INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN ECONOMICS & MANAGEMENT SCIENCES

OPEN ACCESS JOURNAL

Vol 12, Issue 4, (2023) E-ISSN: 2226-3624

Foreign Direct Investment and Environmental Degradation in Developing Countries: Does the Quality of Institutions Matter?

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To Link this Article: http://dx.doi.org/10.6007/IJAREMS/v12-i4/19910 DOI:10.6007/IJAREMS/v12-i4/19910

Published Online: 07 December 2023

Abstract

Most developing countries lack adequate financial resources to achieve their sustainable growth goals. As a result, developing countries, depend on foreign direct investment (FDI) to fill the gap. FDI flows have increased significantly around the world, especially in the last two decades to grow capital investment and competitiveness in host countries. Nonetheless, the surge in FDI raises concerns about its potential impact on environmental degradation. Most developing countries face serious environmental challenges because most of these countries are in transition where production activities and energy consumption exponentially rise, and access to cleaner environments and investment in environmental pollution abatement continues to be problematic. Therefore, this study examined the relationship between FDI and environmental degradation in 80 developing countries for the period 2000-2018 using Generalized Method of Moments (GMM) and Least Square Dummy Variable Corrected (LSDVC). The results indicate a positive relationship between FDI inflow and environmental degradation in developing countries. Furthermore, results suggest a significant positive relationship between FDI and environmental degradation in only middle-income countries when categorized into income groups. Interestingly, the magnitude of the impact reduces as the quality of institutions increases in these countries. In addition, results confirm a significant positive relationship between degradations and economic growth, energy usage, and population density. These results suggest that, while the negative impact of FDI does not necessitate concerted efforts to reduce it due to its enormous contribution to the economy, adequate efforts must be made to ensure that real FDI does not continue to contribute significantly to emissions.

Introduction

Economies all over the world are interested in their growth and development prospects. Most developing countries are lagging behind in this respect, characterized by high levels of unemployment, low living standards, poverty, low capital accumulation, low consumption, investment, and savings. Domestic investment in most developing countries is insufficient to stimulate the desired growth and development path. Hence, the need for foreign capital in the form of foreign direct investments (FDI). The discussions on the impact of FDI have in the past focused on the impact on the host country's environmental standards. It highlights the likely environmental standards compromises in a bid to woo FDI, resulting in a "pollution haven". However, most investment decisions in most developing countries are not based on environmental standards. Environmental costs are typically a small dot in such investment decisions (UNCTD, 2010).

Managing a balance between ensuring the growth and development of a nation and the maintenance of the environment to ensure a balanced ecosystem is an issue most economies have to grapple with. Environmental sustainability refers to the long-term preservation of valuable natural resources within a developing human context (Dkhili, 2019). While sustainability is a characteristic of dynamic systems that self-maintain over time, it is not a predefined endpoint. With sustainable development comes the issue of a sustainable environment. Due to the effectiveness of FDI in transferring needed capital and modern technology across borders, it is frequently desired by recipient or "host" countries and can be a critical channel for stimulating and spreading the type of innovation and investment required for environmentally sustainable economic growth and development. However, as recent debates over multinational corporations' (MNCs) behaviour demonstrate, FDI does not necessarily result in net economic, social and environmental gains. The activities of FDI could lead to the degradation of the environment through the emission of greenhouse gases, especially CO_2 emissions. Global CO_2 emissions have been the primary contributor to environmental deterioration and climate change risk over the last four decades (Hunjra et al., 2020).

Historically, FDI has been based on the use and extraction of natural resources, primarily agriculture, minerals, and fuel production. This balance, however, has altered in recent years. The world's poorest countries continue to disproportionally share of investment in their natural resource sectors (Hajzler, 2012; Mihalache-O'Keef & Li, 2011). At both the macro and micro levels, the influence of FDI on environmental concerns has received increased attention. From a macroeconomic standpoint, it has sparked concern among governments and the international community as to whether FDI may harm the natural environments of the host countries. While at the micro level, the issue of corporations seeking FDI regardless of the environmental cost has garnered much attention (Li et al., 2019). However, the effect of FDI on environmental quality has not been sufficiently researched, and the available information on the FDI-environment relationship is contradictory (Kostakis, Lolos & Sardianou, 2017).

Natural resources are critical for any economy's growth and are critical for the promotion of the manufacturing and service sectors. However, during the last few decades, these resources have been disproportionately impacted by urbanization and rapid growth, particularly in developing economies (Farooq et al., 2020). As a result, many emerging countries are concerned about environmental difficulties such as deforestation, water scarcity and pollution, air pollution, biodiversity loss, and a decline in the wildlife. Poor environmental quality has a detrimental effect on humans, resulting in social losses (i.e. loss of healthy life, discomfort, and premature death), economic losses (i.e. decreased global tourism, soil erosion and wastage of other natural resources), and ecological losses (i.e. diminished recreational values of forests, lakes, and canals) (Hussein, 2008). However, empirical studies indicate that FDI inflows have a significant impact on stimulating growth in host countries via creative activities, technology transfers, and spill-over effects (Destek & Sinha, 2020).

