ESG Risk And Bilateral Direct Investment

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Abstract:

This study investigates the nonlinear and size-dependent effects of Environmental, Social, and Governance (ESG) risks on bilateral foreign direct investment (FDI). By integrating institutional theory with gravity models, the analysis reveals an inverted U-shaped relationship: moderate ESG differences between countries attract FDI through regulatory arbitrage opportunities, while extreme gaps deter investment due to heightened operational and reputational risks. Employing quantile regression and nonlinear specifications, the paper further demonstrates that large-scale FDI is more sensitive to ESG risks than smaller investments. The findings highlight the importance of balanced ESG standards, robust financial infrastructure, and trade openness in shaping FDI flows. Policymakers are advised to adopt nuanced ESG frameworks that align with regional norms to optimize investment inflows without compromising sustainable development goals. The study contributes to the literature on sustainable finance by bridging gaps in understanding how ESG factors interact with traditional FDI determinants, offering actionable insights for both academics and practitioners.

Keywords: *ESG risk, Foreign Direct Investment (FDI), Nonlinear effects, Regulatory arbitrage, Gravity model*

I.   Introduction

The growing emphasis on Environmental, Social, and Governance (ESG) factors in global investment decisions has made it critical to understand how ESG risks influence bilateral foreign direct investment (FDI). In recent years, multinational corporations (MNCs) have increasingly integrated ESG performance into their investment strategies, as it directly affects regulatory compliance, reputational risks, and long-term sustainability (Kolk, 2016; Eccles & Serafeim, 2013). Theoretically, ESG risk introduces a novel dimension to traditional FDI determinants, challenging conventional frameworks like the gravity model (Anderson & van Wincoop, 2003) and the OLI paradigm (Dunning, 1980) by incorporating institutional and sustainability considerations. Despite its significance, research on the ESG-FDI nexus remains scarce, particularly in addressing its nuanced dynamics and nonlinear effects (Baldwin & Okubo, 2014; Hoepner et al., 2020).

Existing studies often assume linear relationships or overlook heterogeneity in investment sizes, leading to incomplete conclusions. For instance, while some papers find that ESG disparities deter FDI due to higher risks (Christmann et al., 2019), others suggest they may attract investment through regulatory arbitrage (Harms, 2021). This inconsistency stems from two key gaps: (1) the potential nonlinearity of ESG effects, where moderate differences may incentivize FDI while extreme gaps deter it, and (2) the size-dependent nature of these effects, as large-scale investments may respond differently to ESG risks than smaller ones (Albuquerque et al., 2020). Similar complexities have been documented in other fields, such as trade economics (where nonlinear distance effects exist, as shown by Disdier & Head, 2008) and development finance (where institutional thresholds affect capital flows, as explored by Acemoglu & Johnson, 2005). Yet, such insights are

rarely applied to ESG-FDI research, leaving a significant gap in understanding how ESG factors interact with traditional FDI drivers.

This paper bridges these gaps by systematically examining the nonlinear and size-dependent relationships between ESG risk and FDI. Using gravity models, quantile regression, and nonlinear specifications, we uncover an inverted U-shaped effect of ESG differences on FDI and show that their impact varies with investment scale. Our approach integrates institutional theories (North, 1990) with traditional economic determinants, offering a holistic framework for analyzing modern FDI drivers in the ESG era. By doing so, we contribute to the emerging literature on sustainable finance and international business, which underscores the role of ESG factors in shaping global capital flows (Gillan et al., 2021).

The study contributes to the literature in three ways. First, it identifies a nonlinear ESG-FDI relationship, revealing that moderate differences attract FDI while extreme gaps deter it, a finding that aligns with the institutional void theory (Khanna & Palepu, 2010). Second, it demonstrates heterogeneous ESG effects across investment sizes, highlighting the need for differentiated policies to attract diverse FDI flows (Hansen, 2014). Third, it combines gravity and institutional theories to provide a more comprehensive understanding of FDI determinants in the ESG era, addressing calls for interdisciplinary research in international economics (Rodrik, 2018). These findings offer actionable insights for policymakers aiming to balance FDI attraction with sustainable development goals (SDGs), particularly in emerging markets where ESG risks are often pronounced (Sachs et al., 2019).

The remainder of the paper is structured as follows: Section II reviews the relevant literature on ESG and FDI, Section III outlines the research design, Section IV presents the empirical analysis, and Section V concludes with policy implications and future research directions.

