

The Nexus of Institutional Quality, Foreign Direct Investment, and Environmental Degradation: Evidence from Developing Economies

Qualité institutionnelle, investissement direct étranger et dégradation environnementale : étude empirique dans les économies en développement

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ABSTRACT. This study examines the relationship between foreign direct investment (FDI), institutional quality, and environmental degradation in 50 developing countries from 1996 to 2024. Using a panel ARDL model, it distinguishes between short- and long-run effects on CO₂ emissions. The results strongly support the Pollution Haven Hypothesis (PHH). FDI, trade openness, and economic growth significantly increase emissions in the long run. In contrast, corruption control plays a key mitigating role. In the short run, the impact of FDI is limited, but causality tests reveal a one-way effect from FDI to emissions. This highlights the structural influence of foreign investment on environmental outcomes. Countries with weak governance are particularly vulnerable. Foreign capital often flows into pollution-intensive sectors. Strengthening institutions and promoting green FDI are essential for sustainable development.

RÉSUMÉ. Cette étude analyse le lien entre l'investissement direct étranger (IDE), la qualité institutionnelle et la dégradation environnementale dans 50 pays en développement entre 1996 et 2024. En utilisant un modèle ARDL en panel, elle distingue les effets à court et à long terme des émissions de CO₂. Les résultats confirment fortement l'hypothèse du paradis de pollution (PHH). L'IDE, l'ouverture commerciale et la croissance économique augmentent significativement les émissions à long terme. En revanche, le contrôle de la corruption joue un rôle atténuateur important. À court terme, l'impact de l'IDE reste limité, mais une causalité unidirectionnelle vers les émissions est observée. Cela souligne le rôle structurel des investissements étrangers dans la pollution. Les pays à faible gouvernance apparaissent particulièrement vulnérables. Les capitaux étrangers se dirigent souvent vers des secteurs polluants. Des réformes institutionnelles et des politiques environnementales plus strictes sont nécessaires. La promotion d'un IDE vert est essentielle pour concilier croissance et durabilité.

KEYWORDS. Developing countries, FDI, Corruption, CO₂ emissions, ARDL, Pollution Haven Hypothesis.

MOTS-CLÉS. Pays en développement, investissement direct étranger (IDE), corruption, émissions de CO₂, modèle ARDL, hypothèse des paradis de pollution.

1. Introduction

The rapid integration of developing economies into global markets has significantly intensified Foreign Direct Investment (FDI) inflows. While endogenous growth theories highlight FDI's role in capital accumulation and technology transfer, growing concerns surround its environmental implications. Developing countries face a complex trade-off: attracting foreign capital versus preserving environmental quality.

The environmental consequences of FDI vary. The Pollution Haven Hypothesis (PHH) suggests that pollution-intensive industries relocate to jurisdictions with lax environmental regulations, exacerbating emissions and environmental degradation. Conversely, the "Pollution Halo" effect posits that FDI transfers environmentally friendly technologies, reducing emissions and aligning with Sustainable

Development Goals (SDGs). Ultimately, FDI's impact is contingent upon structural factors, regulatory stringency, and institutional capacity—particularly corruption control [AHM 21], [UME 14].

Numerous studies have examined this nexus [ASH 20], [BAE 09], [SMA 01]. While evidence often supports the PHH in low-income nations [XIN 02], literature points to governance as a decisive mitigating factor. Weak regulatory capacity undermines enforcement, making developing economies attractive to dirty industries. This raises a critical question: Does FDI, compounded by institutional weaknesses, inherently contribute to environmental degradation in developing countries?

This study contributes to the literature in three important ways. First, it provides updated evidence on the FDI–environment nexus using a long panel of 50 developing countries over the period 1996–2024. Second, it explicitly integrates institutional quality, measured through corruption control, to clarify whether FDI acts as a pollution haven or a pollution halo. Third, by employing a panel ARDL approach combined with Toda–Yamamoto causality tests, the paper disentangles short- and long-run dynamics, offering more nuanced policy insights for developing economies.

The remainder of this paper is organized as follows: Section 2 outlines the theoretical background. Section 3 provides a comprehensive review of the existing literature regarding the FDI–environment nexus and the crucial influence of institutional quality. Section 4 details the data sources, variable selection, and the econometric methodology employed. Section 5 presents the empirical results and their interpretations, including both long-term effects, short-term dynamics, and the causality analysis. Finally, Section 6 concludes the study and offers targeted policy recommendations for developing economies.