The link between FDI and the environment is mostly studied through the lens of two opposing hypotheses: the pollution heavens theory and the pollution haloes hypothesis. According to the first, established economies enforce strong environmental regulations, whereas certain (mostly developing) countries have low environmental regulations, luring "dirty" sectors (Levinson, 1996; Hassaballa, 2014). This tendency results in the specialization of polluting sectors in emerging countries and non-polluting industries in mature economies. Additionally, empirical research indicates that high polluting sectors in developed countries frequently relocate to less developed economies with laxer environmental regulations in an attempt to skirt strong environmental regulations.

The pollution haloes hypothesis, on the other hand, is supported by the neo-classical school of thought, which claims that FDI inflows and environmental quality are linked through advancement in technology and knowledge spill-overs with the transfer of more environmentally friendly technologies from advanced economies to developing countries (Gorg & Strobl, 2005). Thus, FDI and environmental pollution in developing countries have a negative or neutral association, or FDI has a positive or neutral link with clean energy consumption (Lee, 2009). According to previous studies such as Kim and Adilov (2012), FDI causes pollution halo effects by spreading good management practices and sophisticated environmentally friendly technology, resulting in less pollution.

However, Hunjra et al. (2020) believe that environmental degradation decreases when government institutions are sufficiently successful at enforcing accepted environmental norms and laws. According to Hunjra et al. (2020), for FDI to have a beneficial influence on the environment, robust governance and high-quality institutions must be in place to monitor the behaviour of enterprises backed by FDI flows. However, a rise in FDI inflows greatly accelerates environmental degradation, thus compromising the quality of the environment. Institutions and governance were found to significantly mitigate the negative consequences of this connection, while host country-specific actions also have an influence on the environment. Additionally, institutions are critical for a variety of development initiatives in underdeveloped countries, including environmental conservation and FDI. According to Chhibber and Laajaj (2008), countries with strong institutions grow faster and are more capable of addressing environmental challenges. The low quality of institutions prevalent in the majority of developing countries is associated with environmental degradation caused by inefficient allocation of resources and misuse of foreign assistance. Institutional factors such as inadequate governance can have a detrimental effect on environmental quality if left unchecked. Institutional characteristics such as sound laws, rules, and policies are thought to influence environmental quality. Environmental pollution can be significantly decreased with well-defined and well-implemented rules, regulations, policies, and programmes. As a result, increased institutional quality is likely to translate into increased environmental quality.

Schmieding (1993) stated that institutions include not only bureaucracies and administration but also, and perhaps more importantly, the entire body of formal laws, rules, and regulations, as well as informal conventions and patterns of behaviour that serve as the non-budget constraint on economic agents' ability to pursue their own individual goals. Institutional quality, which includes the rule of law, the risk of expropriation, corruption, and the efficiency of the bureaucracy, is a less-considered aspect in determining the reasons for FDI and environmental degradation, despite its significance. The quality of institutions is inextricably linked to the reduction of information asymmetries regarding market circumstances, goods, and participants, which can boost both local and foreign investment. Indeed, developing countries' ability to construct an effective FDI-friendly policy requires a better knowledge of the function of institutions in boosting FDI inflow and its influence on the environment. Therefore, to reap the full benefits of FDI, developing nations must reinvent themselves through the establishment of a sound, transparent, broad, and effective enabling policy environment for investment and build strong and quality institutions to ensure the enforcement of policies and human capacity adequate to handle the investment flow and a healthier environment.

Recent literature suggests that institutions play a significant role in preserving the quality of the environment and biodiversity. In this study, the soaring environmental problems in developing countries were investigated on the basis of FDI. Mixed findings have been largely reported in the empirical literature, and consensus has not been reached as to whether FDI is a significant determinant of environmental degradation in developing countries, hence the two opposing views on the relationship between FDI and the environment—the arguments of the "pollution haven" and "pollution halo" hypotheses. The rising pollution level of developing countries is worrisome in the face of poor institutions. Hence, this study examines the role of institutions in the FDI and environment relationship in 80 developing countries, using the asymptotic efficient generalized method of moment (GMM) and the bias-corrected least squares dummy variable (LSDVC).

Literature

Foreign investments have helped some developing countries cover up a lack of financial resources, skilled employees, and technological know-how, according to empirical evidence. One of the accelerators for economic expansion has been the flow of people, resources and expertise into a country. FDI has also aided in the development of robust capital formation in developing nations, bridging the gap between the domestic and international markets. However, this section review studies that focused on the relationship between FDI and the environment, as well as considering the role of institutional quality in the FDI-environment relationship. In order to establish a clear-cut link between FDI and the environment, Huang et al. (2019) investigate the association between the environment and FDI using the two-step system GMM to establish fresh evidence. The findings suggest that carbon emissions discourages FDI inflows (given a negative relationship between the variables), while it has a positive effect on renewable energy. This implies that carbon emission increases renewable energy development and decreases FDI inflows. Additionally, Al-Mulali and Tang (2013) examined the validity of the PHH in Gulf Cooperation Council (GCC) states using a Fully Modified Ordinary Least Squares (FMOLS). The study found that FDI inflows had a long-run negative correlation with carbon emissions. Similarly, Cole and Elliott (2005) examined the influence of FDI on pollution in Brazil and Mexico using the random and fixed effects. The study concluded that FDI had significantly increases the levels of pollution in the two countries over the years.

