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The Effect of Foreign Direct Investment on Environmental Pollution: New Evidence From Panel CCE for Different Income Groups

ABSTRACT

FDI may have positive effects on welfare with the transfer of environmentally friendly techniques of production to developing countries from developed countries. This study examines the effects of foreign direct investment, per capita GDP and energy consumption on CO2 emission in the different four income groups from 1992 to 2014 by using common correlated effect mean group estimator. The panel results reveal that foreign direct investments have statistically significant negative effects to CO2 emissions in Canada, Egypt, India, Mongolia, Sri Lanka, Ukraine, Brazil, Dominican Republic, Jordan, Finland, Iceland, Ireland, Italy, Korea Republic, Malta, Portugal, Trinidad, U.S.A, Bangladesh, Egypt, India, Mongolia, Sri Lanka, Ukraine, Brazil, Dominican Republic, Jordan, Kazakhstan, and South Africa. Contrarily, the results show that foreign direct investments have statistically significant positive contributions to CO2 emissions in with lower income countries compared to the countries above, such as Ethiopia, Tanzania and Togo, Armenia, Ecuador, Gabon, Mauritius, Paraguay, Honduras, Morocco.

Keywords: Foreign Direct Investment, Gas Emissions, Environment, Panel Data

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INTRODUCTION

FDI is an investment by an individual or multinational enterprise of one country that establishes a lasting interest in and control over an enterprise in another country. The inflow of Foreign Direct Investment (FDI) has increased rapidly during the late 1980s and 1990s in almost every region of the world. At the same time, the discussions about the costs and benefits of FDI inflows increased. The positive benefits of FDI to the receiving host country include capital, skill and technology transfer, market access and export promotion in the literature. In addition, FDI can cause the adoption of new technology in the production process with the effect of capital spillovers.

FDI may have positive effects on welfare with the transfer of environmentally friendly techniques of production to developing countries with FDI flows from developed countries. From this point of view, the halo effect hypothesis suggests that multi-nationals will tend to spread its environmental friendly technology to their counterparts in the host country (Birdsall and Wheeler, 1993; Zarsky, 1999). Hence, there exists a scale effect and multinational FDI operations would significantly contribute to a host nation's industrial output (Zarsky, 1999). Therefore, the linkage between FDI and the environment cannot be neglected.

In this study, we investigated the effects of FDI inflows, per capita GDP and energy consumption on CO2 emissions, which is considered to be the primary greenhouse gas responsible for global warming in the different four income groups (nine low-income, twenty-two lower-middle income, twenty-seven upper-middle income, thirty-seven high income) from 1992 to 2014. Using second-generation panel estimation technique, the Common Correlated Effects Estimation, the remainder of the study is as follows: Section 2 presents the previous studies focus on FDI and environment, Section 3 describes the methodology and data and reports the estimations strategy, results and their interpretations, Sections 4 presents conclusion and policy implications.

A BRIEF LITERATURE REVIEW

Many studies focused on FDI literature have been investigated the spillover effects of FDI on the environment. Such studies exert that FDI could threat the environment on the one hand as it could be a source of energy-saving on the other hand.

Mielnik and Goldemberg (2002) studied the linkage between FDI and energy consumption in 20 developing economies during the period 1987-1998. The findings revealed that the decline in energy intensity is associated with an increase in foreign direct investment.

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Grimes and Kentor (2003) examined the relationship between FDI inflow and CO_2 emissions in 66 underdeveloped countries using panel regression analysis using data from 1980 to 1996. In their study, they concluded that the inflow of FDI into the country increased CO_2 emissions, id est a positive relationship between the two variables.

Hoffmann et al. (2005) examined the relationship of FDI-CO_2 emissions for low-income and middle-income countries with a time length that varies between 15 to 28 years. Using the panel data VAR with the MLE estimator, the authors found that low-income countries with high levels of CO_2 attract more FDI. In addition, for middle-income countries, a positive significant coefficient of FDI is found implying that FDI creates more CO_2 emission.

Cole et al. (2006) examined the relationship between environmental pollution and FDO using panel data from 33 countries during the period 1982-1992. The empirical findings suggested that as the degree of corruption in a country rises, FDI causes environmental pollution.

Jorgenson (2007) investigated the relationship between foreign investment and environmental degradation in 35 underdeveloped countries using panel data analysis using data from 1980 to 1999. In his research, he concluded that there is a positive relationship between foreign investment in the agricultural sector and the CO_2 emissions from agricultural production.

The study of Sadorsky (2010) investigated the effect of foreign direct investment on energy consumption in 22 developing countries. The empirical results show that FDI promotes energy consumption along with the increase of liquidity will encourage the proliferation of new plants and factories rising energy demand.

Blanco et al. (2011) investigated the relationship between FDI and CO_2 emissions in 18 Latin American countries using data from 1980-2007 with the help of panel data analysis and Granger causality test. They concluded that there is a causal relationship between FDI and CO_2 emissions.

