not Granger Cause LCO2. Hence, we refuse to reject the null hypothesis and conclude that MFDI does not Granger Cause CO2. With a probability value of 0.6404 for the second null hypothesis, we employ the same deduction and conclude that CO2 does not Granger Cause MFDI. Implicitly, we cannot predict climate change from MFDI, neither can we predict MFDI from climate change.

Table 5 6: Granger-Causality Test Result

Null Hypothesis	Obs.	F-Stats	P-Values
LMFDI does not Granger Cause LCO2	33	0.42359	0.7900
LCO2 does not Granger Cause LMFDI		0.63812	0.6404
Lag Length = 4			

Source: *Author's Construction from Eviews 9 (Extract from Complete Results)*

Summary of Findings

The analysis of data was undertaken in relation to the research objectives. Following this outline, the study made interesting findings as summarized below:

All variables of the model were found to be an I(1) process with all the variables becoming stationary after first differencing. The Johannsen-Juselius cointegration test established the existence of long run association between the variables of the study.

The R-squared and adjusted R-squared showed that more than 50 percent of the variations in carbon dioxide emission (climate change) is explained by the variables of the model, with a probability of the F-statistic also revealing the general fitness of the model at 1 percent significance. The error correction term showed indications of long run convergence following any distortions in the model with 66 percent of any disturbances corrected in a year.

In the short run, both lags (first and second) of carbon dioxide emissions have significant negative effect on climate change at 1 and 5 percent respectively. Thus, previous emissions are found to significantly impact on current emissions of carbon dioxide. Impliedly, emissions in previous years are found to have negative impact on climate change.

The second lag of manufacturing FDI also reported a significant negative result which implied that increases in manufacturing FDI is good for the environment, specifically climate change. Inflows of FDI into the manufacturing sector reduce carbon dioxide emissions in the short run. A long run relationship was established between the independent variables and carbon dioxide emissions. In the long run, manufacturing FDI is found to have positive effect on climate change (carbon dioxide emissions). Gross domestic investment and population growth are also found to result in increases in emissions, hence, having devastating effects on climate change. However, manufacturing value added and trade openness were also found to have decreasing effect on carbon dioxide emissions in the long run.

Finally, manufacturing FDI was found not to granger cause carbon dioxide emission. Similarly, carbon dioxide emission was found not to granger cause FDI in the manufacturing sector.

4. CONCLUSION

The environmental effect of foreign direct investment been debated by various empirical studies and in various field of study and sectors as espoused in the literature. This current study however, find different short run and long run effects of manufacturing FDI on climate change. Manufacturing FDI enhances climate change in the short run but adversely affects the climate with increasing carbon dioxide emissions in the long run. The implication is that initially FDI into the sector initially help reduce the level of carbon dioxide emission probably because these investments are in technologies that are less polluting in their initial operation phase. Subsequently however, these technologies becomes obsolete over a shorter period due to ineffective maintenance, hence, becoming more polluting in the long run.

Another plausible explanation is that foreign direct investments, in its introduction phase tend to be more concerned about the environment, and taking necessary operational precautions to ensure the quality of the climate. Over a period of time, foreign investors tend to exploit the environment, focusing extensively on making supernormal profits, hence, having less concerns of the environment and its people with subsequent effect on the climate change and the global environment as a whole. The long run implication of gross domestic investment (GDI) on climate change is similar to that of manufacturing FDI on climate change. GDI tend to have no significant effect in the short run but have long run significance.

Lastly, the reducing effect of trade openness and manufacturing value added on carbon dioxide emission which contradicts various studies in literature suggests that the sector should continue adding value and also the more liberalized the economy is, the better. Thus, the economy could reduce emission as long as it opens its boarders to the international market. However, this should be done without compromising the environmental and health related regulations.

Recommendations

Following from the findings outlined above, the study make construction recommendations among which include but not limited to the following:
The study suggest that policy makers, government, and government agencies should ensure that environmental quality regulations are strictly adhered to, especially for foreign investors and foreign related investments. This can be done through effective implementation of environmental protection regulations and/or policies. In as much as government would want to boost growth through foreign investment, the environmental impact should not be overlooked. Government and foreign investment regulators like Ghana National Investment Promotion Centre (GNPC) and regulators of foreign trade should ensure that the importation of obsolete plants and machineries are critically
Again, effective monitoring and evaluation should be undertaken to ensure that investors consistently adhere to laid down policies and regulations on emissions. Monitoring should be active and be on a regular basis to ensure that firms are kept in check; maintain the acceptable level of pollution or fined dearly for emissions in excess over the acceptable level.
Manufacturing companies and investors are also advised to ensure the use of environmentally friendly technologies to ensure that the level of emission is kept at optimal levels. Impliedly, manufacturing companies and its linking sector should undertake regular maintenance or servicing of plants and heavy productive equipment to ensure that pollution is kept at a minimum levels possible.

Limitations and Area for Further Study

The scope of the study was also constrained by time and availability of data for a longer time period. Especially, data on manufacturing FDI was lacking for early years of the period under study. Manufacturing FDI for periods beginning 1975 to 2000 were obtained using the backcasting approach.
Also, this current study was limited to the manufacturing sector and how FDI inflows in the sector impacts on climate change. A sectoral analysis in further studies will help assess critically the effect of FDI on climate change from the various sectors which will be a more holistic approach to curbing the incidence of emissions resulting from the various sectors.

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