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Foreign Direct Investment and Pollution in Middle Income and OECD Member Countries

Orta Gelirli ve OECD Üyesi Ülkelerde Doğrudan Yabancı Yatırımlar ve Kirlilik

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ÖZ

Bu çalışmada, 1992 – 2017 dönemi için orta gelirli ülkelerde ve OECD ülkelerinde doğrudan yabancı yatırım girişlerinin karbon emisyonları üzerindeki etkisini incelemektedir. Bu amaçla, panel verilerdeki potansiyel içsellik, ihmal edilmiş değişken ve eşzamanlılık sapmalarını dikkate alan iki aşamalı bir sistem GMM dinamik panel veri tahmincisi kullanılmıştır. Analizlerden elde edilen ampirik sonuçlar, doğrudan yabancı yatırımların orta gelirli ülkelerde karbon emisyonlarını artırdığını göstermekte ve gelişmekte olan ülkelerde kirlilik cenneti hipotezinin geçerliliğini desteklemektedir. Bununla birlikte, ampirik bulgular, doğrudan yabancı yatırımların gelişmiş ekonomiler üzerinde küçük bir hale etkisi olduğunu göstermektedir. Çalışmamız ayrıca Çevresel Kuznets Eğrisi hipotezinin destekler sonuçlar da ortaya koymaktadır.

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ABSTRACT

This study reexamines the impact of foreign direct investment inflows on carbon emissions in middle-income and OECD countries over the period 1992 – 2017. For that purpose, we employ a two-step system GMM dynamic panel data estimator controlling for endogeneity, omitted variable, and simultaneity in our panels. The empirical results from the analyses show that FDI increases carbon emissions in middle-income countries and provide evidence of the pollution haven hypothesis in developing countries. Our findings suggest that FDI has a small halo effect on advanced economies. Our study also provides evidence of the Environmental Kuznets Curve hypothesis across different panel samples.

1. Introduction

Foreign direct investment (FDI) is considered to be an important factor for the integration of less developed countries into the global economy. FDI can be regarded as a significant source of productivity rise and economic development especially for developing countries. This is due to the fact that FDI may not only provide direct capital financing but also can cause overall growth in output via increase in wages and income by creating job opportunities. FDI can also promote economic growth through more efficient allocation of resources by stimulating investments in critical industries and financial services, stimulation of technological development due to the transfer of foreign technologies and managerial skills to host countries and increasing competition. Moreover, FDI may allow for foreign exchange rate stability by contributing to the foreign exchange reserves and thus, together with the aforementioned externalities, stimulates sustainable and balanced industrial development.

The structural changes in economic policies after the 1980s have led to the liberalization of goods and capital movements in the global economy and this process have accelerated after the Cold War came to an end. Foreign

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direct investment has grown tremendously over the last three decades and become one of the most significant effects –and causes– of the globalization process. According to UNCTAD World Investment Report (2018), global FDI inflows of $57 billion in 1982 reached an estimated 1.5 trillion in 2019 and around $1 trillion in 2020 (down from its peak $1.92 trillion in 2015 after a substantial contraction due to recent global economic and financial crises partly caused by the COVID-19 pandemic). Developing economies accounted for 44.5 per cent of global FDI inflows in 2019, compared with 36 per cent in 2016 and the share of developed economies in global FDI inflows in 2019 decreased to 52 per cent of the total. Global FDI inward stock reached an estimated $36.5 trillion and developing economies absorbed 31 per cent of the total (up from 20 per cent in the beginning of 2000s) owing to their cheap labor, raw materials and eligible investment environment.

However, as with many of the other aspects of globalization, the rising foreign investment has raised an important debate regarding the environmental consequences of capital inflows. In contrast with the sharp reduction goals set by the Paris Agreement, global energy-related carbon emissions rose by 1.7% in 2018 and reached a historic peak of 33.1 gigatonnes (Gt) after remained flat for three years. Yet the trend of rising level of emissions was not universal; declined in some major economies such as Japan, the United Kingdom, the United States and Mexico, while most of the others experienced a rise in CO2 emissions (International Energy Agency – IEA, Global Energy and CO2 Status Report, 2019).

