International Journal of Economy, Energy and Environment
2022; 7(4): 87-99
http://www.sciencepublishinggroup.com/j/ijeee
doi: 10.11648/j.ijeee.20220704.12
ISSN: 2575-5013 (Print); ISSN: 2575-5021 (Online)

Effect of FDI on CO_2 Emissions: Panel Study from Developing Countries

Mohamed Fathy Abdelgany*, Ahmed Gad Mohamed Gad-Elhak

Economics Department, Faculty of Politics and Economics, Beni-Suef University, Beni Suef, Egypt

Email address:
mfathy@eps.bsu.edu.eg, office@egypt.at (M. F. Abdelgany), ahmed.gad.mohamed@eps.bsu.edu.eg (A. G. M. Gad-Elhak)

*Corresponding author

To cite this article:
Mohamed Fathy Abdelgany, Ahmed Gad Mohamed Gad-Elhak. Effect of FDI on CO_2 Emissions: Panel Study from Developing Countries. *International Journal of Economy, Energy and Environment.* Vol. 7, No. 4, 2022, pp. 87-99. doi: 10.11648/j.ijeee.20220704.12

Received: June 29, 2022; **Accepted**: July 18, 2022; **Published**: July 28, 2022

Abstract: Climate change represents a massive challenge to the continuation of life on Earth; Therefore, it is meaningful to study how different macroeconomic variables affect environmental pollution, to enable policymakers to take appropriate policies that maintain the environment and line up with Sustainable Development Goals (SDGs). So, this paper comes to examine the validity of the Pollution Haven Hypothesis (PHH), and the pollution halo hypothesis besides the Environmental Kuznets Curve (EKC). Furthermore, estimate to what extent FDI affects environmental pollution in developing countries, including energy consumption and income as further determinants of carbon dioxide emissions. To accomplish this purpose, the research employs an econometric model that utilizes the panel data estimation techniques of pooled OLS, fixed effects, and random effects, in addition to, the dynamic Generalized Method of Moments (GMM) estimator. Moreover, the results are confirmed by using two separate samples, the first sample consists of 30 countries and the second sample consists of 42 countries during the period from 1990 to 2019. The research reveals that results from the first and second samples conform with the pollution halo hypothesis, while the EKC hypothesis does not valid in developing countries. Moreover, both energy consumption and economic growth lead to increasing environmental pollution, while FDI leads to a decrease in both samples.

Keywords: Foreign Direct Investment, CO_2 Emissions, Developing Countries, Environmental Kuznets Curve, Pollution Haven Hypothesis, Pollution Halo Hypothesis, Dynamic GMM Approach

1. Introduction

FDI inflows around the world were regularly raised during the past two decades. FDI is anticipated to boost economic growth in developing countries by promoting productivity, capital accumulation, employment opportunities and transferring modern technologies. This explains the reasons for which why many developing countries try to attract a lot of FDI inflows. Despite their contribution to promoting economic growth in host countries, increasing in FDI inflows cause an argument about their potential impact on pollution [1-3]. Many studies that discuss the environmental pollution determinants fundamentally focus on the Gross Domestic Product (GDP) variable with or without energy use variable. These studies test mainly the validity of the EKC hypothesis in developing countries.

The EKC hypothesis states that the inverted U-shaped EKC establishes a nexus between pollution and GDP per capita. This means that an increase in GDP per capita firstly rises the pollution until a tipping point is reached, then it decreases. Nevertheless, the inverted U-shaped EKC nexus would not be valid in all cases, implying that there are different shapes of EKC hypothesis [4, 5]. Recent, inflows of FDI were identified as another source of pollution due to their potential impact on pollution. In fact, the nexus between FDI inflows and the environmental pollution is uncertain, and there are two opposing hypotheses about the FDI inflows and environmental pollution nexus [3]. First hypothesis, the Pollution haven hypothesis, argues that the difference in environmental regulations between countries can affect industry siting decisions. In the PHH hypothesis, multinational corporations, in particular, polluting industries tend to move from developed to developing countries with less stringent environmental regulations and rules, so this lead to increasing environmental pollution in developing countries, implying that the PHH hypothesis supports the bad role of FDI inflows in increasing environmental pollution.

Second hypothesis, the pollution halo hypothesis argues that inflows of FDI from foreign corporations may raise environmental standards in developing countries through the adoption of advanced technology and more efficient management systems in environment field, so this lead to decreasing environmental pollution in developing countries, implying that the pollution halo hypothesis supports the good role of FDI inflows in decreasing environmental pollution [6].

Through the world interest in climate change issues and Egypt interest as well since Egypt would host the agreement for the 27th session of the United Nations (UN) Climate Change Conference of the Parties (COP27) in 2022. So, the main purpose of this paper is to examine the overall effect of income, energy consumption, and FDI on environmental pollution using CO_2 emissions as a proxy in developing countries. Mainly this paper aims to test to what extend does FDI affect environmental pollution (CO_2 emissions) in two samples of developing countries, the first sample consists of 30 countries and the second sample consists of 42 countries (N_1=30, and N_2=42) over 1990 to 2019. In addition to that, tests the validity of the EKC hypothesis in these two samples of developing countries and its shape.

The paper is organized as follows: section 2 presents literature review. Section 3 explains theoretical framework and describes data. Section 4 discusses methodology and estimation results. Finally, section 5 provides conclusion and some recommendation.

2. Literature Review

The nexuses between environmental pollution (CO_2 emissions as a proxy), FDI, and income can be classified into two research groups. First one focus on the relationship between environmental pollution and income analyses the validity of the EKC hypothesis. Second one focus on the relationship between FDI and environmental pollution to validate the PHH or the pollution halo hypothesis.

2.1. Environmental Pollution and Income Related Literature

ECK theory reveals the relationship between economic growth and environmental pollution. The EKC hypothesis defines a connection between income and environment that becomes apparent when income reaches to a certain threshold. Furthermore, Grossman and Krueger in 1991 assumed the inverted U-shaped connection between pollution and income levels. According to the EKC, at the beginning of economic growth, natural environmental pollution levels increase until it reached to a certain point, after which the economy reduces pollution levels [4, 7]. Furthermore, Inverted U-shaped would not be valid in every country, and it is not the only shape of the relationship, so if environmental pollution levels rise after countries reach long-term high-income levels, another shape, known as the N-shaped EKC model is recommended. The N-shaped of EKC model supports that in the long run, when GDP per capita increases, the CO_2 emissions increase. This heightened nexus happens when the relationship between pollution and GDP per capita become positive, then this nexus becomes negative at a certain point, and again the nexus becomes positive [8]. Moomaw, W. R., & Unruh, G. C. [9] studied the environmental pollution and economic growth nexus in 16 countries during 1950-1993 using Fixed-Effects (FE) method and cross-section OLS method and found an N-shaped EKC, they detected that CO_2 emissions would increase again after the second turning point of GDP per capita was passed. They also concluded that neither the U-shaped nor the N-shaped relationship between carbon emissions and income provides a consistent pattern of impending behavior. The results of the paper concluded that the interpretation of EKC in terms of economic growth stages would be deceptive because of these stages of income all countries would pass through them. López-Menéndez et al. [10] studied the relationship between pollution and GDP, to test EKC, they detected inverted N-shaped curve in 27 countries from 1996 to 2010. Where less than 20% of energy comes from sustainable sources, they also concluded that renewable energy sources could play a vital role in improving the environment. Alvarez-Herranz, A., & Balsalobre-Lorente, D. [11] studied the relationship between environmental degradation and economic growth in 28 countries between 1993 and 2010. They used Greenhouse gas emissions (GHG emissions) as a proxy for environmental pollution. The paper discovered N-shaped EKC, finally they detected that environmental destruction would not disappear when GDP increased.

