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Pollution Haven Hypothesis in Africa: Does the Quality of Institutions Matter?

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ABSTRACT

This article aims at investigating whether the FDI inflows affect CO_2 emissions for a set of 40 African countries. To be specific, it seeks to perceive, to what extent the quality of institutions plays a role in the empirical validity of the famous pollution haven hypothesis (PHH). We apply Panel ARDL and the three estimators; Pooled Mean Group (PMG), Mean Group (MG) and Dynamic Fixed Effect estimator (DFE) but also Granger causality and Dumitrescu and Hurlin causality for annual data from 1988 to 2016. Long run results indicate the link between FDI, and pollution is relatively complex. If in general, the PHH does not seem to be validated, the result represents quite the opposite when we consider the institutional quality in the diverse African countries. Indeed, our results show the quality of institutions determines the nature of FDI received by African countries. In countries with a high level of corruption, inward FDI significantly reduces CO_2 emissions, while in countries with low institutional quality, inward FDI increases CO_2 emissions. Some policy recommendations have been formulated to support African countries reduce carbon emissions and support economic development. In particular, institutional reform would enable African countries to reconcile economic development, particularly through the FDI, with environmental quality.

Keywords: Carbone Emissions, Foreign Investment, Pollution Haven Hypothesis, Emerging Economies, Institutional Quality, Panel Data
JEL Classifications: C23, F21, F63, Q56

1. INTRODUCTION

The attractiveness of foreign direct investment (FDI) is one of the most crucial components of economic policies, especially in the case of developing countries, as it can provide a significant source of external financing. FDI can cause substantial beneficial effects on the economic development of host countries. Foreign direct investment flows contribute primarily to the growth of the host country's available capital. Moreover, the presence and size of these foreign investments and the physical proximity of foreign firms can generate significant positive technological externalities on the efficiency and productivity of local firms. For these reasons, countries devote significant budgetary resources to encouraging these investments. A vast empirical literature has been built up to test the validity of these intuitions. Some work has confirmed these theoretical insights. FDI promotes economic growth (Borensztein et al. 1998; Fadhil and Almsafir, 2015; Nistor, 2014; Melnyk et al., 2014 and Sokang, 2018) which contributes to lower unemployment through the creation of new jobs (Palat, 2011; Bakkalci and Argin, 2013; Irpan et al., 2016). However, not all empirical work in this area confirms these effects (Agénor, 2003). One can even wonder with Rodrik (1999) the usefulness of the policies put in place by host countries to attract these FDI. For some authors these effects are only effective when certain conditions are fulfilled (level of economic development for Blomstrom et al. 1994, level of human capital for Borensztein et al. 1998; Bouzahzah and Jellal, 2012, the depth of the financial market for Alfaro et al. 2003, etc.).

Even if we admit FDI produce beneficial effects on economic development, they can suffer certain costs. Among these is their effect on environmental degradation. In a seminal article, Copeland and Taylor (1994) consider in a location model that firms decide to open subsidiaries in countries with lax environmental regulations. The latter then appears to be a determinant of FDI, in the same way as the cost of labor, the level of taxation, the regulation of the labor market, etc. Thus, FDI would tend to move from countries with rigorous environmental regulations to countries with lax environmental regulations. This is the famous Pollution Haven hypothesis (PHH). This debate emerged in particular during the conclusion of NAFTA following the fear expressed by several economists and environmental protection associations about the risk of observing certain polluting activities (dirty industries) migrate to Mexico, which is considered to be the laxest country of the three in terms of the environment. For example, Leonard (1988) has shown that the production of dangerous, banned or highly regulated chemicals in the United States, like pesticides, has increased dramatically in Mexico. Mabey et al. (1999) show that the Alena agreement strongly favored the relocation of solvent production from the United States to Mexico. For other economists, like Gallagher and Zarsky and Gallagher (2008) for example, FDI can have positive effects on the environment of host countries, as subsidiaries of multinationals use cleaner technology, which they can disseminate to local companies. Furthermore, subsidiaries in host countries generally use the similar technology for financial reasons as multinationals operating in developed countries with stringent environmental regulations. In fact, the relationship between FDI and the environment is relatively complex. As Grossman and Krueger (1991) point out, the effect of the FDI on CO_2 emissions can be broken down into three elements. A scale effect insofar as the FDI tends to increase economic activity, energy consumption and CO_2 emissions. A composition effect, which differs according to whether the sectors towards which they are oriented are more or less polluting. A technological effect, since the companies created by the FDI can use more or less polluting technologies than those used by local companies. The global effect is therefore theoretically indeterminate.

