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The Role of Institution on FDI and Environmental Pollution Nexus: Evidence from Developing Countries

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Abstract

The research aim is to empirically study the role of institutions in the relationship between foreign direct investment (FDI) and environmental pollution in 86 developing countries during 2008–2018. This study collects key data from the World Development Indicators (WDI). Institution indicators are collected from the Global Governance Indicators (WGI). To carry out the research objectives, the authors conducted quantitative analysis through System Generalized Method of Moments (S-GMM). The research results indicate that FDI positively impacts on environmental pollution. In particular, governmental efficiency, political stability and non-violence, quality regulations, the rule of law and the voice and accountability play an important role in the FDI-environmental pollution nexus in developing countries. The findings of this study suggest that these countries in question need to consider very carefully welcoming FDI inflows. In other words, host governments should build 'filter funnel' to attract FDI for long-term development. Moreover, they also have to manage strictly foreign invested enterprises domestically in order to minimize negative impacts on environment quality. For a stable governance environment, each country must strictly follow international environmental agreements, and people and businesses must comply with environmental regulations and raise awareness of environmental protection as the foundation for economic growth and environmental sustainability.

Keywords: Developing Countries, Institutions, FDI, Environmental Pollution

JEL Classification Code: F64, G38, Q53

1. Introduction

Environmental pollution is becoming a major concern in many countries and a topic for many scholars. However, what the determinants causing environmental pollution are is still unclear and controversial. The environmental quality is getting worse due to the increasing emissions of production and consumption activities. This not only affects the quality of life and human health, but causes global warming, which seriously threatens human survival. Due to climate change, natural disasters such as super typhoons, droughts or forest fires occur continuously with increasing intensity, greater losses and wider scope.

However, some proposed solutions to improve environmental pollution currently have not been as effective as expected and need to be further studied. To cope with this problem, several United Nation climate change conferences have been organized, thereby encouraging governments to join hands in solving environmental issues. Many agreements were signed such as the Kyoto Protocol on Emission Reductions (1997) and the Paris Agreement on Climate Change (2016). Though, these efforts are not enough to improve the current environmental situation.

Remarkably, even though the current environmental problem is alarming, many developing countries have been focusing on economic growth targets while ignoring environmental hazards. In order to promote growth and investment, these countries apply policies and enforce regulations related to the protection of the natural environment that are still untighten and limited. This leads to more serious environmental problems. According to an annual study on the environment conducted by US universities and presented at the World Economic Forum in Davos, among

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the 10 countries most seriously affected by global warming, nine countries are poor and developing countries located in coastal areas on continents such as the Philippines, Nigeria, Vietnam, Haiti, Bangladesh, Papua New Guinea, Malawi, Fiji and Sudan. If this problem is not resolved, the worst thing that can happen is that some countries may be wiped out by rising sea levels. Therefore, the discovery of variables affecting the environment, from which effective solutions could be found, is essential and urgent worldwide.

Similarly, most studies show the positive impact of foreign direct investment (FDI) on economic growth (Naila et al., 2016) but its effect on environment pollution still remains unclear. According to the Pollution Halo Hypothesis, FDI will help improve environmental issues while the Pollution Haven Hypothesis assumes that developing countries, which attract more and more FDI inflows, will gradually become 'pollution havens' compared to developed countries by the process of industrialization.

The literature shows the inconsistency of FDI's impact on the level of environmental pollution or the relationship between growth and environment goals depends on the government roles in each country. Some studies indicate that environmental pollution will be more and more serious unless environmental protection policies are strictly followed. However, most of these studies are conducted from the perspective of public governance and the empirical evidence is not clear and consistent. In contrast, the quality of regulations and the degree of compliance with the law impact on increasing CO_2 emissions. In this context, the paper will contribute to the literature by exploring two research questions: first, what is the impact of FDI on environmental pollution in developing countries? Second, what is the institutional role in the relationship between FDI and environmental pollution in developing countries? To this end, the paper is structured as follows. Section 2 reviews the literature on the impacts of FDI and institution on environmental pollution. The results of empirical research are analyzed in Section 3. Section 4 concludes and offers some policy recommendations.

2. Literature Review

2.1. The Impact of FDI on Environmental Pollution

Similar to the theoretical arguments, empirical evidence on these effects has so far been inconclusive (Smarzynska & Wei, 2001). The empirical evidence on this hypothesis is inconsistent and there are many conflicting opinions (Lan et al., 2012; Solarin et al., 2017). For instance, some studies agree with the Pollution Haven Hypothesis (Mani & Wheeler, 1997) while other studies have found no empirical evidence to support it (Grossman & Kruger, 1995). Accordingly, the paper reviews these studies in the context of two main hypotheses about the impact of FDI inflows on environmental quality.

