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Trade Openness and the Impact of Foreign Direct Investment on CO_2 emissions: Econometric Evidence from ECOWAS Countries

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Abstract

This study examines the effect of trade openness on the relationship between foreign direct investment (FDI) and carbon dioxide emissions in ECOWAS Countries. It applies the bounds testing approach to cointegration to annual data covering the period 1970 to 2010. The empirical evidence supports the environmental Kuznets curve for four countries (Cote d'Ivoire, Gambia, Mali and Niger). In most cases, economic growth and population contribute to environmental degradation. More interestingly, the effect of FDI on CO_2 emissions is contingent on trade openness. This effect is positive and increases with the degree of trade openness in Burkina Faso, Gambia and Nigeria, suggesting that trade and FDI are complementary in worsening environmental quality. The effect of FDI decreases with trade in Ghana, Mali and Togo while in the case of Benin, Niger, Senegal and Sierra Leone, FDI has no significant long-run effect on CO_2 emissions.

***Keywords**:* Foreign Direct Investment, CO_2 emissions, Trade openness, ECOWAS.

1. Introduction

The impact of foreign direct investment (FDI) on environment is a subject of intense debate among economists and environmentalists. According to the pollution haven hypothesis, multinational firms engaged in highly polluting activities move their activities in developing countries with weaker environmental regulation laws. This hypothesis suggests that FDI inflows to developing countries contribute to pollution. On the other hand, an optimistic point of view, known as the pollution halo hypothesis, argues that FDI to developing countries may have positive effects on environment through the transfer and adoption of cleaner technologies and more developed environmental management practices (Grossman and Krueger, 1991; Frankel and Rose, 2005; UNCTAD, 2006).

A growing body of empirical literature has investigated the relevance of these arguments. The results from this literature are however mixed across countries, data, methodologies and pollution indicators. Some studies reported evidence supporting that FDI adds to pollution (He, 2006; Waldkirch and Gopinath, 2008; Acharyya, 2009; McDermott, 2009; Pao and Tsai, 2011; Chakraborty and Mukherjee, 2013) while others reached the conclusion that FDI improves air quality in the host country (Birdsall and Wheeler, 1993; Talukdar and Meisner, 2001; Zeng and Eastin, 2007; Merican *et al.,* 2007). A third stream of the empirical literature found no significant impact of FDI on air pollution (Eskeland and Harrison, 2003; Hassaballa, 2013; Shaari *et al.,* 2014). These findings have raised the issue of heterogeneity in the FDI-environment nexus.

One important limitation of these empirical studies is that they so far have not asked whether there are local conditions that influence the impact of FDI on pollution. The possibility of a non-linear relationship between FDI and CO_2 emissions has largely been ignored in these studies. Another common feature of studies that use panel regression framework is that they impose cross-sectional homogeneity on coefficients that in reality may vary across countries because of differences among countries with respect to energy consumption, trade policy and institutional aspects. Most of the studies that focus on the relationship between FDI and pollution have largely ignored the impact of trade policy.

According to Bhagwati's proposition, the growth enhancing effect of FDI depends on the trade policy regime (see Bhagwati, 1981; Basu *et al*., 2003; Balasubramanyam *et al.,* 1996 and Kohpaiboon, 2003). An environment that increases trade openness is likely to attract more FDI inflows. Flexner (2000) argued that distortionary trade policies may lead to a misallocation of resources and inhibit the ability of FDI to act as a channel for advancing technology transfer. This may impact the levels of energy consumption and CO_2 emissions in the host country. These interesting arguments suggest that the impact of FDI on environment may depend on trade policy of the recipient country. Despite its relevance, so far only a few studies have examined this hypothesis. The study of Birdsall and Wheeler (1993) for Latin America has provided important contribution to the empirical literature by showing that protected economies are likely to attract pollution intensive industries, while openness to trade and FDI encourages cleaner industries. However, rather than providing general evidence, the study by Birdsall and Wheeler (1993) opens a promising way for further research.

