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TRADE OPENNESS, ECONOMIC GROWTH AND THE ENVIRONMENT THE CASE OF GHANA

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Abstract

With carbon dioxide been the major cause of global warming and hence climate change, this paper investigated the effect of trade openness and economic growth on carbon dioxide emissions in Ghana. It employed the use of annual time series data from the World Bank's World Development Indicators for the period 1970 to 2010. Using the Johansen multivariate test for cointegration, the study found out that carbon dioxide emissions increase with economic growth and trade openness in the long-run. The study found real GDP per capita and real GDP per capita squared to have positive and negative impacts on CO_2 emissions in the long-run respectively. The long-run equilibrium equation also found a positive relationship between trade openness and CO_2 emissions. To reduce carbon dioxide emissions and its impact, the study recommends that the nation engages in less polluting (carbon dioxide emitting) activities in its economic growth and trade expeditions, and also afforestation. At the end, limitations of the study and scope of future research were discussed.

Keywords: carbon dioxide emissions, environmental Kuznets curve, climate change, Ghana

INTRODUCTION

Climate change and global warming have been major concerns to environmentalists and governments of nations lately as a result of their consequences on human health and the environment. Carbon dioxide (CO_2) emission is the major cause of global warming (Narayan and Narayan, 2010) accounting for about 72% of emitted greenhouse gases (GHGs) (Sanglimsuwan, 2011).With human activities and changes in land use which are directly associated with economic growth and development, pollution (CO_2) emissions have increased significantly in the past century (Boopen and Vinesh, 2010).

CO_2 emissions have been increasing as a result of the growing usage of fossil fuels for the production of goods and services (Sharma, 2011). The usage of energy has become all time imperative as a result of increased consumption, production, industrialization, trade and population. These activities exert increasing degrading pressure on the environment in the form of global warming.

Trade liberalization will affect the environment by increasing the scale of economic activities (increased production). It changes the composition of economic activities and also the technique of production (Grossman and Krueger, 1991). Trade may cause the emission of CO_2 and on the whole cause an increase in GHG emissions (Wyckoff and Roop, 1994). Nearly one third of the world's CO_2 emissions are as a result of manufacturing and the rest are as a result of power generations and other activities (Grether et al., 2007).

The most abundant GHG produced and emitted in Ghana is CO_2 (EPA, 2011). From 1989 to 2007, the emissions of CO_2 generally showed an upward movement with the exception of years 2000 and 2005.With 3344kt emission in 1989, CO_2 emissions increased till 1999 where it dropped from 6549kt to 6288kt in 2000, after which it increased till 2004 (to 7275kt) and dropped to 6956kt in 2005. It increased to 9578kt in the year 2007 (World Development Indicators). The emission of CO_2 in Ghana is about 0.05% of the total global emissions and it places 108^{th} in the world. It represented a total per capita emission of nearly $1MtCO_2e$ per person as of 2006 (EPA, 2011). The Energy sector contributes the largest to emissions in the country accounting for about 41% of the nation's emissions between the years 1990 and 2006. This is followed by the agricultural sector which contributes about 38% of the emissions (EPA, 2011).

The EPA (2011) has indicated that though Ghana's emissions are lower than other major developing economies, there is a high potential for it to increase overtime considering its quest to increase trade and other economic activities. As the economy continues to grow and expand, dominated by agriculture, forestry, oil and trade there is a high potential for CO_2 emissions to increase. The more CO_2 emissions increase, the more the country faces the harsh conditions of climate change.

Works of Grossman and Krueger (1995) indicates that economic growth at its initial stage leads to environmental degradation but the environment improves as the nation attains per capita income of $8000. Holtz-Eakin and Selden (1995) infer a turning point of $35,418, Neumayer (2004) cites a range between $55,000 and $90,000 Panayotou (1993) $3137 and Stern and Common (2001) $101,166. If these are anything to go by, then there is high potential for environmental degradation in Ghana since its per capita income is nowhere near these benchmarks.