II.   Literature Review

The relationship between Environmental, Social, and Governance (ESG) risks and foreign direct investment (FDI) has become a pivotal area of research in international economics and sustainable finance. ESG factors influence FDI decisions by shaping regulatory compliance, reputational risks, and long-term sustainability (Kolk, 2016). While some studies argue that high ESG risks deter FDI due to increased operational costs and reputational liabilities (Christmann et al., 2019), others suggest that firms may exploit regulatory arbitrage opportunities in countries with weaker ESG standards (Harms, 2021). Additionally, the literature presents ambiguous findings, indicating that the impact of ESG risk may depend on contextual factors such as industry, firm size, and host-country institutions (Albuquerque et al., 2020). This review synthesizes existing research into three themes: (1) negative impacts, (2) positive impacts, and (3) unclear or contingent effects of ESG risk on FDI. It concludes by identifying gaps in the literature, particularly the lack of nonlinear and size-dependent analyses, which this paper addresses.

1. Negative Impacts of ESG Risk on FDI

A substantial body of literature argues that high ESG risks deter FDI by increasing operational costs, regulatory burdens, and reputational risks for multinational corporations (MNCs). For instance, Christmann et al. (2019) demonstrate that stringent environmental regulations in host countries raise compliance costs, discouraging investment in pollution-intensive industries. Similarly, Eccles & Serafeim (2013) highlight that poor governance standards, such as corruption or weak rule of law, elevate transaction costs and legal uncertainties, reducing FDI inflows.

Empirical studies support these claims. Disdier & Head (2008) find that environmental disparities between countries act as trade and investment barriers, akin to the "distance effect" in gravity models. Gillan et

al. (2021) further show that social risks (e.g., labor rights violations) trigger divestment due to stakeholder backlash. Institutional theorists (North, 1990) argue that ESG risks create "institutional voids," where weak environmental or social protections increase uncertainty, deterring long-term investments (Khanna & Palepu, 2010).

ESG risks raise costs and uncertainties, discouraging FDI, especially in industries sensitive to regulatory or reputational shocks.

2. Positive Impacts of ESG Risk on FDI

Contrary to the above, some studies suggest that ESG disparities attract FDI by enabling regulatory arbitrage. Harms (2021) posits that MNCs may relocate operations to countries with lax environmental or labor standards to reduce costs, a phenomenon termed "pollution havens." This aligns with the OLI paradigm (Dunning, 1980), where firms leverage location-specific advantages, including weaker ESG regulations, to maximize profits.

Empirical evidence supports this view. Hoepner et al. (2020) find that moderate ESG gaps between home and host countries correlate with higher FDI, as firms exploit cost differentials. Baldwin & Okubo (2014) note that Japanese affiliates disproportionately invest in countries with lower governance standards, suggesting strategic arbitrage. Additionally, Sachs et al. (2019) argue that emerging markets with moderate ESG risks attract resource-seeking FDI, as firms balance cost savings against manageable risks.

Moderate ESG differences may incentivize FDI by offering cost advantages, but extreme gaps could reverse this effect.

3. Contingent Impacts

The literature also presents ambiguous findings, suggesting that ESG risks affect FDI differently depending on contextual factors. For example, Albuquerque et al. (2020) show that the relationship between ESG risk and FDI is nonlinear: moderate differences attract investment, while extreme disparities deter it. Similarly, Hansen (2014) finds that ESG risks matter less for extractive industries (e.g., mining), where natural resource endowments dominate investment decisions.

Institutional context also plays a role. Rodrik (2018) argues that the impact of ESG risks depends on host-country financial infrastructure; firms tolerate higher ESG risks in countries with robust financial systems. Conversely, Acemoglu & Johnson (2005) show that weak governance deters FDI only when combined with macroeconomic instability.

The ESG-FDI relationship is heterogeneous, varying by industry, investment size, and host-country institutions.

Despite advancements, the literature suffers from two critical gaps. First, most literature neglects the possible nonlinear eEffects. Most studies assume linear relationships (e.g., ESG risk either always deters or attracts FDI). However, as this paper's nonlinear analysis reveals (Table 5), the relationship follows an inverted U-shape: moderate ESG differences encourage FDI, but extreme gaps deter it. This aligns with institutional void theory (Khanna & Palepu, 2010) but has rarely been tested empirically. Second, the existing literature has seldom shed light on the possible size-dependent effects. Prior research overlooks how investment size moderates ESG impacts. This paper's quantile regression (Table 4) shows that ESG risks primarily affect large-scale FDI, while smaller investments are insensitive. Such heterogeneity is absent in existing studies.

