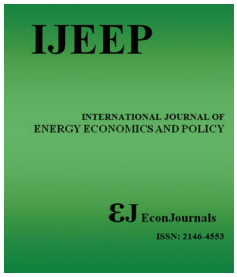

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Do Foreign Direct Investment and Trade lead to Lower Energy Intensity? Evidence from Selected African Countries

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ABSTRACT

The aim of this study is to examine the impact of foreign direct investment (FDI) and trade on energy intensity in a sample of six sub-Saharan countries. It applies the bounds testing approach to co-integration and Granger causality analysis to annual data covering the time period from 1970 to 2011. The results indicate evidence for energy-reducing effect of FDI in Benin and Nigeria, while in Cote d'Ivoire and Togo, energy efficiency declines as FDI increases. The results also indicate that energy intensity is negatively affected by imports in Cameroon, Cote d'Ivoire and Togo, suggesting that trade improves energy efficiency. Results of Granger causality suggest that in the short-run, energy intensity is caused by FDI in Cote d'Ivoire and Nigeria, and by imports in Cameroon and Nigeria.

Keywords: Energy Intensity, Foreign Direct Investment, Trade
JEL Classifications: C32, F21, Q43

1. INTRODUCTION

The relationship between foreign direct investment (FDI), trade and economic growth has been a subject of intense research in the past two decades. The conventional belief is that FDI and trade has several positive effects on host country economies. Among these are productivity gains, technology transfers, introduction of new processes, managerial skills, employee training and access to markets (Borensztein et al. 1998; UNCTAD, 2006). In addition, there are existing empirical studies that have further highlighted the benefits of FDI and trade in promoting economic growth (De Mello, 1997). Based on these findings, an increasing number of developing countries including African and Asian countries have attempted to design policy measures to attract more flow of foreign capital and to be integrated into the world economy. These policies include administrative facilities, privatization of state monopolies, capital market liberalization, tax concessions and removal of trade restrictions.

With the threat of global warming and climate change, economists and environmentalists contend that FDI and trade are not free of cost. They may have negative effects on the environment as well as on human health. The so-called pollution haven hypothesis suggests that reductions in trade barriers enables polluting multinational firms, particularly those engaged in highly energy consumption and polluting activities, to outsource their activities to countries with less stringent environmental regulation. Another opinion posits that FDI and trade could reduce the energy consumption intensity and improve energy efficiency and productivity through the transfer and adoption of energy-efficient technologies and better environmental management practices (Grossman and Krueger, 1991; Keller, 2004). Energy consumption is regarded as the major underlying cause of environmental pollution and global warming (Jacobson, 2009; Hübler and Keller, 2010). This means that the environmental effects of FDI and trade are consequences of energy consumption. Therefore, it is meaningful to focus on the effects of FDI and trade on energy consumption. FDI and trade can affect energy consumption through changes in the economic growth (scale effect), through changes in the structure of the economy (composition effect), and through changes in the technique and technologies used for production (technique effect). The total effect depends on which effect is stronger and dominates the others (Antweiler et al. 2001).

At the empirical level, a number of studies have examined the influence of openness to trade and FDI on energy intensity. The findings from this literature are however controversial and inconclusive across countries, data, methodologies. Mielnik and Goldemberg (2002), in a study on 20 developing countries, found that energy intensity declines as FDI increases. Eskeland and Harrison (2003) analyzed the relationship between pollution abatement costs and the pattern of foreign investment in four developing countries (Mexico, Morocco, Cote d'Ivoire and Venezuela). They found that pollution abatement costs have no significant impact on the pattern of foreign investment. Only in the case of Morocco, they found that foreign investors are concentrated in the cement industries. Their results also showed that foreign companies are more energy efficient and use cleaner types of energy than their domestic counterparts. A similar result is reported by Kumar (2003) and Sahu and Narayanan (2009) for India and Fisher-Vanden et al. (2004; 2006) for China. Hubler (2009) analyzed the influence of FDI and trading to energy-saving technology using CGE modeling and concluded that FDI and trade could improve the energy-saving technology and reduce energy consumption intensity. Hübler and Keller (2010) failed to find evidence of robust energy reducing effect of FDI in a sample of 60 developing countries, including China, for the period 1975-2004. According to these authors, the effect of FDI on energy use depends on country-specific characteristics. Yue et al. (2011) decomposed the energy intensity in Jiangsu province in China into FDI scale, structure and technology effects. They obtained that only FDI scale effect reduces the energy intensity. Herrerias et al. (2013) showed that FDI have played a leading role in the decline of energy intensity in China. Elliott et al. (2013) investigated the relationship between the energy intensity of 206 Chinese cities and FDI inflows over the period 2005-2008. They found a nonlinear inverted-U shaped relationship between energy intensity and per capita income. Their results also revealed that FDI reduces energy intensity. However, the FDI effect varies across geographic areas. Omri and Kahouli (2014) reported evidence of a positive association between FDI and energy consumption for a sample of 65 countries.