On the other hand, Kingston (2011) explored the causal link between mineral extraction, economic growth, and environmental degradation in Nigeria's Niger Delta area, using the OLS. The outcome of the estimate indicates that environmental pollution and FDI are statistically related in Nigeria. Additionally, the link between FDI and environmental sustainability was examined in this study. Li et al. (2019) design a panel quantile regression model to assess the influence of FDI on environmental performance (EP). Using panel data from 1990 to 2014. The study revealed that, FDI has a minor influence on EP in general. In addition, it suggests that the influence of FDI on EP varies considerably between develop and developing countries. Similarly, Kostakis et al. (2017) conduct an empirical analysis of the impact of FDI inflows on environmental quality in Brazil and Singapore. The empirical study is multivariate in nature and employs a range of models (ARDL, FMOLS, and OLS) from the early 1970s through 2010. The findings reveal that whereas FDI inflows have harmed the environment in Brazil, they have not harmed the environment in Singapore. The findings emphasize the critical role of FDI's sectoral makeup in determining its influence on environmental quality.

In order to understand the relationship between FDI and institutional quality, the following studies were reviewed: Ali et al (2011) carried out a study on the role of institutions in determining FDI. Between 1981 and 2005, the study examined a wide panel of 107 nations. The analysis discovered that institutions are a strong predictor of FDI and that the most important institutional characteristics are related to intellectual property rights, the rule of law, and the danger of expropriation. The study found that while institutions have little effect on FDI in the primary sector, institutional quality matters for FDI in manufacturing, particularly in services. Additionally, Saibu and Mesagan (2016) examined the association between FDI and corruption using data from 48 countries from 1998 to 2014. Corruption is a statistically significant feature that has a detrimental effect on investment inflows, the findings indicate. He asserts that a 1% reduction in corruption can result in a 10% rise in FDI inflows.

Furthermore, in order to understand the relationship between environmental quality and the role of quality institutions, which is the main focus of this paper, the following literatures were reviewed: Alege and Ogundipe (2013) used co-integration analysis to investigate the influence of institutional quality and environmental quality. In their environmental–economic model, carbon dioxide emissions were included as an endogenous variable. Instead of the EKC, they found a monotonic positive linear between GDP and carbon dioxide emissions. This is in line with Kingston (2011). Similarly, Hichem (2018) empirically confirms that the level of growth has a positive effect on the level of environmental performance and institutional quality significantly influences the quality of environment, using the GMM.

Using the case of some African countries, Egbetokun et al. (2020) investigate the EKC in terms of the impact of institutional quality on six variables of environmental pollution including; carbon dioxide (CO_2), nitrogen oxide (N_2O), suspended particulate matter (SPM), rainfall, temperature, and greenhouse emissions (GHG). The study applied the Auto Regressive Distribution Lag (ARDL) econometric approach. The findings suggests the existence of EKC for CO_2 and SPM. Similarly, Ali et al. (2019) used dynamic panel GMM estimates to empirically assess the dynamic influence of institutional quality on carbon dioxide emissions across 47 developing countries. Empirical findings show that institutional quality lowers carbon dioxide emissions and, as a result, lowers the amount of environmental deterioration in the countries studied. This conclusion implies that higher-quality institutions will aid in improving environmental quality. Lau, Choong, and Eng (2014) used the bound testing technique to investigate the influence of quality institutions and carbon dioxide emissions on economic development in Malaysia from 1984 to 2008. Its co-integration results revealed a long-term link between variables. That is, institutional quality, carbon emissions, and exports all have a positive and considerable effect on economic development. When carbon dioxide emissions and institutional quality combine, the effect is positive and substantial for economic growth. This study implies that high-quality institutions may successfully act to reduce carbon dioxide emissions, thus enhancing environmental quality while also boosting economic development. The contributions of institutional structures in lowering carbon dioxide emissions were also confirmed by the Granger causality tests. Economic growth is influenced by institutional integrity both directly and indirectly through the continual decrease of carbon dioxide emissions.

Several other studies also incorporated the role of institutional quality in different environmental models. For example, Ibrahim and Law (2015) also looked at the marginal impacts of institutional quality in the trade-environment model for 40 Sub-Saharan African (SSA) countries. They used the system-GMM. The findings found that the environmental impact of trade is influenced by the quality of institutions in these countries. Specifically, the study suggests that trade openness has a detrimental impact on environmental quality in countries with weak institutions, whereas it tends to benefit those with strong institutions. Implying that, a country must have a relatively strong institutions in order to benefit from trade in terms of environment. In addition, Hunjra et al. (2020) investigate the moderating influence of institutional quality in the finance-environment relationship in South Asian from 1984 to 2018. The study found that financial development in this region increases CO_2 emissions, meaning that governments in South Asia have used financial development for capitalization rather than increased manufacturing technologies. The detrimental impact of financial development on environmental sustainability is mitigated by institutional quality. Hence, efforts to increase institutional quality might aid in the promotion of sustainable development in South Asia.

By synthesizing the research, we may conclude that diverse studies have produced inconsistent findings, leaving open the question of how and to what degree institutional quality and FDI have beneficial or detrimental effects on environmental deterioration. The majority of research indicates that institutional quality can help to control FDI flows, which can have a detrimental effect on the environment of the host country. However, there is very little if any to show the joint influence of FDI and institutional quality on environmental quality especially in developing countries in the literature (see, Ali et al., 2011; Saibu & Mesagan, 2016; Buchanan et al., 2012; Mengistu & Adhikary, 2011).

