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Trade Openness and the Environment: A Time Series Study of ECOWAS Countries

Yaya KEHO[1]

Abstract

This paper examines the relationship between international trade and the environment for the Economic Community of West African States (ECOWAS). It uses the bounds test for co integration to disentangle the long –run relationship and explore the extent of Granger causality among these variables. Results are mixed across countries. Results support that trade cause's degradation of air quality in some countries while it is compatible with environmental improvements in other countries. We also find evidence of bidirectional causality between economic growth and CO_2 emissions in four countries. In addition, it has been found that trade causes economic growth in six countries. These findings further confirm that studies based on pooled or cross-section data would provide incorrect inferences regarding the relationship between trade, economic growth and CO_2 emissions and could be grossly misleading in formulating environmental policies for an individual country

Key words: Carbon dioxide (CO2) emissions, Trade openness, Co integration, ECOWAS

JEL Classification: C32, F18, O55.

I. Introduction

During the past few decades, many countries have experienced a considerable expansion of international trade after adopting liberalization policies.In the same time, global warming has become a major global concern. These trends have revitalized the debate about the impact of trade on the environment. Carbon dioxide, regarded as the main greenhouse gas responsible of global warming and climate change, has captured great attention in the international negotiations aiming at curbing its emissions. At the theoretical level, the relationship between trade, growth and the environment is ambiguous. As highlighted by the traditional theory of international trade, countries 'specialization is driven by comparative advantages. The effects of trade on the environment will then depend on the distribution of comparative advantages across countries which are determined by the interaction between differences in factor endowments and pollution policy.

The environmental impact of free trade is decomposed into scale, technique and composition effects (Antweiler *et al*. 2001; Copeland and Taylor, 2004). The scale effect indicates the increase in pollution resulting from economic growth and growing market access. The composition effect is captured by the change in the share of the dirty goods in GDP. Trade may reduce or increaseCO_2emissions depending upon whether the country has comparative advantage in cleaner or dirty industries. FDI inflows to developing countries may be viewed asa way to transfer dirty industries to developing countries hence increasing pollution levels. However, FDI may allow access to better technologies and thus may contribute to significant reduction in pollution. The technique effect refers to import of cleaner technique of production that goes with trade liberalization. All these three effects interact with each other and the overall effect is ambiguous depending on which effect is stronger and dominates the others.

[1] Ecole Nationale Supérieure de Statistique et d'Economie Appliquée (ENSEA) Abidjan. Tel.: (+225) 22 44 41 24, Fax: (+225) 22 48 51 68. 08 BP 03 Abidjan 08, Côte d'Ivoire. Email: yayakeho@yahoo.fr

The well-known pollution haven hypothesis states that if a country has comparative advantages in weak environmental regulations, then the composition effect will affect negatively the environment, because it will shift to the most pollution intensive production. These arguments seem to reveal that the relationship between trade and the environment is complex.

Based on these arguments, a growing body of literature has examined the relationship between trade and the environment. The results from these studies are however mixed and inconclusive to offer policy recommendations that can be applied across countries. Results vary across countries, methodologies and indicators of environmental degradation. Copeland and Taylor (2004) and Frankel and Rose (2005) provided recent surveys of the related literature. On the one hand, some studies found significant positive impact of trade openness on carbon dioxide emissions, giving support to the pollution haven hypothesis (Opoku *et al*., 2014; Olugbenga and Oluwole, 2013; Shahbaz and Leitao, 2013;Sharma, 2011; Ang, 2009; Halicioglu, 2009; Jalil and Mahmud, 2009; Frankel and Rose, 2005; Copeland and Taylor, 2004; Cole, 2004).On the other hand, other works reported evidence supporting the optimistic view that trade openness is good for the environment (Akin, 2014; Jayanthakumaran *et al*., 2012; Shahbaz *et al.* 2012; Managi *et al*., 2009; Aka, 2008; Cole, 2006; Antweiler *et al.,* 2001).A third stream of empirical studies failed to identify any significant relationship between trade and pollution (Rahman, 2013; Kander and Lindmark, 2005*).*

Based on these controversial findings, one cannot draw any type of generalizations of the impact of trade on the environment. In designing a recovery policy aimed at protecting the environment and promoting trade and growth, the case of each country should be considered separately. To our knowledge, only Opoku *et al*. (2014) has conducted a country study for Ghana. Aka (2008) examined the issue for Sub-Saharan Africa. But Sub-Saharan Africa has been considered as a whole and it is not proven that the findings apply to all countries in the same way. The impact of trade openness on the environment is likely to depend on initial conditions and therefore cross-country results are likely to hide significant heterogeneity which may lead to wrong policy recommendations.