Additionally, Lee (2013) investigated the FDI-energy consumption nexus for G-20 countries. The study revealed that FDI increases clean energy adoption.

In the study of Akin (2014), the linkage between FDI and CO_2 emissions has been examined by panel GMM method for 12 high-income countries from 1970 to 2012. The findings reveal that there has been a statistically significant and negative linkage between the variables.

Pazienza (2015) tested the relationship between CO_2 emissions and FDI in agricultural and fishery sectors in 30 OECD countries with the help of panel data analysis using annual data from 1981 to 2005. In his study, he concluded that there is a negative relationship between FDI and CO_2 emissions.

Mert and Boluk (2016) examined the effect of FDI and renewable energy consumption on CO_2 emissions in 21 Kyoto countries from 1970-2010. According to the results of the PMG estimation, there is a statistically significant and negative relationship between FDI and CO_2 emission, supporting the pollution haloes hypothesis in the long-run.

Yilmaz et al. (2017) studied the linkage between FDI and CO_2 emissions in BRICS and MINT countries from 1992-2013. The findings show that there is a positive and statistically significant relationship between the two variables in long-run.

Sarkodie and Strezov (2019) studied the effect of FDI inflows, economic development, and energy consumption on greenhouse gas emissions over the period of 1982-2016 for the top five emitters of greenhouse gas emissions from fuel combustion in the developing countries, namely; China, India, Iran, Indonesia and South Africa. The findings of the study suggested a strong positive effect of energy consumption on greenhouse gas emissions and proved the presence of the pollution heaven hypothesis.

Consequently, previous studies show the complexity of the causal relationship between CO_2 emissions, energy consumption, FDI and economic growth. The findings of these relationships are not robust.

DATA AND ECONOMETRIC METHODOLOGY

Data

This paper institutes an econometric model to illustrate the relationship between carbon dioxide emissions, foreign direct investment, energy consumption and per capita GDP for the different four income groups (nine low-income, twenty-two lower-middle income, twenty-seven upper-middle-income, thirty-seven high income). In the analyzing of this relationship between the variables by incorporating a balanced panel, this study considers the equation (1):

$$co2_{it} = c + \beta_1 lfdi_{it} + \beta_2 lenergy_{it} + + \beta_3 lpgdp_{it} + u_{it} \tag{1}$$

where cO2 is cO2 emissions metric tons per capita, fdi is foreign direct investment, which is an investment made by a firm or individual in one country into business interests located in another country(US$), energy is total energy consumption per capita, pgdp is the GDP per capita (constant US$). The data was obtained from World Economic Outlook Database. The annual data is used. This sample is determined based on data availability.

Econometric Methodology and Empirical Findings

Cross-sectional dependence

Testing for cross-sectional dependence, which means that a shock affecting individuals forming a panel may also affect other individuals in a panel data analysis is important for selecting the appropriate estimator. In this study, Pesaran's CD_{LM} test and Breusch and Pagan's LM_{BP} test are used in order to control cross-sectional dependence. The test statistics can be calculated through the below panel data model:

$$y_{it} = \alpha_i + \beta_i '.x_{it} + \mu_{it} \text{ for } i=1,2,\ldots,N;\ t=1,2,\ldots,T \quad (2)$$

The test statistics, developed by Pesaran (2004) is as follows:

$CD_{LM} = \sqrt{\frac{1}{N.(N-1)}}\left[\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}(T.\hat{\rho}_{ij}^2 - 1)\right] \rightarrow N(0,1)$ where $\hat{\rho}_{ij}$ shows the estimation of the correlation coefficient among the residuals obtained from individual OLS estimations of Equation (2). Under the null hypothesis of no cross-sectional dependence CD_{LM} test is useful when N is large relative to T and it is asymptotically distributed as standard normal. The null and the alternative hypotheses of this test are as follows: $H_0 : Cov(\mu_{it,}\mu_{jt}) = 0$ for all t and $i \neq j$ $H_1 : Cov(\mu_{it,}\mu_{jt}) \neq 0$ for at least some $i \neq j$. The Lagrange multiplier test statistic (LM_{BP}) developed by Breusch and Pagan (1980) is employed. The test statistics can be calculated using the Equation (2). The test statistic developed by Breusch and Pagan (1980) is as follows:

$LM_{BP} = T.\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^2 \sim \chi^2_{N.(N-1)/2}$ where $\hat{\rho}_{ij}$ shows the estimation of the correlation coefficient among the residuals obtained from individual OLS estimations of Equation (2). Under the null hypothesis of no cross-sectional dependency on the LM_{BP} test, is used when N is fixed and T goes to infinity, is asymptotically distributed as chi-squared with N(N-1)/2 degrees of freedom.

The empirical findings of cross-sectional dependence test are presented in Table 1 below. It is clear that the null of no cross-sectional dependence across all country groups is rejected at the 1% level of significance.