In addition, the discrepancies observed in the literature could be as a result of several influencing factors ranging from the structure peculiarity of the economies, the level of institutions, income heterogeneity and the empirical methodologies employed in previous studies. This study therefore seeks to bridge this gap by employing a panel dataset of 80 developing countries for the period 2000-2018 to investigate the relationship between FDI and environmental degradation using generalized method of moment (GMM) and the least squares dummy variable corrected (LSDVC), which are efficient dynamic panel estimators, while addressing the moderating role of institutional quality on the FDI-environment relationship on the other hand. Also, the study will classify developing countries into their respective income categories according to the World Bank classification of countries. This strategy would help to eliminate the income heterogeneity problem.

Empirical model

To achieve the objective of this study, that is, investigating the role of institutional quality on the relationship between FDI and the environment, this study follows Seker et al. (2015) specifies the following model accordingly.

$$EVD_{it} = \alpha + \beta X_{it} + \mathcal{E}_{it} \quad (1)$$

However, following the specification of the EKC model which is a traditional environmental pollution model that assumes environmental degradation as a function of income (Y) and the squared of income (Y^2), Where income captures the nature of the pollution-income relationship during the early stages of development, and the square of income verifies the EKC's validity by indicating whether a turning point has happened or not, we modify the model as follows:

$$EVD_{it} = \beta_1 Y_{it} + \beta_2 Y^2{}_{it} + E_{it} \quad (2)$$

Where *EVD* represents environmental degradation, *E* is error term, while the subscripts *i* and *t* denote individual countries and time, respectively. Adding other exogenous variables to (2) following (Zheng & Shi, 2017; Lian et al., 2016; Chandran & Tang, 2013; Al-Mulali & Tang, 2013) we have:

$$EVD_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 Y^2{}_{it} + \beta_3 FDI_{it} + \beta_4 INST_{it} + \beta_5 FDINST_{it} + \beta_6 EC_{it} + \beta_7 PD_{it} + E_{it} \quad (3)$$

Where *FDI* represents foreign direct investment, *EC* is energy consumption, *Z* denotes institutional quality, *FDINST* denotes the interaction between FDI and institutional quality, *PD* represents population density, while other variables are as defined in (2).

However, in response to criticisms of the EKC hypothesis's quadratic form, Narayan and Narayan (2010) proposed and implemented the EKC model's linear form, which they believe is more appropriate and produces more reliable results. This linear form is recommended over the quadratic form due to the quadratic form's econometric weakness. For example, Narayan and Narayan (2010) and Bah et al. (2019) found a perfect correlation between income and income-squared, resulting in a multi-collinearity problem. Hence, modify the model of this study as follows:

$$EVD_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 FDI_{it} + \beta_3 Z_{it} + \beta_4 FDIZ_{it} + \beta_5 EC_{it} + \beta_6 PD_{it} + E_{it} \quad (4)$$

Equation 4 was estimated using the generalized method of moments (GMM) estimators and the least square dummy variable corrected - developed for dynamic models. These methods are said to be superior over most dynamic panel estimators as they address the challenges from individual country effect and bias, simultaneity, and the probability of getting reliable estimates even in the presence of endogeneity of regressors (Bond, Hoeffler, & Temple, 2001; Levine, Loayza, & Beck, 2000). Furthermore, the methods are relevant to this study because they are suitable to analyze large cross-section with small time series (see Ibrahim & Law, 2015; Abdulwakil et al., 2020; Abdulwakil et al., 2023).

The Data

The study evaluates the relationship between foreign direct investment and environmental degradation among developing countries. The sample size for this study covers 80 developing countries during the period 2000-2018. This countries were selected in line with the IMF classification of countries by their level of development or income as well as on the data availability for the period of 2000 to 2018. Environmental degradation in this study is measure by CO_2 emissions obtained from the International Energy Agency (IEA). The choice of this proxy is the lack of adequate data on other measures of environmental pollution such as GHG emissions, particular matter 2.5 (PM2.5), Sulphur dioxide emissions etc. especially for developing countries. Although some of these measures have been previously adopted by several studies, the literature revealed that these studies are mostly focused in developed countries. However, a change in environmental quality as a result of changes in the flow of FDI will also affect these measures of environmental pollution.

Data on FDI, GDP per capita, population density, energy consumption were obtained from the World Development Indicators (WDI). While FDI (inflows) measures the total amounts of foreign investment received by a country during a given period of time, economic growth in this study is measured by GDP per capita (constant 2010 US$). Increased income is expected to worsen environmental pollution in developing countries. This could be as a result of rapid increased economic activities. There is a rich empirical literature on the income-environment relationship. Frankel and Rose (2005) and Poudel et al, (2009) find that CO_2 emissions rise monotonically with income. This implies that most of the economies lack the incentives to investment in cleaning pollution even after reaching the ideal level of income. However, Panayotou et al. (2000) find the existence of EKC for CO_2 emission, suggesting that this relationship is only possible as economies shift from agriculture to manufacturing and then to service dominated economies as their incomes increase.

Energy Consumption is measured as total energy consumption per capita. Generally, energy is one of the most important input in every production process, transport system, for cooking, heating and cooling etc. Hence, it is considered one of the major causes of environmental pollution. Empirically, several previous studies included energy consumption into environmental model (see, Bah et al., 2019; Khan et al., 2013; Chandran & Tang, 2013). Majority of these studies concluded that energy consumption is a significant contributor to environmental pollution. Similarly, when population density rises, more emissions is experienced especially in urban area where there are numerous economic activities. In the case of developing countries, there is a high rate of urbanization which result in high population density and consequently, high level demand and consumption of energy and hence increased emissions. Population density is measured by a number of people per sq. kilometre of land area.