Regarding the Pollution Haven Hypothesis, empirical studies conducted by different methods (Omri et al., 2014; Jiang, 2015b; Behera & Dash, 2017) all confirm that FDI reduces environmental quality in host countries. Bakhsh et al. (2017) showed that economic growth and FDI caused environmental pollution analyzing the case of Pakistan for the period 1980–2014 by simultaneous equation modeling. At the same time, Solarin et al. (2017) supported the hypothesis of pollution haven in Ghana during 1980–2012 by using ARDL estimation method. Similarly, researching a group of countries, Abdouli and Hammami (2017) also supported the theory of pollution haven. Sapkota and Bastola (2017) confirmed that the Pollution Haven Hypothesis and the Kuznets environmental curve are valid for both high-income and low-income country groups. Most recently, Ssali et al. (2019) found that there is a significant positive outcome and unidirectional causality from CO_2 to FDI in the long run, yet no causal relationship in the short was observed in six sub-Saharan African countries for the period 1980–2014. Subsequently, Vo et al. (2019) indicated the FDI leads to an increase in environmental degradation in the first stage of economic growth and reduces it in the next stage in 25 emerging markets in Asia over the 1980–2016 Period. Nguyen (2020) shows that FDI has a positive effect on CO_2 emissions in the short term, but has no effect on the long term.

Al-Mulali and Tang (2013), testing the Pollution Halo Hypothesis, concluded that FDI helps improve the environmental quality in host countries. Indeed, Vlad and Lahiri (2009) developed a North-South game theory model with cross-border pollution and the North polluted from the South. The conclusion of the model is that FDI inflows reduce pollution. Mert and Bölük (2016) supported the Pollution Halo Hypothesis, which implies that FDI brings clean technologies and improves environmental standards. Meanwhile, Zhu et al. (2016) found that the effect of FDI on CO_2 emissions was negative, except in the fifth percentiles and became significant in the higher percentiles. In addition, Zhang and Zhou (2016) and Ayamba et al. (2019) identified that FDI contributes to reducing CO_2 emissions in China. Moreover, Hille et al. (2019) showed that FDI inflows concurrently stimulate regional economic growth and reduce air pollution intensities in 16 provinces in Korea over the 2000–2011 period. And the latest study conducted by Demena and Afesorgbor (2020) also reaffirmed that FDI significantly reduces environmental emissions in 83 empirical studies.

In addition to the two main hypotheses about the impact of FDI inflows on the environmental quality, some studies show mixed results, that is, the results depend on certain conditions. For instance, Lan et al. (2012) pointed out that

the impact of FDI on pollutant emissions depends on human capital while Chang (2015) emphasized the increase in FDI, which increases the amount of CO_2 after the threshold value of corruption is reached. Similarly, Zugravu-Soilita (2015) argued the impact of FDI on environmental quality depends on the ratio of capital to labor. Solarin and Al-Mulali (2018) investigated the influence of FDI on CO_2 emissions, carbon footprint, and ecological footprint. They have utilized the augmented mean group estimator, which is supported by common correlated effect mean group estimator in the analysis for 20 countries. The empirical results revealed that FDI has no effect on environmental degradation indicators.

2.2. The Impact of Institutions on Environmental Quality

Many scholars did not achieve consensus on empirical results of the institutional impact on environment. There are two horizontal axes on this effect. For negative effects, Goel et al. (2013) asserted that both corrupted countries and those economies featured by large underground economic sectors share similar effects in achieving less emissions. Meanwhile, Bae et al. (2017) claimed that corruption directly effects on CO_2 emissions as well as indirectly through its impact on economic growth. In particular, democracy and economic freedom increase CO_2 emissions. For positive effects, Gani and Scrimgeour (2014) found that the rule of law, the quality of laws, the control of corruption, the effectiveness of government, and the voice and explanation have an impact on reducing water pollution sources. Subsequently, Lau et al. (2014) identified a significant positive relationship between institutional quality and CO_2 emissions, meaning that good institutional quality plays an important role in controlling CO_2 emissions in the process of economic development. Similarly, Ibrahim and Law (2016) also figured out that clear institutional reforms would improve environmental quality. CO_2 emissions can have a significant and negative effect on life expectancy (Murthy et al., 2021).