The main objective of this paper is to assess how trade openness influences the relationship between FDI and pollution for 11 member countries of the Economic Community of West African States (ECOWAS). The twin policy targets of FDI attraction and trade liberalization have been central in the ECOWAS agenda since the IMF adjustment programs in the 1980s. The role of FDI as a source of capital is of a great interest for African countries because of their low levels of savings and investment. Contrary to most previous empirical works, we prefer a country case study. The experience of African countries is different from that of industrialized and Asian countries. For instance, African countries are generally plagued with deficient infrastructure, laxer environmental regulations and political uncertainty. Under such conditions, there could be wide disparities in energy use and pollution between African countries and other developing economies.

The rest of the paper is structured as follows. Section 2 presents the methodology of the study. Section 3 presents the data and analyses the empirical results. Finally, Section 4 provides summary and gives some policy implications.

2. Econometric methodology

2.1 Empirical model

The equation used in the empirical analysis is specified as follows:

$$CO_{2t} = \theta_0 + \theta_1 GDP_t + \theta_2 GDP_t^2 + \theta_3 POP_t + \theta_4 FDI_t + \theta_5 TR_t \times FDI_t + \mu_t \quad (1)$$

Where CO_2 is the carbon dioxide emissions as the proxy for the level of pollution; GDP is per capita real gross domestic output, FDI is foreign direct investment inflows, TR is trade openness and POP is population. We include per capita GDP square to test for the Environmental Kuznets Curve.

The impact of FDI on pollution is given by $\theta_4 + \theta_5 TR_t$. To test whether this impact depends on trade openness, the statistical significance of θ_5 is examined. Under the pollution haven hypothesis, the sign of θ_5 is positive. The sign of θ_4 is ambiguous; it can be positive or negative. Even when θ_4 is negative, it does not imply that FDI is good for the environment.

2.2 Estimation method

To estimate Eq.(1) we use the ARDL bounds testing approach to cointegration developed by Pesaran *et al.* (2001). This approach has better small sample properties in comparison to other widely used alternatives (see Cheung and Lai, 1993; Inder, 1993). The ARDL bounds test for cointegration involves estimating by OLS the following autoregressive equation:

$$\begin{aligned} \Delta CO_{2t} = {} & \phi_0 + \phi_1 CO_{2t-1} + \phi_2 GDP_{t-1} + \phi_3 GDP_{t-1}^2 + \phi_4 FDI_{t-1} + \phi_5 POP_{t-1} + \phi_6 TR_{t-1} \times FDI_{t-1} + \sum_{i=1}^{m_1} \gamma_{1i} \Delta CO_{2t-i} \\ & + \sum_{i=0}^{m_2} \gamma_{2i} \Delta GDP_{t-i} + \sum_{i=0}^{m_3} \gamma_{3i} \Delta GDP_{t-i}^2 + \sum_{i=0}^{m_4} \gamma_{4i} \Delta FDI_{t-i} + \sum_{i=0}^{m_5} \gamma_{5i} \Delta POP_{t-i} + \sum_{i=0}^{m_6} \gamma_{6i} \Delta TR_{t-i} \times FDI_{t-i} + \varepsilon_t \end{aligned} \quad (2)$$

The existence of cointegration between the variables is tested by restricting the lagged levels variables in the above equation equal to zero. Therefore, the null hypothesis for no cointegration is: $\phi_1 = \phi_2 = \phi_3 = \phi_4 = \phi_5 = \phi_6 = 0$. This hypothesis is tested by the mean of the *F-s*tatistic. The critical values are provided by Pesaran *et al.* (2001) for large samples. We are aware of the fact that these critical values are not suitable for our small sample size (n=41). Hence, we generate exact critical values using stochastic simulations following the procedure suggested by Pesaran *et al.* (2001). Once cointegration is found, the long-run estimates are computed as the coefficient of the one lagged level explanatory variable divided by the coefficient of CO_2 and then multiplied by a negative sign. The bounds test is sensitive to the choice of lag structure for firstdifferenced variables. In this study, the optimal lag structure is selected following the general-to-specific procedure with maximal lag set to five.

3. Data and empirical results

The empirical analysis uses annual time series data for a sample of 11 member 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. The variables under study include CO_2 emissions in kt, per capita real GDP in constant 2005 US dollars, foreign direct investment as share of GDP (FDI), population (POP) and the interactive term (TRxFDI) obtained by multiplying trade openness and foreign direct investment. All data cover the period 1970 to 2010 and are sourced from the World Bank's World Development Indicators. The data for CO_2, GDP and POP were converted into natural logarithms.