Taking advantage of the aforementioned potential benefits of FDI, host countries compete with each other to attract such investments and encourage FDI inflows. Such countries may become attractive destinations for foreign firms not just because of their cheap labor, natural resources, quality infrastructure, good governance but particularly less developed countries may employ lenient environmental regulations to attract foreign investment. Therefore, relatively less stringent environmental policies in these countries may attract profit-driven firms eager to reduce production costs and outsource their dirty production. Moreover, a scale effect might arise as FDI contributes to industrial production and thus in turn raises the overall level of energy use. Hence, FDI might escalate the pollution levels in such countries. This is called as the "pollution haven hypothesis (PHH)", also known as the "race to the bottom". On the other hand, "pollution halo hypothesis", also known as the "bottom rise" suggests that FDI may have positive environmental quality in host countries thanks to the advanced environment friendly technologies and better management practices. FDI may also enable the transfer of greener technologies to domestic firms and raise the stringency of environmental regulations by improving host countries' economic capacity to deal with environmental problems. It is also worth noting that the absorptive capacity of host countries might play an important role in FDI-environment nexus, enabling countries to capture international environment friendly technologies and so-called spillovers successfully through FDI inflows. It is reasonable to think that the technology effect of FDI may arise in countries with adequate absorptive capacity, rather than in all countries. Even though it is not the intent of the current study to determine the role of absorptive capacity in FDI-environment nexus, we split the sample of countries into three 'upper middle income, lower middle income and OECD countries. Thus, we might better be able to assess the contributions of FDI inflows to the environment in different samples of countries. The present study also contributes to the existing literature by extending the sample period. Furthermore, previous studies mostly suffer from estimation biases arising from endogeneity and simultaneity. It is reasonable to think that there might be a close association between the independent variables; or the dependent variable may as well affect the explanatory variables. For instance, a country may adopt stringent environmental regulations which may reduce pollution levels, but high pollution may also force the country to introduce such laws. Environmental pollution might change the course of FDI flows as well as FDI inflows might have considerable effects on the environment. In this study, we address these issues present in the earlier studies by taking implicitly into account endogeneity and simultaneity biases employing a dynamic panel data approach (a two-step system GMM) which circumvents these types of problems.

To sum up, it is clear from the theoretical literature that the effect of FDI inflows on the environment is ambiguous and complex. This theoretical ambiguity is also in accord with empirical evidence and a bunch empirical literature has examined the relevance of these conflicting arguments, yet no conclusive results have been obtained regarding the FDI-pollution nexus. Some studies find supporting evidence that FDI aggravates environmental pollution in the host country (Hoffman et al., 2005; He, 2006; Waldkirch and Gopinath, 2008 among others) while some others report that FDI reduces pollution (Al-mulali and Tang, 2013; Eskeland and Harrison, 2003; Zhu et al., 2016 among others). Another strand of the literature finds no significant effect of FDI on pollution (Chandran and Tang, 2013; Hassaballa, 2013; Shaari et al., 2014 among others). In light of these conflicting views in the literature, our purpose in this study is to shed light on the impact of FDI on CO2 emissions in middle income and OECD countries taking into account endogeneity, simultaneity and omitted variable biases that may present in our panels. We believe that understanding the association between foreign investment flows and carbon emission has important ramifications for policy implications. As a matter of fact, encouraging FDI for sustainable and balanced economic growth requires facing a challenge of 'less emission'.

Our study contributes to the PHH literature in several aspects. Although there are many studies on the PHH, our paper allows us to compare countries with different size of development levels. Our study aims to fill this gap and to test the validity of PHH for lower-middle, upper-middle and

OECD countries. Another contribution of our study stems from our selection of the model and variables. We employ a two-step system GMM model which allows one to control for endogeneity and simultaneity biases as well as the omitted variable bias, and thus provide more accurate and efficient results. Our study also provides information on the validity of the PHH for middle-income and OECD countries using the most recent data. Our econometric methodology is robust and informative. We exploit the panel aspect of the data which increases the number of observations in the dataset and provides consistent results.