Gani (2014) and Abib (2016) studies showed the political stability index (in the institutional set) positively impacts on CO2 emissions. Accordingly, Gani (2014) examines the relationship between the 5 dimensions of governance (political stability, government effectiveness, quality of laws, legislation and control of corruption) and CO_2 emissions in 99 developing countries, during 1998–2007 by using the Fixed Effects method. The results indicated that political stability, legislation and control of corruption are statistically significant and reduce CO_2 emissions per capita. Concurrently, Abid (2016) found that political stability, government efficiency, democracy, and corruption control reduce CO_2 emissions while the quality of laws and the rule of law state increase CO_2 emissions.

2.3. The Role of Institutions on FDI-Pollution Nexus

There are empirical studies on the relationship among institution, FDI and environment pollution such as Damania et al. (2003), Wang and Chen (2014), Ibrahim and Law (2016). However, this relationship is still being debated. The paper will briefly review some typical studies.

Damania et al. (2003) used Random Effect econometric method for the panel data of 30 developed and developing countries from 1982 to 1992 to find out some important points. First, countries with more open trade regimes tend to have stricter environmental regulations. Second, corruption seriously undermines environmental policies. Moreover, reducing corruption creates a greater effect on environmental policy in relatively closed economies. In essence, distorted trade policies increase the effect of reducing corruption on environmental standards. Protection and corruption are, therefore, complementary in creating environmental policy distortions.

Cole et al. (2006) empirically tested the data from 33 countries (including 13 OECD countries and 20 developing countries) from 1982–1992 by FE, RE and IV (2SLS) methods. The experimental results demonstrated that FDI positively impacts on environmental regulation in all models. The interaction variable between FDI and corruption was also analyzed with the result of being statistical negative in all models, showing the effectiveness of FDI in environment regulations depending on corruption.

Wang and Chen (2014) examined the relationship between institution and FDI's impact on the environment in China (specifically, proxied by sulfur dioxide emissions in industry). By using the Fixed Effect method over panel data of 287 cities in the period of 2002–2009, they concluded the empirical results support the Pollution Haven Hypothesis. Foreign capital flows into places where the environment is lax, creating negative environmental impacts. Weak and inconsistent environmental regulations coupled with high local economic growth and inefficiencies of competition can be combined to explain the negative external factors generated by FDI. For more developed regulation localities and stronger environmental management capacity, it will force foreign companies to apply global environmental standards and the city's overall environmental quality will rise. In contrast, the environment problems will be worse in places where institutions are not well enough.

Ibrahim and Law (2016) studied the role of FDI and institutional quality and their interaction in explaining CO_2 emissions in the panel data of 40 African countries belonging lower Sahara by S-GMM method. The results showed that institutional reform is clearly improving the environment quality. Meanwhile, the impact of trade on the environment tends to depend on a country's

institutional context. More specifically, FDI is harmful for the environment in countries with low institutional quality and good for those with high one. This means that institutional reforms are a prerequisite for countries to realize the beneficial environmental impacts of trade. For countries with good institutional quality, trade and institutions reinforce each other in reducing pollution. Ibrahim and Law (2016) argued that institutional quality is important in FDI and environment relations, where environmental quality is related to strict environmental policies. Therefore, the study also analyzes the role of mitigation or supplementation of institutional quality in the FDI-environment relationship by putting the interaction variables into the model. Other works of Bhattacharyya and Hodler (2014) also used interaction variables to investigate the role of institutions in the FDI-environmental quality nexus.

Cong and Hong (2019) empirically investigate how FDI affects air pollution and how this effect depends on institutional quality. By using a panel data for 19 Asian countries over the period of 2002–2015, the authors find that FDI inflows initially increase air pollution in Asia and the institutional quality improvement reduces this effect until it obtains a threshold, then beyond this, FDI reduces air pollution. The findings indicate that the Pollution Haven Hypothesis and the Pollution Halo Hypothesis are not contradictory when the institutional quality is taken into consideration. This consolidates the institutional reform in Asian countries in attracting FDI and diminishing the air pollution simultaneously.

3. Research Methods

3.1. Data

The data derived from the World Bank's data source. Specifically, the paper collects key data from the World Development Indicators (WDI). Institutional indicators are collected from the Global Governance Indicators (WGI). The study extracted data from 86 developing countries around the world from 2002 to 2018.