Leitao (2015) examined the relationship between FDI, energy consumption and gross domestic product (GDP) in Portugal for the period 1990-2011. He validated an inverted-U shaped relationship between energy consumption and per capita income. He also found a positive impact of FDI and carbon dioxide emissions on energy consumption. Acaravci et al. (2015) examined both the long-run and causal relationships between electricity consumption per capita, real GDP per capita, trade openness and FDI inflows per capita in Turkey during the time period 1974-2013. The overall results from the three error-correction based Granger causality models show that there is an evidence of unidirectional short-run, long-run and strong causalities running from the electricity consumption per capita to real GDP per capita. However, there is no causal evidence from the real GDP per capita to electricity consumption per capita. This result also support that, "Growth hypothesis" is confirmed in Turkey. Balibey (2015) investigated the causal relationships between economic growth, carbon dioxide emission and FDI and evaluates the environmental Kuznets curve (EKC) hypothesis in Turkey for 1974-2011 period. The causality relationships display that foreign direct investment (LFDI) and economic growth (LGDP) have a significant effect on carbon dioxide emissions (LCO_2). Moreover, impulse-response functions and variance-decompositions of VAR model support these relationships among LGDP, LCO_2 and LFDI. Secondly, the study investigates the validity of the EKC hypothesis in Turkey for the period 1974-2011 by using Regression Model approach for the various EKC model forms such as linear, quadratic, and cubic. Consequently, economic growth leads to degradation of environment and depletion of natural resources. Ben Jebli et al. (2015) based on the EKC hypothesis, used panel co-integration techniques to investigate the short- and long-run relationship between CO_2 emissions, GDP, renewable energy consumption and international trade for a panel of 24 sub-Saharan Africa countries over the period 1980-2010. Short-run Granger causality results reveal that there is a bidirectional causality between emissions and economic growth; bidirectional causality between emissions and real exports; unidirectional causality from real imports to emissions; and unidirectional causality runs from trade (exports or imports) to renewable energy consumption. There is an indirect short-run causality running from emissions to renewable energy and an indirect short-run causality from GDP to renewable energy. In the long-run, the error correction term is statistically significant for emissions, renewable energy consumption and trade. The long-run estimates suggest that the inverted U-shaped EKC hypothesis is not supported for these countries; exports have a positive impact on CO_2 emissions, whereas imports have a negative impact on CO_2 emissions.

As can be seen from this literature, studies on single countries especially on Sub-Saharan African countries are rather rare. Furthermore, most of the empirical studies used cross-section or panel data analysis under the assumption of common coefficients of the estimated relationship across countries. This is a very restrictive assumption because of differences among countries with respect to energy consumption. As suggested by Stern et al. (1996), the experience of individual countries should be considered. The present study contributes to the literature by looking at the impact of both FDI and trade on energy intensity for a sample of Sub-Saharan African countries. Energy intensity is the amount of energy required to produce one unit of GDP. In what extent openness to FDI and trade can effectively help to reduce energy intensity and thus CO_2 emissions in African countries? Contrary to most empirical studies, we conduct a country case study. We apply the bounds testing approach to cointegration of Pesaran et al. (2001) and Granger causality analysis to annual data covering the time period from 1970 to 2011.

The remainder of the study is organized as follows. Section 2 deals with the econometric methodology of the study. Section 3 analyses the empirical results. Finally, Section 4 provides summary and gives some policy implications.