Table 1: Results for cross-sectional dependence test

Variable	BP CD test statistic (prob.value) low	BP CD test statistic (prob.value) Lower-middle	Pesaran's CD test statistic (prob.value) upper-middle	Pesaran's CD test statistic (prob.value) high income
co2	273.79*** (0.00)	1929.70***(0.00)	78.64***(0.00)	104.24***(0.00)
lfdi	296.68***(0.00)	1838.85***(0.00)	102.30***(0.00)	64.33***(0.00)
lenergy	333.74***(0.00)	2726.20***(0.00)	96.09***(0.00)	99.18***(0.00)
lpgdp	670.86***(0.00)	4649.02***(0.00)	247.13***(0.00)	312.63***(0.00)

*** indicates rejection of the null hypothesis at the 1% level of significance.
Source: Authors' estimations.

Unit root analysis

Once we have found evidence of dependence, we study the order of integration of the variables. Using first generation panel data unit root testing methods, such as Hadri (2000), Levin Lin Chu (2002) and Im Pesaran Shin (2003) will increase the probability of the occurrence of the spurious unit root (Samadi and Rad, 2013). Therefore, for overcoming this problem, we take into consideration Cross-Sectionally Augmented IPS statistic value, which is average of Cross-Sectionally Augmented Dickey Fuller (thereafter CADF) statistics from second generation unit root tests, allowing cross section dependence.

Pesaran (2003) proposes a test based on standard unit root statistics in a CADF regression. CADF process can be reduced with an estimation of this equation:

$$\Delta Y_{it} = \alpha_i + \beta_i.Y_{i,t} - 1 + \sum_{j=1}^{pi}\delta_{ij}\Delta Y_{i,t-j} + d_i.\tau + c_i.\bar{Y}_{t-1} + \sum_{j=0}^{pi}\varphi_{ij}.\Delta\bar{Y}_{i,t-j} + \varepsilon_{it} \quad (3)$$

where $\bar{Y}_t = N^{-1}.\sum_{j=1}^{N}Y_{jt}$, $\Delta\bar{Y}_{i,t} = N^{-1}\sum_{j=1}^{N}\Delta Y_{jt}$ and ε_{it} is regression errors. Let $CADF_i$ be the ADF statistics for the i-th cross-sectional unit given by the t-ratio of the OLS estimate $\hat{\beta}_i$ of β_i in the CADF regression. Individual CADF statistics are used to develop a modified version of IPS t-bar test (denoted CIPS for Cross-Sectionally Augmented IPS) that simultaneously take into account of cross-section dependence and residual serial correlation: $CIPS = N^{-1}\sum_{i=1}^{n} CADF_i$. The hypotheses of CIPS are formulated as: $H_0 : \beta_i = 0$ all the time series are non-stationary, $H_A : \beta_i \prec 0$ all the time series are stationary process.

As shown in Table 2, Table 3, Table 4 and Table 5, in case of most country we can not reject the null hypothesis of nonstationary for all variables at the 5 percent significance level.

Table 2: Results for unit root test (low)

co2		energy		pgdp	fdi
Lags	CADF-stat	Lags	CADF-stat	Lags CADF-stat	Lags CADF- stat
2	-1,05	2	-2,234	2.000 -1.431	2.000 -1.050
3	-2,502	2	-1,076	3.000 -2.674	3.000 -2.502
2	-1,275	2	0,724	2.000 -0.265	2.000 -1.275
4	-2,905	2	-2,434	2.000 -3.555**	4.000 -2.905
2	-1,088	2	-2,787	2.000 -3.736**	2.000 -1.088
2	-2,928	3	-3,218***	2.000 -1.427	2.000 -2.928
4	-0,278	2	-2,839	2.000 -2.737	4.000 -0.278
2	-2,524	2	-0,51	2.000 -3.073***	2.000 -2.524
2	-2,317	2	-2,722	2.000 -2.405	2.000 -2.317

*,**,*** are implied that provided stationary in 1%, 5% and 10% according to the Table (1.b) Pesaran (2007) critical values of constant model.

Table 3: Results for unit root test (lower-middle)