2. Theoretical Background

Economic globalization and climate concerns have fundamentally altered the global economy. International frameworks, like the Kyoto Protocol and the Paris Agreement, compel countries to adopt strict environmental policies to reduce greenhouse gas emissions. However, implementation remains highly asymmetric. Developed countries enforce stringent regulatory and carbon-pricing mechanisms, while developing nations—constrained by the need for rapid industrialization—adopt more cautious reforms.

This regulatory divergence drives the relocation of pollution-intensive industries to more lenient environments. The OLI (Ownership–Location–Internalization) paradigm [DUN 77] explains this behavior: location advantage is heavily influenced by regulatory costs. Facing high compliance costs at home, firms are incentivized by permissive regulations in specific host countries.

2.1. The Pollution Haven vs. Pollution Halo Hypotheses

First articulated by [GRO 95], the Pollution Haven Hypothesis (PHH) suggests that strict environmental regulations in developed nations drive dirty industries to less regulated developing countries, facilitated by lower costs and lax enforcement. While early studies [COP 04b] supported this, it implies a pessimistic view where global efforts merely shift pollution geographically.

Conversely, the Pollution Halo Hypothesis ([ZAR 99] and [DEM 20]) posits that multinational enterprises often transfer advanced, cleaner technologies and management practices, reducing local emissions. Whether FDI acts as a "haven" or "halo" largely depends on the host country's absorptive capacity and the type of investment (e.g., green FDI vs. traditional manufacturing [SIN 21]).

2.2. The Environmental Kuznets Curve and Institutional Quality

The Environmental Kuznets Curve (EKC) posits an inverted U-shaped relationship between environmental degradation and economic development. Initially, pollution rises as nations prioritize

rapid growth. However, beyond a specific income threshold, pollution declines as wealthier societies invest in cleaner technologies through composition and technique effects.

The validity of the PHH or EKC remains context-dependent [SHA 19], creating a critical trade-off for developing nations: relaxing regulations to stimulate growth versus enforcing strict standards that might deter investment. Successfully navigating this trade-off is fundamentally dictated by institutional quality [AHM 21]. Countries with robust governance and low corruption can attract "green FDI" and flatten their EKC, proving that regulation and investment are not mutually exclusive.

3. Literature Review

Globalization has made the environmental impact of Foreign Direct Investment (FDI) a major research topic. As climate change takes center stage, researchers are debating whether FDI drives innovation or simply worsens pollution, dividing the literature into four main themes.

3.1. The Fundamental Debate:

Pollution Haven vs. Pollution Halo Early theories like the Pollution Haven Hypothesis (PHH) argued that dirty industries move to less regulated countries. However, research ([COS 08]; [SOI 12]; [ABI 17]) shows that environmentally conscious multinational enterprises often avoid lax regulations. To stay competitive, these companies prefer sharing green technologies rather than exploiting weak rules. This "Pollution Halo" effect is confirmed by [DEM 20], who found that FDI can actually reduce overall pollution when paired with clean technology.

3.2. The Moderating Role of Economic Development and the EKC

FDI's environmental impact heavily depends on a country's wealth, reflecting the Environmental Kuznets Curve (EKC). Studies in Asia ([BAE 15], [BAE 09]) and recent global analyses [SIN 21] reveal a clear divide: FDI tends to increase emissions in low-income, rapidly industrializing nations, but helps reduce pollution in wealthier countries. Ultimately, whether FDI hurts or helps the environment depends heavily on the host country's current economic stage.

3.3. The Crucial Influence of Institutional Quality

Beyond wealth, good governance is the ultimate deciding factor. Research ([UME 14]; [SAR 15]) consistently shows that corruption and weak enforcement actively attract polluting FDI, creating pollution havens—a dynamic highly visible in the MENA region [BAR 21]. Conversely, strong institutions deter harmful investments and trigger a cycle of lower emissions and better growth [LAU 14]. In well-governed countries, citizens are also more empowered to demand environmental protection.

3.4. The New Frontier: Energy Transition and Financial Development

Recently, researchers have started looking at how FDI interacts with a country's energy and financial systems. Studies ([OMR 15b], [SEK 15]) confirm that relying on fossil fuels limits long-term growth. To fix this, "green FDI" in renewable energy can help developing countries grow without enduring a severe pollution phase [ADE 21], [MUR 22]. Furthermore, strong financial systems and carbon pricing [YU 24] are essential to encourage these sustainable investments, provided the host country has solid regulations in place.