2. METHODOLOGY

2.1. Model

To examine the impacts of FDI and trade on energy intensity, we specify the empirical model as follows:

$$E_t = \varphi_0 + \varphi_1 FDI_t + \varphi_2 M_t + \varphi_3 GDPh_t + \mu_t \quad (1)$$

where E stands for energy intensity, obtained by dividing the total energy consumed by the real GDP, FDI is FDI inflows as a proportion of GDP, M is imports of goods and services as share of GDP and GDPh is per capita real GDP.

As income increases, the demand for a better environment and a greater efficiency will increase as well. Therefore, the predictive sign of real GDP is negative. FDI and imports are indicators for the integration of a country into the world economy and potential channels for technology transfer. Therefore, the coefficients ϕ_1 and ϕ_2 are expected to be positive under the pollution haven hypothesis, and negative under the pollution halos hypothesis.

2.2. Estimation Method

Eq.(1) is estimated using the bounds testing approach to co-integration developed by Pesaran et al. (2001). The main advantage of this approach is that it can be applied irrespective of whether the regressors are purely I(0) or I(1). This allows us to avoid the problem associated with conflicting results of the conventional unit root tests and the low power of these tests in small samples. The bounds test generally provides unbiased estimates of the long-run coefficients even when some of the regressors are endogenous (Inder, 1993). To implement this procedure, Eq. (1) is specified as a conditional autoregressive distributed lag model as follows:

$$\Delta E_t = \theta_0 + \theta_1 E_{t-1} + \theta_2 FDI_{t-1} + \theta_3 M_t + \theta_4 GDPh_t + \sum_{i=1}^{m} \gamma_{1i} \Delta E_{t-i} + \sum_{i=0}^{n} \gamma_{2i} \Delta FDI_{t-i} + \sum_{i=0}^{p} \gamma_{3i} \Delta M_{t-i} + \sum_{i=0}^{q} \gamma_{4i} \Delta GDPh_{t-i} + e_t \quad (2)$$

The presence of co-integration 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 $\theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$. This hypothesis is tested by the mean of the F-*s*tatistic. However, its asymptotic distribution is non-standard under the null hypothesis. 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. Hence, we calculate exact critical values using stochastic simulations based on 40000 replications, following the procedure recommended by Pesaran et al. (2001). Once cointegration is found, the long-run coefficients are computed as the coefficient of the one lagged level explanatory variable divided by the coefficient of E and then multiplied by a negative sign.

3. EMPIRICAL RESULTS

The empirical investigation uses annual time series data for a sample of six Sub-Saharan African countries, namely Benin, Cameroon, Democratic Republic of the Congo (Congo DR, hereafter), Cote d'Ivoire, Nigeria and Togo. The variables under study are energy intensity in kg of oil equivalent per real GDP (E), FDI as share of GDP, imports as share of GDP and per capita real GDP in constant 2005 US dollars. Data on foreign direct investment inflows come from World Investment Report of the United Nations Conference on Trade and Development (UNCTAD) and the World Development Indicators of the World Bank. Data on energy intensity, imports and per capita real GDP are sourced from the World Development Indicators of the World Bank. All data cover the period 1970-2011.

Table 1 presents the average for energy intensity, FDI and imports over the sample period. From the Table 1, shows that energy intensity shows a decreasing trend in Benin. It is increasing in Congo Democratic, Cote d'Ivoire and Togo. This suggests that energy consumption increases faster than real GDP and thus it is necessary to improve energy use in these countries.

As a first step of our empirical analysis, we test for the order of integration of the series by means of unit root tests. To this end, we perform two well-known unit root tests-the PP test of Phillips-Perron (1988) and the Kwiatkowski–Phillips–Schmidt–Shin test of Kwiatkowski et al. (1992). These tests have been performed under the models with constant and trend for the level series and with constant for series in first difference. This step is necessary to ensure that none variable is I(2). In addition, the bounds test requires the dependent variable to be I(1). The results displayed in Table 2 indicate that all conditions are satisfied.

The results of the bounds F-test statistics are reported in Table 3. According to the F-statistics, we find evidence of co-integration for all countries under study. This implies that energy intensity, FDI, imports and real income do not move to far away from each other in the long-run. Given the evidence of co-integration, we further present our estimation results concerning the long-run coefficients.

