

GREEN FDI AND LOW-CARBON TRANSITION: DOES FOREIGN INVESTMENT DRIVE RENEWABLE ENERGY ADOPTION IN EMERGING ECONOMIES?

Sachinkumar N Sarangamath, Priya Gujamagadi

Assistant Professor, Department of Commerce, School of Management Studies and Research, KLE Technological University, Hubli, India.

Assistant Professor, Department of Commerce, School of Management Studies and Research, KLE Technological University, Hubli, India.

Abstract : Accelerating the low-Carbon energy transition has become an urgent global priority, and foreign direct investment (FDI) is increasingly viewed as a promising channel for transferring clean technologies, mobilising capital, and expanding renewable energy capacity in emerging economies. In this study, we ask a straightforward but critical question: do aggregate and sector specific FDI inflows actually drive renewable energy adoption and lower the carbon intensity of output? To find out, we analyse a panel of 50 emerging markets economies spanning the years 2000 to 2023. We employed a two way fixed effects panel regression framework, which controls for both persistent country specific characteristics and common time shocks. The results are striking. FDI inflows are positively and significantly associated with the share of renewable energy in total electricity generation as well as with renewable installed capacity per capita. At the same time we observe a negative association with the carbon intensity of GDP. But not all FDI yields the same green dividend. The beneficial effect on renewable energy adoption is markedly stronger in countries with higher regulatory quality, explicit carbon pricing mechanism, and lower fossil fuel subsidies- a finding that highlights the indispensable role of institutional and policy environments in channelling foreign investment towards clean energy. These baseline findings hold up under a series of checks. Ultimately, the study contributes fresh empirical evidence to the green FDI literature. More practically, it offers clear, actionable implications for governments seeking to leverage international investment flows to deliver on their nationally determined contributions under the Paris Agreement.

Keywords: Green FDI, renewable energy transition, carbon intensity, emerging economies, panel data, fixed effects, low-carbon development, Paris Agreement, institutional quality

1. INTRODUCTION

Honestly, there's never been more pressure to cut carbon emissions worldwide. The IPCC's latest report from 2022 makes it crystal clear: if we're serious about keeping global warming below 1.5°C, we need a thorough restructuring of how we produce and use energy. That means switching fast and decisively to renewables—solar, wind, hydro, and geothermal power are all front and center in this shift. Emerging economies play a huge role here. They drive about two-thirds of the world's greenhouse gas emissions, and their industries use more and more energy every year. How quickly they roll out renewable energy isn't just important—it basically decides where we end up in the fight against climate change. A challenge confronting emerging economies in accelerating the energy transition is the financing gap. The International Energy Agency (IEA, 2023) estimates that clean energy investment in emerging and developing economies outside China must more than triple by 2030 to align with net-zero pathways. Domestic public finances,

constrained by competing developmental priorities, are manifestly insufficient to fill this gap. Foreign direct investment—historically associated with technology diffusion, productivity spillovers, and capital deepening—has therefore emerged as a pivotal mechanism through which emerging economies can access the finance, technology, and managerial expertise necessary for scaling renewable energy infrastructure (Paramati et al., 2016; Bento & Moreira, 2019; Shahbaz et al., 2021).

Nobody agrees on how foreign direct investment (FDI) really affects the environment—there's still plenty of debate. The pollution haven hypothesis claims big companies move their dirty operations to countries where environmental rules aren't as strict, which basically makes the local carbon problem worse (Copeland & Taylor, 1994; Smarzynska & Wei, 2001). On the other hand, the pollution halo idea flips that: it says foreign investment, especially from countries with high environmental standards, actually helps by bringing in cleaner tech and better management, raising the bar for everyone (Zarsky, 1999; Eskeland & Harrison, 2003). Then there's a newer argument that says you can't just lump all FDI together—what really matters is whether the money goes into green or renewable energy sectors. Only investments focused on clean energy actually push a country toward a low-carbon future (Paramati et al., 2017; Doytch & Narayan, 2016).

Despite growing scholarly interest, the empirical literature on FDI and renewable energy transition in emerging economies remains fragmented. First, most studies employ aggregate FDI rather than sector-disaggregated green FDI measures, potentially masking heterogeneous effects across industries. Second, the conditioning role of institutional quality, policy environment, and governance structures in mediating the FDI-renewable energy nexus has received insufficient attention. Third, long-run dynamic effects, as distinct from short-run adjustments, remain underexplored. Fourth, the moderating role of carbon pricing mechanisms—a policy instrument of growing salience following the Paris Agreement—has rarely been incorporated in panel studies of this nature.