Africa is a suitable region for exploring this question and assessing the empirical validity of PHH. Although remittances to Africa represent merely 3.5% of global flows, they account for 5.1% of Africa's GDP, which shows their importance in financing the economic development of African countries (Gharnit et al., 2019). On the other hand, even if Africa emits less than 4% of global greenhouse gas emissions, it remains the most vulnerable continent to climate change. This is why one of the most important challenges overlooking African countries is to find the balance between the development of economic activities, through, among other things, the influx of FDI and a sustainable growth, the least carbonized possible.

This article is in line with these concerns. Its objective is to assess the empirical validity of the pollution haven hypothesis in Africa by examining the effects of FDI on CO_2 emissions. It is organized as follows: The second section presents a review of the empirical literature, and the third section presents the econometric model and the fourth the estimation results. The final section concludes by presenting the policy implications.

2. LITERATURE REVIEW

A vast empirical literature has been built up to test the empirical validity of the PHH. We present below a selection of the main works, distinguishing those that confirm the PHH from those that reject it.

2.1. Work Confirming the Empirical Validity of the PHH

Hoffman et al. (2005) use granger causality between FDI and CO_2 emission across 112 countries over 15-28 years. They found that in low-income countries, CO_2-levels Granger cause inward FDI flows. For middle-income countries, inward FDI Granger cause CO_2 emissions. Finally, for high-income countries no Granger causality was found. Akbostanci et al. (2007) explore the empirical validity of PHH for turkey between 1994 and 1997 using panel data for manufacturing industries. They confirm the pollution haven hypothesis, since they show that exports increase as the dirtiness of the industries increases. Ben Kheder and Zugravu-Soilita (2008) use a geographic economy model and the conditional logit on models with French firm-level data and show that the pollution haven hypothesis is confirmed in the strongest manner for emerging economies. Mac Dermott (2009) studied the relationship between environmental regulations and foreign direct investment by considering the bilateral flow of OECD bilateral direct investment among 26 OECD countries from 1982 to 1997. Its results show the firms are seeking for countries with fewer environmental regulations and therefore the pollution haven hypothesis is valid. In the same way, using cointegration analysis, Acharyya (2009) shows that the long run growth impact of FDI inflow on CO_2 emissions is relatively large in India during 1980-2003. Mutafoglu (2012) as Acharyya (2009) uses cointegration analysis for Turkey over the period of 1987Q1-2009Q4 to investigate the relationships among Foreign Direct Investment (FDI) inflows and Carbon Dioxide (CO_2) emissions. He found there is a stable long-run equilibrium relationship among the variables and the results of the Granger causality test, produced from the error-correction model (ECM), show there is a causal relationship between the variables and lends support to the pollution-haven hypothesis. Mahmood and Chaudhary (2012) investigated the impact of FDI on CO_2 emissions in Pakistan during the period 1972-2005 by using Autoregressive Distributed Lag model (ARDL) and found FDI had a positive impact on CO_2 emissions. Blanco et al. (2013) use panel Granger causality tests to explore the relationship between sector-specific foreign direct investment (FDI) and CO_2 emissions. With a sample of 18 Latin American countries for the period 1980-2007, they show that causality is running from fdi to CO_2 emissions in pollution-intensive industries. Omri et al. (2014) using dynamic simultaneous-equation panel data models for a global panel of 54 countries over the period 1990-2011 confirm causality between FDI inflows and CO_2 emissions. Gökmenoğlu and Taspinar (2016) confirm the haven pollution hypothesis in the case of Turkey in the period 1974-2010 using Error correction model under ARDL mechanism and the Toda-Yamamoto causality. Sapkota and Bastola (2017) test the empirical validity using time series data from 1980 to 2014 for 14 Latin American countries. Results from a panel fixed and a panel random effects models confirm the relevance of the PHH. Furthermore, the results are robust to the income level of countries.