The results reported in Table 4 indicate that FDI has a negative effect on energy intensity in Benin and Nigeria, implying that

Table 1: Average of energy intensity, FDI and imports over 1970-2011

Country	Energy intensity (kg oil eq. per real GDP)				FDI (% of GDP)				Imports (% of GDP)			
	1970-80	1981-90	1991-00	2001-11	1970-80	1981-90	1991-00	2001-11	1970-80	1981-90	1991-00	2001-11
Benin	0.860	0.752	0.679	0.629	0.547	0.755	2.053	0.962	31.150	33.019	32.819	27.943
Cameroon	0.493	0.356	0.475	0.393	0.779	0.934	0.579	1.820	26.265	24.359	17.450	22.675
Congo DR	0.450	0.570	1.133	1.640	0.566	–0.158	0.107	4.643	16.131	23.489	20.568	32.463
Cote d'Ivoire	0.280	0.296	0.360	0.512	1.179	0.507	1.530	1.803	34.871	32.537	30.882	39.016
Nigeria	0.817	1.238	1.337	0.950	1.332	1.988	4.619	3.194	17.986	14.659	25.162	25.800
Togo	0.691	0.728	0.952	1.098	2.084	0.785	1.265	3.288	49.198	52.203	40.031	54.702

Source: World development indicators of World Bank and UNCTAD, UNCTAD: United Nations Conference on Trade and Development, GDP: Gross domestic product

Table 2: Results of unit root tests

Country	PP								KPSS							
	E	FDI	M	GDPh	ΔE	ΔFDI	ΔM	ΔGDPh	E	FDI	M	GDPh	ΔE	ΔFDI	ΔM	ΔGDPh
Benin	–2.145	–3.650	–2.870	–2.874	–6.566	–8.625	–7.271	–7.861	0.096	0.094	0.128	0.124	0.113	0.093	0.252	0.242
Cameroon	–1.733	–5.721	–1.703	–1.860	–4.161	–20.366	–6.622	–4.119	0.106	0.098	0.129	0.123	0.141	0.390	0.143	0.188
Congo DR	–1.540	–5.669	–3.209	–1.256	–3.343	–15.944	–10.024	–2.525	0.099	0.185	0.108	0.096	0.152	0.021	0.373	0.171
Côte d'Ivoire	–2.250	–3.181	–1.868	–2.249	–6.587	–8.699	–4.919	–4.142	0.171	0.116	0.132	0.103	0.281	0.090	0.101	0.101
Nigeria	–0.008	–3.864	–3.706	–0.331	–5.443	–18.204	–17.169	–5.535	0.193	0.121	0.084	0.184	0.405	0.219	0.355	0.314
Togo	–2.738	–4.306	–2.580	–2.765	6.700	–9.082	–6.657	–6.418	0.147	0.075	0.097	0.088	0.128	0.024	0.054	0.052

Notes: Critical values at the 5% level are –3.523 (level) and –2.936 (first difference) for PP test and 0.146 (level) and 0.463 (first difference) for KPSS test, PP: Phillips-Perron, KPSS: Kwiatkowski–Phillips–Schmidt–Shin

FDI is energy efficient in these two countries. In the case of Cote d'Ivoire and Togo, FDI has a positive effect on energy intensity, meaning that energy efficiency declines as FDI increases. In Cameroon and Congo Democratic, the effect of FDI on energy intensity is positive but not significant.

GDP is found to have the predictive negative sign, indicating that an increase in income causes a decrease in energy intensity and thus an increase in energy efficiency. With respect to trade, we find that increased imports lower energy intensity and thus improve energy efficiency in Cameroon, Cote d'Ivoire and Togo. For the other countries, imports do not affect significantly energy intensity.

The existence of co-integration between energy intensity and foreign direct investment suggests that there must be Granger-causality in at least one direction, but it does not indicate the direction of causality. Table 5 reports the causality test results. As can be seen, in the long-run, energy intensity is Granger-caused by FDI, imports and income in all countries under study. In the short-run, FDI causes energy intensity in Cote d'Ivoire and Nigeria, while imports cause energy intensity in Cameroon and Nigeria. FDI and economic growth cause energy intensity both in the short run and long run in Nigeria.