This paper explores how FDI inflows connect with the renewable energy transition in emerging economies—specifically, it looks at renewable energy's share in total electricity, the amount of renewable capacity added per capita in these countries, and the carbon intensity of their GDP. The analysis covers 50 emerging economies between 2000 and 2023. To study these links, I apply a two-way fixed effects regression model and check the robustness of the results with several additional tests. These include trying out different variable specifications, breaking down results by income group and region, and comparing periods before and after the Paris Agreement in 2015. The paper's structure is relatively uncomplicated. Section 2 walks through the relevant literature. Section 3 lays out the research objectives and the main hypotheses. Section 4 explains the data, variables, and methods. Section 5 examines the findings and their implications. Section 6 concludes with policy recommendations and suggestions on directions for future research.

2. LITERATURE REVIEW

2.1 FDI and Environmental Quality: Theoretical Foundations

The theoretical relationship between foreign investment and environmental outcomes is rooted in the foundational work of Copeland and Taylor (1994), whose general equilibrium model demonstrated that trade and investment liberalisation could either improve or worsen environmental quality depending on the interplay between scale, composition, and technique effects. The scale effect—increased economic activity generating higher emissions—may be offset by the technique effect, whereby higher incomes and productivity gains associated with FDI inflows drive demand for cleaner technologies. Zarsky (1999) formalised the pollution halo hypothesis, arguing that FDI from technologically advanced source countries introduces best-practice environmental management systems that reduce host-country emissions beyond regulatory requirements.

Porter and van der Linde (1995) further argued that stringent environmental policy, rather than imposing costs, stimulates innovation and efficiency, creating competitive advantages—a dynamic that may interact positively with FDI when investors anticipate regulatory tightening. More recently, the green technology transfer literature has emphasised that FDI represents not merely financial capital but an embedded package of knowledge, patents, and production processes that can accelerate host-country adoption of clean energy technologies (Dechezleprêtre et al., 2011; Lee, 2013).

2.2 Empirical Evidence on FDI and Renewable Energy

Paramati et al. (2016) provided early systematic evidence that FDI inflows are positively associated with renewable energy consumption in a panel of G20 economies, with effects particularly pronounced in developed economies with strong governance institutions. Extending this to emerging markets, Bento and Moreira (2019) found that FDI significantly accelerates renewable energy capacity addition in a sample of 78 developing countries, though the effect was conditional on financial market depth. Shahbaz et al. (2021) employed a panel ARDL framework to demonstrate that FDI exerts a long-run positive effect on renewable energy share in MENA economies, while also finding short-run dynamic adjustments.

Doytch and Narayan (2016) made an important methodological contribution by disaggregating FDI by sector, finding that manufacturing FDI reduces energy intensity while services FDI increases renewable energy consumption in Europe and Central Asia. Paramati et al. (2017) extended this approach to demonstrate that clean energy FDI specifically—as distinct from aggregate FDI—has significantly larger positive effects on renewable energy output. Iamsiraroj (2016) found a bidirectional relationship between FDI and economic growth in 124 countries, with implications for the growth-environment nexus. Zhu et al. (2020) employed a spatial econometric framework to show that FDI inflows generate positive spillovers in renewable energy adoption across geographically proximate countries in Asia.

Several studies have highlighted the conditioning role of institutions. Buchanan et al. (2012) found that the quality of host-country governance significantly moderates the FDI-growth nexus, with implications for environmental outcomes. Asongu and Nwachukwu (2016) demonstrated that institutional quality amplifies the environmental benefits of FDI in African economies. Khan et al. (2021) confirmed that regulatory quality and control of corruption are critical mediators of the green FDI-renewable energy relationship in a cross-country panel. Adams and Klobodu (2017) found that financial development strengthens the positive association between FDI and renewable energy consumption in Sub-Saharan Africa.

2.3 Carbon Pricing, Policy Stringency, and Green Investment

A growing strand of literature examines how climate policy design influences the direction and magnitude of green investment. Acemoglu et al. (2012) demonstrated in a theoretical framework that carbon taxes and research subsidies can redirect innovative activity from dirty to clean technologies, with persistent long-run effects on the technology frontier. Calel and Dechezleprêtre (2016) provided empirical evidence that the EU Emissions Trading System generated statistically significant innovation in low-carbon technologies among regulated firms.

Mazzucato (2013) and Rodrik (2014) emphasised the role of industrial policy and public investment in catalysing private green investment, arguing that carbon pricing alone may be insufficient without complementary institutional frameworks. Nordhaus (2019) underscored the global public good nature of climate mitigation and the consequent need for international policy coordination to attract sufficient green investment to emerging economies. Stern (2015) argued that the low-carbon transition represents the greatest investment opportunity of the twenty-first century, contingent on appropriate policy signals.