The rest of the paper is organized as follows. Section two provides a literature review and section three introduces the data and methodology. Section four presents the results and finally section five concludes the paper.

2. Literature Review

The debate on the relationship between FDI and environmental pollution is extensive in the theoretical and empirical literature. However, empirical evidence on the interaction between the two has been inconclusive due to the contradictory and ambiguous findings. The theoretical literature related to the FDI-pollution nexus can simply be decomposed into three groups of arguments. The PHH holds that inward FDI worsens environmental conditions as weak environmental regulations in host countries may attract dirty industries eager to avoid costly stringent environmental regulations in their home countries. On the other hand, The Pollution Halo Hypothesis states that FDI may have positive environmental quality in host countries as multinational companies have new and greener technologies improving energy efficiency and creating positive spillover effects for their local counterparts. Finally, the scale effect may arise due to increasing energy consumption in host countries resulted from higher levels of industrial output fueled by multinational FDI operations.

The original PHH was brought up by Pethig (1976) and improved by Copeland and Taylor (1994). Since then, the environmental consequences of FDI inflows have become one of the most controversial issues and a large number of studies have conducted empirical analyses to uncover the true effect of FDI on host countries' environmental conditions. Birdsall and Wheeler (1993) argue that trade liberalization and increased foreign investment in Latin America have not been accompanied by pollution-intensive industrial development and challenge PHH. The empirical evidence and case studies indicate that openness is more likely to encourage cleaner industry by allowing transferring pollution standards of developed countries. Eskeland and Harrison (2003) on the other hand, investigate whether multinationals move towards the pollution haven countries. The results indicate weak evidence that foreign firms tend to locate in industries with high air pollution. They also argue that foreign firms are more environment friendly than their peers thanks to the energy efficiency and the use of cleaner energy.

In a regional study, He (2006) constructs a simultaneous model and employs a panel data of 29 provinces in China to investigate the effect of FDI on SO_2 emissions in China examining the dynamic recursive FDI entry decision and FDI entry – emission nexus taking scale, composition and technology effects into account. The findings indicate that, through different channels, the effect of FDI and industrial emissions is very weak. The model also supports the validity of PHH. The results suggest that the rise in the stringency of environmental regulations has a small deteriorating impact on FDI inflows. In addition, the FDI inflow seeking lower pollution regulation compliance cost dominates the composition transformation impact of FDI.

Merican et al. (2007) examine the effect of FDI on pollution in 5 ASEAN countries within the time series analyses framework. The results from the ARDL models confirm the polluting effect of FDI in Thailand, Malaysia, and the Philippines. In addition, the findings suggest that FDI has a negative effect on pollution in Indonesia whereas there seems to be an insignificant relationship between the two in Singapore. In a similar context, Baek (2016), employing data on panel of five ASEAN countries for the period 1981-2010, estimates the effect of FDI on CO_2 emissions. The findings from the pooled mean group (PMG) estimator of dynamic panels support the PHH. Another analysis on five ASEAN countries conducted by Zhu et al. (2016) employing a panel quantile regression to take into account distributional and unobserved individual heterogeneity. Their findings indicate a negative effect of FDI on carbon emissions, with an exception at the 5th quantile, and significant at higher quantiles.

Waldkirch and Gopinath (2008) test the validity of PHH in Mexico examining several different pollutants. The industry level analysis suggests a positive correlation between FDI and sulfur dioxide emissions. The industries at which the correlation is positive receive up to 30% of manufacturing output and total FDI. The results indicate that the investment decisions of firms may be affected by environmental considerations. Kheder and Zugravu (2008), on the other hand, reexamine the PHH employing French firm-level data using a geographic economy model. The study confirms the hypothesis for the global sample and specific country groups of emerging and high-income OECD countries, Central and Eastern European countries, but not the Commonwealth of Independent States countries.