The sample of developing countries includes Algeria, Angola, Armeni, Azerbaijan, Bahrain, Bangladesh, Barbados, Belarus, Belize, Benin, Bhutan, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Cambodia, Central African Republic, Chile, China, Colombia, Congo, Dem. Rep., Congo, Rep., Costa Rica, Cote d'Ivoire, Croatia, Czech, Dominican Republic, Egypt, El Salvador, Estonia, Fiji, Ghana, Georgia, Guatemala, Honduras, Hungary, India, Indonesia, Iran, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyz, Lao, Latvia, Lebanon, Liberia, Lithuania, Madagascar, Malaysia, Mali, Malta, Mauritius, Moldova, Mongolia, Morocco, Namibia, Nepal, Nicaragua, Nigeria, Oman, Pakistan, Paraguay, Peru, Philippines, Poland, Romania, Russia, Sierra Leone, Slovak, Slovenia, South Africa, Sri Lanka, St. Lucia, Suriname, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, Uruguay and Vietnam.

3.2. Variables

All variables are described and measured as follow (see Table 1).

3.3. Model

In order to test the impact of FDI inflows on the environment pollution, based on the studies of Cole (2006), the paper adds FDI variable to the empirical model. If FDI positively impact on CO_2 emissions, the Pollution Haven Hypothesis is supported then if the empirical results show a negative effect, the Pollution Halo Hypothesis is followed. Accordingly, the empirical model is formed as:

$$\begin{aligned} \mathrm{LnCO}_{2it} = {} & \alpha_{it} + \beta_1 \mathrm{lnCO}_{2it-1} + \beta_2 \mathrm{lnGDP}_{it} \\ & + \beta_3 \mathrm{FDI}_{it} + \beta_4 Z_{it} + \vartheta_i + \varepsilon_{it} \end{aligned} \quad (1)$$

In which: i and t represent country i and the time t.

CO_{2it} is a representative variable for the status of environmental pollution, measured by CO_2 emissions per capita in the country in the form of logarithm.

GDP_{it} is a variable representing income, measured by the annual real per capita income in the country i in the form of logarithm.

FDI_{it} is a representative variable for net foreign direct investment capital, measured by percentage of FDI into the country i in year t (% of GDP).

ϑ_i is an unobservable error (country specific, constant over time) and εit is an error term.

Z_{it} is a set of control variables as domestic investment, trade openness, energy consumption, infrastructure development as well as urbanization. The selection and use of control variables are made on the basis of theory and profile of previous studies, specifically.

Urbanization and industrialization are measured in turn by the ratio of urban population to the total and the ratio of added value of major industries to GDP. Recent studies show that the degree of urbanization and industrialization has a strong impact on environmental pollution (Wu et al., 2016; Canh et al., 2018; Canh et al, 2019). The greater degree of urbanization and industrialization leads to more production and consumption activities, thereby increasing CO_2 emissions.

Table 1: Variables and Measurement

Variables	Description and measurement
$lnCO_2$	CO_2 emissions per capita, representing environmental quality (logarithm)
FDI	Net foreign direct investment of a country (% GDP)
ins	Institutions measured by 6 variables of the Governance Indicators scaled from −2.5 to 2.5
lnrgdp	GDP per capita (logarithm)
urban	Percentage of urban population compared to total population (%)
industry	Value of industry sector (% GDP)
dinv	Domestic investment (% GDP)
open	Total of export and import values (% GDP)
inf	Infrastructure proxied by a number of fixed telephones on 100 people (logarithm).
energy	Energy consumption
ins1	Control of Corruption Index
ins2	Government Effectiveness Index
ins3	Political Stability and Absence Index
ins4	Regulatory Quality Index
ins5	Ruler of Law Index
ins6	Voice and Accountability Index

Domestic investment is the annual gross domestic investment divided by GDP, measured by percentage of GDP. Domestic investment is considered as one of the current sources of pollution. The fact of increasing investment to expand production contributes to an increase in emissions from these activities (Jiang, 2015b; Sapkota and Bastola, 2017). Therefore, an increase in investment is likely to increase CO_2 emissions.

Openness is determined by total import-export divided by GDP, measured in percentage of GDP. Import and export activities help stimulate production and consumption. Both activities contribute greatly to the harmful emissions to the environment (Abid, 2016; Abdouli and Hammami, 2017; Solarin et al., 2017). Although Cole (2006) argued that trade openness can reduce pollution because countries have improved access to environmentally friendly technologies. However, the opposite effect may also occur. Under the Pollution Haven Hypothesis, developed countries can export their dirty industries such as petrochemical and cement industries to developing countries with lower environmental standards. In such a play, higher trade openness may increase environmental problems.