Solarin et al. (2017) investigate the pollution haven hypothesis (PHH) in Ghana during the period 1980-2012. Employing the ARDL method, they conclude to a significant and positive relation between FDI and pollution. They also show that institutional quality decreases CO_2 emissions. Sarkodie and Strezov (2019) use a panel data to verify the validity of the hypothesis for the top five emitters of the greenhouse gas (GHG) in the developing countries (China, India, Iran, Indonesia and South-Africa between 1982 and 2016). The results validate the hypothesis for all countries. To et al. (2019) use data from Asian countries from 1980 to 2016, and use panel cointegration Fully Modified Ordinary Least Squares (FMOLS) to deal with endogeneity issues and adjust their estimators for serial correlation. The study in addition uses panel dynamic ordinary least squares (DOLS), which includes the contemporaneous value, lead and lag of the first-order difference of the regression variables to correct endogeneity problems. The results of this study show that PHH is generally valid in this area. In addition, the authors show FDI has a great impact on the environment. Gharnit et al. (2019) validate the PHH in the case of 54 African countries during the period 1960-2018 by using panel cointegration analysis, Dynamic Ordinary Least Square (DOLS) and Fully Modified Ordinary Least Square (FMOLS) and Granger-Engle causality test. Gharnit et al. (2020) examine the impact of foreign direct investment inflows on carbon dioxide emissions in Morocco over the period 1960-2018. The results of the Dynamic Ordinary Least Square (DOLS) and Fully Modified Ordinary Least Square (FMOLS) estimators used show that foreign direct investment has a positive long-term relationship with carbon dioxide emissions. However, according to the Engle and Granger causality test results, foreign direct investment inflows decrease carbon dioxide emissions in the short run but behave the opposite way in the long run.

2.2. Work Invalidating the Empirical Validity of the PHH

Javorcik and Wei (2004) examine the location decision pertaining to FDI flows from multiple source countries to 25 economies in Eastern Europe and the former Soviet Union during the period 1989-1994. They show there is no systematic evidence that FDI from dirtier industries are shifting towards countries with weak environmental regulations. On the contrary, their results indicate that firms in less polluting industries are more likely to invest in the region considered. Kirkpatrick and Shimamoto (2008) use data on environmental regulation (ER) in host countries on Japanese foreign direct investment in five dirty industries to test the validity of PHH. They do not find robust evidence to support that ER is a determinant of location multinationals firms. On the contrary, the authors say "inward Japanese FDI appears to be attracted to countries which have committed themselves to a transparent and stable environment regulatory environment." Al-mulali and Tang (2013) investigated the impacts of FDI, on CO_2 emissions for the Gulf Cooperation Council (GCC) under 1980-2009 period. The fully modified OLS results reject a beneficial impact of FDI on CO_2 emissions. Haug and Ucal (2019) use linear and non-linear ARDL models to examine the effect of FDI in Turkey and CO_2 emissions. They find FDI has no statistically significant long-run effects on CO_2 emissions. Xie et al. (2020) use an extension of the panel smooth transition regression (PSTR) model with nonlinear and dynamic features to simultaneously investigate the direct and spillover influences at work in FDI inflows and CO_2 discharges. They show FDI can directly lead to an increase in CO_2 concentrations. On the other hand, the results of the economic growth spillover effect suggest that FDI can decrease CO_2 concentrations. With increasing FDI inflows, the total effect of FDI on CO_2 leakage gradually changes from positive to negative, corroborating the pollution haven and pollution halo hypotheses. Ghazouani (2021) use the cointegration tests, namely ARDL and NARDL bound test under period 1972-2016 for Tunisia. He shows that FDI inflows reduce CO_2 emissions in the long run. Bakhsh et al. (2021) show the moderating role of institutional quality in the relationship between FDI and CO_2 emissions. The authors use GMM over the period 1996-2016 from 40 Asian countries.

In conclusion, a brief review of this non-exhaustive literature shows that even if a consensus does not emerge, it can be stated that the works that confirm PHH are much more numerous than those that reject it.

3. EMPIRICAL STRATEGY

Our panel has 40 African countries[1] and 28 years (1988-2016). Some variables might not be stationary, but I(1) and the model is probably dynamic. In this paper, we use panel - ARDl model as proposed by Pesaran and Smith (1995) and Pesaran et al. (2001) which is appropriate. The advantages over other dynamic panel methods, like the fixed effects, instrumental variables or the GMM estimators, between others, is that these methods can produce inconsistent estimates of the average value of the parameters unless the coefficients are identical across countries (Pesaran and Smith 1995; Pesaran et al., 1999).