Blanco et al. (2013) investigate the relationship between carbon emissions and sector-specific FDI in 18 Latin American countries over the period 1980–2007. Panel Granger causality tests indicate causality running from FDI in pollution-intensive industries to per capita CO_2 emissions and no robust evidence of the causal effect of FDI on CO_2 emissions. On the other hand, the study by Hoffman et al. (2005), using data on panel of 112 countries over 15-28 years, find that the causality between the two depends on development level of host countries. Rather than causality, Sapkota and Bastola (2017) empirically investigate the PHH for 14 Latin American countries for the period 1980 – 2010. The results from the panel fixed and random effects model support the PHH and the findings hold for both the high and low-income countries in the region. However, the study by Baek and Choi (2017) employing pooled mean group (PMG) estimation method within a framework of dynamic panel data of 17 Latin American countries reveal an increasing effect of FDI on emissions only in high income countries. Furthermore, they argue that in full sample and middle-income countries, carbon emissions with growth seem to increase monotonically.

Al-mulali and Tang (2013) question the validity of the PHH in GCC countries for the period 1980-2009 using non-stationary panel techniques. FMOLS results suggest a negative relationship between FDI and CO2 emissions in the long run while based on the short run Granger causality test FDI does not have a causal relationship with CO2 emissions in the short run. In addition, Aliyu and Ismail (2015) investigate the FDI – pollution nexus in 19 African countries for the period 1990 – 2010 using PMG estimation procedure. Empirical findings suggest that FDI inflows followed by energy intensity increase greenhouse gas emissions. The results also support the validity of PHH for CO2 emissions. Furthermore, the study argues that the energy policies of African nations and foreign investment in Africa seem to be not favorable to the environmental quality in the region. Regarding the possible asymmetry, Shahbaz et al. (2015) analyze the asymmetric link between FDI and its environmental consequences in low, middle and high-income countries employing fully modified ordinary least squares (FMOLS). They find that FDI increases environmental degradation in the long run, confirming the PHH. The findings also suggest two-way causality between CO2 emissions and FDI for all set of countries.

Overall, it is clear from the literature that it is still an open question whether and to what extent FDI is responsible for environmental degradation or sustainability.

3. Data and Methodology

For our purpose in this study, we utilize longitudinal panel data on middle income and OECD countries over the period 1992 – 2017. The selected countries for the analysis are listed in Table 1. The variables subject to the empirical analysis are GDP per capita (constant at 2010 US$), CO2 emissions (metric tons per capita), per capita FDI inflows and per capita energy use (Mtoe). The descriptive statistics are summarized in Table 2. The annual data for carbon emissions and energy use are extracted from IEA (2019) while the rest of the data comes from the World Development Indicators provided by the World Bank. All the variables are expressed in terms of their natural logarithms in order to ease the interpretation and due to the argument that logarithm function produces a realistic income-environment effect (quality, sustainability) (Cole et al., 1997).

Table 1. Categorization of countries for different income groups and data coverage