This paper therefore seeks to investigate and establish the effect economic growth and trade openness have on the emissions of CO_2. Studies on CO_2 emissions in Ghana are imperative due to their contribution to global warming and climate change. To the best of author's knowledge, there is no work done solely on the effect trade openness and economic growth has on CO_2 emissions in Ghana. Nevertheless very limited literature on Ghana and other countries in a panel data analysis do exist (Lopez, 1997; Narayan and Narayan, 2010; Adom et al., 2012).

Econometrically, the study employed the use of Johansen and Juselius (1990) Cointegration test and found a positive relationship between CO_2 emissions and economic growth, and also trade openness in the long-run. The remainder of this paper is organized as follows: the next section outlines brief theoretical and empirical literature on the topic. The third section describes the data and empirical strategy, the fourth section includes the results and discussions, and the last section concludes the paper.

LITERATURE REVIEW

The environmental Kuznets curve undoubtedly has become the fundamental economic hypothesis (theory) underlying the relationship between economic growth and environmental degradation. The environmental Kuznets curve is the hypothesis that the relationship between environmental degradation and per capita income (economic growth) demonstrates an inverted-"U" shape nature. This means that, as the economy grows emissions increase but as it further grows, environmental quality starts to improve. The environmental Kuznets curve was initiated by Grossman and Krueger (1991) in a work to investigate the environmental impacts of the North American Free Trade Agreement. Their work shows that as income (per capita) increases, environmental degradation (emissions) also increases but reaches a point and then starts to fall. Following this, a number of studies have been done on the relationship between emissions (mainly CO_2) and economic growth. However these studies have produced mixed findings.

Ahmed and Long (2012) found results that conform to the environmental Kuznets curve between CO_2 and growth in Pakistan between 1971 and 2008. Song et al., (2013) testing the existence of the environmental Kuznets curve for 30 provinces and cities in China found that environmental Kuznets curve does not hold for some provinces and for others they had reached their turning points. Iwata et al., (2010) provide results supporting the assertion of the environmental Kuznets curve hypothesis with CO_2 emissions by taking into account nuclear energy in the production of electricity in France. Roca and Alcantara (2001), in examining the relationship between growth and CO_2 emissions rejected the existence of the environmental Kuznets curve in Spain from 1972 to 1997. Song et al., (2008) found an inverted "U"-shaped relationship between pollutants (waste gas, waste water and solid waste) and economic growth from 1985 to 2005 in China. He and Richard (2010) found little evidence in favour of the environmental Kuznets curve hypothesis in Canada for CO_2 emissions. Akpan and Akpan (2012) using data from 1970 to 2008 in Nigeria, found out that in the long-run there exists a positive relationship between economic growth and carbon emissions. Saboori et al., (2012) found in Malaysia a strong long-run relationship between CO_2 emissions (per capita) and GDP (per capita) for the period 1980 and 2009. Narayan and Narayan (2010) using panel co-integration for 43 developing countries from 1980 to 2004, their work indicate that for Iraq, Jordan, Kuwait, Yemen, Qatar, the UAE, Argentina, Mexico, Venezuela, Algeria, Kenya, Nigeria, Congo, Ghana and South Africa, income have contributed to less CO_2 emissions in the long-run. However its impact was positive. Menyah and Wolde-Rufael (2010), using data from 1965 to 2006 in South Africa found a positive long-run relationship between economic growth and CO_2 emissions. In Saudi Arabia, Alkhathlan et al., (2012) show that in the long-run, income (growth) leads to an increase in carbon dioxide emissions.

Another hypothesis explaining environmental degradation (pollution) especially in developing countries is the pollution haven hypothesis. The pollution haven hypothesis states that, regulations of the environment will move polluting activities of tradable commodities to poorer countries. It predicts that with globalization and trade liberalization, multinational firms in advanced countries where environmental regulations are strict will shift the production of their pollution intensive commodities to regions (developing countries) where environmental regulations are laxer.