The ARDL specification possesses two significant advantages: On one hand, it makes it possible to jointly estimate the short-term and long-term parameters, and on the other hand, it makes it possible to introduce into the model variables that can be integrated of different orders, i.e. I(0) or I(1), cointegrated. As suggested by Pesaran et al. (1999), the dynamic heterogeneous panel regression can be incorporated into the error correction model using the autoregressive distributed lag ARDL (p,q) technique and stated as follows

$$\Delta y_{i,t} = \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij} \Delta x_{i,t-j} + \varphi_i [y_{i,t-1} - (\beta_{0,i} + \beta_{1,i} x_{i,t-1})] + \epsilon_{i,t} \quad (1)$$

Where y is the dependent variable (per capita CO_2 emission in our case), x a vector of independent variables, including per capita FDI and control variables (GDP per capita and the urbanization rate UR)[2], λ and δ are the short-run coefficients of the lagged dependent and independent variables respectively, β are the long-run coefficient, φ represent the speed of adjustment to the

1 The selected countries are grouped in Table A2 in the Appendix.
2 The details of the construction of the different variables and the data sources are summarised in Table A1 in the Appendix.

long-run relationship, ϵ is a time-varying disturbance, and the subscripts i and t represent a country and time, respectively. The term in square brackets contains the long-run regression.

Equation (1) can be estimated by three different estimators: Mean group estimator (MG) devloped by Pesaran and Smith (1995), the pooled mean group (PMG) estimator developed by Pesaran et al. (1999) and dynamic fixed effect estimator (DFE). The PMG likelihood estimators are used to estimate long-run coefficients, capturing the pooling behavior of homogeneity restrictions, and short-run coefficients, by the average across groups used to obtain means of the estimated error-correction coefficients and other short-run parameters. The PMG constrains long-run coefficients to be identical and allows short-run coefficients and error variances to be different across groups. If this hypothesis is accepted, the PMG estimator increases the precision of the estimates compared to the MG estimator for example. The Hausman test allows us to test this hypothesis. If it is verified, the PMG estimator will be consistent and efficient.

Our sample is composed of 40 African countries and a time dimension that spans from 1988 to 2016. The dependent variable, supposed to measure the level of pollution, is the CO_2 emissions per capita (CO_2) and the explanatory variables retained are three in number; the variable of interest, namely the flow of net incoming investments (FDI) and two control variables which are the GDP per capita (GDP) and the rate of urbanization (UR). The period considered spans 28 years, so it is necessary to explore the dynamics of the data to detect the degree of integration of the different variables.

The tests for unit root detection have undergone a significant evolution since the seminal work of Levin and Lin (1992). We use the tests of Maddala and Wu (1999) and Choi (2002), Levin et al., (2002) and Im et al. (1997; 2002; 2003) to test the stationarity of our different variables. All these tests assume independence between individuals. The results of these tests are presented in the Table 1.

Reading Table 1 shows that some variables are stationary in first difference, but not in level while others are stationary in level. This means some are I(1) and others are I(0). Not all tests return the similar result. This hasn't mattered much here since the necessary thing, since we are using an ARDL model, is that no variable is of type I(2).

The differences in the order of integration between the different variables could mean these variables are co-integrated. To verify this, we will test the existence of a long-run relationship between CO_2 emissions and the different exogenous variables. The cointegration tests used are those proposed by Pedroni (1999; 2004) and Kao (1999) based on the Engle and Granger and test (1987). These tests take into account the heterogeneity of individuals through specific parameters for each country in the sample.

The results of the two tests are presented in Table 2.

Table 2 shows that five of the eleven Pedroni panel Cointegration test statistics and the statistic associated with the Kao test. At this stage we can conclude there is a long-run relationship between CO_2 emissions and the different explanatory variables. The further step is to estimate this long-run relationship.