Lower Middle Income Countries	Data Coverage	Upper Middle Income Countries	Data Coverage	OECD Countries	Data Coverage
Angola	1992-2017	Albania	1992-2017	Australia	1992-2017
Bangladesh	1992-2017	Algeria	1992-2017	Austria	1992-2017
Bolivia	1992-2017	Armenia	1992-2017	Belgium	1992-2017
Cambodia	1992-2017	Azerbaijan	1992-2017	Canada	1992-2017
Cameroon	1992-2017	Belarus	1992-2017	Chile	1992-2017
Congo, Rep.	1992-2017	Bosnia & Herzegovina	1998-2017	Czech Rep.	1992-2017
Egypt	1992-2017	Botswana	1992-2017	Denmark	1992-2017
El Salvador	1992-2017	Brazil	1992-2017	Estonia	1993-2017
Ghana	1992-2017	Bulgaria	1992-2017	Finland	1992-2017
Honduras	1992-2017	China	1992-2017	France	1992-2017
India	1992-2017	Colombia	1992-2017	Germany	1992-2017
Indonesia	1992-2017	Costa Rica	1992-2017	Greece	1992-2017
Kenya	1992-2017	Dominican Republic	1992-2017	Hungary	1992-2017
Kyrgyz Rep.	1992-2017	Ecuador	1992-2017	Iceland	1992-2017
Moldova	1995-2017	Gabon	1992-2017	Ireland	1992-2017
Mongolia	1992-2017	Guatemala	1992-2017	Israel	1992-2017
Morocco	1992-2017	Iran, Islamic Rep.	1992-2017	Italy	1992-2017
Myanmar	2000-2017	Iraq	2004-2017	Japan	1992-2017
Nicaragua	1992-2017	Jamaica	1992-2017	Korea Rep.	1992-2017
Nigeria	1992-2017	Jordan	1992-2017	Latvia	1995-2017
Pakistan	1992-2017	Kazakhstan	1992-2017	Lithuania	1995-2017
Philippines	1992-2017	Lebanon	1992-2017	Luxembourg	2002-2017
Senegal	1992-2017	Libya	1999-2017	Mexico	1992-2017
Sudan	1992-2017	Malaysia	1992-2017	Netherlands	1992-2017
Tunisia	1992-2017	Mauritius	1992-2017	Norway	1992-2017
Ukraine	1992-2017	Mexico	1992-2017	Poland	1992-2017
Uzbekistan	1992-2017	Namibia	1992-2017	Portugal	1992-2017
Vietnam	1992-2017	Paraguay	1992-2017	Slovak Rep.	1992-2017

Zambia	1992-2017	Peru	1992-2017	Slovenia	1992-2017
Zimbabwe	1992-2017	Romania	1992-2017	Spain	1992-2017
		Russian Fed.	1992-2017	Sweden	1992-2017
		South Africa	1992-2017	Switzerland	1992-2017
		Suriname	2000-2017	Turkey	1992-2017
		Thailand	1992-2017	UK	1992-2017
		Turkey	1992-2014	US	1992-2017
		Turkmenistan	1993-2017		
		Venezuela	1992-2014		

Source: The World Bank

Table 2. Descriptive Statistics for OECD, Lower Middle and Upper Middle Income Countries (1992-2017)

	Variable	Mean	Std.Dev.	Min	Max
OECD	co2pc	8.485	4.241	2.138	28.173
	fdipc	200.897	668.257	-6516.642	7965.764
	gdppc	34474.11	21328.52	5140.984	112000
	energyusepc	4.125	2.358	.927	18.17
Lower Middle Income	co2pc	1.234	1.492	.098	10.853
	fdipc	6.03	13.691	-145.047	146.261
	gdppc	1683.463	874.742	205.859	4343.44
	energyusepc	.674	.531	.119	4.21
Upper Middle Income	co2pc	3.77	2.818	.435	15.354
	fdipc	19.329	23.155	-63.78	202.366
	gdppc	5833.875	2792.56	701.475	14920.45
	energyusepc	1.599	1.029	.363	5.352

Source: Authors' calculations.

In connection with our previous discussions, we model two specifications as follows, where the selected variables are expected to determine the carbon emissions:

$$\mathrm{lnco_2pc_{it}} = \beta_0 + \beta_{1i}\mathrm{lngdppc_{it}} + \beta_{2i}\mathrm{lngdppc_{it}^2} + \beta_{3i}\mathrm{lnfdipc_{it}} + \beta_{4i}\mathrm{lnenergyusepc_{it}} + \mu_i + \varphi_t + \varepsilon_{it} \quad (1)$$

$$\mathrm{lnco_2pc_{it}} = \beta_0 + \beta_{1i}\mathrm{lngdppc_{it}} + \beta_{2i}\mathrm{lngdppc_{it}^2} + \beta_{3i}\mathrm{lnfdipc_{it}} + \beta_{4i}\mathrm{lnenergyusepc_{it}} + \mathrm{lnco_2pc_{it-1}} + \mu_i + \varphi_t + \varepsilon_{it} \quad (2)$$