Lorente, D. B., & Álvarez-Herranz, A. [12] investigated the nexus between GDP per capita and pollution in 17 economies over 1990-2012. They also used the emissions of GHG per capita as a proxy for pollution. They got N-shaped curve. In addition to that, the paper argued that air pollution would not go away on its own when income growth accelerates. In this way, increased vitality guidelines are essential to reduce natural pollution, the results detected those regulations on energy would help to improve the environment. While Balsalobre-Lorente et al. [13] studied the nexus between GDP and CO_2 emissions in 5 countries from 1985 to 2016. They used other variables in their econometric model such as, electricity use, trade openness, natural resource plenty, and energy innovation. They discovered the presence of N-shaped curve. Allard, A. et al. [14] examined the nexus between carbon dioxide emissions and GDP to test the N-shaped curve, and they found an N-shaped EKC from 1994 to 2012 in 74 countries, but this shape was not valid in some countries from the same sample. They also detected that there was a negative relationship between renewable energy and pollution. The paper used pooled OLS, fixed effects, and panel quantile regression methods, results showed evidence for N-shaped curve in all countries, except for upper-middle-income ones.

Shahbaz, M. et al. [15] examined the nexus between GDP, FDI, and pollution in the Middle East and North Africa (MENA) region over the period 1990-2015. The results detected that the relationship between CO_2 emissions and income growth had N-shaped curve, and the relationship between CO_2 emissions and FDI also had N-shaped curve, the results for the panel using GMM approach, in addition to that they supported the PHH. Le, H. P., & Ozturk, I. [16] investigated CO_2 emissions and globalization, financial development, and energy use in the presence of EKC in 47 countries from 1990 to 2014. They emphasized on the vital role of finance and governance to help the countries to maintain the environment, in addition to that findings of the paper showed that globalization, financial development, and energy consumption increased pollution.

On the other hand, there are some empirical literatures detected the validity of U-shaped inverted U-shaped: Dogan, E., & Inglesi-Lotz, R. [17] studied the shape of the EKC in European countries over 1980-2014. The results detected that the inverted U-shaped relationship between economic growth and environmental degradation, when they use CO_2 emissions as a proxy for pollution, while they detected U-shape curve when the economic structure proxied by industrial share, by using Fully Modified OLS (FMOLS). And Demissew Beyene, S., & Kotosz, B [18] tested the EKC hypothesis in 12 economies in Africa over 1990- 2013 using the Pooled Mean Group approach PMG. They also used CO_2 as a proxy for pollution. The paper showed that the nexus between income and carbon dioxide emissions was bell-shaped, an extension of the traditional inverted version of the U-shaped curve.

Otherwise, some literature review detected that EKC hypothesis does not valid: Aslanidis, N. [19] detected that no validity of EKC hypothesis in 77 countries from 1971 to 1997. And Bakirtas, I., & Cetin, M. A. [20] studied 5 countries from 1982 to 2011. The results reached to that EKC hypothesis was not accepted in this sample.

2.2. Environmental Pollution and FDI Related Literature

Most of the studies support either the PHH or the pollution halo hypothesis. Pazienza, P. [21] used the panel data methods to detect the positive impact of FDI on environmental pollution in 30 countries from 1989 to 2016, the paper used carbon dioxide emissions as a proxy for pollution. the results supported the PHH, meaning that there was evidence for the bad role of FDI on environment. While Sarkodie, S. A., & Strezov, V [22] provided evidence for the PHH in five developing countries, they depended on the emissions of GHG as a proxy for environmental pollution over 1982 to 2016. In addition to that the results detected that EKC was valid in China and Indonesia, and U-shaped curve was valid in India and South Africa by used panel data methods. And Wang, H. et al. [23] supported the PHH in a panel of 157 Chinese units over 2014- 2016. Baek, J. [24] showed that FDI increased environmental degradation in 5 economies, the paper used CO_2 as a proxy for pollution, the results supported the PHH, they also revealed that GDP, and energy use had a bad effect on environment by using the PMG approach during 1981 to 2010 and Zhang, Y. and S. Zhang [25] reported also PHH in China over 1982 to 2016, they detected that the effect of FDI was positive, and increasing pollution by using Autoregressive Distributed Lag (ARDL) approach, they used exchange rate, and carbon dioxide in their regression. The results also detected that EKC was valid in that case. Hanif, I. et al. [26] emphasized that FDI inflows increased pollution in 15 Asian economies over 1990 – 2013, they used CO_2 as a dependent variable. The paper also used ARDL, results detected that FDI had a bad effect on environment, and supported EKC in that case. In contrast, some papers supported the pollution halo effect, the good impact of FDI on environmental pollution. Hille, E. et al. [27] detected that FDI reduced the air pollution in 16 Korean provinces over the period 2000 to 2011, the findings supported the pollution halo hypothesis by using a simultaneous equations.

Zhu, H. et al. [3] detected the pollution halo effect, they used panel quantile regression method in 5 countries over 1981-2011, they also used carbon dioxide as a proxy for pollution. while Jiang, L. et al. [28] detected this hypothesis in 150 cities in China in 2014 using spatial econometric models. In addition to that, the results revealed that there was not any evidence on inverted U-shaped EKC.

Rafindadi, A. A. et al. [29] used a PMG estimator to support the pollution halo hypothesis of foreign direct investment inflows on the environmental pollution in 6 Gulf Cooperation Council (GCC) countries, the results detected that energy use had a positive effect on pollution, meaning that it had a bad effect. during 1990-2014, and Wang, H., & Liu, H. [30] studied panel data of 30 Chinese regions from 2000 to 2014, Panel Corrected Standard Error model technique was used, the findings showed that FDI decreased pollution in central and eastern Chinese regions, while it increased environmental pollution in western Chinese region, they emphasized on the importance of environmental regulation to improve environmental quality. Some studies supported pollution halo effect by using GMM: Shao, Y. [31] supported that FDI inflows decreased environmental pollution (pollution halo effect) in 188 economies from 1990 to 2013, while Sung, B. et al. [32] supported this over 2002-2015 in 28 sectors in China, and detected that industrial GDP reduced the environmental pollution (CO_2 emissions as a proxy). They used system GMM method. In contrast to the above studies, Ansari, M. A. et al. [33] studied 29 economies by using FMOLS, and they supported PHH in East Asian panel, while rejected it in the Southeast Asian panel during 1994 to 2014, the detected that energy consumption energy was the major factor of emissions of CO_2. Likewise, some studies reported a nonlinear nexus between FDI inflows and environment: Abdouli, M. et al. [34] supported halo hypothesis for 5 countries, and EKC hypothesis over 1990 -2014 by using OLS, FE, RE and system GMM methods. Balsalobre-Lorente, D. et al. [35] studied the nonlinear nexus between FDI and pollution, and they supported it in 4 countries by FMOLS, and Dynamic Ordinary Least Squares (DOLS) from 1990 to 2013. They detected that there was an inverted-U relationship between FDI and environmental pollution. recently, Xie, Q. and Q. Sun [36] supported pollution halo effect and revealed that the relationship between FDI and pollution was S-shaped, in a sample of 11 emerging countries by a generalized panel smooth transition regression from 2010 to 2016.

Notably, some studies detected that FDI had not any clear effect on environment: Albulescu, C. T. et al. [37] indicated that in a sample of 14 countries using panel quantiles regression methods over 1980-2010, while Liobikienė, G. and M. Butkus [38] supported that in a sample of 147 countries by the GMM approach over 1990 to 2012.