The objective of our study is to examine the long-run and causal relationship between openness to trade and carbon dioxide emissions for 11 West African countries. Contrary to most empirical studies, weprefer a country-specific in-depth case study since it appears to be more promising in terms of policy recommendations than a panel or cross-sectional approach.The conflicting results from the empirical literature have raised the important issue of heterogeneity and have brought home the usefulness of time series data for one country at a time.In terms of econometric methodology, the study uses the bounds test for co integration developed by Pesaran *et al*. (2001) to overcome many shortcomings of alternative methods which are commonly used in existing empirical literature. The rest of the study is organised as follows. Section 2 presents the econometric methodology of the study. Section 3analyses the empirical findings. Finally, Section 4 concludes with a summary and some policy implications.

2. Data and econometric methodology

2.1 Data

The empirical investigation uses annual time series data for a sample of 11 countries of the Economic Community of West African States (ECOWAS), namely Benin, Burkina Faso, Cote d'Ivoire, Gambia, Ghana, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo[2]. The variables under study include CO_2 emissions per capita in metric tons, per capita real GDP in constant 2005 US dollars and trade openness measured as ratio of exports plus imports to GDP. By considering GDP in the analysis, we take into account not only the direct effect of trade on CO_2emissions, but also its indirect effect through economic growth.

Data cover the period 1970 to 2010 and are obtained from the World Bank's World Development Indicators (WDI, 2014). The data for GDP and CO_2 were converted into natural logarithms for estimation purposes so that they can be interpreted in growth terms after taking first difference.

[2] Cape Verde, Guinea, Guinea-Bissau and Liberia are excluded due to lack of data.

2.2 Testing for co integration

To examine the long-run relationship between the three variables, we employ the bounds testing approach to co integration developed by Pesaran *et al*. (2001). We employ this approach because it has better small sample properties in comparison to other widely alternatives such the Engle and Granger and Johansen approaches. In addition, the bounds test can be applied irrespective of whether the variables are I(1), I(0) or mutually co integrated. These rules out the uncertainties present when pre-testing the order of integration of the series. The bounds test generally provides unbiased estimates of the long-run coefficients and validt-statistics even when some of the repressors are endogenous (Inder, 1993; Pesaran *et al*., 2001). The bounds test for co integration involves estimating by ordinary least square the following unrestricted error correction model considering each variable in turn as a dependent variable:

$$\Delta CO_{2t} = \gamma_0 + \sum_{i=1}^{p} \delta_{1i} \Delta CO_{2t-i} + \sum_{i=0}^{p} \theta_{1i} \Delta T_{t-i} + \sum_{i=0}^{p} \gamma_{1i} \Delta GDP_{t-i} + \phi_1 CO_{2t-1} + \phi_2 T_{t-1} + \phi_3 GDP_{t-1} + \mu_t \quad (1)$$

The bounds testing procedure for long-run relationship between the variables is through the exclusion of the lagged levels variables in Eq.(1). The null hypothesises $H_0: \quad \phi_1 = \phi_2 = \phi_3 = 0$. This hypothesis is tested by the mean of the *F*-statistic. However, its asymptotic distribution is non-standard under the null hypothesis. The critical values are provided by Pesaran *et al*. (2001) for large samples. However, because our study involves relatively small sample size (T=41), we calculate critical values specific to our sample size using stochastic simulations based on 40 000 replications.

2.3 Causality analysis

To shed light on the causal impact of trade on CO_2 emissions, we perform the Granger causality test. In the presence of co integration, Granger-causality is modelled within a dynamic error correction representation in which an error correction term is incorporated into the model. Accordingly, the Granger causality tests will be based on the following equations:

$$\begin{bmatrix} \Delta CO_{2t} \\ \Delta GDP_t \\ \Delta T_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \beta_{1i} & \gamma_{1i} & \theta_{1i} \\ \beta_{2i} & \gamma_{2i} & \theta_{2i} \\ \beta_{3i} & \gamma_{3i} & \theta_{3i} \end{bmatrix} \times \begin{bmatrix} \Delta CO_{2t-i} \\ \Delta GDP_{t-i} \\ \Delta T_{t-i} \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{bmatrix} ecm_{t-1} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \end{bmatrix} \quad (2)$$

Where ecm_{t-1} stands for the lagged error correction term derived from the long-run co integrating relationship. In the absence of co integration, this term is not included. An error correction model enables one to distinguish between long-run and short-run Granger causality. The long-run causality is performed by testing the significance of the coefficients λ_i, while the short-run causality examines the significance of the lagged dynamic terms. Thus, trade does not Granger-cause CO_2 emissions in the short-run if $\theta_{11} = \theta_{12} = ... = \theta_{1p} = 0$.