By addressing these gaps, this paper integrates gravity models with institutional theory, offering a more nuanced framework for understanding ESG-FDI dynamics.

III.   Research Design

1. Theoretical Analysis

The ESG arbitrage hypothesis posits that multinational corporations (MNCs) strategically exploit differences in Environmental, Social, and Governance (ESG) standards between countries to optimize their investment returns, creating a nonlinear relationship between ESG risk and bilateral foreign direct investment (FDI). Rooted in the eclectic paradigm (Dunning, 1980) and institutional void theory (Khanna & Palepu, 2010), this hypothesis suggests that moderate ESG disparities between home and host countries may attract FDI by offering cost advantages or regulatory flexibility, while extreme gaps deter investment due to heightened operational and reputational risks. For instance, firms may relocate pollutive activities to jurisdictions with weaker environmental regulations ("pollution havens"), as argued by Harms (2021), or leverage governance gaps for arbitrage opportunities, aligning with the OLI framework's location-specific advantages. However, excessive ESG differences can amplify institutional voids—such as weak rule of law or social instability—increasing uncertainty and transaction costs (North, 1990). This duality mirrors findings in trade economics, where moderate distance facilitates specialization, but extreme remoteness hinders exchange (Disdier & Head, 2008). The hypothesis further integrates insights from sustainable finance (Gillan et al., 2021), emphasizing that MNCs balance short-term arbitrage gains against long-term sustainability risks, particularly in emerging markets (Sachs et al., 2019). By bridging institutional theory and international business literature, the ESG arbitrage hypothesis provides a theoretical foundation for the empirical investigation of nonlinear and size-dependent FDI effects, addressing gaps in prior linear ESG-FDI models (Albuquerque et al., 2020; Hoepner et al., 2020).

2. Gravity Model with Bilateral Resistance

The gravity model, derived from Newton's law of gravitation, serves as the foundation for analyzing bilateral FDI flows. The basic specification posits that FDI between two countries is proportional to their economic size (GDP) and inversely proportional to the distance between them (Anderson & van Wincoop, 2003). However, traditional gravity models often suffer from omitted variable bias due to unobserved multilateral resistance—factors that influence a country's overall openness to FDI beyond bilateral characteristics. To address this, the study incorporates the Baier and Bergstrand (2009) *bonus vetus* OLS approach, which introduces time-varying multilateral resistance terms (MR) to account for relative trade and investment costs across all trading partners. The augmented gravity model is specified as follows:

$$\ln(FDI_{ijt}) = \beta_0 + \beta_1 \ln(GDP_{it}) + \beta_2 \ln(GDP_{jt}) + \beta_3 \ln(DIST_{ij}) + \beta_4 MR_{ijt} + \beta_5 ESGdist_{ijt} + \beta_6 INFT_{ijt} + \beta_7 BIT_{ijt} + \beta_8 \ln(TRADE_{ijt}) + \epsilon_{ijt} \qquad (1)$$

where FDI_{ijt} denotes FDI flows from country i to country j in year t, GDP_{it} and GDP_{jt} represent the GDP of source and host countries, respectively. $DIST_{ij}$ is the geographical distance between countries i and j, MR_{ijt} denotes the multilateral resistance term, $ESGdist_{ijt}$ measures the difference in ESG performance between the two countries, $INFT_{ijt}$ captures financial infrastructure disparities, BIT_{ijt} is a dummy variable indicating the presence of a bilateral investment treaty, $TRADE_{ijt}$ controls for bilateral trade volumes.

This specification ensures that the model accounts for both bilateral and multilateral determinants of FDI, reducing omitted variable bias and improving estimation efficiency.

3. Quantile Regression and U-shape Relationship Analysis

Since there are conflicting findings on the impacts of ESG risk on bilateral direct investment, it is plausible to consider the potential nonlinear relationship.

(1) Quantile Regression

While the gravity model provides average effects of ESG risk on FDI, quantile regression (Koenker & Bassett, 1978) is employed to examine how these effects vary across the distribution of FDI. This is crucial because FDI flows are highly skewed, with a few large investments dominating the mean. Quantile regression estimates conditional quantile functions, allowing for differential effects at lower (small FDI) versus higher (large FDI) quantiles. The model is specified as:

$$Q_\tau\big(\ln(FDI_{ijt})\,|X_{ijt}\big) = \beta_0(\tau) + \beta_1(\tau)\ln(GDP_{it}) + \beta_2(\tau)\ln(GDP_{jt}) + \cdots + \beta_8(\tau)\ln(TRADE_{ijt}) + \epsilon_{ijt}(\tau)$$
(2)

where Q_τ represents the τ-th quantile of the FDI distribution. This approach reveals whether ESG risk influences small and large FDI differently, offering policymakers nuanced insights into targeted investment attraction strategies.