3. Theoretical Framework and Data

To evaluate the effect of FDI on CO_2 emissions in developing economies, the paper uses Cobb–Douglas production function where income depends on capital, labor, and energy consumption, which relates to CO_2 emissions [39-42]. Specifically, the paper uses the following function:

$$Y = e^{e} AK^{\alpha} E^{\lambda} L^{\beta} \tag{1}$$

Where Y is the Real-GDP, E is the energy consumption, K is the capital stock, L is the labor, while A refers to technology, and e refers to the error term. α, λ, and β refer to production elasticities with respect to the variables. There is a direct linear relationship between energy consumption and carbon dioxide emissions as following: $E = bCO_2$. Moreover, having the following function:

$$Y = b^{\lambda} e^{\varepsilon} AK^{\alpha} \left(CO_2\right)^{\lambda} L^{\beta} \tag{2}$$

Let FDI to determine technology endogenously within the previous production function [43-45]. The FDI inflow in addition to transfer advanced technologies support economic growth. Therefore, having the following:

$$A = \theta\ FDI\ \left(t\right)^{\psi} \tag{3}$$

FDI refers to FDI inflows. Substituting from Equation (3) into Equation (2):

$$Y = \theta b^{\lambda} e^{\varepsilon} k^{\alpha} (CO_2)^{\lambda} (FDI)^{\psi} L^{B} \tag{4}$$

After dividing Eq. (4) by L. All variables transform into per capita form, after this arrangement, the equation equals:

$$\frac{Y}{L} = \theta b^{\lambda} e^{\varepsilon} \left(\frac{K}{L}\right)^{\alpha} \left(\frac{CO_2}{L}\right)^{\lambda} \left(\frac{FDI}{L}\right)^{\psi} \tag{5}$$

Then, the function is transformed by adding log:

$$logY_t = log\ (\theta b^{\lambda}) + \alpha_1 logCO_{2t} + \alpha_2 logFDI_t + \alpha_3 logK_t + \varepsilon_t \tag{6}$$

Let: $\alpha_0 = \log (\theta\ b^{\lambda})$, after substituting in Eq (6):

$$logY_t = \alpha_0 + \alpha_1 logCO_{2t} + \alpha_2 logFDI_t + \alpha_3 logK_t + \varepsilon_t \tag{7}$$

Because the paper depends on panel data, Equation. (7) would be in this following form:

$$Log\ Y_{it} = \alpha_0 ?+ \alpha_1 LogCO_{2it} + \alpha_2 Log\ FDI_{it} + \alpha_3 LogK_{it} + \varepsilon_{it} \tag{8}$$

To investigate the effect of FDI, economic growth, and energy consumption on environmental pollution (CO_2 emissions as a proxy), This equation is built based on literature review [40, 42, 46].

$$log\ CO_{2,it} = \beta_0 + \beta_1 log\ GDP_{it} + \beta_2 log\ ENC_{it} + \beta_3 log\ FDI_{it} + \varepsilon_{it} \tag{9}$$

This equation investigates effect of FDI inflows, Real-GDP, Real-GDP squared, cubic Real-GDP, and energy consumption altogether on CO_2 emissions by using Panel Data framework. Also, this equation evaluates the EKC hypothesis in two samples of developing countries (N_1=30 and N_2=42). In this model, the cubic term is included to investigate the shape of the EKC. The empirical model is shown in Eq. (10):

$$Log\ CO_{2,it} = \beta_0 + \beta_1\ log\ GDP_{it} + \beta_2 log\left(GDP_{it}\right)^2 + \beta_3 log\left(GDP_{it}\right)^3 + \beta_4 log\ ENC_{it} + \beta_5 log\ FDI_{it} + \varepsilon_{it} \tag{10}$$

Where β_0 symbolizes the intercept. Log CO_2 denotes logarithm of emissions of CO_2. Log-GDP, log-GDP^2, log -GDP^3, log ENC, and log FDI represent logarithms of real-GDP per capita, the square of real-GDP per capita, the cubic of real-GDP per capita, energy consumption and FDI, respectively. β_1, β_2, β_3, β_4, and β_5 are elasticities of the variables. Scatter plots in Figures 1 and 2 reveal a positive but weak correlation between CO_2 emissions and FDI for two samples of 30, and 42 developing economies over the 1990–2019 period. (Table 1 below shows the list of sampled 30 and 42 developing countries). Data description and sources are shown in Table 2. and descriptive statistics of the variables are reported in Table 3 and Table 4.