Dean (2009) using 2,889 manufacturing equity joints venture projects in China from 1993 to 1996 found evidence supporting the pollution haven hypothesis by foreign investors but not from investors from high income countries. Mani and Wheeler (1999) using data from 1960 to 1995 between OECD (particularly Japan) and developing economies (Asia and Latin America) found evidence for the pollution haven hypothesis. Cave and Blomquist (2008) in their study found evidence for pollution haven hypothesis with EU energy intensive trade but finds no evidence supporting toxic intensive trade with poorer OECD economies and non- EU European countries from 1970 to 1999. He (2006) studied the pollution haven hypothesis using 29 provinces in China and found out that a 1% increase in FDI led to 0.098% increase in pollution (SO_2). Cole (2004) found little evidence for the pollution haven hypothesis using four developed and developing trade pairs namely; USA-Asia, USA-Latin America, UK-Asia and Japan-Asia between 1977 and 1995.

RESEARCH METHODOLOGY

The paper is modeled based on the environmental Kuznets curve hypothesis. Following Saboori et al., (2012), the environmental Kuznets curve in its general form can be given as:

$E = f(Y, Y^2, Z)$.......................... (1)

Z is a vector of control variables that may contribute to environmental degradation and defined by the paper as;

$Z = (TO)$ ... ... (2).

Equation (1) therefore becomes $E = f(Y, Y^2, TO)$ ... ... (3)

E is an environmental indicator representing environmental degradation and it is represented by CO_2 emissions per capita measured in metric tonnes. Y^2 is represented by W. E can therefore be expressed as;

$$CO_2 = f(Y, W, TO) \text{ ... ... } (4)$$

The explicit estimable econometric model in its logarithm form is formulated as follows:

$$ln(CO_2)_t = \beta_0 + \beta_1 lnY_t + \beta_2 lnW_t + \beta_3 ln\,TO_t + \mu_t \text{ ... ... } (5)$$

Y is a measure of economic growth measured in the study as real GDP per capita, W is real GDP per capita squared which depicts the curvature nature of the EKC (Wang, 2012). *TO* is trade openness measured as sum of total trade as a percentage of GDP. μ is the error term, $t$is time and *ln* is natural log. The variables are logged so as to have all assessed in the same unit. All data are obtained from the World Bank's World Development Indicators (2013) and it is for the period 1970 to 2010. The limit of the sample size is determined by the availability of data, especially CO_2 which is the dependent variable. Based on the environment Kuznets curve hypothesis, β_1 and β_2 are expected to be positive and negative respectively. Based on the pollution haven hypothesis, $\beta_3$is expected to be positive.

Unit Root Test (Stationarity Test)

The purpose of stationarity test is to determine the order of integration of each individual series in the study in order to guide the choice of estimator. One underlying assumption of the ordinary least squares estimator is that the distribution of the data generating process is stationary. Hence application of this estimator in the presence of nonstationary regressors could lead to nonsensical inference and conclusions. It is therefore important to determine the order of integration of each variable in a time series study prior to estimation. The study tested for stationarity within the framework of the Phillips-Perron test by Phillips and Perron (1988). The Phillips-Perron test works well with small sample sizes and also in the presence of hetereoskedasticity. It is also capable for adjusting for serial correlation.

The Johansen Cointegration Procedure

The cointegration procedure enables us to investigate the long-run relationship between the variables under consideration in the model. The paper employed the use of the Johansen maximum likelihood method of cointegration by Johansen and Juselius (1990). This cointegration method allows researchers to estimate simultaneous models involving two or more variables. It is based on the maximum likelihood estimation and in so doing avoids the inconsistencies of the OLS estimation. It is also more suitable and efficient for determining the number of cointegrating vectors without depending on a random normalization. For the Johansen cointegration to hold all the variables must be nonstationary at the levels and be integrated of the same order, I(1).

Johansen put forward two likelihood ratio tests namely; the trace and the maximum eigenvalue tests. The trace test tests the null hypothesis of *r* cointegrating vectors against the alternative hypothesis of *n* cointegrating vectors. The test statistic is given by;

$$J_{trace} = -Tln\sum_{i=r+1}^{n}(1-\hat{\lambda}_i)$$

The maximum eigenvalue tests the null hypothesis of *r* cointegrating vectors against the alternative hypothesis of $(r+1)$ cointegrating vectors. The test statistic for the maximum eigenvalue test is computed by the following formula:

$$J_{max} = -Tln(1-\hat{\lambda}_{r+1})$$

T denotes the sample size and $\hat{\lambda}_i$ is the i^{th} largest canonical correlation. None of the tests above follows the chi square distribution but rather a different distribution tabulated by Johansen and Juselius (1990) and are also provided by most econometric software (Hjamarsson and Osterholm, 2007).