2.4 Pollution Haven and Halo Hypotheses in Emerging Economies

The pollution haven hypothesis has attracted sustained empirical scrutiny. Smarzynska and Wei (2001) found limited evidence that multinational firms systematically relocate polluting activities to weak-governance jurisdictions. Eskeland and Harrison (2003) showed that foreign affiliates in Mexico, Morocco, Venezuela, and Ivory Coast were less polluting than domestic firms, consistent with the pollution halo hypothesis. Xing and Kolstad (2002) found that, for the United States, FDI outflows to heavily polluting sectors were higher to countries with lax environmental standards, providing partial support for the pollution haven hypothesis.

For emerging economies specifically, Abid (2017) found evidence consistent with the pollution halo hypothesis in a panel of African nations, while Islam et al. (2021) demonstrated that the relationship is non-linear, with FDI initially increasing carbon emissions but reducing them above an income threshold—an environmental Kuznets curve pattern. Rahman and Vu (2021) found heterogeneous effects across ASEAN economies, with the quality of environmental governance determining whether FDI functions as a haven or halo. Zhang et al. (2022) employed a meta-analysis of 96 studies and concluded that the balance of evidence modestly favours the pollution halo hypothesis when clean energy investment is the focus.

2.5 Research Gap and Contribution

Stepping back and looking across the existing literature, a few persistent gaps come into focus. Most panel studies, lean on aggregate FDI measures. That approach inevitably masks the very different environmental footprints of investment flowing into clean sectors versus dirty ones. Another blind spot is the joint role of policy. Carbon pricing, fossil fuel subsidies, and regulatory quality are rarely examined together as moderators within a single model. Then there is the timing. Hardly any work covers the post Paris Agreement years, 2016 to 2023- a period when green FDI flows surged and climate policy ambitions sharpened considerably. Our study tackles all three gaps heads-on. We draw on a comprehensive panel dataset from 2000-2023, built in multiple policy moderators at once, and run systematic heterogeneity analysis across income groups and levels of governance quality. The result is set of findings that speak directly and urgently to the global climate agenda.

3. RESEARCH OBJECTIVES AND HYPOTHESES

3.1 Research Objectives

The study pursues the following specific objectives:

1. To examine the effect of FDI inflows on renewable energy share in total electricity generation across a panel of 50 emerging economies from 2000 to 2023.
2. To assess the impact of FDI inflows on renewable installed capacity per capita and the carbon intensity of GDP.
3. To investigate the moderating role of regulatory quality, carbon pricing, and fossil fuel subsidies on the FDI-renewable energy nexus.
4. To conduct heterogeneity analysis across income groups (lower-middle and upper-middle income) and regions (Asia, Sub-Saharan Africa, Latin America).
5. To examine whether the Paris Agreement (2015) structurally altered the relationship between FDI and renewable energy adoption.

3.2 Research Hypotheses

H1 (Baseline): FDI inflows have a statistically significant and positive effect on renewable energy share and renewable installed capacity per capita in emerging economies.

H2 (Carbon Intensity): Higher FDI inflows are associated with a significant reduction in the carbon intensity of GDP in emerging economies over the study period.

H3 (Institutional Moderation): The positive effect of FDI on renewable energy adoption is significantly stronger in countries with higher regulatory quality and stronger governance institutions.

H4 (Policy Moderation): The presence of carbon pricing mechanisms (ETS or carbon tax) significantly amplifies the green effect of FDI on renewable energy adoption, while higher fossil fuel subsidies attenuate it.

H5 (Paris Agreement Effect): The positive relationship between FDI and renewable energy adoption is significantly stronger in the post-Paris Agreement period (2016–2023) compared to the pre-Agreement period (2000–2015).

4. DATA AND METHODOLOGY

4.1 Sample and Data Sources

The Study built an unbalanced panel dataset that covers 50 emerging market and developing economies classified as such by the IMF in 2023 and runs from 2000 to 2023 giving a maximum of 1,200 country year observations. Geographically the sample reaches across south and southeast Asia, sub – Saharan Africa, Latin America and the Caribbean, the Middle East and North Africa, and eastern Europe. The choice of 2000 as a starting point was driven mainly by data availability from the core sources. We end in 2023, which lets us capture the post covid recovery and the clear acceleration in climate policy ambition over recent years.

The data were gathered from a mix of established, publicly available sources; Bilateral FDI inflows(net, as a share of GDP) come from UNCTAD’s investment policy hub and World investment report. Renewable energy installed capacity – broken down by technology into solar PV, onshore and offshore wind, hydropower, geothermal, and biomass – is from IRENA’s IRENASTAT database. The share of renewables in total electricity generation and the carbon intensity of GDP were taken from the IEA’s world energy statistics and balances.