fdi	pgdp	co2	energy
Lags CADF-stat	Lags CADF-stat	Lags CADF-stat	Lags CADF-stat
3.000 -4.430*	2.000 -3.840**	2.000 -1.144	2.000 -2.163
3.000 1.742	2.000 -1.455	2.000 0.544	2.000 -0.681
3.000 -2.399	2.000 1.217	2.000 -2.490	2.000 -2.295
3.000 -2.637	2.000 -5.846*	4.000 -3.094***	5.000 -2.624
2.000 -4.035**	4.000 -1.874	2.000 -1.652	3.000 0.173
2.000 -2.398	3.000 -2.423	2.000 -1.630	3.000 -3.374***
2.000 -2.453	3.000 -2.001	2.000 -0.059	2.000 -0.776
2.000 -3.185***	2.000 -2.939	2.000 -2.061	2.000 -1.453
2.000 -2.399	2.000 -1.764	2.000 -2.402	2.000 -0.902
2.000 -1.212	2.000 -0.356	2.000 -1.878	2.000 -3.812**
2.000 -1.784	2.000 -2.376	2.000 -0.462	2.000 -0.179
3.000 -2.943	2.000 -2.992	3.000 -0.867	2.000 0.031
2.000 -2.412	2.000 -3.827**	2.000 -1.612	2.000 -1.010
2.000 -6.586*	2.000 -3.193***	3.000 0.123	2.000 -2.718
2.000 -1.967	4.000 -2.747	2.000 0.504	2.000 -2.413
2.000 -2.551	2.000 -10.343***	2.000 -1.196	2.000 -2.065
2.000 -0.521	2.000 -2.718	2.000 -1.848	2.000 -4.211*
2.000 -1.987	2.000 -2.826	2.000 -0.486	2.000 -1.704
4.000 -0.178	2.000 -1.343	2.000 -1.620	2.000 -0.090
2.000 -3.107***	2.000 -6.616*	2.000 -1.398	2.000 -2.686
2.000 -2.339	2.000 -2.403	2.000 0.685	2.000 -0.195
3.000 -0.337	2.000 -3.272***	2.000 -4.720	2.000 -2.088

*,**,*** are implied that provided stationary in 1%, 5% and 10% according to the Table (1.b) Pesaran (2007) critical values of constant model.

Table 4: Results for unit root test (upper-middle)

co2		fdi		pgdp		energy	
Lags	CADF-stat	Lags	CADF-stat	Lags	CADF-stat	Lags	CADF-stat
5.000	-0.213	2.000	-4.356*	2.000	-0.855	5.000	0.473
2.000	- 3.162***	2.000	-2.271	2.000	-0.188	2.000	-3.220
2.000	-4.140**	2.000	-1.275	2.000	-3.127***	2.000	-4.734*
2.000	-0.943	2.000	-4.138**	3.000	0.095	2.000	-0.485
5.000	-1.526	2.000	-1.930	2.000	-2.671	5.000	-1.903
2.000	-0.638	2.000	-2.753	2.000	-1.406	2.000	-2.179
4.000	-1.260	5.000	-2.149	2.000	-1.297	2.000	-1.333
2.000	-3.010***	2.000	-2.778	5.000	-1.810	2.000	-0.822
2.000	-3.432**	2.000	-1.477	2.000	-3.113***	2.000	-0.883
3.000	-4.125**	5.000	-1.885	3.000	-1.870	4.000	-1.875
2.000	-4.616*	2.000	-3.550**	2.000	-2.827	2.000	-1.601
2.000	-1.995	5.000	-0.590	2.000	-4.909*	2.000	-3.527**
2.000	-0.595	2.000	-2.890	2.000	-2.206	2.000	0.590
2.000	-3.198***	2.000	-2.025	5.000	-3.231***	2.000	-3.482**
4.000	-3.117***	3.000	-1.703	2.000	-1.953	3.000	-2.065
2.000	-2.924	2.000	-0.877	2.000	-2.736	2.000	-2.660
2.000	-3.600**	5.000	-0.129	2.000	-2.831	2.000	-2.499
2.000	0.345	4.000	-1.901	2.000	-2.584	2.000	0.023
2.000	-1.803	4.000	-1.474	2.000	-1.730	4.000	-1.668
2.000	-3.593**	5.000	-0.421	5.000	-4.893*	2.000	-3.182***
3.000	-2.507	5.000	-1.201	2.000	1.415	2.000	-2.334
5.000	-1.675	2.000	-3.021***	2.000	-2.763	5.000	0.697
2.000	-1.223	2.000	-1.808	2.000	-4.472*	2.000	-1.463
2.000	-3.844**	2.000	-1.457	2.000	-3.307***	2.000	-4.922*
2.000	-2.882	2.000	-3.444**	2.000	-2.058	2.000	-3.139***
2.000	-1.635	2.000	-3.830**	2.000	-2.581	4.000	-0.733
2.000	-2.393	2.000	-3.559**	2.000	-1.318	2.000	-2.244

*,**,*** are implied that provided stationary in 1%, 5% and 10% according to the Table (1.b) Pesaran (2007) critical values of constant model.

Table 5: Results for unit root test (high)