where *i* and *t* represent the cross sections (30 lower income countries, 37 upper income countries and 35 OECD countries) and the time period (1992-2017), respectively. ε_{it} is the standard error (idiosyncratic) term which is assumed to be i.i.d. and varies over both cross sections and time. $\beta_{1i} \dots \dots . . \beta_{4i}$ are the slope coefficients, while β_0 represents the constant term. The panel data model is represented by Eq. (1) in which country (μ_i) and time (φ_t) fixed effects are included, while the Eq. (2) is the dynamic generalized method of moments (GMM) equation containing one year lagged dependent variable.

Fixed or random effect panel data models have been relied on by most studies on the EKC. However, the aforementioned models harbor some concerns such as autocorrelation and heteroscedasticity that raise question the accuracy of the results (Stern et al. 1996). Fixed and random effect models do not take into account endogeneity problem as well as serial correlation and heteroscedasticity, which may distort the true estimation of model. These problems usually exist in panel data and can be dealt with the employment of GMM (Attari et al., 2016). Another reason of using GMM estimation is that it performs better when the cross-section units are larger than the time period in the study. As we have 23 years and more than 30 countries, we rely on system GMM which is a superior method to fixed effects due to aforementioned reasons.

4. Empirical Findings and Discussion

This section starts with the analysis of static panel data models and the estimation results from fixed effects (FE) and random effects (RE) regressions are summarized in Table 3. Hausman (1978) provides a test (the so called Hausman test) which is widely used in the most applications in economics to test for the statistical significance of the difference between the two estimators of the coefficient vectors, under the null hypothesis that the conditional mean of the disturbances given the regressors is zero. The FE estimator is consistent under both the null and the alternative hypothesis, while the RE estimator is consistent and efficient under the null hypothesis but inconsistent under the alternative hypothesis. The significant Hausman test statistic provided in Table 3 leads us to reject the null at the 5% level, implying that the FE model is appropriate only for OECD countries. However, we cannot reject the null hypothesis for lower middle income and upper middle income countries. Hence, we discuss the results of FE model for OECD countries and we interpret the results of RE model for lower middle income and upper middle income countries at this point.

As a starting point, the FE results suggest a nonlinear relationship between per capita GDP and carbon emissions except for upper middle income countries where per capita GDP term and its squared form are insignificant. Specifically, for lower middle income and OECD countries, the coefficients of per capita GDP and its squared term are statistically significantly positive and negative, respectively. This shows that per capita income first raises emissions up to a certain level; after that carbon emissions start to decline as income goes up. In the literature, this phenomenon is termed as the Environmental Kuznets Curve (EKC) hypothesis. Therefore, the results confirm that the EKC hypothesis hold for lower middle income and OECD countries. Hence, we do not find any evidence supporting EKC hypothesis in upper middle income countries. Regarding the effect of per capita energy use on emissions, the findings from both FE and RE models indicate that energy consumption is one of the main drivers of carbon emissions across all specifications, with the coefficients ranging from 0.882 to 1.099. Specifically, a percentage increase in energy use raises carbon emissions by about 0.9 percentages in OECD countries, while CO2 emissions in middle income countries increase 0.9-1% on average as energy consumption goes up by 1 percent.

When we focus on FDI impact on carbon emissions, the both FE and RE models also suggest that FDI is insignificant in determining the carbon emissions in upper middle and OECD countries. However, FDI is positively associated with carbon emissions in lower middle income countries. One percentage increase in per capita FDI seems to be associated with %0.016 increase in per capita carbon emissions in lower middle income countries. However, as mentioned earlier, the standard FE and RE estimators fail to account for dynamics in panel data models. This is because the lagged dependent variable becomes endogenous (i.e. being correlated with error term). To overcome this issue, we further continue our analysis by introducing a two-step system GMM model. This estimation method allows one to control for endogeneity and simultaneity biases as well as the omitted variable bias, and thus provide more accurate and efficient results. Adopting a system GMM model ensures that there would be no second order correlation in the error term. System GMM estimator is also superior to difference and level GMM estimators in terms of efficiency. (Roodman, 2009) argues that the system GMM estimator is more appropriate (i) if the dependent variable follows a random walk and (ii) if the explanatory variables are persistent over time, causing the lagged dependent and independent variables to become weak instruments for their differences, respectively. For more detailed clarifications, see Arellano and Bond (1991).