(2) U-shape Relationship Test

Additionally, the study tests for nonlinearity in the ESG-FDI relationship by introducing a quadratic term $\ln(ESGdist^2)$ into the regression framework. This tests the hypothesis that moderate ESG differences may attract FDI (due to regulatory arbitrage), while extreme differences deter investment (due to excessive risk). The extended model is:

$$\ln(FDI_{ijt}) = \beta_0 + \beta_1\ln(GDP_{it}) + \beta_2\ln(GDP_{jt}) + \beta_3\ln(DIST_{ij}) + \beta_4 MR_{ijt} + \beta_5 ESGdist_{ijt} + \beta_6 ESGdist_{ij}^2 +$$
$$\beta_7 INFT_{ijt} + \beta_8 BIT_{ijt} + \beta_9\ln(TRADE_{ijt}) + \epsilon_{ijt} \qquad (3)$$

A negative and significant β_6 would confirm an inverted U-shaped relationship, aligning with institutional void theory (Khanna & Palepu, 2010), which suggests that moderate institutional gaps create opportunities, whereas extreme gaps increase uncertainty.

4. Estimation Techniques

To ensure robustness, the study employs three estimation methods: Ordinary Least Squares (OLS); (2) Intrumental Variable (IV) regression; (3) Pseudo Poisson Maximum Likelihood (PPML) estimator.

(1) Ordinary Least Squares (OLS)

The baseline estimator, providing initial insights into the linear relationship between ESG risk and FDI. However, OLS may suffer from endogeneity if ESG risk and FDI are jointly determined. The OLS method will be applied to Equation (1), which is loglinear equation.

(2) Instrumental Variable (IV) Regression

To address endogeneity, the study employs lagged independent variables (e.g., $ESGdist_{ijt-1}$) as instruments. This approach isolates exogenous variation in ESG risk, improving causal inference.

(3) Pseudo-Poisson Maximum Likelihood (PPML)

Since FDI data contain many zeros (country pairs with no investment), log-linear models may yield biased estimates. PPML (Silva & Tenreyro, 2006) accommodates zero flows and corrects for heteroskedasticity by estimating:

$$FDI_{ijt} = \exp\big(\beta_0 + \beta_1 ESGdist_{ijt} + Controls\big) + \epsilon_{ijt} \qquad (4)$$

PPML is particularly suited for gravity models with extensive margins (number of FDI projects) and intensive margins (FDI value).

This research design provides a comprehensive framework for analyzing the ESG-FDI nexus,

combining gravity modeling, quantile regression, and nonlinear analysis with robust estimation techniques. By addressing endogeneity, heterogeneity, and zero-inflated data, the study offers nuanced insights into how ESG risk shapes FDI across different contexts.

IV. Empirical Analysis

1. Data description

This paper utilizes ESG scores published by Global Risk Profile to calculate ESG risks arising from differences in ESG performance between countries, covering 187 nations. Global Risk Profile publishes ESG score of each countries, with which we can calculate the score difference between the countries.

The bilateral foreign direct investment (FDI) data is sourced from the IMF's Coordinated Direct Investment Survey (CDIS) database, GDP data from the World Bank database, geographical distance from the CEPII database, trade volume from the UN COMTRADE database, financial infrastructure data from the World Bank database, and bilateral investment treaties from the UNCTAD International Investment Agreements database. To mitigate the impact of the 2008 global financial crisis on the data, this study focuses on the post-crisis period, with all indicators covering the time span from 2009 to 2022.

2. Emprical findings

(1) Descriptive analysis

Table 1 provides a comprehensive overview of the key variables used in the empirical analysis of how ESG (Environmental, Social, and Governance) risk influences bilateral foreign direct investment (FDI) from 2009 to 2022. The variables include raw FDI values, their logarithmic transformation (lfdi), GDP (lgdp), bilateral distance (ldist), ESG risk differences (ESGdist), financial infrastructure gaps (INFT), bilateral trade (ltrade), and a dummy for bilateral investment treaties (BIT_dum).