energy		co2		pgdp		fdi	
Lags	CADF-stat	Lags	CADF-stat	Lags	CADF-stat	Lags	CADF-stat
2.000	-0.643	2.000	-1.048	2.000	-1.007	2.000	-2.251
3.000	-1.831	2.000	-3.081	2.000	-2.192	3.000	-0.987
2.000	-1.973	2.000	-3.237***	2.000	-2.073	3.000	-1.640
2.000	-2.051	2.000	-1.787	2.000	-2.280	2.000	-2.380
2.000	-2.305	3.000	-2.701	2.000	-4.004**	2.000	-0.739
2.000	-2.464	2.000	-2.282	2.000	-3.756**	2.000	-0.502
3.000	0.266	3.000	-2.659	2.000	-1.134	2.000	-3.533**
2.000	-0.812	2.000	-0.312	2.000	-2.716	2.000	-1.904
2.000	-1.909	2.000	-3.601**	2.000	-2.315	2.000	-2.228
2.000	0.337	2.000	1.091	2.000	-2.036	2.000	-0.450
2.000	-1.494	2.000	-1.134	2.000	-1.380	2.000	-2.627
2.000	-0.693	2.000	0.043	2.000	-2.456	3.000	-1.558
2.000	-1.226	3.000	-0.140	2.000	-1.916	2.000	-1.840
2.000	0.132	2.000	-0.258	2.000	-1.765	3.000	-0.469
4.000	-3.531**	3.000	-2.423	2.000	-1.555	4.000	1.113
3.000	2.749	2.000	-0.979	2.000	-1.310	4.000	-1.034
2.000	-0.744	2.000	-3.398***	2.000	-3.277***	3.000	-3.610**
2.000	-0.533	2.000	-1.574	2.000	-2.697	2.000	-2.814
2.000	-1.428	3.000	-2.542	2.000	-2.260	2.000	-1.263
2.000	-0.404	2.000	-1.249	2.000	-2.054	2.000	-2.130
2.000	-0.600	2.000	-0.897	2.000	-0.655	2.000	-2.469
4.000	-1.731	4.000	-1.417	2.000	-3.885**	4.000	-3.110***
2.000	-1.840	2.000	-0.617	2.000	-2.591	3.000	-1.767
2.000	-1.051	2.000	-1.169	3.000	0.955	3.000	1.260
2.000	-1.661	2.000	-0.994	2.000	-3.445**	2.000	-3.488**
2.000	0.082	2.000	0.134	2.000	-1.893	4.000	0.300
2.000	-2.087	2.000	-1.336	2.000	-2.698	2.000	-3.372**
2.000	-1.695	3.000	-2.796	2.000	-1.705	2.000	-2.466
2.000	-3.487**	2.000	-2.246	2.000	-2.111	2.000	0.534
2.000	-0.061	4.000	-2.268	2.000	-1.596	2.000	-3.235
2.000	-2.764	2.000	-0.983	2.000	-2.507	2.000	-1.477
3.000	0.303	2.000	-1.005	2.000	-1.497	2.000	-4.845*
2.000	-3.444	2.000	0.025	2.000	-2.505	2.000	-1.931
2.000	-2.189	2.000	-3.625**	2.000	-2.909	2.000	-0.585
4.000	-0.485	2.000	0.748	2.000	-1.883	4.000	-0.425
2.000	-1.364	2.000	0.810	2.000	-0.190	2.000	-1.890
2.000	-0.999	2.000	-2.184	2.000	-1.943	2.000	-1.224

*,**,*** are implied that provided stationary in 1%, 5% and 10% according to the Table (1.b) Pesaran (2007) critical values of constant model.

Estimation

In a panel analysis, due to common factors included in error terms, estimations can be inconsistent and misleading, and hence, it is important to consider cross-sectional dependence that arises from multiple factors that cannot be observed (Soydan and Bedir, 2015).

In this study, common correlated effects (CCE) estimator is used developed by Pesaran (2006). CCE takes into account the cross-sectional dependence and heterogeneity in the dataset. The CCE estimator can be used when T is greater than N or not.

There have been two versions of the CCE estimator. These are the CCE mean group estimator and the CCE pooled estimator. The first was used in the presence of heterogeneity in the dataset. Thus, in this study we estimated the regressions for four country groups via the CCE mean group estimator.

Table 6: Results for CCE estimation (low)

Country	energy	se	t	ppgdp	se	t	fdi	se	t
Benin	0.183	0.17	1.076	0.08	0.08	0.9534	-0.01	0.00	-2.8
Congo Dem. Rep.	0.085	0.03	2.5	-0.00	0.00	-2	0	0.00	0
Ethiopia	0.854	0.034	2.33	-0.01	0.00	-1.71	0.00	0.001	2
Haiti	0.145	0.04	3.15	-0.04	0.02	-1.5	-0.02	0.00	-7.333
Mozambique	0.027	0.36	0.075	0.15	0.09	1.670	0.00	0.00	0.1428
Senegal	0.157	0.11	1.33	0.068	0.072	0.9444	-0.02	0.01	-2
Tajikistan	0.831	0.04	19.78	-0.145	0.03	-4.677	0.00	0.00	1
Tanzania	-0.06	0.09	-0.615	-0.13	0.05	-2.5192	0.02	0.01	1.8461
Togo	0.679	0.11	6.062	0.02	0.06	0.4328	0.00	0.00	2

The long-run results for nine low countries in Table 6 show that in Benin, Haiti, Senegal foreign direct investments have statistically significant negative effects to co2 emissions in contrast to Ethiopia, Tanzania and Togo. In addition to these, in Congo, Ethiopia, Haiti, Tajikistan and Togo total energy consumption have statistically significant positive contributions to co2 emissions. Moreover, in Tajikistan, Mozambique and Tanzania per capita GDP have statistically significant negative effects to co2 emissions in contrast to in Mozambique.