The positive relationship between energy consumption and CO_2 emissions is explained by many studies on climate change (Tsuji et al., 2002). The high consumption of energy in production and daily life is a major cause of the greenhouse effect, contributing to climate change. Notably, this phenomenon becomes more particularly serious in developing countries. Energy consumption is the main factor leading to serious air pollution in megacities. Therefore, the most debated issue in energy management workshops is the solutions to limit the dangers of excessive energy consumption to the environment (Tsuji et al., 2002). Accordingly, the paper expects a positive relationship between energy consumption and CO_2 emissions.

Infrastructure is measured by the number of telephone subscribers per 100 people in the form of logarithm. Infrastructure development creates both direct and indirect effects on emissions. The direct impact comes from the construction of the main infrastructure such as roads, piers, telecommunications, etc., meanwhile the indirect effect is to promote production activities through convenient distribution of goods and services. Studies related to the use of infrastructure variables as Cole et al. (2006), Bakhsh et al. (2017). Accordingly, the paper expects a positive impact of infrastructure on CO_2 emissions.

In order to assess the effect of institutions on the correlation between FDI inflows and environment pollution, the paper in turn added institutional variables and interaction variables between the two into the empirical model. Thereby, the experimental model formulates as following:

$$\begin{aligned} \mathrm{LnCO}_{2it} = \alpha_{it} + \beta_1 \mathrm{lnCO}_{2it-1} + \beta_2 \mathrm{lnGDP}_{it} + \beta_3 \mathrm{FDI}_{it} \\ + \beta_4 \mathrm{INS}_{ijt} + \beta_5 Z_{it} + \vartheta_i + \varepsilon_{it} \end{aligned} \quad (2)$$

$$\begin{aligned} \mathrm{LnCO}_{2it} = {} & \alpha_{it} + \beta_1 \mathrm{lnCO}_{2it-1} + \beta_2 \mathrm{lnGDP}_{it} + \beta_3 \mathrm{FDI}_{it} \\ & + \beta_4 \mathrm{INS}_{ijt} + \beta_5 \mathrm{INS} \times \mathrm{FDI}_{it} + \beta_6 Z_{it} \\ & + \vartheta_i + \varepsilon_{it} \end{aligned} \quad (3)$$

In which,

INS_{ijt} is a representative variable for the institution, which is determined by the indexes of public administration of country *i* in year *t* and the average index of public governance. Six indicators of public governance include: Controlling the level of corruption (ins1); Governmental efficiency (ins2); Political stability and non-violence (ins3); Quality regulations (ins4); The rule of law (ins5) and the Voice and accountability (ins6). The index ranges from −2.5 to +2.5.

INS × FDI_{it} is the interaction variable between the average public governance index and FDI.

Based on the conceptual framework of environmental institutions and 6 indicators of public governance of the World Bank (WGI), the paper explains the role of institutions for environmental protection as follows:

Corruption control: La Porta et al. (1999) argued that corruption tends to increase with the size of the government. Meanwhile, corruption also conflicts with the provisions of the law. Therefore, these conflicts result in corrupted societies, officials can be bribed and rules are not followed, including standards for environmental protection. Accordingly, many studies concluded that corruption negatively impacts on environmental policies, leading to an increase in air pollution emissions.

Welsch (2004) provided evidence that at low-income levels, air pollution levels as NO_2 and CO_2 sharply increase with corruption. Damania et al. (2004) also conclude that stricter policies must go hand in hand with efforts to reduce corruption. The increase in corruption reduces the strict of environmental policy. Empirical findings showed a greater degree of rule of law increases environmental policy strict, but the effect is lower when corruption is high. Biswas et al. (2012) showed the better control of corruption reduces the negative impact of the underground economy on air quality. Similarly, Povitkina (2015) investigated the impact between democracy and bureaucracy (corruption control) on environmental quality. The results indicated that the effect of democracy on CO_2 really depends on the officials' ability. Democratic countries emit less emissions if their officials' ability is high (controlling good corruption or little corruption).

Government effectiveness: Government performance measures the quality of public services and the government's commitment to implementing policies. Bernauer and Koubi (2009) found that larger government sizes tend to have lower environmental quality because large scale can be less effective in providing services. In addition, state-owned enterprises often increase with the size of the government and exemptions from control regulations can exacerbate environment pollution.