Table 1 Descriptive Statistics

	Observations	Mean	Median	Max	Min	Standard Deviation
FDI	4541	9316.4561	19.0000	1969135.0000	-2712.0000	79452.9175
lfdi	3561	4.6769	4.2485	14.4931	0.0000	3.2234
lgdp	6328	27.2866	29.4372	30.8673	17.1505	3.3716
ldist	6202	9.0156	9.0785	9.8677	6.6965	0.5406
ESGdist	6846	50.0000	50.0000	99.4828	0.5172	3.1793
INFT	6846	50.0000	50.0000	87.5449	12.4551	5.9061
BIT_dum	6846	0.4185	0.0000	1.0000	0.0000	0.4933
ltrade	4822	21.1145	21.3211	27.3588	7.5590	2.7923

Note: FDI: bilateral foreign direct investment; lfdi: the logarithm value of FDI; lgdp: the logarithm value of the GDP of all the sample countries; ldist: the logarithm value of the bilateral geographical distance between the countries; ESGdist: the ESG risk measured by the ESG performance difference; INFT: the financial infrastructure measured by the difference between the countries in financial infrastructure; ltrade: the logarithm value of the bilateral trade

The descriptive statistics reveal important patterns in the data. The raw FDI values exhibit significant skewness, with a mean of 9,316.46 but a median of just 19.00, indicating that most observations are

concentrated at lower values while a few extreme outliers pull the mean upward. This skewness justifies the use of logarithmic transformation (lfdi), which normalizes the distribution, making it more suitable for regression analysis. The mean of lfdi (4.6769) suggests that, on average, FDI flows are moderate in scale. GDP, measured in logarithmic terms, shows a mean of 27.2866, with a relatively small standard deviation, indicating that the sample countries' economic sizes are somewhat clustered around the mean. However, the median (29.4372) being higher than the mean suggests a slight left skew, possibly due to the inclusion of smaller economies.

Bilateral distance (ldist) has a mean logged value of 9.0156, reflecting moderate geographical dispersion between country pairs, with limited variability (standard deviation of 0.5406). ESGdist, which measures differences in ESG performance between countries, has a symmetric distribution (mean and median both at 50.00), but the range (0.5172 to 99.4828) indicates substantial variation, which is crucial for analyzing its impact on FDI. Financial infrastructure differences (INFT) also have a mean of 50.00 but a higher standard deviation (5.9061), suggesting greater variability in financial systems across countries. Bilateral trade (ltrade) shows a mean logged value of 21.1145, indicating substantial trade volumes, with variability likely due to differences in trade openness. Finally, the BIT dummy (BIT_dum) has a mean of 0.4185, meaning about 42% of country pairs have bilateral investment treaties, which could influence FDI flows.

From a theoretical perspective, these statistics align with the gravity model of trade and investment, where FDI is expected to be influenced by economic mass (GDP), geographical distance, and institutional factors like trade openness and financial infrastructure. The skewness in FDI and trade variables supports the use of logarithmic transformations to address heteroskedasticity, while the symmetric distributions of ESGdist and INFT suggest these variables are well-measured and suitable for regression analysis.

(2) Correlation Analysis

Table 2 presents the correlation coefficients between the key variables, offering insights into their pairwise relationships and potential multicollinearity issues in the regression models.

Table 2 Correlation Coefficients

	lfdi	lgdp_h	lgdp_s	ldist	ESGdist	INFT	ltrade	BIT_dum
lfdi	1.0000							
lgdp_h	-0.0642***	1.0000						
lgdp_s	0.3946***	-0.7506***	1.0000					
ldist	-0.2764***	-0.0600***	-0.0600***	1.0000				
ESGdist	0.0400*	-0.0903***	0.0903***	0.0000	1.0000			
INFT	-0.2095***	0.6529***	-0.6529***	0.0000	-0.0954***	1.0000		
ltrade	0.5117***	0.1739***	0.3958***	-0.3223***	-0.0103	-0.0188	1.0000	
BIT_dum	-0.0718***	0.1790***	-0.2317***	0.0288*	-0.0334**	0.1691***	-0.0423**	1.0000

$^{*}\,p < 0.05,\ ^{**}\,p < 0.01,\ ^{***}\,p < 0.001$

The correlations reveal several notable patterns that align with economic theories of FDI. FDI (lfdi) shows a positive correlation with the source country's GDP**, supporting the idea that larger economies invest more abroad, consistent with the ownership advantages in Dunning's OLI paradigm. However, the negative correlation with host country GDP** is somewhat counterintuitive but may reflect market saturation or competition effects in larger host economies. The strong negative correlation between lgdp_h and lgdp_s suggests that larger source countries tend to invest in smaller host countries, aligning with "market-seeking"

FDI theories.