Data on institutional quality were obtained from Worldwide Governance Indicators (WGI). Institutional quality in this study is measured by the six standard measures of institutional quality by WGI which are control of corruption, political stability, government effectiveness, regulatory quality, rule of law and voice and accountability. These measures of institutional quality were converted into a single composite measure (institutions). This was done in other to prevent the problem of multi-collinearity that exist between measures of institutional quality.

Results and discussion

This section presents results of the estimation of the impact of FDI on environment for 80 developing countries for the 2000 – 2018 period averaged across five (5) periods. This was done in order to prevent the proliferation of instruments which is common problem in the GMM approach. The diagnostic test conducted revealed that the system GMM results are reliable. The Hansen test of identification restrictions showed that the instruments used for the estimation of all models are valid since all the *p*-values exceed the 0.05 level of significance. Also, the tests for first and second order autocorrelation failed to reject the null of no first and second order autocorrelation for all the estimated models (see Tables 2 and 3, respectively). Furthermore, in order to confirm the reliability of the results, we applied a different dynamic panel estimator before conclusion. Hence, the least square dummy variable corrected (LSDVC) was used, and the results are compared with the results obtained from the system GMM approach. The LSDVC was executed based on the three independent estimators (Arellano & Bond, Blundell & Bond, and Anderson & Hsiao) which are equally efficient estimators. However, the discussion is centred on the results of Arellano & Bond estimator.

The first model as shown in Table 2 is the baseline model which does not include the interaction between FDI and institutional quality. From Table 2, the system GMM results found that the lagged dependent variables of emissions is positive and significant. This is the justification for the specification of a dynamic model. Thus, the results are interpreted and discussed as follows: the results in Table 2 indicate that FDI, energy consumption, economic growth and population density are significant determinants of environmental degradation. The coefficients for FDI, GDPC, energy consumption, and population density are all positive, implying that they have significantly contributed to environmental deterioration in developing countries. While institutional quality is insignificant. Similarly, the results from the LSDVC approach show that environmental deterioration is significantly influenced by FDI, energy usage and population density. While institutional quality is negative but insignificant. These results are consistent with the system GMM model in terms of signs and magnitude of impact, except for economic growth, which is insignificant in the model. Specifically, the LSDVC estimates suggest that a 1% increase in FDI, energy consumption and population density will increase environmental degradation by about 0.035%, 1.047%, and 0.186%, respectively.

Additionally, the positive effect of FDI confirms the developing country's pollution haven argument. To be more precise, the coefficient of FDI suggests that a 1% increase in FDI results in about a 0.028 percent rise in CO_2 emissions. This conclusion is compatible with findings from prior empirical investigations, such as (Hitam & Borhan, 2012; Pao & Tsai, 2011, Merican et al., 2007). The coefficient of energy consumption implies that a 1% increase in energy consumption will result in a 0.874% increase in CO_2 emissions. While the results indicate that an increase in GDPC and population density will lead to a rise in CO_2 emissions by about 0.047% and 0.121%, respectively.

Table 2:
Summary Results on the impact of FDI on Environmental Degradation

	Difference GMM	System GMM	Arellano & Bond	Blundell & Bond	Anderson & Hsiao
L.emissions	0.359***	0.332***	0.153***	0.481***	0.192**
	(0.003)	(0.004)	(0.000)	(0.000)	(0.034)
FDI	0.035**	0.028**	0.035***	0.039***	0.019*
	(0.036)	(0.042)	(0.000)	(0.000)	(0.062)
Institutions	-0.024	-0.104	-0.039	-0.059	-0.027
	(0.663)	(0.355)	(0.700)	(0.681)	(0.915)
Energy consumption	0.839***	0.874***	1.047***	1.122***	0.975***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Real GDPC	0.000	0.047**	0.000	0.000	0.000
	(0.225)	(0.028)	(0.732)	(0.637)	(0.562)
Population density	0.127	0.121**	0.186***	0.203***	0.143**
	(0.132)	(0.045)	(0.000)	(0.000)	(0.032)
Constant		-5.529***			
		(0.000)			
Observation	389	389	389	389	389
Time period (*T*)	5	5	5	5	5
Countries (*N*)	80	80	80	80	80
Instruments	19	20	-	-	-
Sargan test (*p*-value)	26.81(0.010)	44.35(0.018)	-	-	-
Hansen *j*-test (*p*-value)	18.17(0.133)	23.28(0.138)	-	-	-
AR(1)	-0.47(0.637)	-0.06(0.950)	-	-	-
AR(2)	-1.22(0.222)	-0.75(0.454)	-	-	-

Notes: *p*-values are in parentheses; *, **, and *** represent significance at 10%, 5% and 1% levels of significance.

The second model incorporates the interaction between institutional quality and FDI (FDINST). As with the results in Table 2, the necessary diagnostic test was carried out to ascertain the reliability of our results. Hence, the estimated variables based on the models with interaction of FDI and institutional quality are interpreted and discussed as follows: the results in Table 3 indicate that FDI, energy consumption and economic growth are consistently positive and significant despite the inclusion of the interaction between FDI and institutional quality, while population density is negative but significant at 10% level. Interestingly, the coefficient of institutional quality is negative and significant. However, this discussion concentrates on the interaction between FDI and institution quality.