In this study, the vector error-correction model (VECM) with a lag order of *P* is modeled as:

$\Delta\ln(CO_2)_t = \alpha_0 + \sum_{i=1}^{P}\alpha_{1i}\Delta\ln(CO_2)_{t-i} + \sum_{i=0}^{P}\alpha_{2i}\Delta lnY_{t-i} + \sum_{i=0}^{P}\alpha_{3i}W_{t-i} + \sum_{i=0}^{P}\alpha_{4i}\Delta lnTO_{t-i} + \varphi ECM_{t-1} + \varepsilon_{t-i}$........ (6)

All variables are as defined already. ECM_{t-1} is the error correction term, the residuals that are obtained from the estimated cointegrating model of equation (6). Δ denotes the first differenced form of the variables in the model. The coefficients $\alpha_{1i}, \alpha_{2i}, \alpha_{3i}$ and α_{4i}, measure the (short-run) impact a change in the independent variable has on a change in the dependent variable respectively. $\varphi$is the coefficient on the error correction term which represents the speed of the adjustment parameter which measures the speed of adjustment to long-run equilibrium after a shock to the system.

RESULTS AND DISCUSSION

Stationarity Test

Table 1 shows the results as tested at the levels and at the first difference. The Phillips-Perron test shows that all the variables are log level nonstationary and therefore contain unit root. However they all achieved stationarity after the first differencing.

It may be concluded that the variables are log level nonstationary and therefore exhibit unit root. They however became stationary after first differencing. The variables are therefore integrated of order one, $I(1)$.

Table 1. Results of the Phillips-Perron Unit Root Test

Variable	Levels		First Difference	
	Constant	Constant and Trend	Constant	Constant and Trend
$lnCO_2$	-1.948632	-3.767710	-12.56140***	-13.16048***
lnY	0.141124	0.006988	-4.375087***	-11.51614***
lnW	0.604661	0.852449	-4.484739***	-14.76001***
lnTO	-0.934424	-2.030871	-5.465908***	-5.390799***

*Note: *** represents the rejection of the null hypothesis of unit root at the 1% level of significance*

Cointegration Test

Now that it has been established that all the variables are integrated of the same order, $I(1)$, the use of Johansen and Juselius cointegration approach is permitted. Table 2 presents the Johansen Cointegration test results for all the variables (carbon dioxide emissions, real GDP per capita, real GDP per capita squared and trade openness).

Table 2. Result of the Cointegration Test

			Trace Test		Maximum-eigenvalue Test		
Hypothesize No. of CE(s)	Eigen Value	Trace Statistic	0.05 Critical Value	Prob**	Max-Eigen Value	0.05 Critical Value	Prob**
None *	0.590225	58.66989	47.85613	0.0035	34.79373	27.58434	0.0050
At most 1	0.305774	23.87616	29.79707	0.2057	14.23335	21.13162	0.3462
At most 2	0.213103	9.642809	15.49471	0.3092	9.346650	14.26460	0.2584
At most 3	0.007565	0.296159	3.841466	0.5863	0.296159	3.841466	0.5863

*Note: Trace test indicates 1 cointegrating eqn(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level and**MacKinnon-Haug-Michelis (1999) p-values. Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level and**MacKinnon-Haug-Michelis (1999) p-values.*

At the 5% level of error level, both the trace and maximum eigenvalue tests indicate one cointegrating equation (CE) among the variables. Thus, the null hypothesis of no cointegration relationship among the variables is flatly rejected at the 5% error level, by both the trace test and the maximum eigenvalue test. The existence of cointegration among the variables implies a long-run relationship among the variables. The optimal lag length of one (1) was selected based on the Schwarz Information Criterion (SC).