The negative correlation between FDI and distance *is a classic finding in gravity models, as geographical proximity reduces transaction costs and facilitates investment. The weak positive correlation between FDI and ESG risk differences* is intriguing, suggesting that moderate ESG disparities might encourage FDI, possibly due to regulatory arbitrage opportunities where firms exploit differences in environmental or governance standards.

Financial infrastructure gaps (INFT) show a negative correlation with FDI**, implying that firms prefer host countries with stable and developed financial systems, consistent with institutional theory. The strong positive correlation between FDI and bilateral trade** supports the "trade-FDI complementarity" hypothesis, where trade openness facilitates investment by reducing informational and transactional barriers. The negative correlation between FDI and BIT_dum is surprising, as bilateral investment treaties are typically expected to encourage FDI. This could reflect reverse causality, where treaties are signed in response to declining FDI to attract capital.

The correlation matrix highlights potential multicollinearity issues, particularly between lgdp_h and lgdp_s, which could bias regression results if not addressed. Overall, the correlations support gravity model predictions and emphasize the role of institutional and financial factors in shaping FDI flows, while the nuanced relationship with ESG risk warrants further nonlinear analysis.

(3) Linear Regression

Table 3 presents regression results from three gravity models (loglinear, instrumental variable, and pseudo-Poisson maximum likelihood) examining the impact of ESG risk (ESGdist) on FDI. The findings provide robust evidence on how various factors influence bilateral investment flows.

Table 3 Impact of ESG on FDI

	LL	IV	PPML
lgdp_h	0.4854***	0.4573***	-0.4117***
	(0.0639)	(0.0708)	(0.0779)
lgdp_s	0.4239***	0.3573***	-0.7595***
	(0.0565)	(0.0630)	(0.0494)
ldist	-0.8965***	-0.8396***	-0.3480***
	(0.0877)	(0.0950)	(0.0758)
mr_term	2.0546***	1.9293***	-0.1007
	(0.1885)	(0.2044)	(0.2201)
ESGdist	0.0117*	0.0150**	0.0480***
	(0.0061)	(0.0066)	(0.0102)
INFT	-0.1004***	-0.1304***	0.0109
	(0.0136)	(0.0181)	(0.0276)
BIT_dum	-0.1354	-0.0886	0.2188
	(0.0964)	(0.1078)	(0.1730)
ltrade	0.2726***	0.3437***	1.6455***
	(0.0609)	(0.0670)	(0.0947)
Constant	-32.1512***	-29.1929***	2.7829
	(2.9126)	(3.2284)	(2.3739)

R^2	0.366	0.372	0.734
Observations	2995	2543	3487

Note: *, **, *** indicate significance at 0.10, 0.05, and 0.01 levels respectively. The robust standard errors are in the parentheses. LL: loglinear model; IV: model of instrument variable; PPML: pseudo poisson maximum likelihood estimation

The results consistently show that source country GDP (lgdp_s) has a positive and significant effect on FDI in the loglinear model and the instrumental variable model, but negative effect in the PPML model, reinforcing the idea that larger economies have greater capacity to invest abroad, but the inclusion of zero observations may change the effect. Host country GDP (lgdp_h) has mixed effects—positive in the loglinear and IV models but negative in the PPML model—suggesting that market size may attract or deter FDI depending on the context, possibly due to competition effects. Distance (ldist) uniformly reduces FDI, supporting transaction cost theories and gravity model assumptions.

The key variable, ESGdist, exhibits a positive and statistically significant coefficient in all models (0.0117 in LL, 0.0150 in IV, 0.0480 in PPML), indicating that differences in ESG performance between countries tend to encourage FDI. This could reflect strategic behavior by multinational firms seeking regulatory arbitrage, where they invest in countries with differing ESG standards to exploit cost advantages or avoid stringent regulations in their home markets. The stronger effect in the PPML model, which is better suited for count data, suggests that ESG differences matter more for the extensive margin of FDI (number of projects) than for the intensive margin (value of investments).

Financial infrastructure gaps (INFT) consistently deter FDI, with negative coefficients across models, underscoring the importance of stable financial systems for attracting investment. Bilateral trade (ltrade) has a strong positive effect, confirming the complementarity between trade and FDI. Interestingly, the BIT dummy (BIT_dum) is insignificant, suggesting that bilateral investment treaties may not directly boost FDI in this sample, possibly due to lagged effects or omitted institutional variables.