Stable political institutions: Political stability reflects the ability of the government not to be unstable or toppled through non-political means or violence. Political stability is the foundation for better governance quality, leading to strong governance institutions such as highly effective regulatory and judicial systems. Policymakers have a long period of time to set optimal policies, which can lead to environmental improvements. Fredriksson and Svensson (2003) found that political instability negatively impacts on the strict of environmental regulation in case of low corrupted level. Zugravu et al. (2009) suggested that reductions can be achieved in transition economies through the convergence of indicators of institutional quality as corruption control and political stability for industrial countries.

Quality of regulation: Formulating effective environmental regulations will reduce environmental pollution while weak or ineffective environmental policies will not achieve the goal of reducing industrial pollution. Porter and Van der Linde (1995) argued that well-designed environmental protection standards will stimulate innovation and reduce pollution.

Law enforcement effect: The provisions of law are essential to protect the environment and achieve sustainable development. The rule of law can only exist in a transparent legal system with a clearly accessible set of laws. The powerful enforcement structure protects citizens oppose the use of arbitrary power. A weak rule of law and inefficient judicial system reduce the effectiveness of environmental regulations. Fredriksson and Mani (2002) provided some evidences and suggested that a greater degree of regulation of law increases the stringent environmental policy. However, this effect may be weakened because companies increase bribery officials to circumvent environmental laws.

Voice and accountability: According to many authors, democratic institutions help improve the quality of the environment. Payne (1995) argued that people are more aware of environmental issues (free media) with democracy. They can express their concerns about the environment (free speech) and create lobby groups (freedom of association). Political leaders are reminded (the right to vote) to implement environmental policies. However, based on empirical evidence, some studies show that democratic institutions positively effect on environmental quality control while others find a negative impact. These two effects are determined by the effect of civil servant efficiency (the level of corruption) and social variables (income inequality and urbanization). Kinda (2011) provided evidence that democratic institutions attract investments that are detrimental to environmental quality. Moreover, the direct

negative impact of democratic institutions is higher on local pollutants (SO_2) than global pollutants (CO2). Povitkina (2015) argued that democracies emit less pollutants only when their civil servant capacity is high, otherwise democracies are never better than dictatorships.

3.4. Methodology

Taking advantages of dealing with econometric issues as autocorrelation, heteroscedasticity and endogeneity, the main estimation method applied is the two-step GMM estimation method (Arellano & Bond, 1991) proposed by Roodman (2006). Because the empirical models of the paper are dynamic models, it is necessary to take the first-order difference to eliminate fixed effects featured by national characteristics. Then, the variables in the model in the form of difference are used as instrumental variables with different lags, assuming that the errors that change over time in the original models are not autocorrelation (Judson & Owen, 1999). This approach is called the Arellano-Bond difference GMM estimation method with the ability to resolve bias problem due to endogeneity.

In case of lag variables provide little or no information about future values, causing their lag variables becomes weak instrument variables in the form of difference. Arellano and Bover (1995) proposed a combination of the original equation and the differential equation to form a system of two equations, a differential equation with variables that are instrumented in the level form (not lag variables) and an equation in the level form with the instrument variables in the differential form. This approach is called the Arellano-Bond system GMM estimation method, a strategy capable of increasing the effectiveness of estimates by reducing bias and well solving the problem of weak instrument variables (Blundell & Bond, 1998). The consistency of the system GMM method is completely based on the assumption that the error terms have no correlation, the appropriate instrument variables and the change in the additional instrument variables (variables other than the model included as instrumental ones) are not correlated with the national fixed effects. In particular, compared to one-step GMM estimates, two-step GMM estimates are more effective. Therefore, the Arellano-Bond two-step system GMM method (S-GMM) is recommended to ensure the lowest possible bias and higher efficiency.

4. Empirical Results and Discussion

Table 2 records the average per capita CO_2 emissions of 3.68 tons/year in 86 developing countries during the 2002–2018 period. The standard deviation is also relatively high (4.88), suggesting that there is rather large disparity between the nations in terms of CO_2 emissions that cause greenhouse effect. In general, the quality of public governance in developing countries is relatively low, below the average of zero (a neutral scale of public governance quality). In particular, middle-income and high-income