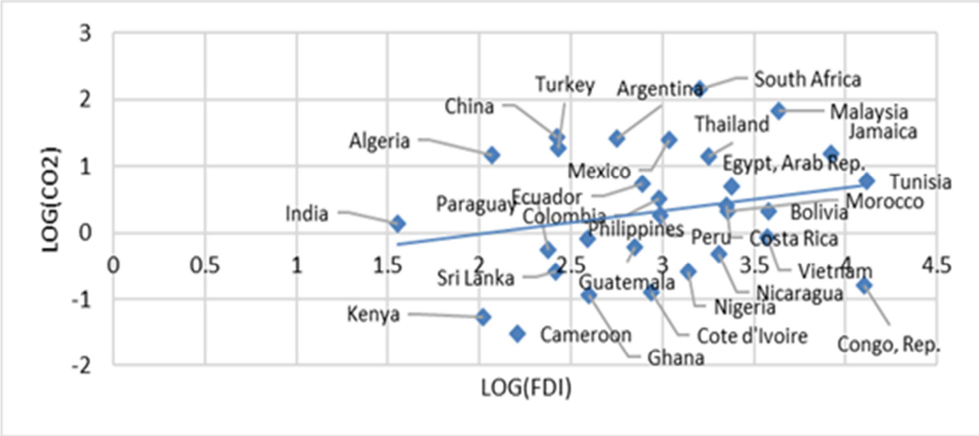

Figure 1. *CO_2 Emissions and FDI for a Sample of 30 developing countries.*

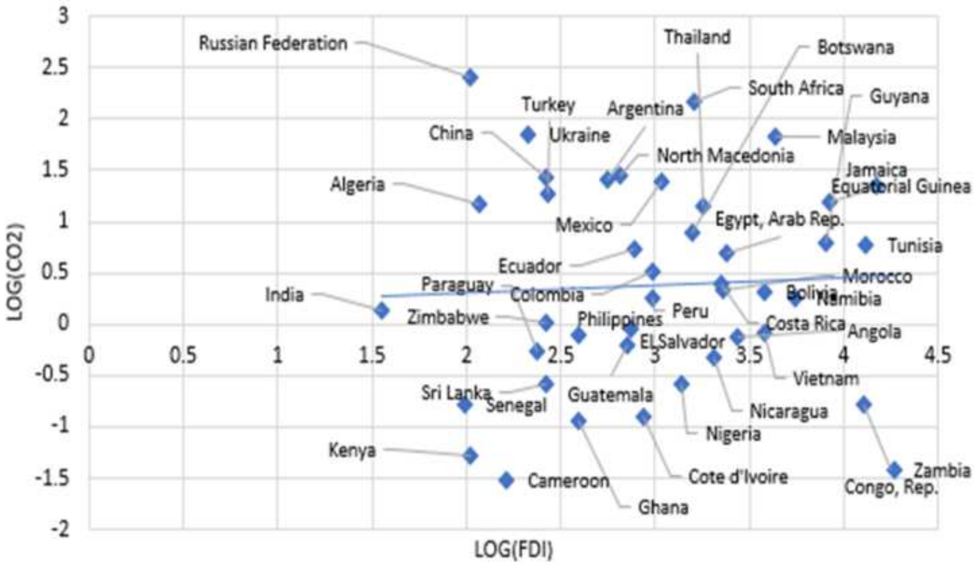

Figure 2. *CO_2 Emissions and FDI for a Sample of 42 developing countries.*

Table 1. *The list of sampled 30 and 42 developing countries.*

The list of sampled 30 developing countries			**The list of sampled 42 developing countries**				
Algeria	Egypt	Nigeria	Algeria	Côte d'Ivoire	Jamaica	Russian Federation	Zambia
Argentina	Ghana	Paraguay	Angola	Ecuador	Kenya	Senegal	Zimbabwe
Bolivia	Guatemala	Peru	Argentina	Egypt	Malaysia	South Africa	
Cameron	India	South Africa	Bolivia	El Salvador	Mexico	Sri Lanka	
China	Jamaica	Sri Lanka	Botswana	Equatorial Guinea	Morocco	Thailand	
Colombia	Kenya	Thailand	Cameron	Ghana	Nicaragua	The Philippines	
Congo Rep	Malaysia	the Philippines	China	Guatemala	Nigeria	Tunisia	
Costa Rica	Mexico	Tunisia	Colombia	Guyana	North Macedonia	Turkey	
Côte d'Ivoire	Morocco	Turkey	Congo Rep	Namibia	Paraguay	Ukraine	
Ecuador	Nicaragua	Vietnam	Costa Rica	India	Peru	Vietnam	

Table 2. *Data description and sources.*

Variables	**Description**	**Sources**
CO_2	Carbon Dioxide emissions (Metric tons per capita)	World Bank, World Development Indicators
FDI	Foreign direct investment inflows (% of GDP)	UNCTAD
GDP	Real GDP per capita (current US$)	World Bank, World Development Indicators
ENC	Energy consumption (million metric tons of oil equivalent)	U. S Energy Information Administration

Source: Authors' compilation.

Table 3. *Descriptive statistics of the variables for a sample of 30 developing countries.*

	(CO_2)	**(GDP)**	**$(GDP)^2$**	**$(GDP)^3$**	**(ENC)**	**(FDI)**
Mean	321	1.325	2.650	3.975	2.876	2.968
Median	391	1.597	3.194	4.791	2.674	3.009
Max	2.301	3.846	7.692	11.538	8.221	5.453
Mini	-4.772	-4.026	-8.052	-12.078	-1.204	-.6864
Std. Dev.	978	1.576	3.158	4.738	1.766	831
Obs	900	900	900	900	900	900

Source: Authors' compilation.

From EKC hypothesis, when Real-GDP rises, CO_2 emissions rise to a certain point, after that emissions begin to decrease. Therefore, the sign of β_1 is expected to be positive, while the sign of β_2 expected to be negative, and β_3=0, this case refers to inverted-U-shaped EKC.(Table 5 shows the different EKC shapes according to coefficients).

Table 4. *Descriptive statistics of the variables for a sample of 42 developing countries.*

	(CO_2)	**(GDP)**	**$(GDP)^2$**	**$(GDP)^3$**	**(ENC)**	**(FDI)**
Mean	0.388	0.467	0.934	1.400	2.471	3.005
Median	0.431	1.575	3.150	4.726	2.035	3.105
Max	2.683	4.167	8.333	12.500	8.221	5.453
Mini	-4.773	-20.833	-41.665	-62.498	-3.130	-3.226
Std. Dev.	1.034	3.731	7.463	11.194	1.995	0.957
Obs	1260	1260	1260	1260	1260	1260

Source: Authors' compilation.

In contrast, when energy consumption increases, the pollution would increase, therefore, β_4 is expected to be positive. Lastly, the β_5 is expected to be positive or negative, according to the PHH or pollution halo effect, respectively.

Table 5. *Different EKC shapes according to coefficients.*

Monotonically increasing	**Monotonically decreasing**	**Inverted U-shaped**	**U- shaped**	**N- shaped**	**Inverted-N shaped**
$\beta1 > 0$	$\beta1 < 0$	$\beta1 > 0$	$\beta1 < 0$	$\beta1 > 0$	$\beta1 < 0$
$\beta2 = \beta3 = 0$	$\beta2 = \beta3 = 0$	$\beta2 < 0$	$\beta2 > 0$	$\beta2 < 0$	$\beta2 > 0$
		$\beta3 = 0$	$\beta3 = 0$	$\beta3 > 0$	$\beta3 < 0$

Source: Authors' compilation.

4. Methodology and Estimation Results

4.1. Estimation Methods

Firstly, the paper investigates effect of FDI on CO_2 emissions in developing countries by using the traditional panel data methods such as: pooled Ordinary Least Squares (OLS) regression, Fixed Effects (FE) regression, and Random Effects (RE) regression. Lastly, using dynamic Generalized Method of Moments (Dynamic GMM) estimator on panel data from 1990 to 2019. GMM uses first difference to remove individual fixed effects, and for standard error uses White test because of the problem of heteroskedasticity, so it provides robust estimates in existence of heteroscedasticity, endogeneity and first order autocorrelation. The estimators would be consistent, efficient, and asymptotically normal. Regressions were run for 30 developing countries; and 42 developing countries as a robustness check (N_1=30, and N_2=42), data constraints preclude a separate regression for lower-middle, and upper-middle income developing economies.

4.2. Estimation Results for 30 Developing Countries

4.2.1. Results of Pooled OLS

Table 6 presents the regression results of pooled OLS between the CO_2 emissions and FDI. Column (1) presents the results of the regression model where the dependent variable is a function of Energy Consumption, (log (ENC), Real Gross Domestic Product per capita (log Real-GDP), and Foreign Direct Investment (log FDI).

Column (2) presents the results of the regression model where the dependent variable is a function of Energy Consumption, (log (ENC), Real Gross Domestic Product per capita squared (log $(\text{Real-GDP})^2$), and Foreign Direct Investment (log FDI).

Column (3) presents the results of the regression model where the dependent variable is a function of Energy Consumption, (log (ENC), Cube of real Gross Domestic Product per capita (log $(\text{Real-GDP})^3$), and Foreign Direct Investment (log FDI).

From results in Table 6. FDI contribute positively to CO_2 emissions, implying that FDI increases CO_2 emissions. The results show that: 1% increase in FDI will bring about 0.406% increase in CO_2 emissions.

1% increase in energy consumption will lead to 0.373 percent increase in CO_2 emissions. The argument behind this relationship is that energy consumption contributes to environmental degradation by increasing the demand and consumption of fossil fuels. Since energy-intensive industries increase pollution from production processes because of using pollutant inputs in their production processes, it can also increase pollutant emissions from processing, manufacturing, and installing manufacturing goods [47].

The results reveal that higher pace of GDP contributes to decrease the quality of environment. The results in estimated model (column 1), implying that 1 percent increase in GDP leads to 0.132 percent rise in CO_2 emissions. The results in estimated model (column 2), implying that 1 percent increase in GDP squared leads to 0.066 percent rise in CO_2 emissions. And the results in estimated model (column 3), meaning that 1% increase in cube of GDP leads to 0.044 percent rise in CO_2 emissions. All coefficients are significant at 1 percent level of significance, and signs of the parameters of GDP, GDP squared, and cubic of GDP implying that EKC hypothesis is not valid in this case.

Moreover, R^2 equals 0.612 (column 1 & 2 and 3) indicating that around 61 percent variation in CO_2 emissions is explained by the independent variables.

