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## The Role of Economic Growth, Foreign Direct Investment in Determining Environmental Degradation: A Panel Data Analysis

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### Abstract

This research examines the intricate non-linear connection between foreign direct investment and environmental degradation, leveraging panel data encompassing 110 economies from both developed and developing regions. Employing a rigorous analytical approach, the study investigates the existence of an environmental Kuznets curve, unraveling the nuanced impact of foreign direct investment on environmental degradation. The discerned outcomes not only affirm the presence of such a curve but also shed light on a noteworthy trend: the positive association between foreign direct investment and increased environmental degradation. Moreover, an in-depth exploration of the findings across different income groups and regional analyses unveils variations in the relationship, offering valuable insights into the multifaceted dynamics at play.

**Keywords:** economic growth, foreign direct investment, environmental degradation

**JEL Codes:** F43, F64

### 1. INTRODUCTION

The prevailing consensus suggests that foreign direct investment not only serves as a pivotal source of external capital but is also widely perceived to exert a positive influence on the developmental endeavors of host countries. Beyond its primary role as an injection of financial resources, foreign direct investment plays a crucial role in bridging critical gaps within the host nation's economic landscape. One such gap is the disparity between targeted investments and locally mobilized savings, where the influx of foreign investment acts as a vital catalyst, supplementing domestic capital and fostering economic growth. Additionally, foreign direct investment contributes significantly to mitigating the resource gap between the targeted foreign exchange requirements and those generated by net exports earnings. This infusion of external capital helps balance the delicate equilibrium in foreign exchange dynamics, providing the necessary financial impetus to meet the targeted levels and promoting stability in the host country's economic trajectory. In essence, the inflow of foreign investment emerges not only as a means of financial augmentation but also as a strategic mechanism for addressing crucial economic disparities, thereby contributing to the holistic development of the recipient nation. Indeed, foreign direct investment goes beyond its financial implications, extending its impact into the realm of human capital and technological advancement within the host country. One of its instrumental contributions lies in the development of managerial expertise and specialized technological skills. Through comprehensive training programs and experiential learning opportunities, foreign direct investment becomes a conduit for the transfer of knowledge and expertise from the investing entities to the local workforce. This not only enhances the skill set of the local workforce but also cultivates a culture of continuous learning and innovation. Moreover, foreign direct investment acts as a catalyst for the introduction of cutting-edge technologies and advancements in production techniques. The investing entities often bring with them state-of-the-art technologies, fostering innovation and efficiency in the host country's industrial landscape. The collaborative efforts between local and foreign entities create a dynamic environment conducive to the exchange of ideas, methodologies, and best practices. This process of "learning by doing" not only elevates the host country's technological capabilities but also positions it on the global map as a hub for innovation and competitiveness (Xing and Kolstad, 2002; He, 2006).

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Environmental regulations play a crucial role in internalizing the external environmental costs associated with the economic activities of firms. However, a noteworthy phenomenon observed in economic theory is the "pollution haven hypothesis." This hypothesis suggests that, in a bid to attract foreign investment, governments of developing countries may tend to compromise environmental concerns by adopting relaxed or non-enforced regulations. This approach is seen as a strategy to make their nations more appealing to foreign investors. Consequently, the relaxation of environmental regulations can give rise to the "industrial flight hypothesis," where companies find it advantageous to shift their operations to these developing countries. The primary incentive lies in exploiting the lower production costs facilitated by lax environmental regulations. While this relocation may boost economic activity and attract foreign investment, it often comes at the expense of environmental standards in the host countries. Both the pollution haven and industrial flight hypotheses contribute to a scenario where there is an increased risk of excessive pollution and degradation in the environmental standards of the host countries. This trade-off between economic development and environmental sustainability underscores the delicate balance that policymakers must navigate to ensure that foreign investment contributes positively to a nation's growth without compromising its environmental well-being. Striking this equilibrium is essential for fostering sustainable development that harmonizes economic progress with ecological responsibility (Zarsky, 1999). Contrary to the pollution haven and industrial flight hypotheses, there exists an optimistic perspective encapsulated in the "pollution haloes hypothesis." This viewpoint posits that foreign companies, driven by superior management practices and advanced technologies, can contribute to a cleaner environment in host countries. The essence of this hypothesis is grounded in the belief that the adoption of innovative and environmentally friendly practices by foreign firms can lead to a positive impact on the environmental landscape of the host nation. As highlighted by Zarsky (1999), the pollution haloes hypothesis suggests that foreign direct investment can be associated with a "halo effect" where the implementation of cutting-edge technologies and efficient management practices results in a mitigation of environmental damage. In this scenario, the trend in environmental impact due to foreign investment is not only sustainable but potentially contributes to an improvement in environmental conditions. This perspective underscores the transformative potential of foreign direct investment, emphasizing that the integration of advanced technologies and managerial expertise by multinational corporations can catalyze positive environmental outcomes. However, the realization of this hypothesis depends on the commitment of foreign companies to uphold stringent environmental standards and actively engage in sustainable business practices. As such, fostering a harmonious relationship between economic development and environmental stewardship becomes essential for creating a sustainable and mutually beneficial framework for both host countries and foreign investors (Blackman and Wu, 1998; BIAC, 1999).