3. Empirical results

3.1 Unit root and co integration tests

Before we proceed with the bounds test for co integration, we test for unit roots in the variables for each of the 11countries.

This step is necessary to ensure that none of the variables is I (2) so as to avoid spurious inference in co integration tests. To test for unit-roots in the series, we apply the well-known Phillips and Perron unit-root test (PP hereafter). This test has been performed under the models with constant and trend for the level series and with constant for series in first difference. The results reported in Table 1 reveal that all time series contain unit roots, save for trade and CO_2 in Mali. However, all variables become stationary after taking the first difference. This provides a good rationale for using the bounds test approach.

Table 1: Results of PP Unit Root Test

	Level				First difference		
Country	GDP	T	CO2		ΔGDP	ΔT	ΔCO2
Benin	-2.826	-2.141	-2.413		-7.759*	-7.345*	-7.277*
Burkina Faso	-1.393	-3.337	-2.277		-7.407*	-6.754*	-6.491*
Côte d'Ivoire	-2.490	-1.717	-3.508		-4.312*	-6.460*	-8.910*
Gambia	-2.114	-2.219	-2.743		-5.922*	-7.255*	-6.560*
Ghana	-0.598	-2.031	-3.930		-4.298*	-5.466*	-18.067*
Mali	-1.510	-4.824*	-4.877*		-6.632*	-19.968*	-6.062*
Niger	-2.199	-1.572	-1.874		-6.027*	-6.239*	-4.782*
Nigeria	-0.244	-3.021	-3.076		-5.454*	-8.541*	-6.748*
Senegal	-1.242	-3.345	-3.122		-7.551*	-8.088*	-8.581*
Sierra Leone	-0.726	-3.818	-1.919		-7.516*	-11.761*	-6.710*
Togo	-2.815	-2.370	-4.963*		-6.359*	-7.115*	-14.236*
Notes: * and ** indicate that the null hypothesis is rejected at the 5% and 10% levels, respectively.							

Table 2 reports the results of the bounds F-test statistics together with the exact critical values. An important observation at the outset is that the exact bound critical values are larger than the asymptotic critical values reported in Pesaran *et al.* (2001). For instance, our upper bound critical values for a sample size of 41 observations under case III are 21 and 16% higher than those reported in Pesaran *et al*. (2001) at the 5 and 10% levels, respectively. From the table we can see that there exists a long-run relationship between the three variables for all the countries under study except for Mali. This implies that trade openness, economic output and CO_2 emissions do not move to far away from each other in the long-run. We complement the bounds test of co integration by Johansen maximum likelihood test to provide a sensitivity check on the results. As all the three series are not I(1) for Mali, this country is not concerned with the co integration test. Results reported in Table 3 confirm co integration for all the countries except for Cote d'Ivoire, Ghana and Nigeria.

Table 2: Bounds Test Results for Co integration

Country	FCO2	FGDP	FT	Co integration?	
Benin	20.988(4)	5.674(4)	4.203(4)	Yes	
Burkina Faso	4.684(3)	4.606(3)	3.228(3)	Yes	
Cote d'Ivoire	3.216(4)	5.329(3)	4.738(3)	Yes	
Gambia	10.638(3)	9.751(3)	2.518(4)	Yes	
Ghana	5.618(3)	8.426(4)	1.183(3)	Yes	
Mali	-	3.934(3)	-	No	
Niger	6.654(3)	10.046(4)	2.700(3)	Yes	
Nigeria	4.270(3)	10.725(3)	37.827(3)	Yes	
Senegal	5.827(4)	9.269(4)	4.691(3)	Yes	
Sierra Leone	1.128(3)	6.213(4)	6.710(4)	Yes	
Togo	8.600(3)	6.515(4)	6.654(4)	Yes	
	Exact critical values for F-statistics				
	5%			10%	
	I(0)	I(1)		I(0)	I(1)
Case III	4.155	5.273		3.387	4.369
Case IV	4.360	5.156		3.675	4.374
Notes: The F-statistic is reported for each dependent variable. Figure sin parentheses indicate the case under which the test is performed. Exact critical values for F-statistics are calculated using stochastic simulations based on 40 000 replications and T=41. See Pesaran et al. (2001: 301) for more details. * and ** denotes the rejection of the null hypothesis at the 5% and 10% significance levels, respectively.					