A summary of key empirical contributions is provided in Table I.

Study	Context / Period	Methodology	Key Variables	Main Findings
Costantini & Crespi (2008); Al-Mulali & Tang (2013)	International	Comparative analyses	Green technology, FDI, CO ₂	Long-term competitiveness is linked to sustainability; firms shift toward green innovation (Pollution Halo).
Baek & Koo (2009)	China & India	ARDL	FDI, GDP per capita, CO ₂	China: FDI increases emissions (PHH). India: short-run negative effect, weak long-run influence.
Lau et al. (2014)	Malaysia (1984–2008)	Cointegration	Institutional quality, CO ₂ , growth	Institutional improvement lowers CO ₂ and boosts growth; virtuous governance–environment cycle.
Baek (2015)	5 ASEAN countries (1981–2010)	Dynamic panel	FDI, income, energy use, CO ₂	FDI raises emissions in low-income but reduces them in high-income countries.
Omri et al. (2015)	12 MENA countries (1990–2011)	Simultaneous equations	CO ₂ , finance, trade, growth	EKC validated; bidirectional causality between growth and CO ₂ ; strong interdependencies.
Tamat et al. (2015)	110 countries	GMM estimator	FDI, environmental regulation, corruption	Strict environmental rules reduce FDI; corruption increases inflows; institutions mediate effects.
Seker et al. (2015)	Turkey (1974–2010)	ARDL	FDI, energy use, growth, CO ₂	FDI increases CO ₂ long-term (modest magnitude); strong FDI-energy-growth relationships.
Shahbaz et al. (2019)	MENA region (1990–2015)	Dynamic panel models	Biomass energy, FDI, economic growth, CO ₂	EKC validated; PHH supported; N-shaped FDI–CO ₂ relationship; non-linear technological effects.
Singhania & Saini (2021)	Developed vs. Developing nations	Advanced panel estimators	FDI, CO ₂ , institutional quality	FDI degrades environment in developing nations (PHH) but promotes sustainability in developed ones.
Bardi & Hfaiedh (2021)	MENA region (1990–2016)	ARDL	FDI, corruption, environmental quality	Corruption attracts dirty FDI; supports both EKC and PHH in regions with weak institutions.
Adebayo et al. (2021); Murshed et al. (2022)	Global / Regional	Panel data analysis	Green FDI, renewable energy, CO ₂	Green FDI alters the EKC trajectory, allowing economic growth without severe environmental degradation.
Yu et al. (2024)	57 economies (2000–2017)	Panel framework	FDI, financial development, carbon pricing	Institutional financial depth reduces CO ₂ in developed economies but increases it in developing ones.

Table 1. Summary of key empirical studies on the fdi-environment nexus

4. Data and Methodology

The sample consists of 50 developing countries over 1996–2024. The descriptive statistics provide important insights into the structural and institutional context of the sampled developing countries, which in turn shape the mechanisms through which FDI affects environmental outcomes. Average CO₂ emissions stand at 0.84 tons per capita, average FDI inflows—representing 3.37% of GDP—display relatively low dispersion, suggesting that most countries in the sample attract foreign capital at comparably modest levels, often concentrated in specific sectors such as natural resources or low-cost manufacturing.

Trade openness, averaging 67.55%, points to a moderate but uneven degree of integration into global markets, which may facilitate technology transfer but also expose economies to environmental pressures linked to export-oriented activities. The control of corruption index (−0.74) signals persistent institutional fragility, reflecting weak enforcement mechanisms, limited regulatory oversight, and vulnerabilities to rent-seeking behavior. Such institutional constraints can undermine the ability of governments to impose or monitor environmental standards, thereby altering the ecological implications of foreign investment.

Finally, the log of GDP per capita (5.10) confirms the relatively low level of economic development, which often correlates with inadequate environmental infrastructure, limited green technological adoption, and prioritization of short-term economic gains over long-term sustainability goals.