The interplay between economic growth and its environmental repercussions has sparked intense debates, particularly in the context of rapid industrialization. The nexus between environmental quality and economic growth has been a focal point of discussion over the last decade. Notably, empirical studies, such as those conducted by Grossman and Krueger (1995) provided substantial evidence supporting an intriguing pattern: an inverted U-shaped relationship between environmental degradation and economic growth. This systematic pattern, commonly referred to as the Environmental Kuznets Curve (EKC), posits that environmental degradation tends to increase in the initial stages of economic development, reaches a peak, and subsequently starts to decline as the economy progresses further. The EKC encapsulates the idea that the relationship between economic growth and environmental impact is dynamic and follows a distinctive trajectory over time. The concept implies that as economies advance, they undergo a phase where environmental degradation intensifies due to the demands of rapid industrialization. However, as these economies mature and become more sophisticated, a turning point is reached where environmental consciousness, technological advancements, and regulatory measures lead to a decline in environmental degradation despite continued economic growth. While the Environmental Kuznets Curve offers a conceptual framework that suggests a potential decoupling of economic growth and environmental degradation at higher income levels, it is essential to note that its applicability can vary across regions and environmental indicators. The challenge lies in aligning economic development with sustainable practices to ensure that the trajectory of environmental impact conforms to a more positive and sustainable course as economies progress.

The trajectory of economic reforms and globalization, initiated in the early 1980s, has seen a remarkable surge in foreign direct investment (FDI) inflows, concurrently driving rapid economic growth. This transformative period is exemplified by a substantial increase in FDI, with the average annual FDI per capita soaring to US\$400.19 between 2000 and 2005—more than three times the amount observed in the period of 1991-1995. This surge in investment has, in turn, contributed to a noteworthy escalation in average annual GDP per capita, rising from US\$6025.87 to US\$8307.06 during the same time frame. However, this unprecedented economic growth has been accompanied by a pressing challenge—the escalation of

environmental pollution. Despite the economic benefits, the surge in economic activities has brought about an increase in carbon emissions. For instance, the average annual CO<sub>2</sub> emissions per capita have risen from 3.38 metric tons in 1986-1990 to 3.82 metric tons in 2000-2005. This environmental consequence underscores the intricate relationship between economic development and environmental sustainability. The observed rise in carbon emissions highlights the need for a comprehensive approach to reconcile economic growth with environmental responsibility. Balancing the economic advantages of foreign direct investment with the imperative to mitigate environmental impact becomes paramount in fostering sustainable development. Policymakers face the challenge of formulating strategies that harness the benefits of economic growth while implementing measures to curb and offset the environmental footprint, ensuring a harmonious and sustainable trajectory for future development.

## 2. LITERATURE REVIEW

A multitude of theoretical frameworks has been advanced to expound upon the impact of foreign direct investment (FDI) on economic growth, offering diverse perspectives on the dynamics involved. Influential works by economists such as Lucas (1988) and Rebelo (1991) have laid the foundation for understanding the intricate relationship between FDI and economic growth. For instance, Romer (1993) emphasized the pivotal role of foreign direct investment as a catalyst for the transfer of crucial technological and business know-how to host countries. According to Romer, this technology transfer through FDI has the potential to yield substantial positive spillover effects that reverberate throughout the broader economy. Contrastingly, some theories posit a less optimistic outlook on the effects of FDI, particularly in the presence of existing liberalization, deregulation, and privatization policies. The work of Boyd and Smith (1992) is illustrative in this regard. Their theories suggest that foreign direct investment, when coupled with pre-existing policies promoting liberalization and privatization, may have adverse effects on resource allocations. The potential outcome of this scenario is a slowdown in the rate of economic growth, as the allocation of resources may be hindered by the influence of foreign investors. These divergent perspectives underscore the complexity of the relationship between foreign direct investment and economic growth. The varying outcomes are contingent upon factors such as the nature of technology transfer, existing policy frameworks, and the interplay of FDI with broader economic policies. As a result, navigating the impact of foreign direct investment on economic growth necessitates a nuanced understanding of these multifaceted dynamics to formulate effective policies and strategies conducive to sustainable and balanced economic development.