Table 1 displays averages for CO_2 emissions and FDI over the sample period. As can be seen from this Table, CO_2 emissions and FDI exhibit increasing trends over time in all countries. From this picture, we hypothesize a positive long run relationship between FDI and CO_2 emissions.

Prior to implementing the bounds test, it is important to check the variables for the stationarity property. Some empirical studies wrongly claim that this step is not necessary as the bounds test can be applied irrespective of whether the variables are I(0) or I(1). In fact, in the bounds test the dependent variable must be I(1) and the regressors must be I(0) or I(1). Hence, it is necessary to ensure that these conditions are satisfied. To test for the order of integration of the variables, we apply the KPSS unit-root test. This test has been performed under the models with constant and trend for the level series and with constant for series in first differences. The results reported in Table 2 reveal that all variables contain unit roots and are stationary after taking the first differences.

Table 1: Average of CO_2 emissions, FDI and trade openness in ECOWAS countries, 1970-2010

	CO_2 (kt)				FDI (% of GDP)				Trade (% of GDP)			
Countries	1970-80	1981-90	1991-00	2001-10	1970-80	1981-90	1991-00	2001-10	1970-80	1981-90	1991-00	2001-10
Benin	363.69	580.11	1233.58	3383.54	0.54	0.76	2.05	0.83	46.68	49.93	58.6	47.92
Burkina Faso	245.02	562.88	750.63	1336.25	0.18	0.09	0.40	0.58	32.80	38.20	35.61	35.74
Côte d'Ivoire	3946.02	6527.62	6505.99	6837.48	1.179	0.51	1.53	1.86	72.16	69.32	68.52	87.54
Gambia	95.34	171.98	222.95	361.19	1.51	0.95	2.31	7.33	85.55	111.34	56.73	62.40
Ghana	2648.24	3271.33	5469.69	8013.12	0.81	0.18	2.03	4.25	31.23	27.96	70.05	85.04
Mali	323.69	398.96	487.71	574.98	0.14	0.17	1.30	4.26	37.11	49.93	58.09	66.87
Niger	347.69	915.65	923.72	928.85	1.02	0.42	0.25	3.84	46.03	47.34	39.96	50.17
Nigeria	49733.19	62242.19	49653.38	91333.2	1.33	1.99	4.62	3.3	36.76	37.67	61.40	61.81
Senegal	2091.19	2970.63	3596.59	5350.52	0.71	0.28	1.22	2.00	46.15	18.80	77.96	140.01
Sierra Leone	627.39	561.05	314.63	639.16	1.14	-1.96	0.62	3.56	53.40	42.75	48.23	42.87
Togo	484.04	694.16	1043.62	1363.02	2.08	0.78	1.26	3.16	97.57	96.57	70.32	92.62

Source: World Development Indicators Online, World Bank, 2015.

Table 2: Results of KPSS Unit Root Test

Country	Level						First difference					
	CO_2	GDP	GDP2	FDI	POP	TRADE*FDI	ΔCO_2	ΔGDP	ΔGDP2	ΔFDI	ΔPOP	ΔTRADE*FDI
Benin	0.194	0.124	0.127	0.103	0.181	0.114	0.245	0.252	0.253	0.055	0.184	0.099
Burkina Faso	0.130	0.170	0.128	0.140	0.204	0.133	0.126	0.199	0.082	0.054	0.186	0.013
Côte d'Ivoire	0.409	0.215	0.215	0.196	0.159	0.103	0.397	0.439	0.439	0.400	0.271	0.400
Gambia	0.174	0.133	0.133	0.147	0.099	0.130	0.232	0.400	0.400	0.202	0.324	0.201
Ghana	0.168	0.201	0.162	0.179	0.094	0.191	0.234	0.084	0.420	0.349	0.083	0.387
Mali	0.102	0.152	0.154	0.274	0.206	0.275	0.393	0.148	0.158	0.422	0.129	0.387
Niger	0.177	0.157	0.148	0.169	0.210	0.166	0.279	0.173	0.147	0.458	0.110	0.413
Nigeria	0.098	0.178	0.178	0.114	0.167	0.115	0.152	0.313	0.316	0.236	0.137	0.258
Senegal	0.099	0.183	0.183	0.166	0.126	0.167	0.118	0.276	0.276	0.073	0.155	0.070
Sierra Leone	0.142	0.119	0.172	0.155	0.089	0.165	0.204	0.276	0.500	0.262	0.096	0.174
Togo	0.098	0.082	0.083	0.072	0.136	0.070	0.120	0.049	0.050	0.022	0.133	0.021