Table 3: Johansen Cointegration Test Results

Country	r=0	r=1	r=2
Benin	48.611*(42.915)	21.792(25.872)	10.208(12.517)
Burkina Faso	31.953*(29.797)	10.688(15.494)	0.636(3.841)
Cote d'Ivoire	36.102(42.915)	18.226(25.872)	3.535(12.517)
Gambia	44.995*(42.915)	15.387(25.872)	4.949(12.517)
Ghana	30.540(35.010)	6.288(18.397)	1.038(3.841)
Niger	39.717*(35.010)	22.750(18.397)	8.021(3.841)
Nigeria	28.336(29.797)	8.496(15.494)	1.541(3.841)
Senegal	41.769*(35.010)	19.036 (18.397)	1.509 (3.841)
Sierra Leone	45.160*(42.915)	17.419 (25.872)	7.190 (12.517)
Togo	50.269*(42.915)	17.164 (25.872)	4.915 (12.517)
Notes: r is the number of cointegrating equations. Trace statistics are reported. Values in parenthesis are the 5% critical values. * denotes the rejection of the null hypothesis at the 5% significance level.			

Owing to the fact a long-run relationship exists between the series for 10 countries, we now estimate the long-run coefficients. The results reported in Table 4 are mixed across countries. The results for Burkina Faso, Ghana, Senegal and Togo indicate a positive and significant impact of trade openness on CO_2 emissions. This means that increase in trade openness in these countries has contributed to the degradation of air quality. This finding is in line with the pollution haven hypothesis and the works of Opoku *et al*. (2014), Sharma (2011), Cole (2004) and Copeland and Taylor (2003). In contrast, for Benin and Gambia, trade openness enters the long-run equation significantly with negative signs. This result is very interesting as it suggests that trade expansion can be achieved without harming the environment. In other words, trade is not bad for the environment in these two countries. This finding is consistent with those of Akin (2014) for 85 African countries and Aka (2008) for Sub-Saharan Africa.

Table 4: Long-run estimates

Country	Dependent variable	CO2	Trade	GDP
Benin	CO2	-	-0.027* (-6.823)	4.882* (6.366)
Burkina-Faso	CO2	-	0.031* (2.370)	1.272* (5.070)
Cote d'Ivoire	GDP	-0.112 (-0.387)	0.017* (2.501)	-
Gambia	CO2	-	-0.001* (-2.112)	3.595* (8.475)
Ghana	CO2	-	0.006* (3.090)	0.086 (0.196)
Niger	GDP	-0.110* (-4.435)	0.008* (9.183)	-
Nigeria	GDP	0.553* (21.076)	0.008* (7.235)	-
Senegal	CO2	-	0.011* (2.516)	-0.124 (-0.251)
Sierra Leone	GDP	0.867* (2.288)	0.007 (1.295)	
Togo	CO2	-	0.008** (1.927)	-1.667* (-2.350)
Notes: Figures in parenthesis are t-statistics. * and ** indicate significance at the 5% and 10% levels, respectively.				

Results indicate that trade is growth-promoting in Cote d'Ivoire, Niger and Nigeria. These countries are heavily dependent on agriculture and related activities and mining sector. Cote d'Ivoire is among the largest producers and exporters of coffee, cocoa beans, palm oil and cashew nuts.

The agricultural sector accounts for 24% of GDP. Consequently, the economy is highly sensitive to fluctuations in international prices of raw commodities and whether conditions. The economy of Niger is based largely upon subsistence agriculture and the export of uranium and mines. Fluctuation of GDP is explained to changes in world prices for these raw minerals. Nigeria's economy is strongly linked to global market through the trade in crude oil. Oil accounts for more than 90% of the country's exports and 15% of GDP. These three countries are export-dependent and are vulnerable to external shocks. Results for Sierra Leone indicate that trade openness has a positive but statistically insignificant impact on economic growth. The results also show that economic expansion degrades the environment in the long-run in Benin, Burkina Faso and Gambia. This finding is in line with Akin (2014) and Opoku *et al*.(2014). Whereas, results for Togo indicate that economic growth is good for the environment.