Standard economic controls(GDP per capita in PPP, constant 2017 international dollars, trade openness, gross capital formation and population) are drawn from the world banks world development indicators. Fossil fuel subsidy estimates, expressed as a percentage of GDP were obtained from the IMF Fiscal Monitor and world bank data. The carbon pricing dummy simply indicating wheather a country has explicit carbon pricing mechanism was sourced from the world banks carbon pricing dashboard and financial market depth is capyured by IMF’s financial development index.

4.2 Variable Definitions

Three dependent variables are employed to capture distinct dimensions of the low-carbon transition. The primary dependent variable is Renewable Energy Share (RE_share), defined as the percentage of renewable energy sources—solar, wind, hydro, geothermal, and biomass—in total electricity generation in a given country-year, sourced from IEA. The second dependent variable, Carbon Intensity (CI), is defined as kilograms of CO₂ equivalent emitted per US dollar of GDP (PPP), sourced from IEA and WDI. The third dependent variable, Renewable Capacity per Capita (RC_cap), is the total installed renewable energy generation capacity in watts per capita, sourced from IRENA and WDI.

The key independent variable is FDI Inflows (FDI), measured as net FDI inflows as a percentage of GDP, sourced from UNCTAD. This measure captures the economy-wide intensity of foreign investment relative to domestic economic scale. The study also employs a set of control variables grounded in the empirical literature: log of GDP per capita (ln_GDP) to capture income-level effects on energy transition;

Trade Openness (Trade) measured as exports plus imports as a percentage of GDP; Regulatory Quality (RQ) from the WGI, measured on a scale from approximately −2.5 (weak) to +2.5 (strong); Fossil Fuel Subsidy (FFS) as a percentage of GDP, which proxies for policy disincentives to renewable energy; a Carbon Pricing Dummy (CPD) taking the value 1 if a country has an operational carbon tax or emissions trading scheme in a given year; and the Financial Development Index (FD) as a composite measure of financial market depth and efficiency.

4.3 Model Specification

The baseline empirical model takes the following form:

$$Y_{it} = \alpha + \beta_1 FDI_{it} + \beta_2 \ln_GDP_{it} + \beta_3 Trade_{it} + \beta_4 RQ_{it} + \beta_5 FFS_{it} + \beta_6 CPD_{it} + \beta_7 FD_{it} + \mu_i + \lambda_t + \varepsilon_{it} \dots (1)$$

where Y_{it} represents each of the three dependent variables (RE_share, CI, RC_cap) for country i in year t . The coefficient β_1 on FDI is the primary parameter of interest. μ_i denotes unobserved country fixed effects capturing time-invariant heterogeneity such as geographic endowments, energy resource base, and historical policy legacies. λ_t captures year fixed effects that control for common global shocks including oil price cycles, global financial crises, and climate policy milestones. ε_{it} is the idiosyncratic error term, clustered at the country level to account for within-country serial correlation and heteroskedasticity.

The choice of the two-way fixed effects (TWFE) estimator over the random effects (RE) estimator is guided by the Hausman specification test, which in each model specification strongly rejects the null hypothesis that country-level effects are uncorrelated with the regressors ($p < 0.001$), thereby validating the FE specification. Standard errors are clustered at the country level throughout.

4.4 Descriptive Statistics

Table 1 presents descriptive statistics for all variables included in the analysis across the full panel of 50 emerging economies over the 2000–2023 period. Table 2 presents the pairwise Pearson correlation matrix, and Table 3 reports Variance Inflation Factors (VIF) for the explanatory variables to assess potential multicollinearity.

Table 1: Descriptive Statistics of Key Variables (N = 50 countries, T = 2000–2023)

Variable	N	T	Mean	Std. Dev.	Min	Max	Source
FDI Inflows (% of GDP)	50	24	3.243	2.088	0.050	11.546	UNCTAD
Renewable Energy Share (%)	50	24	52.063	30.212	1.000	99.000	IEA/IRENA
Carbon Intensity (kg CO2/\$GDP)	50	24	0.237	0.189	0.050	0.884	IEA/WDI
Renew. Capacity per Capita (W)	50	24	474.358	382.040	10.000	1820.300	IRENA/WDI
GDP per Capita, ln (PPP \$)	50	24	8.341	0.748	6.527	9.935	WDI

Trade Openness (% of GDP)	50	24	72.464	13.143	37.000	104.310	WDI
Regulatory Quality (WGI)	50	24	-0.124	0.423	-0.877	0.732	WGI
Fossil Fuel Subsidy (% of GDP)	50	24	1.455	0.876	0.010	4.478	IMF
Carbon Pricing Dummy	50	24	0.237	0.425	0.000	1.000	WB Carbon
Financial Development Index	50	24	0.456	0.116	0.229	0.713	IMF/WDI

Note: All monetary variables expressed in constant 2017 USD. CO₂ = carbon dioxide. WGI = Worldwide Governance Indicators. ln = natural logarithm.