Notes: Critical values at the 5% level are 0.146 and 0.463 * and ** indicate that the null hypothesis is rejected at the 5% and 10% levels, respectively.

The results of the bounds test are reported in Table 3. As can be seen the computed F-statistic exceeds the upper critical values at 5% level of significance for all countries implying that the null hypothesis of no cointegration among the variables can be rejected. Therefore, there exists a long-run relationship among CO_2 emissions and its determinants.

Table 3: Results of bounds test for cointegration

	F-stat	Case	5% exact critical values		Cointegration?
			I(0)	I(1)	
Benin	3.793	Case I	2.392	3.725	Yes
Burkina Faso	9.156	Case III	2.977	4.319	Yes
Côte d'Ivoire	10.088	Case III	2.977	4.319	Yes
Gambia	9.451	Case III	2.977	4.319	Yes
Ghana	18.355	Case I	2.392	3.725	Yes
Mali	13.615	Case III	2.977	4.319	Yes
Niger	6.851	Case V	3.599	4.889	Yes
Nigeria	16.034	Case I	2.392	3.725	Yes
Senegal	5.138	Case III	2.977	4.319	Yes
Sierra Leone	6.326	Case I	2.392	3.725	Yes
Togo	63.881	Case I	2.392	3.725	Yes

Note: Lag length on each variable is selected using the general-to-specific approach, with maximum lag set to five. Critical values for F-statistics are calculated using stochastic simulations specific to the sample size n = 41 based on 40,000 replications.

Given the evidence of cointegration, we estimate the long-run coefficients on each determinant of CO_2 emissions. The results are reported in Table 4. The positive sign for GDP and the negative sign for GDP squared in five countries (Cote d'Ivoire, Gambia, Mali, Niger and Nigeria) are supporting the EKC hypothesis that pollution initially increases with income and then decreases after income reaches a threshold level. The estimated per capita income turning point at which CO_2 emissions start to decline are 1518, 447, 387, 336, and 7 900 US dollars for Cote d'Ivoire, Gambia, Mali, Niger and Nigeria, respectively. Compared to the mean value of GDP for each country, the predicted level of income where the turning point occurs for Nigeria is relatively high and greater than the maximum value of the sample data. This means that economic growth in Nigeria harms environment. Results for all other countries show a U-shaped relationship between GDP and CO_2 emissions. However, the turning point at which CO_2 emissions start to increase is lower than the minimum value of GDP in

Benin, Burkina Faso, Ghana, Sierra Leone and Togo. This suggests that economic growth contributes to worsen the environmental conditions in these five countries.

With respect to population, the results show this variable is positively related to CO_2 emissions in all countries except Burkina Faso, Niger and Nigeria. This implies that increasing population leads to more environmental degradation in the long-run. In the case of Burkina Faso, Niger and Nigeria, population enters the long-run relationship significantly with a negative sign, suggesting that it is unlikely that demographic decline will curb CO_2 emissions. It is worth noting that in most cases the coefficient on population is greater than unity, implying that population has a positive effect on per capita CO_2 emissions. These findings have important implications for sustainable development and climate change policies. They suggest that forecasting models of CO_2 emissions that fail to take into account the impact of population will likely lead to inaccurate results and misleading environmental policies. Since most African countries are on a trajectory of increasing population, reductions in CO2 emissions are going to have to come from increases in energy efficiency and a diversification of energy sources.