Table 2: Statistic Description

Variables	Obs.	Mean	Std.Dev.	Minimum	Maximum
CO_2 per capita	1462	3.68	4.88	0.02	37.16
RGDP per capita	1462	5915.6	5588.91	278.45	25884.2
FDI	1462	6.88	21.46	−15.66	465.84
Domestic investment	1266	24.55	7.18	6.38	69.04
Energy consumption	1282	1816.4	2115.6	147.91	15311.1
Industrialization	1376	29.81	12.44	3.36	78.22
Openness	1332	89.55	41.89	23.01	324.42
Infrastructure	1462	15.752	12.775	.006	61.418
Urbanization	1462	54.628	18.919	14.15	95.816
Institutions					
ins1	1462	−0.28	0.71	−1.54	1.74
ins2	1462	−0.17	0.72	−1.86	1.99
ins3	1462	−0.27	0.89	−2.82	1.61
ins4	1462	−0.08	0.73	−1.87	1.69
ins5	1462	−0.25	0.75	−1.80	1.65
ins6	1462	−0.17	0.82	−1.79	1.49

countries have better governance quality and are largely above the average. This implies that when incomes increase, the quality of institutions has significantly improved.

As presented, the impact of FDI on the environment pollution is still controversial and explained by two conflicting hypotheses. Therefore, this paper aims to test the impact of FDI on the environment pollution in developing countries and the empirical results are presented in Table 3.

The test results show that FDI positively effect on CO_2 emissions in developing countries. This result supports Pollution Haven Hypothesis proposed by Abdouli and Hammami (2017), Behera and Dash (2017), Sapkota and Bastola (2017), Solarin et al., (2017), Duc et al., (2019). In developing countries, the increase in FDI inflows leads to the upstream of environment pollution. Environmental problems are worse in association with rapid economic growth (Zhang & Zhou, 2016). This finding is a warning for developing countries about the negative effects of FDI inflows, which are firstly the risk of the trend of moving dirty industries from developed countries. Along with FDI inflows, multinational companies in heavily polluted manufacturing industries will move their operations to branches in developing countries (Cole et al., 2006; Williamson et al., 2006). This implies that developing countries become destinations of FDI inflows with outdated production technologies. This shift not only led to production restructuring but also changes in the trade model among countries (Cole et al., 2017).

The empirical results imply that FDI policy in developing countries should be considered carefully. On the one hand, FDI creates a great motivation for economic development goals (Adeleke, 2014). On the other hand, increasing FDI makes environmental problems more serious (Zhang & Zhou, 2016). Accordingly, the government plays a decisive role in attracting and managing FDI flows effectively. From this argument, the paper continues to debate the role of government in both institution and policy aspects in FDI-environment pollution nexus.

Table 3: The Impacts of FDI on CO_2 Emissions in Developing Countries

Dependent Variable: $LnCO_2$	
Independent Variables	**Coefficients**
CO_{2t-1}	0.9112***
GDP	0.0188***
Domestic investment	0.0019***
Openness	0.0001
Infrastructure	0.0024***
Energy consumption	0.0000***
Urbanization	0.0018***
Industrialization	0.0012***
FDI	0.0019***
Hansen test	0.4381
Sargan test	0.5394
AR (2) test	0.8927

In order to examine the role of institutions for the environment, the paper introduces the institutional dimensions of measurement as described in the model (2). The testing results are presented in Table 4.

Table 4 indicates that all the institutional indices negatively impact on CO_2 emissions in developing countries, showing the consistency for all six institutional component variables. This finding is similar to the studies of Lau et al. (2014), Gani and Scrimgeour (2014), Ibrahim and Law (2016) and Ali et al. (2019). As such, improving the quality of institutions is one of the important factors helping to hinder environmental pollution in these countries. Institutional improvement is not only a key to environmental issues, but also an important factor for economic development goals (Dorota & Wirginia, 2020). Accordingly, improving the quality of institutions can be an effective and strategic solution for the economic and environment goals in developing countries.

However, the use of six institutional indicators makes difficult in implementation. Therefore, the paper uses the institutional average variable (the average of the six institutional indices) in subsequent tests. To analyze the institutional influence in the relationship between FDI and environment pollution, the paper uses the interaction variables between the two in empirical model as described in the model (3). The results are presented in Table 5.

The figures show that the average institutional variation also has a negative effect on CO_2 emissions, implying an important role of improving institutional quality in the formulation of environmental protection policies. Moreover, the interaction variable between FDI and institutions is also negative, implying that improving institutional quality will reduce the negative impact of FDI on the environment (Bissoon, 2011). Apart from reducing direct CO_2 emissions, the fact of increasing institutional quality also reduces indirect CO_2 through the effect on FDI inflows. As the quality of institutions increases, government policies and regulations related to attracting FDI inflows become tighter, leading to high-quality FDI flows, meaning that modern technologies with more appropriate and efficient post-production waste treatment technology.