Table 3: Results of bounds test for co-integration

Country	F-stat	Case	5% exact critical values		Co-integration?
			I (0)	I (1)	
Benin	4.912	1	2.654	3.913	Yes
Cameroon	6.004	4	3.715	4.639	Yes
Congo DR	6.268	3	3.433	4.653	Yes
Cote d'Ivoire	15.942	3	3.433	4.653	Yes
Nigeria	6.824	3	3.433	4.653	Yes
Togo	6.211	4	3.715	4.639	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 T=41 based on 40,000 replications

Table 4: Long-run estimates

Country	FDI	Imports	GDP
Benin	–0.046 (–2.199)*	0.003 (0.389)	–0.056 (–1.106)
Cameroon	0.015 (0.410)	–0.021 (–5.742)*	–0.560 (–6.174)*
Congo DR	0.002 (0.530)	0.003 (1.502)	–1.080 (–58.132)*
Côte d'Ivoire	0.046 (3.131)*	–0.010 (–1.919)**	–0.635 (–5.435)*
Nigeria	–0.035 (–2.133)*	0.003 (1.337)	–1.222 (–13.111)*
Togo	0.026 (2.761)*	–0.007 (–3.509)*	–0.938 (–2.819)*

Notes: Figures in parenthesis are t-statistics. * and ** denote statistical significance at the 5% and 10% levels, respectively, FDI: Foreign direct investment, GDP: Gross domestic product

Table 5: Granger-causality test results

Country	Null hypothesis of short-run causality		Long-run causality: ECT_{t-1}=0
	FDI does not cause energy intensity	Imports do not cause energy intensity	FDI, Imports and GDP do not cause energy intensity
Benin	1.056 (0.304)	0.002 (0.960)	–0.136 (–1.993)*
Cameroon	1.058 (0.303)	4.787 (0.028)*	–0.539 (–3.766)*
Congo DR	7.227 (0.204)	6.447 (0.265)	–1.040 (–2.686)*
Cote d'Ivoire	4.23 (0.039)*	2.05 (0.152)	–0.65 (–5.390)*
Nigeria	14.97 (0.01)*	17.92 (0.003)*	–0.96 (–2.080)*
Togo	0.482 (0.487)	0.007 (0.932)	–0.267 (–1.963)*

Note: Statistics for short-run causality are χ^2 with P values in parentheses. Statistics for long-run causality are coefficients on ECT_{t-1} with t-statistics in parentheses. *denotes statistical significance at the 5% level, FDI: Foreign direct investment, GDP: Gross domestic product

4. CONCLUSION

This paper has examined the impact of FDI and trade on energy intensity in a sample of six African countries over the period 1970-2011. The empirical analysis used the bounds test to co-integration and Granger causality test. The empirical results are mixed across countries. We found evidence for the existence of energy-reducing technology transfer via FDI for Benin and Nigeria, while in Cote d'Ivoire and Togo, energy efficiency declines as FDI increases. The results also show that increased imports reduce energy intensity in Cameroon, Cote d'Ivoire and Togo, suggesting that trade improves energy efficiency. Results of Granger causality suggest that in the short-run, energy intensity is caused by FDI in Cote d'Ivoire and Nigeria, and by imports in Cameroon and Nigeria.

The policy implications are straightforward. For policy makers who seek to achieve energy efficiency, the results imply that support of FDI inflows in Cameroon, Congo democratic, Cote d'Ivoire and Togo is not enough, it is rather necessary to explicitly encourage foreign investments that bring about energy reducing technology transfer. To achieve economic sustainability they should also implement investments in energy infrastructure and promulgate energy conservation policies to increase energy efficiency and reduce wastage of energy and pollutant emissions. Countries such as Benin and Nigeria should make the home environment attractive to foreign investment by reducing the cost

of doing business and improving the political environment as well as the quality of infrastructures.

The mixed results of this study further indicate that studies based on panel data approach would provide incorrect inferences regarding the true relationship between foreign direct investment, trade and energy intensity and could be grossly misleading in formulating environmental policies for an individual country. The results also suggest the need for more individual country studies in order to provide with more robust conclusions regarding policy guidelines. We suggest future micro-econometric works using firm-level data to ascertain whether foreign owned firms are more energy efficient than their domestic counterparts.

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