The theoretical literature on the nexus between economic success and environmental degradation underscores a critical concern — that the achievements of countries in terms of economic growth have often been accompanied by a detrimental impact on the environment. Notably, Grossman and Krueger (1995) have contributed to this discourse by demonstrating that economic growth tends to correlate with environmental degradation, at least until the per capita GDP of a country surpasses US\$8000. In response to this dynamic, researchers have delved into the exploration of a relationship between economic growth and CO<sub>2</sub> emissions, a concept encapsulated by the environmental Kuznets curve (EKC). The environmental Kuznets curve suggests a distinctive trajectory: as economies undergo the process of economic development, there exists an initial phase where economic growth exacerbates environmental degradation. However, beyond a certain threshold of per capita income, the trend reverses, indicating an improvement in environmental quality. This implies that, according to the EKC hypothesis, economic growth may initially deteriorate the environment, but once a certain level of per capita income is attained, it begins to contribute positively to environmental sustainability. This nuanced perspective highlights the potential for economic development to evolve in a manner that aligns with environmental well-being, provided that appropriate policies and practices are implemented to address the environmental challenges associated with early stages of economic growth. The EKC framework thus becomes an essential tool in understanding the complex interplay between economic progress and environmental preservation.

Stern (2004) further reinforces the Environmental Kuznets Curve (EKC), providing evidence that initially, as per capita income rises, environmental degradation increases, but eventually declines. This observation aligns with the idea that there is a turning point in the relationship between economic growth and environmental impact. However, a complex dichotomy emerges when examining the impact of foreign direct investment (FDI) on environmental quality in developing countries. Many studies indicate a disconcerting trend: foreign investors often gravitate toward developing nations where environmental regulations are comparatively relaxed. This inclination can lead to a consistent increase in FDI, potentially exacerbating environmental degradation in these regions. In contrast, the perspective presented by Porter and van der Linde (1995) offers a counterpoint. They argue that environmental quality can be considered a normal good. As developing

countries experience economic growth facilitated by foreign inflows, there is a tendency for these nations to adopt more stringent environmental regulations. This adoption of stricter regulations is seen as a response to the recognition that environmental preservation becomes increasingly vital with economic progress. The opposing viewpoints highlight the intricacies surrounding the relationship between foreign direct investment, economic growth, and environmental protection. Achieving a harmonious balance that promotes sustainable development necessitates careful consideration of policy frameworks and regulatory measures, emphasizing the importance of aligning economic growth with environmental stewardship to ensure a positive trajectory for both economies and the environment.

The exploration of the relationship between foreign direct investment (FDI), economic growth, and environmental outcomes has indeed been a subject of extensive research, employing a variety of models and methodologies. Studies utilizing cross-country and time-series data have contributed valuable insights, but the empirical evidence remains inconclusive, reflecting the complex and multifaceted nature of these relationships. For instance, Alfaro's (2003) examination of the impact of foreign direct investment on economic growth across different sectors revealed a lack of a clear-cut relationship. The study found that FDI in the primary sector had a negative impact on growth, while in the manufacturing sector, the effect was positive. However, in the services sector, the impact of FDI on growth was deemed ambiguous. This variability highlights the sector-specific nuances that contribute to the complexity of the FDI and economic growth relationship. Similarly, Herzer et al.'s (2008) investigation of the FDI-led growth hypothesis for 28 developing countries using cointegration and error correction models yielded results that did not conclusively support a long-run or short-run relationship between foreign direct investment and economic growth in most countries. Furthermore, their causality analysis failed to provide clear evidence on the direction of causality between foreign direct investment and economic growth, emphasizing the challenges in establishing causal links in this context. The inconclusive nature of empirical evidence underscores the need for nuanced and context-specific analyses. The varied impacts observed across different sectors and countries suggest that the relationship between FDI, economic growth, and environmental outcomes is influenced by a multitude of factors, including sectoral characteristics, policy frameworks, and the broader economic context. As research in this field progresses, a more comprehensive understanding of these intricate relationships is crucial for informing effective policy decisions and promoting sustainable development.