Furthermore, the LSDVC is applied to the second model to provide a robustness check for the results from the system GMM. The results indicate that FDI, energy consumption, economic growth and population density are consistently positive and significant, while institutional quality is negative and significant. This finding is consistent with previous empirical studies such as Saibu and Mesagan (2016) and Alege and Ogundipe (2013). Also, the results revealed that the interaction between FDI and institutional quality is although negative but insignificant. This implies that the level of institutional quality does not matter in the relationship between FDI and environmental degradation, or level of institutional quality in these countries is not enough to reduce the environmental degradation caused by FDI. These results are consistent with the results for the system GMM.

Table 3:
Summary Results on the Role of Institutional Quality on FDI - Environment

	Difference GMM	System GMM	Arellano & Bond	Blundell & Bond	Anderson & Hsiao
L.emissions	0.339**	0.379***	0.159***	0.487***	0.125***
	(0.048)	(0.006)	(0.000)	(0.000)	(0.000)
FDI	0.034**	0.040**	0.036***	0.040***	0.010**
	(0.033)	(0.034)	(0.000)	(0.000)	(0.042)
Institutions	-0.012	-0.023**	-0.042**	-0.073**	-0.029
	(0.913)	(0.049)	(0.032)	(0.024)	(0.910)
FDINST	0.001	0.002	-0.001	-0.001	-0.002
	(0.885)	(0.802)	(0.536)	(0.760)	(0.561)
Energy consumption	0.865***	0.878***	1.051***	1.118***	0.990***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Real GDPC	0.000	0.000	0.124**	0.137***	0.120**
	(0.422)	(0.579)	(0.045)	(0.000)	(0.020)
Population density	0.127*	-0.130*	0.180***	0.205***	0.154*
	(0.061)	(0.062)	(0.000)	(0.000)	(0.081)
Constant		-5.515***			
		(0.000)			
Observations	389	389	389	389	389
Time period (*T*)	5	5	5	5	5
Countries (*N*)	80	80	80	80	80
Instruments	19	20	-	-	-
Sargan test (*p*-value)	26.74(0.001)	40.41(0.000)	-	-	-
Hansen *j*-test (*p*-value)	17.98(0.121)	21.93(0.318)	-	-	-
AR(1)	-0.26(0.792)	-0.26(0.794)	-	-	-
AR(2)	-1.36(0.173)	-1.03(0.302)	-	-	-

Notes: *p*-values are in parentheses; *, **, and *** represent significance at 10%, 5% and 1% levels.

However, we further split our sample into different income categories to determine this relationship across different income groups. This is because the relationship between the variables may vary across income groups given different economic structures and environmental regulations. This serves as additionally robustness test in this study. To achieve this, the model was estimated using the LSDVC initiated by the Arellano and Bond estimator. This is because the LSDVC is a more efficient estimator when the number of cross section (N) is relatively small or finite (see Abdulwakil et al. 2020). The results are presented in Table 4 and Table 5, respectively. From Table 4, the impact of FDI on the environment by decomposing developing countries into income groups.

The results in Table 4 reveal that FDI, GDPC, energy consumption, and population density are significant determinants of environmental pollution, except in the high-income countries where FDI, GDPC and population density are insignificant. This implies that these variables are not significant determinants of environmental degradation in high income countries. On the other hand, FDI, GDPC, energy consumption, and population density have positive and significant impact on environmental degradation in low- and middle-income countries. This implies that environmental pollution increases as the FDI, economic growth, energy consumption and population increase in these countries. However, the positive effect of FDI in low- and middle income countries validates the pollution haven hypothesis. In addition, institutional quality appear to significantly reduce environmental pollution and high income and upper-middle income countries. These findings are in tandem with earlier empirical studies such as Hichem (2018) and Saibu and Mesagan (2016).

Similarly, Table 5 presents the results of the role of institutional quality in the FDI and the environment relationship by decomposing developing countries into income groups. The coefficient of the interaction between FDI and institutional quality is negative and significant mainly in high- and upper-middle-income countries, as shown in Table 5. This suggests that institutional quality matters in the link between FDI and environmental deterioration in high- and upper-income nations, but not in low- and lower-income ones. Specifically, the results suggest that a 1% increase FDI given a certain level of institutional quality, will reduce environmental degradation by 0.004% and 0.003% in high income and upper middle-income countries, respectively.

In addition, Table 5 indicates that FDI has a positive coefficient and significant across all income groups. This implies that FDI inflows significantly contributes to the level of environmental degradation in developing countries regardless of their income levels. However, the magnitude of impact in high- and upper middle-income countries is lesser compared to low- and lower middle-income countries. Similarly, energy consumption and economic growth are consistently positive and significant in middle income and low-income countries. Implying that environmental degradation intensifies as energy consumption and economic growth increase in middle- and low-income countries. However, population density is negative and significant in upper middle-income countries, while it is insignificant in high income countries.