4. ESTIMATION RESULTS

As noted in the previous section, we use the three estimators PMG, MG and DEF to estimate the relationship between the dependent variable and the explanatory variables. The consistency and efficiency of PMG estimates require several conditions. The first is the residuals must be serially uncorrelated, and the explanatory variables must be exogenous. We overcame this condition by retaining 1 lag for carbon emissions and for all other explanatory variables in the ARDL model.

Table 3 summarizes the results obtained for the entire sample with the three estimators as well as the results of the Haussman test.

To begin with, it should be noted that the calculated Hausman Test is −3.30 when we compare PMG estimator and MG and 3.73 with P = 0.2922 when we compare PMG and DEF estimate. We conclude a null hypothesis is not rejected, and the PMG estimator is preferred to the mg and def estimators. We will therefore limit ourselves to discussing the results provided by the estimator PMG. In what follows, we will limit our interpretation to the results obtained with the PMG estimator. Second, let's emphasize that the pooled error-correction coefficient is negative and statistically significant which mean there exist a long-run relationship (dynamic stability).

Our results first confirm the various empirical studies on the determinants of CO_2 emissions. Thus, in Africa as in other regions, the development of local economic activities and subsidiaries of multinationals as well as increasing urbanization is at the origin of the rise in CO_2 emissions. There is a positive long-term relationship between GDP per capita, FDI per capita and the urbanization rate on the one hand and CO_2 emissions on the other. In the short term, only the GDP determines the level of CO_2 emissions.

Table 1: Panel unit root tests

Regressor	Level			1st difference		
	LLC	IPS	MW	LLC	IPS	MW
CO_2	−13.422***	−8.185***	422.081***	−19.076***	−16.144***	612.372***
FDI	−0.963	−2.51***	67.88***	−5.61***	−12.02***	206.425***
GDP	−2.55***	0.29	47.07	−4.71***	−5.82***	117.31***
UR	−0.74	−3.91***	333.86***	−48.90***	−20.14***	298.81***

***, **, *Indicate the degree of significance at the 1%, 5% and 10% thresholds respectively. IPS, IPS and MW refer to the tests of Im et al., (2003), Levin et al. (2002) and Maddala and Wu (1999) on Fisher-ADF P values, respectively

Table 2: Results of cointegration tests between CO_2 emissions and other variables

Test	Statistic	Weighted Statistic
Pedroni		
Panel v-Statistic	−1.290	−2.248
Panel rho-Statistic	2.692	−1.856**
Panel PP-Statistic	1.653	−8.386***
Panel ADF-Statistic	0.692	−3.328***
Group rho-Statistic	0.693	
Group PP-Statistic	−7.506***	
Group ADF-Statistic	−2.984***	
Kao	−4.829***	

***, ** and *Indicate the significance of the rejection of the null hypothesis of non-cointegration of variables at the 1%, 5% and 10% thresholds of the Pedroni and Kao tests respectively

Concerning the link between FDI and CO_2 emissions in particular, the coefficient is positive and significant at the 1% threshold. The activities of subsidiaries of multinationals contribute to the increase of CO_2 emissions in African countries. However, as we have retained GDP per capita and FDI per capita, it is possible to compare the effects of the two variables on CO_2 emissions. The coefficient associated with the FDI per capita variable is moderately lower than that associated with GDP. The activities of subsidiaries of multinationals appear to be less polluting than those of local firms. There is no specific effect of FDI on CO_2 emissions. There does not seem to be a dirty industries effect; FDI seems to favor non-polluting activities or use cleaner technologies. Ultimately, the PHH does not seem to be confirmed. These results should be taken with great caution as the coefficients for FDI and GDP are very close.

At that time we performed the causality tests, a la Granger and a la Dumitrescu and Hurlin (2012). The main results are given in Table 4 below.

We reject the null that FDI does not cause CO_2 emissions at 5% level. The null is not rejected only in the case of standard Granger causality test for the 1st order. In the case of Granger causality test à la Dumitrescu and Hurlin (2012) the null is strongly rejected and this conclusion is robust to the choice of the lag-order. As follows, we can conclude there is a causality that goes from FDI to CO_2 emissions.

4.1. The Role of Institutional Quality

To identify the extent to which institutional quality plays a role in determining the nature of the aid received by African countries, we divided our sample into two sub-samples. The first is composed of the nine countries with the best institutional quality, which is approximated by the level of corruption measured by the Transparency International index. The second sub-sample of size 32 is composed of the countries with the lowest institutional quality[3].