Table 6. *Effect of FDI on CO_2 Emissions: Panel Study from Developing Countries.*

Method: Panel Least Squares (Pooled OLS)

Dependent Variable: Log (CO_2) $_{it}$

	(1)	*(2)*	*(3)*
Log (ENC_{it})	0.373 (31.278) ***	0.373 (31.278) ***	0.373 (31.278) ***
Log (Real GDP_{it})	0.132 (10.026) ***		
Log (Real $GDP_{it})^2$		0.066 (10.026) ***	
Log (Real $GDP_{it})^3$			0.044 (10.026) ***
Log (FDI_{it})	0.406 (16.410) ***	0.406 (16.410) ***	0.406 (16.410) ***
R-squared	0.612	0.612	0.612
F-statistic	471.833***	471.833***	471.833***
No. of observations	900	900	900

The absolute t-statistic values are in parentheses () next to the coefficients of the regressors.
(***, **, *) denote significance level at 1%, 5%, and 10%, respectively.

4.2.2. Results of Fixed Effects

Pooled OLS or common effect model treats all cross sections as homogeneous and temporal and country specific effects are ignored. As a result, it often suppresses the true picture for the nexus behind concerned variables. Fixed and random effects estimation methods were used to capture these unobserved country-specific effects. In fixed effects each country has its own intercept which varies across cross-sectional units.

Findings in Table 7. show that: FDI decreases environmental pollution by decreasing CO_2 emissions. The estimated values of the coefficients show that 1 percent increase in FDI will bring about 0.031 percent decrease in CO_2 emissions, this effect is statistically significant at 1 percent level of significance.

Table 7. *Effect of FDI on CO_2 Emissions: Panel Study from Developing Countries.*

Method: Panel EGLS (Fixed Effects)

Dependent Variable: Log (CO_2)$_{it}$

	(1)	**(2)**	**(3)**
Log (ENC_{it})	0.630 (51.746)***	0.630 (51.746)***	0.630 (51.746)***
Log (Real GDP_{it})	0.024 (10.258)***		
Log (Real $GDP_{it})^2$		0.012 (10.258)***	
Log (Real $GDP_{it})^3$			0.008 (10.258)***
Log (FDI_{it})	-0.031 (-5.180)***	-0.031 (-5.180)***	-0.031 (-5.180)***
R-squared	0.990	0.990	0.990
F-statistic	2732.501***	2732.501***	2732.501***
No. of observations	900	900	900

The absolute t-statistic values are in parentheses () next to the coefficients of the regressors.
(***, **, *) denote significance level at 1%, 5%, and 10%, respectively.

1% increase in energy consumption will lead to 0.630 percent rise in emissions of carbon dioxide. The findings show that increase of GDP contributes to decrease the quality of environment. In estimated model (column 1), implying that 1 percent increase in GDP leads to 0.024 percent rise in CO_2 emissions.

In estimated model (column 2), implying that 1 percent increase in GDP squared leads to 0.012 percent rise in CO_2 emissions. And in estimated model (column 3), 1% rise in cubic GDP leads to 0.008 percent rise in CO_2 emissions. All parameters are significant at 1 percent level of significance, and the signs of parameters of GDP, GDP squared, and cubic GDP implying that EKC hypothesis is not valid in this case.

Moreover, R^2 equals 0.990 (column 1 & 2 and 3) indicating that around 99 percent variation in CO_2 emissions is explained by the independent variables, in addition to that the result is sensitive to country specific effects.

4.2.3. Results of Random Effects

The random effects model assumes that error terms change over cross-sectional units. Findings of random effects estimation are reported in Table 8. according to the findings of all estimated models, FDI is statically nonsignificant on affecting CO_2 emissions. While the other coefficients are significant at 1%.

The results revealed that: 1% rise in energy use will lead to 0.560 percent rise in emissions of carbon dioxide.

Parameter of GDP is positive and significant at 1 percent level of significance in estimated model (coulmn 1), 1% rise in GDP will lead to 0.033 percent rise in CO_2 emissions.

Coefficient of GDP squared is positive and significant at 1 percent level of significance, in estimated model (coulmn 2), 1% rise in GDP squared will lead to 0.017 percent rise in CO_2 emissions. And the coefficient of cubic GDP is significant at 1% level, and positive, in estimated model (coulmn 3), implying that 1 percent increase in cubic GDP will lead to 0.011 percent rise in CO_2 emissions, the signs of the parameters of GDP, GDP squared, and cubic GDP showing that there is no evidence on the presence of EKC hypothesis in this case.

Moreover, R^2 equals 0.585 (column 1 & 2 and 3) means that about 59% of changes in CO_2 emissions are caused by independent variables.

Table 8. *Effect of FDI on CO_2 Emissions: Panel Study from Developing Countries.*

Method: Panel EGLS (random effects)

Dependent Variable: Log $(CO_2)_{it}$

	(1)	(2)	(3)
Log (ENC_{it})	0.560 (44.711)***	0.560 (44.711)***	0.560 (44.711)***
Log (Real GDP_{it})	0.033 (9.741)***		
Log (Real $GDP_{it})^2$		0.017 (9.741)***	
Log (Real $GDP_{it})^3$			0.011 (9.741)***
Log (FDI_{it})	0.013 (0.623)	0.0123 (0.623)	0.0123 (0.623)
R-squared	0.585	0.585	0.585
F-statistic	421.787	421.787	421.787
Hausman test (chi^2)	30.735***	30.735***	30.735***
No. of observations	900	900	900

The absolute t-statistic values are in parentheses () next to the coefficients of the regressors.
(***, **, *) denote significance level at 1%, 5%, and 10%, respectively.

Hausman test was applied for orthogonality of the random effects and the regressors. The null hypothesis is that the individual-specific effect and the regressors are uncorrelated. Its alternative hypothesis is that a correlation exists between the individual-specific effect and the regressors. This means that if the test shows a nonsignificant P-value, indicating that correlation does not exist, it means that the random effects model is the preferred regression. Therefore, if the test estimates a statistically significant P-value, the fixed-effects model is the preferred regression.

So fixed effect Model is better, since the results reject the null hypothesis that the difference in coefficients is not systematic, since its result has a statistically significant P-value.

Omitted variables in fixed effect and random effect regressions can bias the results because omitted variables are correlated with the errors. This creates endogeneity problem within the Model. The fixed effect model is useful when omitted variables are time-invariant (fixed or constant) and correlated with errors, while random effect model provided unbiased estimates only when there are no omitted variables, or such variables are uncorrelated with errors. However, the existence of some omitted variables in a random Model will produce some biasness. So, using Dynamic GMM estimation to have robust estimates in presence of heteroscedasticity, endogeneity and first order autocorrelation.

4.2.4. Results of Dynamic GMM

Problem of endogeneity is resolved by including the instruments variables in the model. Dynamic GMM uses the lag of dependent variable, the lag values of explanatory variables. Regression model (1) in Column (1) in Table 9. treats with dependent variable as a function of Energy Consumption, (log (ENC), (log Real-GDP per capita), (log FDI) and the lagged value of the dependent variable, Log $(CO_2)_{it-1}$.