Table 4:
Summary Results on the impact of FDI on Environmental Degradation by Income Category

	High Income	Upper Middle Income	Lower Middle Income	Low Income
L.emissions	0.759***	0.513***	0.574***	0.991***
	(0.000)	(0.000)	(0.000)	(0.000)
FDI	0.006	0.010**	0.010**	0.024**
	(0.101)	(0.036)	(0.047)	(0.021)
Institutions	-0.028**	-0.058***	-0.013	-0.261
	(0.043)	(0.000)	(0.723)	(0.278)
Energy consumption	0.071**	0.421***	0.423**	0.493***
	(0.034)	(0.000)	(0.037)	(0.003)
Real GDPC	0.005	0.043**	0.218*	0.192**
	(0.947)	(0.035)	(0.054)	(0.014)
Population density	-0.004	0.073**	0.048**	0.014*
	(0.690)	(0.033)	(0.028)	(0.051)
Number of observation	277	400	338	97
Number of countries	21	29	25	10

Notes: *p*-values are in parentheses; *, **, and *** represent significance at 10%, 5% and 1% levels.

Table 5:
Summary Results on the Role of Institutional Quality on FDI - Environmental Degradation by Income Category

	High Income	Upper Middle Income	Lower Middle Income	Low Income
L.emissions	0.761***	0.515***	0.572***	1.049***
	(0.000)	(0.000)	(0.000)	(0.000)
FDI	0.008**	0.009*	0.020***	0.046**
	(0.036)	(0.076)	(0.006)	(0.018)
Institutions	-0.033**	-0.061***	-0.027	-0.222
	(0.018)	(0.000)	(0.636)	(0.714)
FDI X Institutions	-0.004***	-0.003***	0.014	0.042
	(0.000)	(0.002)	(0.477)	(0.834)
Energy consumption	0.071	0.420***	0.424**	0.452***
	(0.217)	(0.000)	(0.041)	(0.006)
Real GDPC	0.006	0.042**	0.219**	0.249***
	(0.943)	(0.036)	(0.049)	(0.008)
Population density	-0.002	-0.073**	0.045*	0.060**
	(0.871)	(0.035)	(0.062)	(0.050)
Observations	277	400	338	57
Number of countries	21	29	25	5

Notes: *p*-values are in parentheses; *, **, and *** represent significance at 10%, 5% and 1% levels.

Discussion of Results

This research examined the influence of FDI on the environment in developing countries from 2000 to 2018. These countries are then subdivided into groups in order to investigate the possibility of income heterogeneity in the FDI-environment relationship. The findings reveal that FDI inflows have a major impact on environmental contamination in these nations. However, while considering income levels of these countries, the result shows that FDI does not significantly influence environmental degradation in high income countries. This means that high-income countries benefited from FDI inflows without transferring pollution to them. However, FDI positively and significantly determines the level of environmental degradation in middle income and low-income countries. This finding could be the result of massive industrial activity in emerging market economies, which are mostly upper middle-income countries such as Brazil, China etc.

The finding supports the pollution haven hypothesis, implying that emissions grow in lockstep with FDI. This entails pollution being exported from developed to developing countries as a result of less severe environmental legislation. This finding is in tandem with Abdulwakil et al. (2023), Rafindadi et al. (2018), Sapkota & Bastola (2017), Seker et al. (2015), and Pazienza et al. (2015). However, when countries are classified according to their income levels, the results vary. While the pollution halo theory has been proven in middle- and low-income nations due to FDI's beneficial influence on emissions, FDI inflows have had little effect on pollution levels in high-income countries.

This finding is interesting, although it is peculiar to high-income developing countries where there are stringent environmental laws and huge investments in public transport systems such as the train system and other commuter services. This helps them reduce emissions even amidst high population density. This assertion is demonstrated with the interaction term, where the results show that the FDI may reduce environmental degradation given a certain level of institutional quality. This implies that, given the level of institutional quality in high income and upper middle-income countries, an increase in FDI will result to significant decrease in environmental degradation. This could be as a result of stringent environmental protection laws that encourages the inflow of FDI in advanced technology and energy efficient machineries.

The findings also show that energy consumption significantly increases emissions. These findings are consistent with previous empirical studies such as Chandran & Tang (2013), and Shahbaz et al. (2014). Interestingly, the finding is consistent across all income groups. Finally, it is expected that high population density will results in a higher use of energy-intensive goods (Bah et al., 2019). This finding supports this empirical finding as results show that population density will positively increase the level of environmental degradation. However, the results further revealed that population density is not a significant determinant of environmental degradation in high income countries. This implies that expanding populations within high-income nations would not necessarily increase pollution as there is a huge investment public transportation unit costs, making for increased use of public transport, which reduces pollutants and improves environmental quality.

Conclusion and Recommendation

This study examined the impact of FDI on the environment for 80 developing countries for the period 2000–2018. The study employed the system GMM approach. This approach is suitable for panel studies with relatively small time series and large cross sections. In addition, the system GMM is an efficient estimator that is capable of tackling the problem of endogeneity as it produces internal instruments that help solve this problem. To further strengthen the findings of this study, we also applied the LSDVC which serves as robustness check. The results indicate that FDI has a positive impact on environmental degradation in developing countries. The positive effect of FDI validates the pollution haven hypothesis in developing countries. This result illustrates a case whereby pollution-intensive industries or companies are shifting from developed countries to developing countries, thereby increasing the net exports of pollution-intensive goods relative to domestic consumption in developing countries. However, the countries were further classified into different income categories, and the results revealed that FDI has a positive impact on environmental degradation in low- and middle-income countries. This implies that environmental pollution increases as FDI increases in these countries. In addition, the pollution haven hypothesis is validated in low- and middle-income countries, given the positive effect of FDI on environmental degradation.