Perman and Stern's (2008) validation of the environmental Kuznets curve (EKC) using a panel data approach to cointegration confirmed the existence of a long-run equilibrium stable relation between sulfur emissions and economic growth. However, their findings did not lend support to the presence of the EKC, suggesting that the relationship between economic growth and environmental degradation may not follow the inverted U-shaped curve proposed by the EKC hypothesis. On a different note, Grimes and Kentor (2003) argued that heavy reliance on foreign direct investment (FDI) contributes to the growth of carbon dioxide emissions in less developed economies globally. In their study, they found that domestic investment had no significant effect on CO<sub>2</sub> emissions. Moreover, the study indicated that foreign direct investment tends to concentrate in energy-intensive industries characterized by high energy emissions. Consequently, foreign investors may prefer to invest in countries where environmental laws are relatively flexible, particularly in industries with higher energy intensity. Haffmann's (2005) examination of the direction of causality between foreign direct investment and environmental pollution across different income groups produced interesting results. Using a panel causality test, the study found unidirectional causality running from foreign direct investment to energy emissions in middle-income countries. In low-income economies, CO<sub>2</sub> emissions were found to Granger cause foreign direct investment, suggesting a different relationship. However, no clear relationship was observed between the variables in high-income countries, leading to the rejection of the pollution haven hypothesis in such advanced economies.

Aliyu's (2005) revisit of the relationship between foreign direct investment (FDI) and the environment, focusing on both OECD and non-OECD countries, provides additional insights. Their use of panel data regression in their analysis shed light on the impact of foreign direct investment on environmental policy and quality. The results of Aliyu's study indicated that "dirty" foreign outflows, presumably referring to investments in industries with higher environmental impact, had a positive effect on environmental policy or quality. This suggests that foreign investments in certain sectors may be associated with efforts to improve or upgrade environmental policies and standards. However, it is important to note that the interpretation of "dirty" foreign outflows contributing positively to environmental policy may seem counterintuitive, and the specific nuances of the term would need to be understood in the context of the study. Conversely, the study found that foreign inflows did not play a significant role in explaining their impact on energy consumption and environmental pollution in non-OECD countries. This implies that the relationship between foreign direct investment and environmental outcomes can

vary based on the direction of investment, with outbound investments potentially influencing environmental policies positively, while inbound investments may not have a clear association with energy consumption and pollution. These findings contribute to the growing body of literature exploring the intricate dynamics between foreign direct investment and the environment, emphasizing the need for nuanced analyses that consider the direction, nature, and sectoral focus of investments in understanding their environmental implications.

### 3. ECONOMETRIC MODEL

The examination of the interrelationships among economic growth, foreign direct investment (FDI), and energy emissions is carried out through a panel data approach encompassing 110 developed and developing economies worldwide from 1985 to 2006. The data, sourced from the World Bank's World Development Indicators, provides a robust foundation for this comprehensive analysis. The review of relevant literature allows constructing an algebraic model given below for empirical investigation:

$$\ln C_{it} = \alpha_1 + \alpha_2 \ln Y_{it} + \alpha_3 Y_{it}^2 + \alpha_4 \ln F_{it} + \mu_i \quad (1)$$

To investigate the monotonic effect of foreign direct investment on carbon emissions, the following model will be used for empirical investigation:

$$\ln C_{it} = \beta_1 + \beta_4 \ln F_{it} + \beta_5 \ln F_{it}^2 + \mu_i \quad (2)$$

We have used carbon dioxide emission per capita (in metric tons) as an indicator of environmental degradation ( $C_{it}$ ). Carbon emission is the main gas which is responsible for generating greenhouse effect and global warming. The linear and non-linear terms of GDP per capita ( $Y_{it}$  &  $Y_{it}^2$ ) have been included in the model to validate the existence of Environmental Kuznets curve (EKC) which implies that environmental degradation increases with economic growth and environmental quality starts to improve after certain level of income.