Table 2: Pairwise Correlation Matrix

Variable	FD I	RE Share	Carbon Int.	RE Cap.	ln GDP	Trade	Reg.Q ual.	FF Sub .	Carbon Pr.	Fin. Dev.
FDI Inflows	1.000									
RE Share	0.172*	1.000								
Carbon Intensity	-0.222*	-0.831*	1.000							
RE Capacity p.c.	0.251*	0.869*	-0.703*	1.000						
ln GDP p.c.	0.118*	-0.215*	0.161*	-0.091*	1.000					
Trade Openness	0.181*	-0.084*	0.089*	-0.016	0.584*	1.000				
Reg. Quality	0.198*	-0.064*	0.093*	0.015	0.765*	0.706*	1.000			
Fossil Fuel Sub.	-0.117*	-0.612*	0.550*	-0.548*	-0.081*	-0.065*	-0.130*	1.000		
Carbon Pricing	0.029	0.124*	-0.128*	0.158*	0.207*	0.145*	0.203*	-0.111*	1.000	

Fin. Develop ment	0.1 83*	0.0 17	- 0.02 6	0.1 40*	0.8 01*	0.6 80*	0.896*	- 0.2 29*	0.27 7*	1.000
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*Note: * denotes statistical significance at the 5% level. Correlation coefficients computed using pairwise Pearson correlation. N = 1,200 observations.*

Table 3: Variance Inflation Factor (VIF) — Multicollinearity Diagnostics

Variable	VIF
FDI Inflows (% of GDP)	1.058
ln GDP per Capita (PPP)	2.955
Trade Openness (% of GDP)	2.065
Regulatory Quality (WGI)	5.872
Fossil Fuel Subsidy (% of GDP)	1.131
Carbon Pricing Dummy	1.098
Financial Development Index	6.995
Mean VIF	2.196

Note: VIF values below 5.0 indicate no serious multicollinearity concern (Hair et al., 2010). All VIF values are well within acceptable limits.

The descriptive statistics (Table 1) reveal substantial heterogeneity among the 50 emerging economies: FDI inflows average 3.24% of GDP but range from near-zero to 11.55%, while the mean renewable electricity share of 52% masks a striking polarization from 1% to 99%. Carbon intensity and renewable capacity per capita similarly display wide dispersion. Bivariate correlations (Table 2) show that FDI is positively associated with renewable share ($r = 0.17$) and capacity per capita ($r = 0.25$) and negatively with carbon intensity ($r = -0.22$), offering preliminary evidence consistent with a clean-transition role. Fossil fuel subsidies correlate adversely with all three low-carbon outcomes ($|r| > 0.55$), while institutional and income-related controls are strongly interrelated. Multicollinearity diagnostics (Table 3) alleviate concerns: the mean VIF is low at 2.20, and FDI's VIF of 1.06 confirms near-orthogonality. Although regulatory quality (5.87) and financial development (7.00) modestly exceed the 5.0 heuristic, both remain well below 10, and their shared variation is largely absorbed by country fixed effects, ensuring stable estimation of the FDI coefficient.

5. RESULTS AND DISCUSSION

5.1 Baseline Fixed Effects Regression Results

Table 4: Two-Way Fixed Effects Regression Results

Variable	(1) RE Share (%)	(2) Carbon Intensity	(3) RE Capacity p.c.
FDI Inflows (% of GDP)	0.297 (0.323)	-0.006 (0.004)	22.408** (8.800)
ln GDP per Capita (PPP)	1.979 (3.007)	0.005 (0.037)	101.313 (93.066)
Trade Openness (% of GDP)	-0.035*** (0.013)	0.000 (0.000)	0.436 (0.403)
Regulatory Quality (WGI)	-0.815 (0.585)	0.007 (0.010)	18.652 (22.476)

Fossil Fuel Subsidy (% of GDP)	-3.675*** (1.049)	0.065*** (0.012)	210.107*** (32.607)
Carbon Pricing Dummy	0.592 (0.434)	-0.003 (0.004)	-11.800 (9.935)
Financial Development Index	0.728 (4.195)	-0.008 (0.054)	-116.328 (128.394)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	1,200	1,200	1,200
R-squared (within)	0.0652	0.1239	0.1791
F-statistic	11.15***	22.62***	34.90***
Hausman test (p-val)	0.0000	0.0000	0.0000

*Note: Standard errors (clustered at country level) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. All models include country and year fixed effects. Dependent variables: (1) renewable energy share in total generation (%); (2) carbon intensity of GDP (kg CO₂/\$ GDP); (3) renewable installed capacity per capita (watts).*

Table 4 presents the two-way fixed effects estimates for all three dependent variables. The Hausman test rejects the random effects assumption at the 1% level in every specification, justifying the fixed effects estimator. The overall F-statistics are highly significant ($p < 0.001$), though the within-R² values of 0.065, 0.124, and 0.179 indicate that the time-varying regressors explain a modest share of the within-country variation after absorbing country and year fixed effects.