Table 9. *Effect of FDI on CO_2 Emissions: Panel Study from Developing Countries.*

Method: Dynamic Panel GMM

Dependent Variable: Log $(CO_2)_{it}$

	(1)	(2)	(3)
Log (ENC_{it})	0.452 (22.698)***	0.452 (22.698)***	0.452 (22.698)***
Log (Real GDP_{it})	0.060 (43.806)***		
Log (Real $GDP_{it})^2$		0.030 (43.806)****	
Log (Real $GDP_{it})^3$			0.020 (43.806)***

	(1)	(2)	(3)
Log (FDI_{it})	-0.049 (-16.350)***	-0.049 (-16.350)***	-0.049 (-16.350)***
Log (co_2)$_{it-1}$	0.305 (129.348)***	0.305 (129.348)***	0.305 (129.348)***
Hansen J-Statistic	27.064	27.064	27.064
Prob (J-statistic)	0.406	0.406	0.406
AR (1)	0.079	0.079	0.079
AR (2)	0.169	0.169	0.169
Instrument rank	30	30	30
No. of observations	840	840	840

The instrument variables used for estimating the model are the first lag of each explanatory variable, and the second lag for the dynamic factor in the model, The absolute t-statistic values are in parentheses () next to the coefficients of the regressors. (***, **, *) denote significance level at 1%, 5%, and 10%, respectively. Values of AR (1), and AR (2) represent the p-values for the Arellano- Bond first, and second-order serial correlation tests, respectively.

Model (2) in column (2) treats with dependent variable as a function of Energy Consumption, (log (ENC), (log Real-GDP per capita)^2), (log FDI) and the lagged value of dependent variable, Log $(CO_2)_{it-1}$.

Model (3) in Column (3) treats with dependent variable as a function of Energy Consumption, (log (ENC), (log Real-GDP per capita)^3), (log FDI) and Log (CO_2)it-1.

The findings reveal that Log (FDI) is -0.049 for Models (1), (2), and (3) (all significant at 1 percent level).

The findings support the pollution halo hypothesis that refers to that FDI inflows decrease environmental pollution (CO_2 emissions), so it's effect could be positive on environmental quality; Hence, the rise in energy use will lead to rise CO_2 emissions, meaning that energy use has a bad effect on environment.

From the findings: The coefficient of R-GDP is positive and significant at 1 percent level of significance in estimated model (coulmn 1), implying that 1 percent rise in R-GDP, increased carbon dioxide emissions by 0.060 percent. The coefficient of R-GDP squared is 0.030, implying that 1 percent increase in R-GDP squared will lead to 0.030 percent rise in CO_2 emissions (coulmn 2). And coefficient of cubic R-GDP is 0.020, implying that 1 percent increase in cubic R-GDP will lead to 0.020 percent rise in CO_2 emissions (coulmn 3). The signs of the parameters of R-GDP, R-GDP squared, and cubic R-GDP implying that EKC hypothesis is not valid in this case.

In the estimation process, instruments validity in dynamic-GMM are confirmed by the Hansen J-statistic and corresponding P-values. Autocorrelation of errors is checked by Arellano-Bond test, AR (2) is nonsignificant, implying that serial correlation problem does not appear.

4.3. Estimation Results for 42 Developing Countries

4.3.1. Results of Pooled OLS

From Table 10: FDI contributes positively to CO_2 emissions, implying that FDI increases environmental pollution. The results reveal that rise with 1% in FDI will bring about 0.257% rise in CO_2 emissions, this effect is significant at 1 percent level.

Table 10. *Effect of FDI on CO_2 Emissions: Panel Study from Developing Countries.*

Method: Panel Least Squares (Pooled OLS)

Dependent Variable: Log $(CO_2)_{it}$

	(1)	(2)	(3)
Log (ENC_{it})	0.317 (26.088) ***	0.317 (26.088) ***	0.317 (26.088) ***
Log (Real GDP_{it})	0.016 (2.516) **		
Log (Real GDP_{it})^2		0.008 (2.516) **	
Log (Real GDP_{it})^3			0.005 (2.516) **
Log (FDI_{it})	0.257 (10.117) ***	0.257 (10.117) ***	0.257 (10.117) ***
R-squared	0.356	0.356	0.356
F-statistic	231.065***	231.065***	231.065***
No. of observations	1260	1260	1260

The absolute t-statistic values are in parentheses () next to the coefficients of the regressors.
(***, **, *) denote significance level at 1%, 5%, and 10%, respectively.

When energy consumption increases with 1%, this leads to increase CO_2 emissions by 0.317 percent, this effect is significant at 1 percent level. When GDP increases, the quality of the environment would decrease. The parameter of GDP is significant at 5 percent level, in estimated regression model (column 1), results show that 1 percent rise in GDP will lead to 0.016 percent rise in carbon dioxide emissions. Parameter of GDP squared is significant at 5 percent level, in estimated model (column 2), parameter of GDP squared implies that 1 percent rise in GDP squared will lead to 0.008 percent rise in CO_2 emissions. And the parameter of cubic GDP is also significant at 5 percent level, in estimated model (column 3), implying that 1 percent rise in cubic GDP leads to 0.005 percent rise in carbon dioxide emissions. The signs of the parameters of GDP, GDP squared, and cubic GDP implying that EKC hypothesis is not valid in this case. Moreover, R^2 equals 0.356 (column 1 & 2 and 3), which means that about 36% changes in CO_2 emissions are caused by the independent variables.

4.3.2. Results of Fixed Effects

From the results in Table 11, FDI decreases environmental pollution by decreasing CO_2 emissions. The estimated values of the coefficients show that 1% rise in FDI will bring about 0.006% decrease in CO_2 emissions, this effect is significant at 5% level.

Table 11. *Effect of FDI on CO_2 Emissions: Panel Study from Developing Countries.*

Method: Panel EGLS (Fixed Effects)

Dependent Variable: Log (CO_2) $_{it}$

	(1)	(2)	(3)
Log (ENC_{it})	0.586 (53.351)***	0.586 (53.351)***	0.586 (53.351)***
Log (Real GDP_{it})	0.018 (14.137)***		
Log (Real $GDP_{it})^2$		0.009 (14.137)***	
Log (Real $GDP_{it})^3$			0.006 (14.137)***
Log (FDI_{it})	-0.006 (-2.145)**	-0.006 (-2.145)**	-0.006 (-2.145)**
R-squared	0.993	0.993	0.993
F-statistic	3931.998***	3931.998***	3931.998***
No. of observations	1260	1260	1260

The absolute t-statistic values are in parentheses () next to the coefficients of the regressors.
(***, **, *) denote significance level at 1%, 5%, and 10%, respectively.

Energy consumption is significant at 1 percent level, the results imply that 1 percent increase in energy consumption leads to 0.586% rise in CO_2 emissions. When GDP increases, the environmental pollution would increase. The parameter of GDP is significant at 1 percent level, in estimated model (coulmn 1), results imply that 1 percent increase in GDP will lead to 0.018 percent rise in CO_2 emissions. The parameter of GDP squared is significant at 1 percent level, results in estimated model (coulmn 2), implying that 1 percent increase in GDP squared, will lead to 0.009 percent rise in CO_2 emissions. And the parameter of cubic GDP is significant at 1 percent level, results in estimated model (coulmn 3), imply that when cubic GDP increases with 1%, CO_2 emissions would increase by 0.006 percent. The signs of the parameters of GDP, GDP squared, and cubic GDP implying that EKC hypothesis is not valid in this case.

R^2 equals 0.993 (column 1 & 2 and 3) implying that about 99% of changes in CO_2 emissions justified by the independent variables, in addition to that the result is sensitive to country specific effects.

4.3.3. Results of Random Effects

According to the results of estimated models in Table 12, FDI is nonsignificant on affecting CO_2 emission. The other coefficients are significant at 1 percent level.