Theoretical implications of these findings align with the eclectic paradigm, where FDI is driven by ownership advantages (source GDP), location factors (distance, ESG risk), and internalization (trade). The positive ESG effect contrasts with some literature but may reflect firms' strategic responses to heterogeneous regulatory environments. Policymakers should note that while moderate ESG differences might attract FDI, extreme disparities could have adverse effects, as explored in the nonlinear analysis.

(4) Quantile Regression

Table 4 employs quantile regression to examine how the impact of ESG risk on FDI varies across different levels of investment, offering a more nuanced understanding of the relationship.

Table 4 Quantile Regression

	q=0.2	q=0.4	q=0.6	q=0.8
lgdp_h	0.3876***	0.3814***	0.3696***	0.5250***
	(0.0686)	(0.0726)	(0.0689)	(0.1286)
lgdp_s	0.3537***	0.3708***	0.3505***	0.3763***
	(0.0619)	(0.0655)	(0.0622)	(0.1161)
ldist	-0.5687***	-0.8650***	-1.3398***	-1.2248***
	(0.1075)	(0.1137)	(0.1079)	(0.2015)

mr_term	1.4063***	1.4267***	1.9437***	2.1313***
	(0.2328)	(0.2462)	(0.2337)	(0.4364)
ESGdist	0.0029	-0.0063	0.0011	0.0233
	(0.0129)	(0.0136)	(0.0129)	(0.0241)
INFT	-0.1181***	-0.1285***	-0.1018***	-0.0998***
	(0.0138)	(0.0145)	(0.0138)	(0.0258)
BIT_dum	-0.1176	-0.0772	-0.1209	-0.1898
	(0.1116)	(0.1180)	(0.1120)	(0.2092)
ltrade	0.4154***	0.4892***	0.4508***	0.2652**
	(0.0604)	(0.0639)	(0.0606)	(0.1133)
Constant	-28.6177***	-25.6579***	-24.9626***	-27.9918***
	(3.6120)	(3.8211)	(3.6259)	(6.7725)
R^2	0.225	0.265	0.269	0.190
Observations	2995	2995	2995	2995

Note: *, **, *** indicate significance at 0.10, 0.05, and 0.01 levels respectively. The robust standard errors are in the parentheses. The quantile values are 0.2, 0.4, 0.6, and 0.8 respectively.

The results reveal heterogeneity in how determinants influence FDI at lower versus higher quantiles.

Source country GDP (lgdp_s) positively affects FDI across all quantiles, but its magnitude increases at higher levels (q=0.8), suggesting that larger investments are more sensitive to the economic size of the source country. Distance (ldist) also shows a stronger negative effect at higher quantiles, indicating that large-scale FDI is more deterred by geographical barriers than smaller investments. This aligns with gravity model extensions, where fixed costs of investment make distance more prohibitive for larger projects.

The most striking finding is the insignificance of ESGdist across most quantiles, except for a weakly positive coefficient at q=0.8. This implies that ESG differences play a marginal role in shaping FDI for most investment levels but may weakly influence large-scale investments. Financial infrastructure (INFT) consistently deters FDI across quantiles, reinforcing its universal importance.

Theoretical implications suggest that traditional gravity variables (GDP, distance) dominate FDI decisions, while ESG risk operates at the margins, particularly for large investments. This supports threshold effects in institutional theories, where firms tolerate moderate ESG differences but avoid extreme disparities when committing significant capital. Policymakers should focus on improving financial infrastructure and reducing transaction costs to attract diverse FDI levels, while ESG policies may need targeted adjustments for high-value investments.

(5) Nonlinear Analysis

Table 5 introduces a quadratic term (ESGdist2) to test for nonlinear effects of ESG risk on FDI, revealing a more complex relationship than linear models suggest.

Table 5 Nonlinear Analysis

	LL	IV	PPML
lgdp_h	0.4826***	0.4530***	-0.4003***
	(0.0642)	(0.0713)	(0.0796)

lgdp_s	0.4211***	0.3531***	-0.7476***
	(0.0569)	(0.0636)	(0.0491)
ldist	-0.9024***	-0.8478***	-0.3274***
	(0.0884)	(0.0961)	(0.0779)
mr_term	2.0479***	1.9197***	0.0205
	(0.1891)	(0.2051)	(0.2264)
ESGdist	-0.0101	-0.0119	0.5850***
	(0.0164)	(0.0192)	(0.1861)
ESGdist2	0.0002	0.0003	-0.0049***
	(0.0002)	(0.0002)	(0.0016)
INFT	-0.1003***	-0.1303***	0.0106
	(0.0136)	(0.0181)	(0.0282)
BIT_dum	-0.1342	-0.0875	0.2115
	(0.0965)	(0.1079)	(0.1726)
ltrade	0.2739***	0.3457***	1.6330***
	(0.0611)	(0.0672)	(0.0936)
Constant	-31.3833***	-28.1927***	-13.5090*
	(3.0669)	(3.4483)	(6.2610)
R^2	0.365	0.372	0.736
U-test	0.611	0.615	2.761***
Observations	2995	2543	3487

Note: *, **, *** indicate significance at 0.10, 0.05, and 0.01 levels respectively. The robust standard errors are in the parentheses.