The study applies a panel ARDL model, appropriate for variables integrated at I(0) and I(1). The key advantages include:

- Ability to estimate short- and long-term relationships
- Robustness to mixed integration orders
- Inclusion of country-specific fixed effects

The variables selected and their sources are shown in Table II

Variable	Definition	Source
CO ₂	Total annual emissions of carbon dioxide (CO ₂); (t CO ₂ e/capita).	WDI
FDI	Foreign Direct Investment, net inflows (% of GDP).	
Trade	Sum of exports and imports of goods and services (% of GDP).	
CC	Control of Corruption.	
Lgdp	GDP per capita, constant price, in logarithm.	
G	General government final consumption expenditure (% of GDP).	
Inf	Inflation, GDP deflator (annual %).	

Table 2. Definitions and sources of data

Stationarity tests indicate that CO₂ is I(1), while all other variables are I(0). Pedroni cointegration tests confirm the existence of long-term relationships among variables.

The estimated equation is:

$$CO_{2(it)} = \alpha_0 + \alpha_1 FDI_{(it)} + \alpha_2 Trade_{(it)} + \alpha_3 CC_{(it)} + \alpha_4 Lgdp_{(it)} + \alpha_5 G_{(it)} + \alpha_6 Inf_{(it)} + \varepsilon_{(it)}$$

The subscript “t” represents the year of observation and “i” designates the country

Toda–Yamamoto causality tests are used to examine directionality.

5. Empirical results

5.1. Long-Term Effects

The long-run ARDL estimates highlight how structural, economic, and institutional factors jointly determine CO₂ emissions in developing countries. The positive and significant effect of FDI on environmental degradation indicates that foreign investment tends to be directed toward pollution-intensive and resource-dependent sectors. This supports the Pollution Haven Hypothesis, which posits that multinational firms relocate environmentally harmful activities to countries with weaker regulations ([COL 06b], [BAE 09]). The results therefore suggest that developing economies may lack the regulatory and technological capacity to attract cleaner, efficiency-enhancing investment ([JAV 04]).

Trade openness also increases emissions, indicating that integration into global markets reinforces specialization in environmentally harmful industries. This aligns with the scale effect and the structural effect of trade described in the environmental economics literature, where higher production, transportation, and resource extraction raise emissions ([ANT 01], [COP 04b]). Many developing countries continue to rely on carbon-intensive export sectors, which limits their ability to benefit from the potential “technique effect” associated with cleaner technologies.

Variables	Coefficients	p-value
FDI	0.0027***	0.000
Trade	0.0008***	0.000
CC	-0.0287**	0.020
Lgdp	0.4304***	0.000
G	0.0046***	0.000
Inf	-0.0005***	0.000

Significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 3. Estimation results of the long-run ARDL model

Our results highlight that controlling corruption is crucial for environmental protection. Strong governance prevents companies from dodging environmental rules or bribing officials. This aligns with research ([PEL 06], [FRE 03]) proving that robust institutions significantly lower the environmental costs of economic growth, globalization, and foreign investment.

Rising GDP per capita also strongly increases CO₂ emissions. This reflects the early stages of the Environmental Kuznets Curve (EKC), where growth relies heavily on fossil fuels and rapid industrialization ([GRO 95], [DIN 04]). At this stage, pollution rises continuously until nations become wealthy enough to afford cleaner technologies and stricter policies.

Similarly, government spending drives up emissions. This suggests that public funds prioritize energy-heavy infrastructure over green initiatives. As previous studies note ([SHA 13], [HAL 13]), without a clear environmental budget, government spending often indirectly worsens pollution.

Finally, inflation slightly reduces emissions, likely because higher prices slow down production and consumption. Overall, our findings prove that globalization, economic development, and institutional quality dictate long-term environmental health. To successfully cut CO₂ emissions, developing countries must strengthen their governance and shift public spending toward green infrastructure.

5.2. Short-Term Dynamics

The short-run ARDL results indicate that FDI has no immediate effect on CO₂ emissions, suggesting that its environmental impact emerges mainly through longer-term structural adjustments rather than short-term fluctuations. Similarly, trade openness shows no statistically significant short-run impact ($p=0.32$), implying that temporary variations in trade do not immediately alter the emissions trajectory.

Variables	Coefficients	p-value
D(CO ₂ (-1))	-0.0191	0.660
D(FDI)	0.0002	0.950
D(Trade)	0.0005	0.320
D(CC)	0.0601*	0.070
D(Lgdp)	0.8069**	0.020
D(G)	-0.0031	0.500
D(Inf)	-0.0007	0.320
C	-0.2759***	0.000
CointEQ(-1)	-0.1663***	0.000

Notes: The dependent variable is the first difference of CO₂ emissions. **D()** denotes the first difference operator. Significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 4. Estimation results of the short-run ARDL Model

GDP per capita strongly increases pollution in the short run, showing that rapid economic growth in developing countries relies heavily on carbon-intensive production. This short-run positive effect likely reflects institutional transition costs, as governance reforms initially disrupt existing production structures before generating long-term environmental benefits.