Table 12. *Effect of FDI on CO_2 Emissions: Panel Study from Developing Countries.*

Method: Panel EGLS (random effects)

Dependent Variable: Log (CO_2) $_{it}$

	(1)	(2)	(3)
Log (ENC_{it})	0.534 (10.843)***	0.534 (10.843)***	0.534 (10.843)***
Log (Real GDP_{it})	0.014 (3.638)***		
Log (Real $GDP_{it})^2$		0.007 (3.638)***	
Log (Real $GDP_{it})^3$			0.005 (3.638)***
Log (FDI_{it})	0.006 (0.732)	0.006 (0.732)	0.006 (0.732)
R-squared	0.571	0.571	0.571
F-statistic	557.483***	557.483***	557.483***
Hausman test (chi^2)	23.825***	23.825***	23.825***
No. of observations	1260	1260	1260

The absolute t-statistic values are in parentheses () next to the coefficients of the regressors.
(***, **, *) denote significance level at 1%, 5%, and 10%, respectively.

When energy consumption increases with 1 percent, CO_2 emissions would increase by 0.534%. In estimated model (coulmn 1), an increase with 1 percent in GDP will lead to 0.014 percent rise in CO_2 emissions. In estimated model (coulmn 2), results implying that 1 percent rise in GDP squared would lead to 0.007 percent rise in emissions of carbon dioxide. And in estimated model (coulmn 3), implying that 1 percent increase in cubic GDP would lead to 0.005 percent rise in CO_2 emissions. The signs of the parameters of GDP, GDP squared, and cubic GDP implying that EKC hypothesis is not valid in this case. R^2 equals 0.571 (column 1 & 2 and 3) showing that about 57% of the changes in CO_2 emissions caused by independent variables.

Therefore, results from Hausman test shows that fixed effect Model is the preferred regression since the test estimates a statistically significant P-value.

4.3.4. Results of Dynamic GMM

From the findings in Table 13, all parameters are significant at 1% level, log (FDI) equals -0.029 in

Models (1), (2), and (3). The findings support the pollution halo hypothesis. When energy consumption increases with 1%, CO_2 emissions would rise with 0.209 percent. Results in estimated model (column 1), implying that 1 percent rise in GDP would lead to 0.019 percent rise in CO_2 emissions.

Results in estimated model (column 2), implying that 1 percent increase in GDP squared would lead to 0.009 percent rise in CO_2 emissions. And results in estimated model (column 3), implying that 1 percent rise in GDP would lead to 0.006 percent rise in CO_2 emissions. The signs of the parameters of GDP, GDP squared, and cubic GDP implying that EKC hypothesis is not valid in this case.

In the estimation process, instruments validity in dynamic-GMM are confirmed by the Hansen J-statistic and corresponding P-values. Autocorrelation of errors is checked by Arellano-Bond test, AR (2) is nonsignificant, implying that serial correlation problem does not appear.

Table 13. *Effect of FDI on CO_2 Emissions: Panel Study from Developing Countries.*

Method: Dynamic Panel GMM

Dependent Variable: Log (CO_2) $_{it}$

	(1)	(2)	(3)
Log (ENC_{it})	0.209 (53.050)***	0.209 (53.050)***	0.209 (53.050)***
Log (Real GDP_{it})	0.019 (8.638)***		
Log (Real GDP_{it})^2		0.009 (8.638)***	
Log (Real GDP_{it})^3			0.006 (8.638)***
Log (FDI_{it})	-0.029 (-9.675)***	-0.029 (-9.675)***	-0.029 (-9.675)***
Log (CO_2)$_{it-1}$	0.513 (204.292)***	0.513 (207.292)***	0.513 (207.292)***
Hansen J-Statistic	38.878	38.878	38.878
Prob (J-statistic)	0.430	0.430	0.430
AR (1)	0.059	0.059	0.059
AR (2)	0.090	0.090	0.090
Instrument rank	42	42	42
No. of observations	1176	1176	1176

The instrument variables used for estimating the model are the first lag of each explanatory variable, and the second lag for the dynamic factor in the model; The absolute t-statistic values are in parentheses () next to the coefficients of the regressors. (***, **, *) denote significance level at 1%, 5%, and 10%, respectively. AR (1), and AR (2) represents the p-values for the Arellano- Bond first, and second-order serial correlation tests, respectively.

5. Conclusion

FDI and environmental pollution relationship in developing countries in literature review remains inclusive, where most papers done in developing countries focused on the environmental Kuznets curve hypothesis more than test the validity of the PHH and the pollution halo hypothesis. So, this paper empirically investigated the effect of FDI on CO_2 emissions in developing countries from two-panel samples over the period 1990 to 2019. By using pooled OLS, Fixed Effects, and Random Effects, and lastly using a dynamic GMM estimator.

The findings of this paper detected that FDI negatively affects CO_2 emissions, while energy consumption and economic growth positively affect CO_2 emissions in both samples in developing countries. The study found also that the results of the fixed effects method are largely consistent with the results of the dynamic GMM estimator.

Where the results of the latter can be summarized in:

1) FDI negatively affects CO_2 emissions, where a 1% increase in FDI reduces emissions of CO_2 by 0.049% in the first sample and by 0.029% in the second sample, this effect is significant at a level of 1%.
2) Energy consumption positively affects CO_2 emissions where a 1% increase in energy consumption causes an increase in CO_2 emissions by 0.452% in the first sample and by 0.209% in the second sample, this effect is significant at a level of 1%.
3) The coefficients of (R-GDP), (R-GDP)^2, and (R-GDP)^3 are positive at 0.06, 0.03, and 0.02 respectively in the first sample and at 0.019, 0.009, and 0.006 respectively in the second sample, this effect is significant at a level of 1%.

The paper recommended that: the policymakers and environmental regulators in developing countries should be careful to make the regulations of environmental pollution more stringent and effective. Sustainable economic development cannot be achieved if the environmental quality is neglected. Developing countries should ban the import and use of outdated machinery that cause high carbon emissions. Advanced and fewer pollutant technologies must be used in production by foreign companies in developing countries. Finally, developing countries should be selective in attracting FDI inflows.

References

[1] Sapkota, P., & Bastola, U. (2017). Foreign direct investment, income, and environmental pollution in developing countries: Panel data analysis of Latin America. Energy Economics, 64, 206-212.

[2] Demena, B. A., & van Bergeijk, P. A. (2019). Observing FDI spillover transmission channels: evidence from firms in Uganda. Third World Quarterly, 40 (9), 1708-1729.

[3] Zhu, H., Duan, L., Guo, Y., & Yu, K. (2016). The effects of FDI, economic growth and energy consumption on carbon emissions in ASEAN-5: evidence from panel quantile regression. Economic Modelling, 58, 237-248 Studies, 58 (2), pp. 277-297.

[4] Grossman, G., Krueger, A., 1991. Environmental impacts of a North American free trade agreement. National Bureau of Economics Research Working Paper, No. 3194, NBER, Cambridge.

[5] Richmond, A. K., Kaufmann, R. K., 2006. Is there a turning point in the relationship between income and energy use and/or carbon emissions? Ecological Economics 56, 176–189.

[6] Eskeland, G. S., Harrison, A. E., 2003. Moving to greener pasture? Multinationals and the pollution heaven hy- pothesis. Journal of Development Economics 70, 1–23.

[7] Dinda, S. (2004). Environmental Kuznets curve hypothesis: a survey. Ecological economics, 49 (4), 431-455.

[8] Grossman, G. M., Krueger, A. B., 1995. Economic Growth and the Environment. Quarterly Journal of Economics 110, 353–377.

[9] Moomaw, W. R., & Unruh, G. C. (1997). Are environmental Kuznets curves misleading us? The case of CO_2 emissions. Environment and development economics, 2 (4), 451-463.

[10] López-Menéndez, A. J., Pérez, R., & Moreno, B. (2014). Environmental costs and renewable energy: Re-visiting the Environmental Kuznets Curve. Journal of environmental management, 145, 368-373.