Table 7: Results for CCE estimation (lower-middle)

Country	fdi	se	t	energy	se	t	pgdp	se	t
Angola	-0.01	0.01	-0.833	-1.14	0.85	-1.33	0.14	0.09	1.62
Bangladesh	-0.00	0.001	-2	0.381	0.03	10.8857	0.06	0.01	6
Bolivia	-0.02	0.02	-1.4	1.397	0.06	22.9016	0.309	0.12	2.512
Cameroon	0.00	0.00	0.2	0.067	0.196	0.34183	0.098	0.03	3.266
Congo Rep.	-0.02	0.02	-0.7241	0.738	0.266	2.7744	-0.39	0.16	-2.393
Cote d'Ivoire	0.03	0.03	1.0294	0.105	0.145	0.7241	-0.04	0.10	-0.392
Egypt	-0.03	0.01	-2.125	1.299	0.74	1.7412	0.079	0.15	0.526
El Salvador	-0.00	0.00	-1	0.653	0.092	7.09782	0.388	0.09	4.127
Ghana	-0.00	0.01	-0.5833	0.228	0.046	4.95652	-0.032	0.04	-0.695
Honduras	0.10	0.01	7.7142	1.014	0.20	4.94634	0.217	0.05	4.173
India	-0.02	0.01	-2	2.158	0.09	21.7979	-0.459	0.11	-3.889
Indonesia	-0.07	0.05	-1.529	-0.24	1.45	-0.16518	0.552	0.30	1.792
Kenya	0.00	0.00	1	0.927	0.45	2.04635	0.14	0.02	5
Mongolia	-0.43	0.26	-1.675	-3.83	1.97	-1.9412	-1.66	1.54	-1.075
Morocco	0.00	0.00	3	1.195	0.14	8.1292	-0.221	0.09	-2.455
Nicaragua	0.00	0.02	0.125	-0.24	0.33	-0.737	0.069	0.05	1.2545
Nigeria	0.07	0.04	1.5833	3.696	0.70	5.27246	0.329	0.10	3.1941
Pakistan	0.00	0.00	1.1428	1.177	0.15	7.84666	0.052	0.08	0.6046
Philippines	-0.0	0.0	-0.882	1.229	0.19	6.3025	0.15	0.17	0.8483
Sri Lanka	-0.0	0.00	-2.666	0.731	0.18	3.99453	0.085	0.06	1.3281
Tunisia	0.02	0.02	0.84	1.544	0.33	4.6787	-0.45	0.17	-2.594
Ukraine	-0.2	0.04	-5	10.40	1.29	8.0619	-0.05	0.46	-0.125

The long-run results for twenty-two lower-middle income countries in Table 7 illustrate that in Bangladesh, Egypt, India, Mongolia, Sri Lanka and Ukraine foreign direct investments have statistically significant negative effects of co2 emissions in contrast to Honduras, Morocco. In addition to these, in Bangladesh, Bolivia, Egypt, El Salvador, Ghana, Honduras, India, Kenya, Morocco, Nigeria, Pakistan, Philippines, Sri Lanka, Tunisia and Ukraine total energy consumption have statistically significant positive contributions to co2 emissions in contrast to Mongolia. Moreover, in Bangladesh, Bolivia, Cameroon, El Salvador, Honduras, Indonesia, Kenya, Nigeria per capita GDP have statistically significant positive effects of co2 emissions in contrast to Congo, India, Morocco and Tunisia.

Table 8: Results for CCE estimation (upper-middle)