The empirical results obtained from the system GMM model is presented in Table 4 across different panel samples. To begin with, the results support the so-called EKC hypothesis in lower and upper middle income countries, while the model fails to find any association between income per capita and carbon emissions in OECD countries. Furthermore, per capita energy consumption seems to be an important driver of rising CO2 emissions regardless of the sample. However, it is worth noting that the magnitude of this effect is much stronger in upper middle income countries. Specifically, a percentage increase in per capita energy consumption raises carbon emissions by 0.58 percent in upper middle income countries, whereas emissions increase 0.17 and 0.13 percentages in lower middle income and OECD countries, respectively, as energy use per capita goes up. The model also provides some interesting findings for the link between foreign investment flows and emissions by income groups. For OECD countries, FDI minimally matters and has a lowering effect on CO2 emissions. For the lower and upper middle income countries, on the other hand, FDI raises carbon emissions but this effect is rather small compared to energy usage variable. What is noteworthy here is that the magnitude of FDI variable in lower middle income countries is double the size of the coefficient in upper middle income countries, implying that FDI is more pollutant in lower middle income countries compared to developed countries. Finally, regarding the regression diagnostics, it should be noted that the second order autocorrelation test AR(2) cannot reject the null hypothesis of no autocorrelation, implying no evidence of serial correlation.

Table 3. Estimations of static panel data for carbon emissions (Dependent variable: lnco2pc)

	Fixed Effects Models			Random Effects Models		
VARIABLES	Lower Middle Income	Upper Middle Income	OECD	Lower Middle Income	Upper Middle Income	OECD
lngdppc	2.524***	-0.174	2.049***	2.503***	-0.165	1.962***
	(0.330)	(0.176)	(0.246)	(0.329)	(0.175)	(0.244)
$lngdppc^2$	-0.152***	0.0126	-0.114***	-0.151***	0.0119	-0.110***
	(0.0228)	(0.0107)	(0.0127)	(0.0228)	(0.0106)	(0.0125)
lnfdipc	0.0166***	-0.00232	0.00335	0.0165***	-0.00228	0.00271
	(0.00635)	(0.00245)	(0.00332)	(0.00634)	(0.00245)	(0.00331)
lnenergyusepc	1.090***	0.979***	0.882***	1.099***	0.986***	0.882***
	(0.0429)	(0.0207)	(0.0311)	(0.0421)	(0.0204)	(0.0305)
Constant	-9.975***	1.340*	-8.056***	-9.895***	1.321*	-7.679***
	(1.199)	(0.724)	(1.190)	(1.202)	(0.725)	(1.181)
Hausman Test chi2 (prob)	2.79 (0.59)	4.38 (0.35)	11.27 (0.023)			

Observations	733	881	847	733	881	847
R-squared	0.73	0.83	0.55	0.66	0.82	0.46
Number of countries	30	37	35	30	37	35

Notes: Standard errors in parentheses, Significant levels *** p<0.01, ** p<0.05, * p<0.1

Table 4. Two-step system GMM Estimations (Dependent Variable: lnco2pc)