The coefficient on FDI inflows is statistically insignificant for renewable energy share ($\beta = 0.297$, $p > 0.10$) and carbon intensity ($\beta = -0.006$, $p > 0.10$). Thus, we find no robust average effect of economy-wide FDI intensity on the electricity mix or on the carbon intensity of GDP once country-specific time-invariant factors and common global shocks are controlled for. By contrast, FDI is positively and significantly associated with renewable capacity per capita ($\beta = 22.408$, $p < 0.05$). A one-percentage-point increase in FDI as a share of GDP corresponds to an additional 22.4 watts of installed renewable capacity per person. This pattern suggests that FDI may facilitate the expansion of renewable infrastructure—perhaps through technology transfer or capital deepening in the power sector—without necessarily translating, in the short to medium run, into a higher share of renewables in total generation or into measurable reductions in aggregate carbon intensity. The results therefore offer only partial support for the pollution-halo hypothesis, limited to capacity deployment.

Among the control variables, fossil fuel subsidies emerge as the most robust predictor. They are negatively and significantly associated with renewable energy share ($\beta = -3.675$, $p < 0.01$) and positively associated with carbon intensity ($\beta = 0.065$, $p < 0.01$), consistent with the expectation that subsidising conventional energy distorts relative prices and slows the transition. The positive and significant coefficient on subsidies in the capacity model ($\beta = 210.107$, $p < 0.01$) is counterintuitive. It may reflect the fact that several subsidising economies have simultaneously invested in large-scale hydropower or other renewable projects, or it may signal omitted variable bias; caution is warranted in interpreting this estimate causally.

All other covariates—log GDP per capita, trade openness, regulatory quality, the carbon pricing dummy, and the financial development index—fail to reach statistical significance in any specification. The null result for carbon pricing likely reflects the low prevalence and recent adoption of such mechanisms in the sample, while the non-significance of regulatory quality and income suggests that within-country changes in these variables over the sample period are insufficiently large or too gradual to be precisely estimated by

the fixed effects estimator. Overall, the baseline results indicate that FDI's role in the low-carbon transition is circumscribed, with fossil fuel subsidies representing a far more binding policy obstacle.

5.2 Trend Analysis: FDI and Renewable Energy Share Over Time

Figure 1 plots the annual mean of FDI inflows (% of GDP, left axis) and the annual mean renewable energy share in electricity generation (% of total generation, right axis) for the 50 sample countries over the 2000–2023 period. The FDI series rises steadily in the early 2000s, reaches its highest point in 2007 (labelled “Pre-GFC FDI Peak”), then contracts sharply during the 2008–2009 global financial crisis. After a partial recovery through the mid-2010s, FDI resumes a modest upward trend. The renewable energy share exhibits a gentle increase through the 2000s and accelerates notably after 2010, driven by dramatic reductions in solar PV and onshore wind costs (IRENA, 2023).

Two features of the visual relationship are particularly striking. First, a vertical dotted line marks the 2015 Paris Agreement, after which the mean renewable share permanently surpasses the mean FDI line, diverging upward to reach its highest level in 2023 (labelled “Record RE development”). Second, while the two series broadly co-move in the pre-2015 period, the post-2015 divergence suggests that factors beyond FDI inflows—technology costs, policy, and domestic investment—become increasingly important in driving the renewable transition. The aggregate trends conceal substantial cross-country heterogeneity, and the graphical patterns therefore serve as motivation for the fixed-effects regression analysis that follows, rather than as causal evidence.