Country	fdi	se	t	energy se		t	pgdp	se	t
Albania	0.006	0.05	0.12	1.621	0.217	7.4	-0.16	0.09	-1.70
Armenia	0.081	0.032	2.531	5.32	0.82	6.44	-0.03	0.08	-0.4
Belarus	0.058	0.055	1.054	3.993	1.03	3.854	1.52	0.44	3.45
Botswana	0.01	0.03	0.2941	3.392	0.70	4.831	-0.09	0.27	-0.35
Brazil	-.05	0.025	-2	5.447	0.41	13.15	0.12	0.08	1.592
Bulgaria	-.18	0.18	-1.0055	6.401	0.77	8.248	1.04	0.51	2.033
China	-.02	0.11	-0.228	2.863	0.51	5.591	0.86	0.22	3.900
Colombia	0.045	0.037	1.21621	11.39	0.387	3.607	-0.18	0.29	-0.612
Costa-Rica	0.086	0.14	0.5810	1.375	0.51	2.696	-0.42	0.2	-2.13
Dominican Rep.	-0.11	0.02	-4.576	2.37	0.54	4.360	-0.27	0.16	-1.674
Ecuador	0.13	0.05	2.3050	1.5	0.83	1.884	-0.59	0.42	-1.418
Gabon	0.02	0.017	1.6470	-0.624	0.28	-2.17	0.17	0.38	0.462
Guatemala	0.00	0.01	0.5454	0.201	0.20	0.990	0.77	0.51	1.510
Jamaica	0.13	0.10	1.2149	2.328	0.70	3.288	1.29	0.57	2.2630
Jordan	-0.03	0.01	-3.7	22.015	0.131	115.38	-0.42	0.203	-2.083
Kazakhstan	-0.245	0.13	-1.870	7.531	2.21	3.406	3.12	1.12	2.778
Malaysia	-.06	0.045	-1.42	3.673	2.605	1.4099	2.583	1.061	2.434
Mauritius	0.029	0.00	4.42	22.52	0.152	16.625	-0.09	0.09	-0.938
Mexico	-0.03	0.04	.-.75	3.63	0.453	8.028	0.049	0.071	0.6901
Namibia	0.001	0.007	0.1428	1.297	0.30	4.224	-0.32	0.19	-1.7
Paraguay	0.008	0.003	2.666	0.94	0.15	5.974	-0.04	0.043	-1.116
Peru	-0.03	0.06	-0.447	1.03	0.38	2.689	-0.92	0.39	-2.338
Romania	-0.06	0.07	-0.828	5.274	0.40	13.11	0.25	0.27	0.940
Russia	0.07	0.03	2.26470	12.56	0.511	24.58	0.083	0.18	0.4585
South Africa	--0.11	0.064	--1.796	112.22	0.786	15.55	0.452	0.32	1.395
Thailand	--0.03	0.03	-1	3.516	0.35	9.848	0.05	0.11	0.468
Turkiye	.0003	0.02	0.15	3.745	0.27	13.61	-0.02	0.05	-0.37

The long-run results for twenty-seven upper-middle income countries in Table 8 present that there is a statistically significant and a negative relationship between foreign direct investment and co2 emissions in Brazil, Dominican Rep., Jordan, Kazakhstan, and South Africa in contrast to Armenia, Ecuador, Gabon, Mauritius, Paraguay and Russia. Moreover, there is a statistically significant and positive relationship between total energy consumption and co2 emissions in all the upper-middle income countries except for Gabon, Guatemala, and Malaysia. Finally, there is a statistically significant and positive relationship between per capita GDP and co2 emissions in Belarus, Bulgaria, China, Jamaica, Kazakhstan, and Malaysia in contrast to Albania, Costa Rica, Dominican Rep., Jordan, Namibia and Peru.

Table 9: Results for CCE estimation (high)

Country	fdi	se	t	energy	se	t	pgdp	se	t
Argentina	0.142	0.02	6.7619	4.066	0.47	8.6326	-0.069	0.07	-0.8734
Australia	0	0.07	0	21.43	2.69	7.9558	-0.456	1.05	-0.4330
Austria	0.023	0.02	1.0952	13.81	0.62	22.204	1.301	0.31	4.1301
Bahrain	-0.057	0.45	-0.1247	33.18	7.93	4.1835	-18.29	5.35	-3.4168
Canada	-0.159	0.081	-1.9629	6.916	3.31	2.0862	-1.972	1.16	-1.6912
Chile	0.284	0.07	3.7368	2.278	0.35	6.4169	0.466	0.22	2.1085
Cyprus	-0.02	0.03	-0.5405	4.561	0.57	7.8910	1.775	0.45	3.9269
Denmark	-0.041	0.06	-0.6029	19.73	2.45	8.0235	-1.969	1.19	-1.654
Finland	-0.391	0.10	-3.8333	25.38	1.47	17.242	2.494	0.72	3.4542
France	0.079	0.02	3.0384	7.126	0.53	13.220	1.103	0.22	4.9461
Germany	-0.014	0.02	-0.6363	12.13	0.91	13.271	0.116	0.25	0.4531
Hungary	0.092	0.04	2	6.642	0.72	9.1236	-0.07	0.17	-0.3977
Iceland	-0.04	0.02	-2.285	-2.48	0.94	-2.618	0.099	0.69	0.1426
Ireland	-0.12	0.03	-3.875	10.50	0.67	15.492	0.905	0.20	4.3301
Israel	0.058	0.04	1.45	11.97	1.39	8.6053	-0.153	0.48	-0.3141
Italy	-0.01	0.005	-2	8.088	0.343	23.5801	0.787	0.232	3.39224
Japan	-0.056	0.077	-0.727	3.128	1.68	1.86190	-0.639	0.962	-0.6642
Korea Rep.	-0.246	0.12	-2.05	8.544	1.093	7.81701	0.647	0.376	1.72074
Malta	-0.032	0.015	-2.1333	6.265	0.243	25.7818	-0.572	0.402	-1.4228
Netherlands	-0.039	0.048	-0.8125	11.75	1.854	6.33764	-0.589	0.524	-1.1240
New Zealand	0.101	0.097	1.04123	5.288	1.049	5.04099	-0.43	0.471	-0.9129
Norway	-0.048	0.074	-0.6486	15.087	0.663	22.7556	2.079	0.514	4.04474
Oman	-0.236	0.26	-0.9076	7.733	0.765	10.1085	0.754	1.594	0.47302
Panama	0.082	0.067	1.2238	2.491	0.583	4.2727	-0.269	0.405	-0.664
Poland	-0.015	0.022	-0.681	9.693	0.351	27.615	-0.641	0.443	-1.4469
Portugal	-0.061	0.035	-1.742	6.365	0.582	10.936	-0.252	0.498	-0.5060
Qatar	-0.337	0.992	-0.3397	32.215	8.679	3.7118	-6.928	6.899	-1.004
Saudi Arabia	0.083	0.125	0.664	18.378	7.15	2.5696	11.857	2.384	4.9735
Singapore	-0.38	0.574	-0.662	-6.176	3.28	-1.8794	11.034	2.458	4.489
Spain	-0.02	0.05	-0.509	9.059	0.83	10.810	0.816	0.38	2.1305
Sweden	-0.03	0.02	-1.241	7.182	0.55	12.940	0.636	0.25	2.5138
Switzerland	-0.02	0.01	-1.444	8.32	0.39	20.904	-0.09	0.32	-0.276
Trinidad	-0.15	0.06	-2.323	19.77	1.03	19.121	-3.132	2.01	-1.551
U.A.E.	1.28	0.42	3.004	-11.98	12.1	-0.982	4.74	9.75	0.486
U.K.	0.042	0.03	1.2	9.524	1.13	8.3617	-0.17	0.41	-0.421
U.S.A.	-0.08	0.01	-5.8571	20.22	0.91	22.009	-0.70	0.18	-3.80