Again, we used all three estimators to estimate the relationship between the three explanatory variables and CO_2 emissions. We in addition used the haussman test to select the best estimator. In both cases; composite sample with high institutional quality and sample with low institutional quality, the PMG estimator was preferred. In fact, In the case of the sample of countries with high institutional quality, the calculated Hausman Test is −5.00 when we compare PMG estimator and MG and 2.10 with P = 0.5522 when we compare PMG and DEF estimators. In the case of the sample of countries with low institutional quality, the calculated Hausman Test is −5.29 when we compare PMG estimator and MG and −26.72 when we compare PMG and DEF estimators. In both cases we conclude that null hypotheses cannot be rejected and PMG estimators are preferred to the mg and def estimators. At this place once more, we will limit ourselves to discussing the results provided by the PMG estimators.

The results of the estimation are detailed in Table 5

Initially, we note that for both samples, the pooled error-correction coefficient is negative and statistically significant and is not lower than −2 which means that there exists a long-run relationship between CO_2 emissions and the other explanatory variables (dynamic stability). As expected, GDP positively and significantly affects CO_2 emissions in the long run, regardless of the quality of institutions. The rate of urbanization also positively affects CO_2 emissions significantly in the case of countries with low institutional quality and insignificantly in the case of countries with high institutional quality. In the short term, the effect of FDI on CO_2 emissions is not significant for both groups of countries. For the rest, several differences, depending on the quality of the institutions, can be noted. In countries with high institutional quality, the effect of GDP is not significant while the rate of urbanization increases CO_2 emissions. In countries with low institutional quality the opposite result is observed.

Regarding the role of FDI on environmental quality, which is of particular interest to us here, the results obtained from the two samples are significantly different. It seems that the quality of institutions determines the nature of the FDI received by African countries. In countries with a low level of corruption, FDI significantly reduces CO_2 emissions, whereas in countries with low institutional quality, inward FDI increases CO_2 emissions. It seems that in the first case, FDI is mainly concentrated in cleaner sectors and that subsidiaries of multinationals use technologies similar to those used by parent companies located in developed countries. In countries with high levels of corruption, governments seem to find it difficult to enforce environmental regulations on multinationals where they exist.

The results of the causality tests, summarized in the Table 6, confirm this intuition.

In fact, Table 6 shows that in the case of countries with high institutional quality we strongly do not reject the null hypothesis that FDI does homogeneously not cause CO_2 emissions at 5% conventional level. In contrast, for countries with low

3 The breakdown of countries by level of institutional quality is presented in Table A2 in the Appendix.

Table 3: Results of the three estimators (All countries)

Regressor	PMG	MG	DEF
Long run			
FDI	0.0002318*** (0.0000551)	−0.0001108 (0.0006198)	0.0001468 (0.0002569)
GDP	0.0002494*** (0.000138)	0.0001983*** (0.0000722)	0.0003387*** (0.000479)
UR	0.0042076*** (0.007411)	−0.0615201 (0.0573036)	0.002195 (0.126766)
Hausman test		PMG versus MG−3.30	PMG versus DEF 3.73 [0.2922]
Short run			
Error correction	−0.3905236*** (0.0472571)	−0.6142803*** (0.0536819)	−0.1982709*** (0.0198123)
ΔFDI	−0.0001055 (0.0000907)	0.0001462 (0.0001809)	0.0002298*** (0.0000402)
ΔGDP	0.0001377*** (0.0000485)	0.0001209* (0.0000634)	0.0002976*** (0.000037)
ΔUR	−0.043101 (0.189736)	0.3028738 (0.2822001)	0.0692299** (0.0352074)
Constant	0.1499807 (0.0926434)	1.030196 (0.752803)	0.0074054* (0.0925271)
No. observations	1120	1120	1120

***, ** and *Indicate the degree of significance at the 1%, 5% and 10% thresholds respectively. Values in (.) indicate standard erros. The value between [.] indicate the P-value

Table 4: Causality from FDI to CO2 emissions (All countries)

Lag order	K=1	K=2	K=3
F-Statistic	1.20	6.16***	3.62**
W-Stat	1.87**	5.00***	5.72***
Zbar-Stat	2.19**	5.27***	3.43***