Results of the Long-Run Cointegration Model

Since the results from the cointegration test indicate strong evidence of cointegration relationship among the variables, we proceed to estimate the long-run equilibrium relationship. Table 3 displays the estimates of the long-run equilibrium model when the equation is normalized on CO_2 emissions per capita.

Table 3. Estimates of the Long-Run Cointegration Model

Dependent Variable: $\ln CO_2$			
Regressors	Coefficient	Standard Error	t-Statistics
lnY	0.002941***	(0.00098)	2.99846
lnW	-3.29E-06***	(1.1E-06)	-2.98405
lnTO	0.000988***	(0.00019)	5.22184

*Note: *** represents 1% level of significance*

The results of the long-run model show that all the coefficients of the variables are less than one (1), indicating they are inelastic. Considering the magnitude of the coefficients, they are very inelastic. Much emphasis is therefore placed on the direction (signs) of the variables.

The results indicate a positive relationship between per capita carbon dioxide emissions and real GDP per capita. It is statistically significant at 1% error level. Specifically, a 1% increase in real GDP per capita will cause a 0. 003% rise in CO_2 emissions per capita. This means that in the long-run an increase in economic growth in Ghana will lead to a rise in the emissions of CO_2 emissions. Growth in Ghana can therefore be said to be CO_2 emissions intensive. The results also show a negative relationship between real GDP per capita squared and CO_2 emissions. It is also statistically significant at 1% error level. The signs of real GDP per capita (*lnY*) and real GDP per capita squared (*lnW*) meet the expectation of the study. The sign of *lnW* implies that, at a higher economic growth, CO_2 emissions levels fall. The results therefore indicate that as the economy of Ghana grows, pollution (CO_2 emissions) increase nevertheless falls as the economy attains higher levels of growth. CO_2 therefore increases with trade and economic growth. The result is not surprising since Ghana- a developing country has put in several measures to increase its growth. Some of the activities outlined to cause this growth are prone to causing emissions.

The result (sign) of the real GDP per capita (*lnY*) conforms to the findings of Ahmed and Long (2012); Iwata et al., (2010); Song et al., (2008); Narayan and Narayan (2010); Kaufmann et al. (1998); and Schmalensee et al. (1998). The sign of *W* also conforms to the findings of Jayanthakumaran et al., 2012; Friedl and Getzner, 2003; Iwata et al., 2010.

A positive relationship between per capita carbon dioxide emissions and trade openness (*TO*) is also found. It is statistically significant at 1% error level. It shows that a 1% increase in trade openness will lead to a 0.001% rise in the emissions of per capita CO_2 emissions. This means that in the long-run an increase in trade openness in Ghana will lead to a rise in the emissions of CO_2. This suggests that Ghana's trade (imports and exports) has contributed to the increase in the emissions of CO_2. This finding conforms to the assertion of the pollution haven hypothesis.

The pollution haven hypothesis predicts that with globalization and trade liberalization, multinational firms in advanced countries where environmental regulations are strict will shift the production of their pollution intensive commodities to regions (developing countries) where environmental regulations are laxer. This will cause trade openness to lead to the emissions of CO_2. Following the liberalization of trade and market reforms in the 1980s as part of the recommendations of the economic recovery and the structural adjustment programmes, the country has been engaged in enormous trade flows. These market reforms have also seen a very large number of multinational corporations investing in the country. A significant number of these corporations are engaged in activities (extractive and manufacturing) that exert pressure on the environment (causes emissions). As a result of poor enforcement of the already lax environmental regulations of the country, most of these corporations (especially those in the mining sector) pollute the environment with impunity. It is therefore no surprising that trade openness is found to positively impact CO_2 emissions in Ghana.

The Short-Run /VECM Model

Having established the long-run equilibrium model, we proceed to present the estimates of the short-run /VECM model in Table 4.