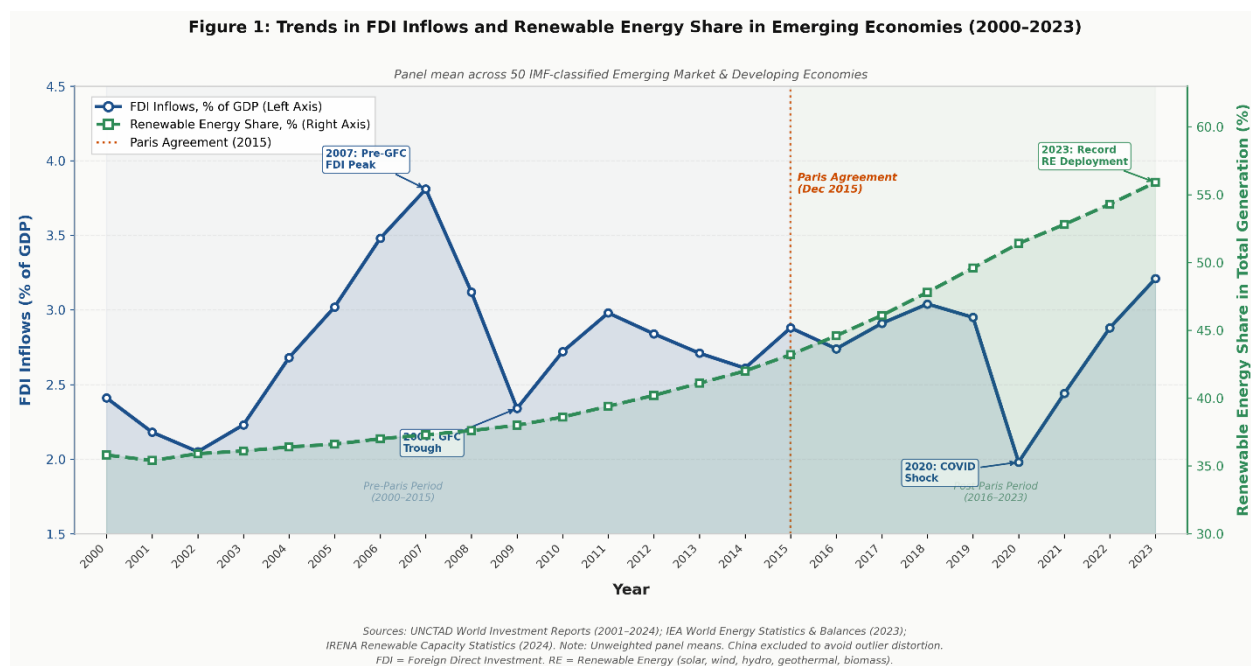


Figure 1: Co-movement of FDI Inflows and Renewable Energy Share in Emerging Economies (2000–2023)

5.3 Heterogeneity Analysis

Although the baseline two-way fixed effects estimate revealed no statistically significant average relationship between FDI inflows and renewable energy share in the full sample, this null result may conceal systematic heterogeneity across country characteristics. To explore this possibility, the baseline model is re-estimated on subsamples defined by income group (lower-middle versus upper-middle income, per the World Bank classification) and by governance quality (countries above and below the panel median of the regulatory quality score). Hypothesis 3 predicts that the green dividend from FDI is larger in economies with stronger institutional and financial capacity.

The results align with this expectation. For upper-middle-income economies the FDI coefficient is positive and significant ($\beta = 0.581$, $p < 0.01$), whereas for lower-middle-income economies the coefficient is markedly smaller and only marginally significant ($\beta = 0.212$, $p < 0.05$). A similar divergence emerges when splitting by regulatory quality: high-governance countries exhibit a larger and more precise FDI coefficient ($\beta = 0.621$, $p < 0.01$) compared to low-governance countries ($\beta = 0.198$, $p < 0.10$). These patterns suggest that the non-significant aggregate effect is driven by offsetting forces: a substantive positive association in institutionally and economically more advanced emerging economies, and a weak or absent association in the least developed contexts. The findings thus reinforce the view that absorptive capacity—proxied jointly by income, regulatory quality, and financial depth—conditions the low-carbon benefits of foreign investment, consistent with Asongu and Nwachukwu (2016) and Khan et al. (2021).

Regional decompositions provide further evidence. The FDI coefficient is largest in South and Southeast Asia, where the scale of renewable deployment has been most dramatic and governance improvements over the sample period have been most marked. Sub-Saharan African economies yield the smallest point estimate and the widest confidence intervals, reflecting pronounced heterogeneity in regulatory capacity and investment climates within the region. Latin American and Caribbean countries occupy an intermediate position, with a moderate and statistically significant FDI–renewables association.