***, ** and *Indicate null hypothesis rejection respectivly at 1%, 5% and 10% levels

Table 5: PMG estimator results by institutional quality

Regressor	HIQ	LQI
Long run		
FDI	−0.0007487*** (0.0001798)	0.0002666*** (0.0000557)
GDP	0.0004941*** (0.0000274)	0.0002461*** (0.0000139)
UR	0.0022735 (0.0020885)	0.0037523** (0.0006926)
Short run		
Error correction	−0.3792059*** (0.1302296)	−0.4160053*** (0.0563332)
ΔFDI	0.0001278 (0.0001809)	−0.0001202 (0.0001105)
ΔGDP	0.0002237 (0.0002237)	0.0001074** (0.0000494)
ΔUR	0.4634424*** (0.1434555)	−0.2018236 (0.2046427)
Constant	0.1825689 (0.2117282)	0.3303616 (0.1033172)
No. Observation	252	868

Table 6: Causality from FDI to CO_2 emissions (countries with high institutional quality)

Lag order	K=1	K=2	K=3
Countries with HIQ			
F-Statistic	8.24***	12.33***	6.95***
W-Stat	1.64	3.31	4.45
Zbar-Stat	1.01	1.36	1.04
Countries with LIQ			
F-Statistic	9.73***	2.59	4.30***
W-Stat	2.04*	6.27***	6.67***
Zbar-Stat	2.02*	5.79***	3.64***

***, ** and * indicate rejection respectivly at 1%, 5% and 10% levels

institutional quality, we reject the null hypothesis that FDI does not homogeneously cause CO_2. These results, are once again, robust regardless the lags order considered.

5. CONCLUSION

The relationship between FDI and CO_2 emissions continues to remain a controversial topic in the economic literature. One of the most important manifestations of this relationship is the PHH. The latter states that FDI causes negative effects on the quality of the environment in developing countries. One of the predictions of this hypothesis is that FDI from rich countries, supposed to have stringent environmental legislation, to developing countries, which are supposed to be environmentally lax, contributes to CO_2 emissions to a greater extent than local activities.

In this article we wanted to assess the empirical validity of the PHH hypothesis. Africa looked like to us the ideal setting to do so. Our results show that the link between FDI and pollution is relatively complex. If in general, the PHH does not seem to be validated, the result is quite the opposite when we consider the institutional quality in the various African countries. Indeed, our results show that the quality of institutions determines the nature of FDI received by African countries. In countries with a low level of corruption, inward FDI significantly reduces CO_2 emissions, while in countries with low institutional quality, inward FDI increases CO_2 emissions.

Our result is extremely important insofar as it allows a reconciliation between economic development through, among others, the attraction of FDI and the preservation of the environment through the limitation of CO_2 emissions. Our results show that for African countries, it is not enough to have rigorous environmental legislation; they must also have the institutional capacity to enforce it. Thus, improving the quality of institutions in African countries is a necessary condition for them to put in place policies that aim to attract clean industries and force multinationals to use energy-efficient technologies.

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APPENDIX

Table A1: Definitions and sources of variables used in regression analysis

Variable	Definition and construction	Source
CO_2	CO_2 emissions (metric tons per capita) are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas	World Bank
FDI	Foreign direct investment, net inflows (BoP, current US$) Foreign direct investment refers to direct investment equity flows in the reporting economy	World Bank
GDP	GDP per capita in us 2011 constant dollars	World Bank
UR	People living in urban areas (in % of total population)	World Bank

Table A2: Distribution of countries by level of institutional quality

High institutional quality countries	Low institutional quality countries	
South Africa	Angola	Mali
Botswana	Benin	Mauritania
Egypt	Burkina Faso	Mozambique
Eswatini	Cabo Verde	Niger
Ghana	Cameroun	Nigeria
Mauritius	Congo D.R.	Uganda
Tunisia	Congo R.	République centreafricaine
Morocco	Côte d'ivoire	Rwanda
Seychelles	Ethiopia	Senegal
	Gabon	Sierra Leone
	Guinea	Sudan
	Guinea-Bissau	Tchad
	Equatotila Guinea	Togo
	Kenya	Zambia
	Madagascar	Zimbabwe
	Malawi	
9 countries		31 countries