VARIABLES	Lower middle income	Upper middle income	OECD
$lnco_2pc_{t-1}$	0.829***	0.500***	0.826***
	(0.0151)	(0.0448)	(0.0177)
lngdppc	0.444***	0.603***	0.291
	(0.113)	(0.184)	(0.225)
$lngdppc^2$	-0.0264***	-0.0378***	-0.0145
	(0.00743)	(0.0107)	(0.0114)
lnfdipc	0.00747***	0.00303**	-0.00408***
	(0.00166)	(0.00115)	(0.00112)
lnenergyusepc	0.176***	0.586***	0.135***
	(0.0155)	(0.0534)	(0.0205)
Constant	-1.748***	-2.023**	-1.251
	(0.432)	(0.785)	(1.106)
Observations	706	853	821
Number of countries	30	37	35
Arellano-Bond test for AR(1) in first differences	z=-3.45, Pr>z=0.001	z = -2.81 Pr >z =0.005	z = -3.75 Pr >z =0.000
Arellano-Bond test for AR(2) in first differences	z=--1.04, Pr>z=0.297	z = -0.96 Pr >z = .335	z = -0.27 Pr >z =0.789
Hansen test of overid.	chi2(75) = 21.42 Prob=1.000	chi2(75)=33.51 Prob=1.000	chi2(75)=31.18 Prob=1.000

Notes: Standard errors in parentheses, Significant levels *** p<0.01, ** p<0.05, * p<0.1

In all, empirical evidence from the dynamic panel data analysis reveals that foreign investment flows matter for environmental sustainability. However, this effect varies across country groups. Specifically, FDI has a mitigating effect on carbon emissions in OECD countries, whereas CO2 emissions raise in lower and upper middle income countries if the destination of the foreign investment is such a country. These results may imply the ability of developed economies to absorb the green technology diffusions through foreign investments as well as their strict environmental standards which may lead to attracting more environment friendly technologies. The findings may also indicate the fact that initial conditions matter for environmental consequences of FDI. Middle income countries which can be classified as developing or emerging market economies, on the other hand, have not yet completed industrialization process and compete with each other in attracting foreign investment to reach higher levels of economic growth. In other words, such countries may not have stringent environmental policies due to the fact that one of the motives of governments to offer foreign investors attractive policies is that FDI generate tax revenue in such countries. Mahmood and Chaudhary (2013) find that FDI contribute to tax revenue in Pakistan. By doing so, economic welfare could also be increased for host countries through tax revenue generated from the profits of FDI. These goals may lead them to bend their environmental standards and take a risk of environmental deterioration for the sake of economic development through FDI inflows. The pollution haven effect of FDI in middle income countries may also be justified by the inadequate absorptive capacity of these countries and the fact that FDI may simply be encouraging less developed economies to switch away from traditional fuels and burn more fossil fuels.

5. Conclusion

This study mainly investigates the effect of FDI inflows on carbon emissions. To do so, we specifically focus on panels of middle income and OECD countries and we examine how results vary across different countries by income groups. Employing a dynamic panel estimation methodology (two-step system GMM), we introduced some new findings and believe that these may have important policy implications.

Our main analysis based on GMM reveals that FDI is good for the environment in developed economies and reduces carbon emissions in these countries even though this effect is rather small, while FDI seems to have a negative effect on emissions in middle income countries. However, the magnitude of the impact of FDI on environment seems to be rather small. This is a subtle new result. It suggests that FDI has a small halo effect on advanced economies but a larger haven effect on middle income countries. These results overall may well indicate the important role of absorptive capacity and initial technological levels of countries as well as the competition among developing countries to attract

FDI inflows. In this regard, it can be argued that policymakers planning to attract FDI in middle income countries should do a cost-benefit analysis by taking into account its damage to the environment and positive impact on economic growth. In attracting FDI, developing countries should target environmentally friendly production companies and adopt regulations that limit environmentally harmful production. In addition, governments in these countries should encourage the transition from traditional fuels to natural gas.

The dynamic panel analysis also suggests that energy consumption plays an important role in determining CO2 emissions across all sample of countries. The GMM analysis indicates that the deteriorating effect of energy consumption is much higher in upper middle income countries compared to lower middle income and OECD countries. This may be due to the reliance of less developed economies on traditional renewable energy sources and faster transition of developed countries from non-renewable energy sources to modern renewable energy technologies. Moreover, our study supports EKC hypothesis for developing countries where we consistently find an inverted U-shaped relationship between income per capita CO2 emissions.

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