This implies that new institutional reforms cause temporary friction, and governance improvements need time to produce true environmental benefits.

Finally, the highly significant, negative error-correction term (-0.1663) confirms a return to long-run equilibrium. However, the adjustment is gradual: only 16.6% of short-term imbalances are corrected each year. Consequently, short-term economic or environmental shocks have lingering effects before finally stabilizing.

5.3. Causality Analysis (Toda–Yamamoto)

The causality analysis for developing countries indicates a unidirectional causal relationship running from FDI to CO₂ emissions, significant at the 5% level. This result suggests that foreign investment actively drives changes in environmental quality rather than responding to them. Such evidence supports the pollution haven hypothesis, whereby multinational enterprises export polluting activities to countries

with weaker regulatory frameworks ([COL 06b], [BAE 09]). In line with [OMR 15b], these findings imply that FDI plays a leading role in shaping long-term environmental trajectories in developing economies.

Null Hypothesis (Direction of Causality)	Chi-Square (χ^2)	df	p-value	Conclusion
FDI $\nrightarrow$ CO ₂ (FDI does not cause CO ₂)	15.89**	8	0.040	Causality exists
CC $\nrightarrow$ CO ₂ (CC does not cause CO ₂)	7.70	8	0.460	No causality
CO ₂ $\nrightarrow$ FDI (CO ₂ does not cause FDI)	4.15	8	0.840	No causality
CC $\nrightarrow$ FDI (CC does not cause FDI)	3.66	8	0.870	No causality
CO ₂ $\nrightarrow$ CC (CO ₂ does not cause CC)	2.31	8	0.980	No causality
FDI $\nrightarrow$ CC (FDI does not cause CC)	2.14	8	0.970	No causality

Notes: The symbol $\nrightarrow$ denotes "does not Granger-cause".
Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 5. *TODA-YAMAMOTO Causality test results*

The absence of causality between corruption and CO₂ emissions—neither from corruption to pollution nor from pollution to corruption—suggests that the influence of institutional quality operates predominantly through long-term structural channels, such as regulatory capacity and enforcement, rather than through short-run dynamic interactions. Previous studies similarly report that institutional effects tend to manifest over extended periods rather than producing immediate causal responses ([PEL 06], [FRE 03]).

Furthermore, the absence of feedback from CO₂ emissions to FDI indicates that environmental quality does not affect foreign investors' location decisions in developing countries. This is consistent with earlier findings suggesting that multinational firms prioritize factors such as market size, labor costs, or resource availability over environmental conditions ([JAV 04], [XIN 02]). Consequently, environmental degradation does not deter FDI inflows, reinforcing the idea that FDI shapes environmental outcomes but does not adapt to them.

Overall, the causality results imply that FDI acts as a driving, non-reactive force in determining environmental degradation in developing countries. Without strong institutional frameworks and environmental regulations, foreign investment may continue to exert a unilateral, pollution-intensive influence on environmental sustainability.

6. Conclusion

This study addresses a major dilemma for developing nations: how to attract foreign capital for economic growth without sacrificing the environment. By analyzing 50 developing countries from 1996 to 2024, our findings confirm the Pollution Haven Hypothesis. Over the long term, FDI, trade openness, and economic growth significantly increase CO₂ emissions. Foreign investment often drives environmental degradation, especially in areas with weak governance and fragile environmental laws.

However, we found that a country's institutional quality—particularly its ability to control corruption—is a decisive game-changer. FDI is not inherently bad; its impact depends entirely on host country institutions. With strong governance, nations can transform a "pollution haven" into a "pollution halo" by forcing foreign companies to adhere to clean practices.

To achieve this balance, policymakers must take decisive action. Governments need to prioritize transparency and anti-corruption measures to stop companies from evading environmental laws. Instead of accepting any foreign capital, countries should specifically target "green FDI," focusing on renewable energy and sustainable infrastructure. By aligning trade policies with global sustainability goals and raising public awareness, developing economies can successfully grow their economies while protecting the planet.

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