[11] Alvarez-Herranz, A., & Balsalobre-Lorente, D. (2015). Energy regulation in the EKC model with a dampening effect. J Environ Anall Chem, 2 (3), 1-10.

[12] Lorente, D. B., & Álvarez-Herranz, A. (2016). Economic growth and energy regulation in the environmental Kuznets curve. Environmental Science and Pollution Research, 23 (16), 16478-16494.

[13] Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D., & Farhani, S. (2018). How economic growth, renewable electricity and natural resources contribute to CO_2 emissions? Energy policy, 113, 356-367.

[14] Allard, A., Takman, J., Uddin, G. S., & Ahmed, A. (2018). The N-shaped environmental Kuznets curve: an empirical evaluation using a panel quantile regression approach. Environmental Science and Pollution Research, 25 (6), 5848-5861.

[15] Shahbaz, M., D. Balsalobre-Lorente and A. Sinha (2019), "Foreign direct Investment-CO_2 emissions nexus in Middle East and North African countries: Importance of biomass energy consumption", Journal of Cleaner Production, 217, pp. 603-614.

[16] Le, H. P., & Ozturk, I. (2020). The impacts of globalization, financial development, government expenditures, and institutional quality on CO_2 emissions in the presence of environmental Kuznets curve. Environmental Science and Pollution Research, 27 (18), 22680-22697.

[17] Dogan, E., & Inglesi-Lotz, R. (2020). The impact of economic structure to the environmental Kuznets curve (EKC) hypothesis: evidence from European countries. Environmental science and pollution research, 27 (11), 12717-12724.

[18] Demissew Beyene, S., & Kotosz, B. (2020). Testing the environmental Kuznets curve hypothesis: an empirical study for East African countries. International Journal of Environmental Studies, 77 (4), 636-654.

[19] Aslanidis, N. (2009). Environmental Kuznets curves for carbon emissions: A critical survey.

[20] Bakirtas, I., & Cetin, M. A. (2017). Revisiting the environmental Kuznets curve and pollution haven hypotheses: MIKTA sample. Environmental Science and Pollution Research, 24 (22), 18273-18283.

[21] Pazienza, P. (2019). The impact of FDI in the OECD manufacturing sector on CO_2 emission: Evidence and policy issues. Environmental Impact Assessment Review, 77, 60-68.

[22] Sarkodie, S. A., & Strezov, V. (2019). Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. Science of the Total Environment, 646, 862-871.

[23] Wang, H., C. Dong and Y. Liu (2019), "Beijing direct investment to its neighbors: A pollution haven or pollution halo effect?", Journal of Cleaner Production, 239, pp. 118062.

[24] Baek, J. (2016), "A new look at the FDI-income-energy-environment nexus: dynamic panel data analysis of ASEAN", Energy Policy, 91, pp. 22-27.

[25] Zhang, Y. and S. Zhang (2018), "The impacts of GDP, trade structure, exchange rate and FDI inflows on China's carbon emissions", Energy Policy, 120, pp. 347-353.

[26] Hanif, I., S. M. F. Raza, P. Gago-de-Santos and Q. Abbas (2019), "Fossil fuels, foreign direct investment, and economic growth have triggered CO_2 emissions in emerging Asian economies: some empirical evidence", Energy, 171, pp. 493-501.

[27] Hille, E., M. Shahbaz and I. Moosa (2019), "The impact of FDI on regional air pollution in the Republic of Korea: A way ahead to achieve the green growth strategy?", Energy Economics, 81, pp. 308-326.

[28] Jiang, L., Zhou, H. F., Bai, L. and Zhou, P. (2018), "Does foreign direct investment drive environmental degradation in China? An empirical study based on air quality index from a spatial perspective. Journal of Cleaner Production, 176, 864-872.

[29] Rafindadi, A. A., Muye, I. M., & Kaita, R. A. (2018). The effects of FDI and energy consumption on environmental pollution in predominantly resource-based economies of the GCC. Sustainable Energy Technologies and Assessments, 25, 126-137.

[30] Wang, H., & Liu, H. (2019). Foreign direct investment, environmental regulation, and environmental pollution: an empirical study based on threshold effects for different Chinese regions. Environmental Science and Pollution Research, 26 (6), 5394-5409.

[31] Shao, Y. (2018), "Does FDI affect carbon intensity? New evidence from dynamic panel analysis", International Journal of Climate Change Strategies and Management, 10 (1), pp. 27-42.

[32] Sung, B., W. Y. Song and S. D. Park (2018), "How foreign direct investment affects CO_2 emission levels in the Chinese manufacturing industry: Evidence from panel data", Economic Systems, 42 (2), pp. 320-331.

[33] Ansari, M. A., N. A. Khan and A. A. Ganaie (2019), "Does foreign direct investment impede environmental quality in Asian countries? A panel data analysis", OPEC Energy Review, pp. 1-27.

[34] Abdouli, M., O. Kamoun and B. Hamdi (2018), "The impact of economic growth, population density, and FDI inflows on CO_2 emissions in BRICTS countries: Does the Kuznets curve exist?", Empirical Economics, 54 (4), pp. 1717-1742.

[35] Balsalobre-Lorente, D., Gokmenoglu, K. K., Taspinar, N., & Cantos-Cantos, J. M. (2019). An approach to the pollution haven and pollution halo hypotheses in MINT countries. Environmental Science and Pollution Research, 26 (22), 23010-23026.

[36] Xie, Q. and Q. Sun (2020), "Assessing the impact of FDI on PM2.5 concentrations: A nonlinear panel data analysis for emerging economies", Environmental Impact Assessment Review, 80, pp. 106314.

[37] Albulescu, C. T., A. K. Tiwari, S. M. Yoon and S. H. Kang (2019), "FDI, income, and environmental pollution in Latin America: Replication and extension using panel quantiles regression analysis", Energy Economics, 104504.

[38] Liobikienė, G. and M. Butkus (2019), "Scale, composition, and technique effects through which the economic growth, foreign direct investment, urbanization, and trade affect greenhouse gas emissions", Renewable energy, 132, pp. 1310-1322.

[39] Ang, J., 2008. Economic development, pollutant emissions and energy consumption in Malaysia. Journal of Policy Modeling 30, 271–278.

[40] Pao, H. T, Tsai, C. M., 2010. CO_2 emissions, energy consumption and economic growth in BRIC countries. Energy Policy 38, 7850-7860.

[41] Arouri, M. E. H., Youssef, A. B., M'henni, H., & Rault, C. (2012). Energy consumption, economic growth and CO_2 emissions in Middle East and North African countries. Energy policy, 45, 342-349.

[42] Omri, A., 2013. CO_2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. Energy Economics 40, 657–664.

[43] Anwar, S., & Sun, S. (2011). Financial development, foreign investment and economic growth in Malaysia. Journal of Asian Economics, 22, 335–342.

[44] Olusanya, & Olumuyiwa, S. (2013). Impact of foreign direct investment inflow on economic growth in a pre and post deregulated Nigeria. A Granger causality test 1970–2010. European Scientific Journal, 9, 335–356.

[45] Omri, A., Khuong, N. D., & Rault, C. (2014). Causal interactions between CO_2 emissions, FDI, and economic growth: Evidence from dynamic simultaneous-equation models. Original Research Article Economic Modeling, 42, 382–389.

[46] Jalil, A., &Mahmud, S. F. (2009). Environment Kuznets curve for CO_2 emissions: a cointegration analysis for China. Energy Policy, 37, 5167–5172.

[47] Suri, V., & Chapman, D. (1998). Economic growth, trade and energy: implications for the environmental Kuznets curve. Ecological economics, 25 (2), 195-208.