Table 4. Results of the VECM

Dependent Variable: D(lnCO_2)				
Regressors	Coefficients	Standard Error	t-Statistics	Prob.
D(lnCO_2(-1))	-0.165542	0.154063	-1.074507	0.2904
D(lnY(-1))	-0.002528	0.002620	-0.964878	0.3416
D(lnW(-1))	3.22E-06	2.97E-06	1.084220	0.2861
D(lnTO(-1))	-0.000832	0.000542	-1.535867	0.1341
C	0.001561	0.005026	0.310561	0.7581
ECT	-0.614328***	0.178160	-3.448175	0.0016

*Note: *** represents 1% significant levels. ECT represents the error correction term*.

Unlike the long-run equilibrium model, the variables in the short-run model are found to be statistically insignificant. The statistical insignificance implies that economic growth and trade do not really explain CO_2 emissions in the short-run. The study therefore focuses on the long-run relationship. The signs are also contrary to the signs of the long-run model. The first lags of GDP per capita squared and trade openness (TO) have negative relationship with CO_2 emissions per capita. As they increase, CO_2 emissions fall nevertheless in the short-run. With higher economic growth (indicated by GDP per capita squared (W)), CO_2 emissions increase. The model also shows a negative relationship between CO_2 emissions and its first lag. The most important factor of the short-run model is however the direction (sign) and statistical significance of the error correction term. Once these meet expectation, the model is fit to explain.

The error correction term (ECT) is found to be statistically significant at 1% error level. It is also found to have a negative sign. The negative coefficient implies the dynamic consistency and stability of the model. The statistical significance of the coefficient gives a signal of joint significance of the coefficients of the long-run model under the VECM structure. It also buttresses the existence of a long-run equilibrium relationship (according to the Granger representation theorem) among the variables as shown under the Johansen Cointegration test. It has a coefficient of 0.614328 and this suggests that the system corrects its previous period's disequilibrium by 61.4% a year. The model passed the residual diagnostics tests of normality (using the Jarque-Bera statistic), serial correlation (Breusch-Godfrey Serial Correlation LM Test) and the hetereoskedasticity test (Breusch-Pagan-Godfrey and the ARCH). They all showed p-values greater than 5%. These therefore made the model fit for interpretation.

CONCLUSION AND POLICY RECOMMENDATION

This paper sought to examine the effect of economic growth and trade openness on CO_2 emissions in Ghana using annual time series data from the World Bank's World Development Indicators between the period 1970 and 2010. The study found the variables to be integrated of same order, $I(1)$ by employing the use of the Phillips-Perron (PP) test of stationarity. The Johansen Cointegration test established cointegration among the variables. The study found real GDP per capita and real GDP per capita squared to have positive and negative impacts on CO_2 emissions in the long-run respectively. The long-run equilibrium equation also found a positive relationship between trade openness and CO_2 emissions. The study therefore concludes that economic growth and trade openness in Ghana are CO_2 emissions intensive in the long-run.

Considering the fact that CO_2 emissions have positive impact on climate change, measures have to be taken to curb the emissions so as to minimize the harmful effect of climate change on the environment and humanity. The study recommends that the nation engages in less polluting activities in its economic growth and trade expeditions since they are found to have positive impacts on CO_2 emissions in the long-run. The Environmental Protection Agency and other regulators of the environment should check corporations whose activities produce CO_2. They should put in measures that will guarantee that these corporations put in steps to cut emissions. The country should also be mindful of the kind of products imported into the country since these could add to the emissions of CO_2. The cheapest CO_2mitigation strategy that the country can embark on is afforestation and reforestation. The paper therefore recommend that the country should embark on a massive tree planting exercise since this will help reduce the amount of CO_2 in the atmosphere thereby reducing its harmful effect on the environment.

Considering carbon dioxide emissions and its contribution to climate change and global warming, this topic is very relevant to be researched into the more. With the limitation of data availability for all variables, the study could not cover a very long span. It is therefore suggested that with the availability of data, other researchers should further research into this topic on a very long term span. It is also suggested that future studies should consider different measurement of variables (for carbon dioxide) and their results compared with this paper for a very concrete conclusion to be drawn. Lastly, the effects of other variables such as population growth, energy consumption and FDI on carbon dioxide emissions can also be investigated.

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