### 4. EMPIRICAL RESULTS

Results of regression analysis of pooled OLS models are presented in Table-1. For the pooled regression, all estimated results reveal that linear and non-linear terms of income per capita i.e.  $Y_{it}$  &  $Y_{it}^2$  have positive and negative effect respectively on energy emissions confirming the existence of inverted U-shaped relationship between economic growth and environmental degradation. The observed relationship between income per capita and energy emissions, termed as the Environmental Kuznets Curve (EKC), suggests an improvement in environmental quality with an increase in per capita income after reaching a certain level. This conceptual framework implies that economic development may initially contribute to environmental degradation, but as income rises, there is a turning point where environmental quality starts to improve in global economies. Regarding the impact of foreign direct investment (FDI) on energy emissions, the study finds a positive effect, indicating a potential association between foreign investment and increased energy emissions. However, it's important to note that this positive effect is statistically insignificant. The lack of statistical significance suggests caution in making definitive conclusions about the impact of FDI on energy emissions in the context of the study. This implies that the observed positive relationship may be due to random variation rather than a robust and consistent pattern. These nuanced findings contribute to the broader discussion on sustainable development and environmental policy. The examination of the Environmental Kuznets Curve and the role of foreign direct investment provides valuable insights into how economic factors may influence environmental outcomes, offering considerations for policymakers seeking to balance economic growth with environmental sustainability.

In the second pooled regressions, the study reveals that both linear and non-linear terms of foreign direct investment (FDI) exhibit a positive and statistically significant effect on CO<sub>2</sub> emissions. This implies that an increase in foreign direct investment is identified as a major contributor to environmental degradation in the context of the study. The positive sign indicates a direct relationship between FDI and CO<sub>2</sub> emissions, suggesting that higher levels of foreign direct investment are associated with increased environmental impact, as measured by carbon dioxide emissions. This finding underscores the potential environmental challenges associated with higher levels of foreign direct investment, emphasizing the need for careful consideration of environmental policies and regulations in the context of economic development and foreign

investment. Policymakers and stakeholders may find these results valuable in shaping strategies that aim to reconcile economic growth with sustainable environmental practices.

**Table 1: Pooled OLS Regression Analysis**

Variables	Dependent Variable = $\ln C_{it}$		
	Coefficient	T-statistic	P-value
$\ln Y_{it}$	2.5288*	25.5692	0.000
$\ln Y_{it}^2$	-0.1029*	-16.5967	0.000
$\ln F_{it}$	0.0099	1.3943	0.166
Variables	Dependent Variable = $\ln C_{it}$		
	Coefficient	T-statistic	P-value
$\ln F_{it}$	0.0488*	2.8016	0.005
$\ln F_{it}^2$	0.2043*	21.5948	0.000

## 5. CONCLUSIONS AND RECOMMENDATIONS

The primary objective of the present study is to test the intricate relationship between economic growth, the environment, and the environmental consequences of foreign direct investment (FDI). While various studies have explored these issues individually using time series and cross-sectional datasets, this study seeks to provide a comprehensive examination by simultaneously investigating the environmental implications of both economic growth and foreign direct investment. The analysis is conducted using pooled regression, along with fixed and random effect models, incorporating data from 110 nations, encompassing both developing and developed countries worldwide. This approach allows for a holistic assessment of the interplay between economic growth, environmental factors, and the influence of foreign direct investment, contributing to a more nuanced understanding of these complex relationships on a global scale. The results obtained through pooled regression in our study confirm the presence of an inverted U-shaped and statistically significant relationship between environmental degradation and economic growth. This pattern, commonly known as the Environmental Kuznets Curve (EKC), is validated across 110 developed and developing economies. The EKC suggests that, initially, as economies experience economic growth, environmental degradation worsens. However, beyond a certain income level, there is a turning point where further economic development leads to an improvement in environmental quality. These findings contribute to the ongoing discourse on the dynamic relationship between economic growth and environmental sustainability. The estimated results of our study yield several implications. Firstly, developing economies may adopt more lenient environmental regulations to actively participate in the competition for foreign direct investment. This strategy may be pursued in the absence of other factors that typically attract foreign investment, such as robust infrastructure and a skilled labor force. Secondly, the results suggest that developing countries might face challenges in affording the high costs associated with implementing and monitoring stringent environmental rules and regulations. This limitation is attributed to the existence of the "innocent pollution haven hypothesis," implying that these nations might struggle to balance economic development with stringent environmental protection measures. Thirdly, the study implies that multinational corporations should prioritize the adoption of advanced and environmentally friendly technologies. This approach not only contributes to improving environmental quality but also reduces per-unit production costs, enhancing overall efficiency. Lastly, the study recommends that multinationals play an active role in preserving the environment by enhancing industrial capacity in host countries. Additionally, developing economies are encouraged to implement tariff regulations to mitigate environmental degradation. Emerging and transitional economies are urged to actively promote environmental protection by facilitating the transfer of technology and know-how from developed nations. This collaborative effort aims to safeguard environmental quality and optimize natural resource consumption on a global scale.

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