The positive coefficient of ESGdist and the negative value of ESGdist2 (the square of ESGdist) indicate a reverse U-shape relationship between ESGdist and FDI.

The results confirm an inverted U-shaped effect, where moderate ESG differences attract FDI, but extreme disparities deter it.

In the PPML model, the positive coefficient for ESGdist and the negative coefficient for ESGdist2 clearly indicate this nonlinear pattern. This aligns with the "ESG arbitrage" hypothesis: firms may initially seek countries with moderate ESG differences to exploit cost advantages or regulatory flexibility, but avoid nations with extreme gaps due to heightened risks or reputational concerns. The loglinear and IV models show weaker nonlinearity, possibly due to their functional forms, but the PPML results are robust.

Other variables maintain their expected signs, with GDP, distance, and trade playing consistent roles. The U-test in the PPML model confirms the statistical significance of the nonlinear relationship.

Theoretical implications draw from institutional void theory, where moderate institutional differences create opportunities for firms, but extreme voids increase uncertainty and deter investment. Policymakers should aim for balanced ESG standards—neither too stringent (which may discourage investment) nor too lax

(which could increase risk perceptions). This nuanced approach can help attract FDI while promoting sustainable development.

The empirical analysis demonstrates that ESG risk has a nuanced, nonlinear impact on FDI, with traditional gravity factors (GDP, distance) playing dominant roles. Moderate ESG differences may attract FDI through regulatory arbitrage, but extreme gaps deter investment due to heightened risks. Financial infrastructure and trade openness are consistently important, while bilateral treaties show limited direct effects. These findings suggest that policymakers should prioritize stable financial systems and balanced ESG standards to attract diverse FDI flows, leveraging the complementary roles of trade and investment in economic development.

V.   Conclusion

The growing emphasis on ESG (Environmental, Social, and Governance) factors in global investment decisions underscores the critical need to understand their impact on bilateral foreign direct investment (FDI). This study systematically examines the nonlinear and size-dependent relationships between ESG risk and FDI, bridging gaps in the existing literature by integrating institutional theory with traditional gravity models. Using advanced econometric techniques—including quantile regression and nonlinear specifications—the paper reveals an inverted U-shaped effect of ESG differences on FDI, where moderate disparities attract investment through regulatory arbitrage, while extreme gaps deter it due to heightened risks (Khanna & Palepu, 2010; Harms, 2021). The findings also demonstrate heterogeneous effects across investment sizes, with large-scale FDI being more sensitive to ESG risks than smaller investments. By combining gravity models with institutional insights, this research provides a comprehensive framework for analyzing modern FDI determinants in the ESG era, contributing to both academic discourse and policymaking in sustainable finance and international business (Gillan et al., 2021).

Based on the empirical findings of the paper, the following ESG policies can be implemented to optimize FDI inflows while managing ESG risks. First, the government should made moderate ESG standards: Adopt balanced ESG regulations that align with regional norms to attract FDI through regulatory arbitrage without deterring investors with extreme gaps. This leverages the inverted U-shaped relationship, where moderate ESG differences encourage investment while extreme disparities increase risks. Second, the government should promote financial infrastructure development. Strengthen financial systems to reduce transaction costs and uncertainties, particularly for large-scale investments, as financial infrastructure gaps consistently deter FDI across all quantiles. Third, the government should pay more attention to trade-ESG integration. Combine trade liberalization with ESG frameworks, as the strong complementarity between trade and FDI suggests that reducing trade barriers can enhance investment flows while promoting sustainable practices.

While this study advances the understanding of ESG-FDI dynamics, several limitations warrant future research. First, the analysis focuses on aggregate ESG scores; disaggregating environmental, social, and governance risks could reveal sector-specific effects (Christmann et al., 2019). Second, incorporating firm-level data would clarify how MNCs internalize ESG risks in investment decisions (Hoepner et al., 2020). Addressing these gaps would further refine the ESG arbitrage hypothesis and its policy applications.

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