Table 4: Long-run estimates

	GDP	GDP2	FDI	POP	TRADE*FDI
Benin	-11.064*	1.341*	0.156	1.669*	0.0007
	(-13.141)	(7.418)	(0.508)	(3.462)	(0.126)
Burkina Faso	-43.197*	3.980*	-2.013*	-1.802**	0.056*
	(-3.152)	(3.388)	(-2.985)	(-1.920)	(3.043)
Côte d'Ivoire	144.531*	-9.865*	-0.967*	1.949*	0.010
	(5.616)	(-5.624)	(-2.248)	(3.736)	(1.596)
Gambia	207.026*	-16.958*	-0.033**	1.032*	0.001*
	(3.488)	(-3.447)	(-1.872)	(18.426)	(2.645)
Ghana	-7.157*	0.507*	0.117**	2.108*	-0.002*
	(-12.847)	(8.569)	(1.861)	(20.705)	(-2.642)
Mali	42.623*	-3.577*	0.056*	0.847*	-0.001*
	(10.578)	(-10.592)	(3.160)	(9.534)	(-4.007)
Niger	37.026*	-3.183*	0.004	-13.560*	0.0002
	(6.003)	(-6.034)	(0.176)	(-27.4397)	(0.603)
Nigeria	9.549*	-0.532*	-1.079*	-0.715**	0.015*
	(3.882)	(-3.653)	(-4.959)	(-1.997)	(4.112)
Senegal	-291.347*	22.167*	-0.138	1.088*	0.001
	(-2.764)	(2.766)	(-0.995)	(12.607)	(0.708)
Sierra Leone	-2.427*	0.324*	-0.004	0.591*	0.0007
	(2.244)	(3.071)	(-0.224)	(3.271)	(0.897)
Togo	-7.520*	0.682*	-0.015	1.776*	-0.001*
	(-15.948)	(14.317)	(-1.069)	(25.428)	(-23.970)

Notes: Figures in parenthesis are *t*-statistics. * and ** denote statistical significance at the 5% and 10% levels, respectively.

Moving on to FDI, the results indicate that the impact of FDI on pollution depends on trade openness. In Burkina Faso, Gambia and Nigeria, the impact of FDI is positive and increases with the degree of trade openness. This suggests that increased FDI degrades the environment in more opened economies. This finding is consistent with the pollution haven hypothesis and the works of Chakraborty and Mukherjee (2013), Beak and Koo (2009) and Acharyya (2009), but contradicts with Birdsall and Wheeler (1993). On the contrary, in the case of Ghana, Mali and Togo, FDI exerts a significant negative effect on pollution, meaning that FDI is beneficial to the environment. This result is consistent with those found by Birdsall and Wheeler (1993), Hassaballa (2013) and Shaari *et al.* (2014). Finally, for Benin, Niger, Senegal and Sierra Leone, FDI has no significant long-run effect on carbon dioxide emissions.

4. Conclusion

This paper has examined the relationship between foreign direct investment and air pollution in a sample of 11 member countries of the Economic Community of West African States (ECOWAS). The main objective was to assess how trade openness influences this nexus. The empirical analysis applied the bounds test to cointegration to annul data covering the period 1970-2010. We found evidence supporting the environmental Kuznets curve for Cote d'Ivoire, Gambia, Mali and Niger. In most cases, economic growth contributes to worsening air quality. The findings also reveal that population leads to environmental degradation in high countries, whereas it is negatively related to pollution in three countries. Consequently, it is unclear whether a demographic decline will help reduce carbon dioxide emissions.

More interestingly, the results show that the effect of FDI on CO2 emissions depends on trade openness. For Burkina Faso, Gambia and Nigeria, the effect of FDI on CO2 emissions is positive and increases with the degree of trade openness. This finding is consistent with the pollution haven hypothesis and suggests that trade openness and FDI are complementary in worsening environmental quality. On the contrary, increased FDI improves air quality in Ghana, Mali and Togo. In Benin, Niger, Senegal and Sierra Leone, FDI has no significant long-run effect on CO2 emissions.

As implication, Ghana, Mali and Togo should make efforts to attract more foreign investment. For the other countries, investment in pollution intensive industries should be monitored. Governments should implement policies that will induce foreign industries to adopt modern technologies that are not detrimental to the environment. The creation of a fund for environmental improvement is also a possible policy action that will ensure better environmental conditions within ECOWAS. The contribution of firms to this fund will depend on their level of carbon dioxide emissions.

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