An interesting finding is the long-run impact of environmental conditions on economic growth in Niger, Nigeria and Sierra Leone. The impact of CO_2 emissions on growth is positive in Nigeria and Sierra Leone, and negative in Niger. Nigeria's economy depends on industry (38%), agriculture (35%) and services (27%), which contribute to air pollution. Air pollution in Lagos is judged high and the major sources of pollution are industries, vehicle exhaust, use of gasoline generators as a result of unstable electric power supply and domestic use of fuel wood (Akinola *et al*. 2014; Ladan, 2013; Otti *et al*., 2011). Although energy use and CO_2 emissions contribute to deteriorate air quality, they are inherent to the Nigerian growth process. It would not be possible to reduce CO_2 emissions in Nigeria without undermining long-run economic growth as reduction in CO_2 emissions causes GDP to decline. Niger's agricultural sector accounts for about 40% of GDP and involves about 90% of the population. The agricultural production is very vulnerable to climate conditions.

3.2 Causality test results

Evidence of co integration implies the existence of causality, at least in one direction. However, it does not indicate the direction of causal relationships. We now examine the issue of causality. The results reported in Table 5 show strong evidence of short-run causality running from trade openness toCO_2 emissions in Benin, Nigeria, Senegal and Togo. Long-run causality is found from trade to CO_2 in Benin, Burkina Faso, Gambia, Ghana, Nigeria, Senegal and Togo.Following the liberalization of trade and market reforms in the 1980s as part of the recommendations of the structural adjustment programs, most African countries have been engaged in enormous trade flows. These market reforms have also seen a very large number of multinational corporations investing in extractive and manufacturing activities that pollute the environment. It is therefore no surprising that trade openness is found to positively impact CO2 emissions in these countries.

Evidence also reveals that GDP causes CO_2 emissions in the short run in Benin and Nigeria and in the long-run in Benin, Burkina Faso, Gambia, Nigeria and Togo. This finding means that economic growth cannot be achieved without affecting the environment. Reverse long-run causality running from CO_2 to GDP is also found for Burkina Faso, Gambia, Niger, Nigeria, Sierra Leone and Togo. The implication of this finding is that environmental policies aiming at reducing CO_2 emissions may have adverse effects on long-run economic growth. The finding of bidirectional causality between GDP and CO_2 emissions in Burkina Faso, Gambia, Nigeria and Togo, implies that the design of economic policies directed at fostering economic growth should include considerations of its impact on the environment and the feedback effects of environmental degradation on long run economic growth.

Granger causality tests show that there is a long-run causality running from trade to GDP in Burkina Faso, Cote d'Ivoire, Gambia, Niger, Nigeria and Togo. This result indicates that any changes in trade will affect output. It suggests that economic growth cannot be achieved without expanding international trade. As mentioned earlier, many African countries depend on export of raw materials and import of inputs and foods.