Furthermore, the interaction between FDI and institutional quality is insignificant. This implies that the level of institutional quality does not matter in the relationship between FDI and environmental degradation in developing countries. More specifically, the interaction between FDI and institutional quality is negative and significant only in high-income and upper middle-income countries. This implies that the level of institutional quality matters in the relationship between FDI and environmental degradation in high-income and upper middle-income countries and can reduce the level of environmental degradation. On the other hand, it does not matter in low- and lower middle-income countries. The results also revealed that economic growth, energy consumption, and population density are significant determinants of environmental pollution, except in high-income countries, where economic growth and population density are insignificant. Generally, economic growth, energy consumption, and population density are considered important factors that influence the level of environmental degradation. However, this suggests that these variables only significantly impact environmental degradation in low- and middle-income countries during the period of study. The decline in emissions experienced in high-income countries can be attributed to the increased demand for environmental regulations, investment in abatement technologies, and energy efficiency.

The findings of this study have various policy implications. To begin with, while the negative impact of foreign direct investment does not necessitate concerted efforts to reduce it due to its enormous contribution to the economy, adequate efforts must be made to ensure that real foreign investment does not continue to contribute significantly to emissions and that multinational companies operating in the country are not there due to stronger environmental policies elsewhere. As a result, the government's environmental legislation should be strengthened. Foreign enterprises operating in the country should be subjected to stricter environmental regulations. Interestingly, institutional quality is important in the fight against environmental degradation in developing countries. Hence, the quality of institutions in developing countries should be improved. In this regard, governments can assist in the development of environmental disclosure by establishing sound institutional and policy frameworks that have long-term advantages for greenhouse gas emission reductions. A favourable institutional framework will aid in not only reducing emissions but also maximizing the benefits of foreign investment. In emerging countries, predatory FDI policies are neither necessary nor recommended. Hence, developing countries should encourage and attract FDI in industries that are both technologically advanced and environmentally hazardous.

Furthermore, funding for pollution reduction in developing countries, particularly in upper middle-income countries, should be made available. These proposals would broaden the pool of public and private investors in low-carbon energy. Subsidies may be used to speed up the diffusion of clean energy solutions and provide the required resources for research and development (R&D) to boost energy efficiency. Similarly, because energy consumption has such a large impact, these countries must implement energy-efficient and low-carbon initiatives to reduce their energy consumption impact. Although energy consumption might not be the main cause of environmental degradation in developing countries, especially in middle-income and low-income countries where the consumption of energy is relatively small. This explains the reluctance of the governments of developing countries to address the problem of environmental degradation. However, this will definitely stimulate more awareness and may even coerce policymakers to be more concerned about the environment.

The study has clearly answered the question of how and to what degree institutional quality and FDI affect the quality of the environment. This question is a result of the inconsistent findings in existing literature. The majority of research indicates that institutional quality can help control FDI flows, which can have a detrimental effect on the environment of the host country. However, there is very little, if any, to show the joint influence of FDI and institutional quality on environmental quality, especially in developing countries, in the literature. In addition, discrepancies have been observed in the relationship as a result of the structural peculiarities of the economies, income heterogeneity, level of institutions, and empirical methodologies. This study therefore bridged this gap by employing a panel dataset of 80 developing countries for the period 2000–2018, using GMM and LSDVC, which are efficient dynamic panel estimators, while addressing the moderating role of institutional quality on the FDI-environment relationship on the other hand. Furthermore, the countries were decomposed into their respective income categories according to the World Bank classification of countries. This strategy helped to eliminate the income heterogeneity problem.

This study identifies some limitations and recommendations for future research in the area of foreign finance and the environment. Firstly, there are a few variables that are relevant and could influence environmental degradation but were not included in our models. These variables include energy prices, renewable energy subsidies, etc. As a result, these variables were primarily excluded from our study as there is little reliable data on energy prices and renewable energy subsidies as a result of energy volatility and the political economy surrounding the production and consumption of fossil fuels in developing countries. Additionally, the contributions of most empirical studies (this study inclusive) often conclude that the pollution haven effects are always present in developing countries. However, since environmental regulations matter to both production and trade/investment flows, it is important to identify FDI according to the industries it is channelled to in order to make further conclusions on PHH.

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Appendix

Table 6:

List of countries

High Income	**Upper-Middle Income**	**Lower-Middle and Low Income**
Bahrain	Algeria	Angola
Chile	Armenia	Bangladesh
Croatia	Azerbaijan	Bolivia
Hungary	Argentina	Cameroon
Kuwait	Albania	Cambodia
Latvia	Botswana	Congo, Rep.
Lithuania	Bosnia and Herzegovina	Cote d'Ivoire
Mauritius	Brazil	El Salvador
Oman	Bulgaria	Ghana
Panama	Belarus	Honduras
Poland	China	India
Qatar	Colombia	Kenya
Romania	Costa Rica	Kyrgyz Republic
Saudi Arabia	Dominican Republic	Moldova
Slovak Republic	Ecuador	Mongolia
Slovenia	Gabon	Morocco
Trinidad and Tobago	Georgia	Nigeria
United Arab Emirates	Guatemala	Pakistan
Uruguay	Iran, Islamic Rep.	Philippines
	Iraq	Senegal
	Jamaica	Tunisia
	Jordan	Ukraine
	Kazakhstan	Vietnam
	Lebanon	Zambia
	Malaysia	Zimbabwe
	Mexico	Benin
	Namibia	Mozambique
	Paraguay	Niger
	Peru	Togo
		Yemen, Rep.