The long-run results for thirty-seven high-income countries in Table 9 show that in Argentina, Chile, France, Hungary and U.A.E. foreign direct investments have statistically significant positive contributions to co2 emissions in contrast to Canada, Finland, Iceland, Ireland, Italy, Korea Rep., Malta, Portugal, Trinidad and U.S.A. Moreover, there is a statistically significant and positive relationship between total energy consumption and co2 emissions in all the high-income countries except for Iceland, Singapore and U.A.E. Finally, there is a statistically significant and positive relationship between per capita GDP and co2 emissions in Austria, Chile, Cyprus, Finland, France, Ireland, Italy, Korea Rep., Norway, Saudi Arabia, Singapore, Spain, and Sweden in contrast to U.S.A, Denmark, Bahrain and Canada.

CONCLUSION

In this study, we investigate empirically the role of foreign direct investment inflows on environmental pollution, as measured by CO2 emissions in the different four income groups from 1992 to 2014 by using common correlated effect mean group estimator. Our findings can be summarized as follows; the empirical results for individual panel show that increases in total energy consumption raise environmental pollution for Congo, Ethiopia, Haiti, Tajikistan, Togo Bangladesh, Bolivia, Egypt, El Salvador, Ghana, Honduras, India, Kenya, Morocco, Nigeria, Pakistan, Philippines, Sri Lanka, Tunisia, Ukraine Albania, Armenia, Belarus, Botswana, Brazil, Bulgaria, China, Colombia, Costa-Rica, Dominican Rep., Ecuador, Jamaica, Jordan, Kazakhstan, Mauritius, Mexico, Namibia, Paraguay, Peru, Romania, Russia, South Africa, Thailand, Turkiye and for all the high-income countries except for Iceland, Singapore and U.A.E.

In addition, the empirical results for individual panel show that increases in per capita GDP raise environmental pollution in Tajikistan, Mozambique, Tanzania, Congo, India, Morocco, Tunisia, Albania, Costa Rica, Dominican Rep., Jordan, Namibia, Peru, U.S.A, Denmark, Bahrain and Canada in contrast to Mozambique, Bangladesh, Bolivia, Cameroon, El Salvador, Honduras, Indonesia, Kenya, Nigeria, Belarus, Bulgaria, China, Jamaica, Kazakhstan, Malaysia, Austria, Chile, Cyprus, Finland, France, Ireland, Italy, Korea Rep., Norway, Saudi Arabia, Singapore, Spain and Sweden.

Finally, in relation to the relationship between FDI and environmental pollution, the empirical results showed that increases in FDI inflows raise co2 emissions in Ethiopia, Tanzania, Togo, Honduras, Morocco, Armenia, Ecuador, Gabon, Mauritius, Paraguay, Russia, Argentina, Chile, France, Hungary and U.A.E, which means that the pollution heaven hypothesis is valid for these countries. On the other hand, the empirical findings showed that the halo effect hypothesis is valid for Benin, Haiti, Senegal, Bangladesh, Egypt, India, Mongolia, Sri Lanka, Ukraine, Brazil, Dominican Rep., Jordan, Kazakhstan, South Africa, Canada, Finland, Iceland, Ireland, Italy, Korea Rep., Malta, Portugal, Trinidad and U.S.A, which means that FDI is beneficial to the host country because by bringing in clean technology and know-how, it improves the environmental standards.

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