Therefore, the interaction between FDI and institutional quality has an impact on improving environmental quality and reducing CO_2 emissions in developing countries (Minh & Hiep, 2019). On the contrary, weak institutions create a disadvantage for companies, including

Table 4: The Impact of Institution on CO_2 Emissions in Developing Countries

Dependent variable: $LnCO_2$						
Variables	**INS1**	**INS2**	**INS3**	**INS4**	**INS5**	**INS6**
CO_{2t-1}	0.9118***	0.9182***	0.9225***	0.9311***	0.9228***	0.9366***
GDP	0.0288***	0.0374***	0.0158*	0.0182**	0.0362***	0.0028
Domestic investment	0.0022***	0.0021***	0.0014***	0.0012***	0.0021***	0.0011***
Openness	0.0001***	0.0001**	0.0001**	0.0002***	0.0001***	0.0002***
Infrastructure	0.0019***	0.0022***	0.0015***	0.0017***	0.0014***	0.0024***
Energy consumption	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Urbanization	0.0007*	0.0010**	0.0003	0.0008**	0.0006	0.0012***
Industrialization	0.0005***	0.0004**	0.0010***	0.0005**	0.0003**	0.0008***
FDI	0.0019***	0.0017***	0.0014***	0.0017***	0.0016***	0.0018***
ins1	−0.0216***					
ins2		−0.0226***				
ins3			−0.0091***			
ins4				−0.0221***		
ins5					−0.0272***	
ins6						−0.0059
Hansen test	0.4366	0.4526	0.3472	0.411	0.4168	0.4253
Sargan test	0.505	0.5291	0.4321	0.5172	0.5142	0.5061
AR (2) test	0.9293	0.8854	0.8573	0.8651	0.8844	0.8877

Table 5: The Impact of Institution and FDI on CO_2 Emissions in Developing Countries

Dependent Variable: $LnCO_2$		
Independent Variables	**Model (2)**	**Model (3)**
CO_{2t-1}	0.9251***	0.9466***
GDP	0.012	0.0385***
Domestic investment	0.0014***	0.0001
Openness	0.0002***	0.0001
Infrastructure	0.0018***	0.0006***
Energy consumption	0.0000***	0.0000**
Urbanization	0.0008*	0.0029
Industrialization	0.0006***	0.0023***
FDI	0.0019***	0.0032***
Institution	−0.0158***	−0.0181**
Interactive variable (INS × FDI)		−0.0007*
Hansen test	0.4088	0.5322
Sargan test	0.4896	0.552
AR (2) test	0.8685	0.7682

multinational companies to commit acts that are harmful to the environment. Damania et al. (2003) pointed out that corruption seriously undermines the implementation of environmental policies. Officials, for their interests, often ignore regulations on environmental protection. Thereby, this creates opportunities for companies, instead of spending big expenses on technology improvement and management improvement, to conduct production practices that are harmful to the environment without penalty. In summary, the empirical evidences institutional improvement is an important factor, not only to help directly minimize the environmental pollution, but also reduce the positive impact of FDI on status of environmental pollution in these developing countries.

5. Conclusion

First, this paper supports the Pollution Haven Hypothesis. In developing countries, more FDI inflows lead to increase in environment pollution. The research investigates the role of institutional aspect as well as its role in the nexus between FDI and environment pollution. The empirical results demonstrate the crucial role of institution in both cases.

Second, a stable governance environment is the foundation for economic growth and environmental sustainability. Therefore, well-defined institutional frameworks are relevant to both economic growth and sustainable environmental development because they act as an intermediary effect. Institutions and its implementation reflect the ability of government policies to control over growth and the environment. Moreover, the government must take action to protect environmental sustainability, including strict environmental legislation (limiting emissions from various sources or using cleaner transportation) and structural changes (reducing amount of burning energy consumption).

Third, people and businesses must comply with environmental regulations and raise their awareness of environmental protection through compliance with environmental institutions. More importantly, businesses should change their behavior by using cleaner production practices, renewable energy sources and energy-efficient production technologies to reduce pollution. Only structural changes in their behavior can make air quality better.

Fourth, each country must strictly follow international environmental agreements to enhance environmental sustainability and reduce air pollution. Based on international economic theories, the estimated effect of environmental regulations on the choice of trade and investment positions is not superior to other determinants, for instance, market conditions and the quality of local workers. If polluting countries are under international pressure created by the international community and international environmental laws, they will limit air pollution and improve environmental sustainability to remain competitive in international trade.

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