Table 5: Results of Granger Causality Tests

Country / Dependent variable	Source of causation				
	Short run				Long run
	Δ CO2	ΔGDP	ΔT		ecm
Benin					
ΔCO2	-	2.589** (0.062)	6.314* (0.001)		-6.183* (0.000)
ΔGDP	1.765 (0.171)	-	1.506 (0.237)		0.546 (0.591)
ΔT	0.740 (0.602)	1.000 (0.445)	-		0.041 (0.967)
Burkina-Faso					
ΔCO2	-	0.013 (0.907)	1.569 (0.219)		-3.566* (0.001)
ΔGDP	0.145 (0.705)	-	1.936 (0.173)		-1.813** (0.078)
ΔT	0.324 (0.572)	0.133 (0.717)	-		0.389 (0.699)
Cote d'Ivoire					
ΔCO2	-	0.240 (0.626)	0.065 (0.799)		-1.368 (0.180)
ΔGDP	0.357 (0.553)	-	1.371 (0.249)		-3.552* (0.001)
ΔT	0.467 (0.498)	0.172 (0.680)	-		-0.835 (0.409)
Gambia					
ΔCO2	-	2.768**(0.100)	1.207 (0.279)		-4.157* (0.000)
ΔGDP	0.497 (0.485)	-	0.031 (0.860)		1.815** (0.078)
ΔT	0.010 (0.918)	0.027 (0.870)	-		-0.224 (0.823)
Ghana					
ΔCO2	-	1.332 (0.297)	1.202 (0.349)		-1.896** (0.075)
ΔGDP	1.667 (0.196)	-	0.393 (0.846)		-1.547 (0.140)
ΔT	1.735 (0.180)	0.908 (0.498)	-		3.259* (0.004)
Mali					
ΔCO2	-	0.175 (0.948)	1.831 (0.158)		-
ΔGDP	2.433** (0.055)	-	0.638 (0.640)		-
ΔT	1.951 (0.137)	0.982 (0.437)	-		-
Niger					
ΔCO2	-	0.288 (0.913)	0.734 (0.607)		0.262 (0.795)
ΔGDP	0.449 (0.808)	-	5.242 (0.003)		-4.741* (0.000)
ΔT	1.086 (0.401)	0.575 (0.718)	-		-0.525 (0.605)
Nigeria					
ΔCO2	-	4.981* (0.032)	3.567** (0.069)		-2.085** (0.082)
ΔGDP	4.638* (0.038)	-	2.911** (0.091)		-4.159* (0.005)
ΔT	2.748 (0.117)	1.094 (0.469)	-		1.468 (0.192)
Senegal					
ΔCO2	-	2.125 (0.115)	2.399**(0.083)		-3.010* (0.009)
ΔGDP	0.148 (0.986)	-	0.678 (0.669)		-0.320 (0.753)
ΔT	1.142 (0.388)	1.406 (0.279)	-		-1.045 (0.313)
Sierra Leone					
ΔCO2	-	0.146 (0.703)	0.598 (0.444)		1.579 (0.123)
ΔGDP	1.034 (0.316)	-	2.821** (0.100)		-3.183** (0.003)
ΔT	0.360 (0.552)	1.445 (0.237)	-		0.703 (0.486)
Togo					
ΔCO2	-	0.299 (0.587)	2.835** (0.100)		-2.552** (0.015)
ΔGDP	13.908*(0.000)	-	1.092 (0.303)		-2.148* (0.038)
ΔT	0.064 (0.800)	0.079 (0.780)	-		-0.332 (0.741)

Note: The asterisks *and ** denote statistical significance at 5% and 10 %. The F-statistic is reported for variables and t-stat for coefficient on ECT. The values in parentheses are the p-value.

The mixed results from this study further confirm that studies based on pooled or cross-section data would provide incorrect inferences regarding the long-run relationship between trade, economic growth and CO_2 emissions.

They also show that the unidirectional hypothesis, in which the economy influences the environment with no inverse effect, is unrealistic and may lead to an endogeneity bias.

4. Conclusion

In this paper, we examine the dynamic relationships between trade and Carbon Dioxide emissions for 11 countries of ECOWAS during the period 1970–2010. To complement the findings of co integration analysis, we perform Granger causality tests to throw light on the causal links between the variables. For four countries, the empirical results provide support to the pollution haven effects in the long-run, indicating that CO_2 emissions are positively related to trade and output in the long-run. The growth processes in these countries are highly pollution intensive. Causality results support the argument that economic growth and trade exert causal influence on air pollution. The evidence also suggests bidirectional long-run causality between the pollution and economic expansion in four countries. This finding is consistent with the experiences of many African countries where much energy inputs are consumed by polluting industries and imported used vehicles. Pollution will increase in the next 30 years as African countries will industrialize by outsourcing polluting industries from the developed countries. Persistent decline in environmental quality may exert negative externalities to the economy through affecting human health, and thereby reduce productivity in the long-run. These results are new and interesting because this study is the first attempt to empirically investigate the causal relationship between international trade, economic growth and CO_2emissions for individual African countries.

As trade is growth-promoting, trade restrictions are an ineffective way to protect the environment. The environmental problems can be better dealt with by adopting effective environmental controls. In Nigeria, measures aiming at curbing CO_2 emissions should include vehicle inspection and steady supply of electricity to stop the use of gasoline generators. The study also recommends that ECOWAS countries engage in less polluting activities in their economic growth and trade expeditions to achieve sustainable economic development. Carbon tariff can also be considered to mitigate the environmental degradation.

Considering carbon dioxide emissions and its contribution to climate change and global warming, this topic is very relevant to be researched into the more. Therefore, the econometric techniques employed in this study can be extended to include large sample of African countries. Future studies should consider different measurement of environmental variables related to air and water pollution. Lastly, the effects of other variables such as population, urbanization, economic structure, on the environment can also be investigated.

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