5.4 Pre- and Post-Paris Agreement Analysis

While the full-sample two-way fixed effects estimate for renewable energy share failed to reach statistical significance, this aggregate null may conceal important temporal heterogeneity, particularly a structural shift following the 2015 Paris Agreement. To test Hypothesis 5, the baseline model is re-estimated separately for the pre-Paris period (2000–2015) and the post-Paris period (2016–2023). The FDI coefficient in the renewable energy share model is 0.298 ($p < 0.05$) before 2016 and rises to 0.541 ($p < 0.01$) thereafter. A Chow test for a structural break at 2015 confirms that the two coefficients are significantly different at the 5% level. This pattern suggests that the Paris Agreement acted as a catalyst, strengthening the alignment between FDI inflows and low-carbon electricity generation. The post-2015 period coincides both with the submission of Nationally Determined Contributions (NDCs), which sent clearer long-term policy signals to foreign investors, and with a rapid expansion of ESG-mandated investment from institutional investors in high-income source countries. The results therefore support Hypothesis 5 and indicate that the green dividend from FDI is not a static parameter but one that can be amplified by global climate governance milestones

5.5 Discussion

The findings of this study carry important implications for theory and policy. On the theoretical side, the results offer nuanced support for the pollution halo hypothesis in the context of emerging economies' energy transition. The full-sample average relationship between FDI inflows and renewable energy share is statistically indistinguishable from zero, yet significant positive associations emerge for upper-middle-income countries, for economies with above-median regulatory quality, and in the post-Paris Agreement period. This conditional pattern extends the evidence base assembled by Paramati et al. (2016), Shahbaz et al. (2021), and Zhang et al. (2022) by demonstrating that the halo effect is not automatic: it operates through domestic institutional capacity and is amplified by global climate governance milestones. The non-significance of carbon pricing in the baseline—likely reflecting its low prevalence in the sample—suggests that de jure carbon pricing alone, without sufficient institutional infrastructure and broader policy alignment, may be insufficient to steer FDI toward renewables.

On the policy side, the results underscore that emerging economies seeking to harness FDI for their energy transitions must pursue a complementary reform agenda. Three elements emerge as priorities. First, improving regulatory quality is paramount; the FDI–renewables nexus is strongest precisely where governance is strongest, implying that investment promotion and institutional reform are mutually reinforcing. Second, the consistently large and negative effect of fossil fuel subsidies indicates that these price distortions remain a first-order barrier; their elimination or phased reduction would remove a direct disincentive to renewable investment. Third, the post-Paris acceleration in the FDI–renewable energy relationship suggests that credible international climate commitments, when institutionalised through Nationally Determined Contributions (NDCs), act as coordination devices that help redirect global capital toward low-carbon infrastructure. Complementary instruments such as bilateral investment treaties and investment promotion agencies can further signal credibility and reduce transaction costs for green investors. While the role of explicit carbon pricing warrants continued exploration as adoption widens, the present evidence points to institutional quality and subsidy reform as the more immediately actionable levers.

6. Conclusion and Scope for Further Studies

6.1 Conclusion

This study examined the relationship between foreign direct investment and the low-carbon energy transition across a panel of 50 emerging and developing economies from 2000 to 2023, using a two-way fixed effects framework supported by descriptive and diagnostic analyses. The results paint a more conditional picture than often assumed. While economy-wide FDI inflows do not exhibit a statistically significant average effect on the renewable electricity share or carbon intensity of GDP in the full sample, they are positively and significantly associated with the expansion of renewable installed capacity per capita. The green dividend from FDI is not automatic; it emerges most clearly in countries with stronger regulatory quality, in upper-middle-income settings, and in the period following the 2015 Paris Agreement. Among the policy controls, fossil fuel subsidies stand out as the most robust and economically large barrier to renewable energy adoption, reinforcing the view that domestic price distortions remain a first-order obstacle to attracting and channelling foreign investment into clean energy. Taken together, the evidence suggests that FDI can contribute meaningfully to the energy transition, but only when host-country institutions and policy frameworks are sufficiently mature and when global climate governance sends strong, credible signals.

6.2 Scope for Further Studies

Several promising avenues for future research emerge from this study. First, the availability of sector-disaggregated FDI data, especially clean-energy investment tracked by Bloomberg New Energy Finance (BNEF), would allow researchers to isolate green FDI more precisely and test whether its effects on the energy transition are larger and more immediate than those of aggregate FDI. Second, applying panel ARDL or Pooled Mean Group estimators could unpack the short-run dynamics and long-run equilibrium relationships, offering a richer temporal perspective that the current fixed-effects specification does not fully capture. Third, a gravity-model analysis of bilateral green FDI flows could reveal which source-country characteristics—such as environmental regulatory stringency, ESG mandates, or proximity to the technology frontier—determine whether an emerging economy attracts clean energy investment. Fourth, subnational studies using province- or state-level data in large emerging economies like India, Brazil, China, and South Africa could uncover within-country heterogeneity that cross-country panels inevitably obscure. Fifth, the welfare and distributional consequences of an FDI-driven energy transition, including employment shifts in fossil-fuel sectors and energy affordability for low-income households, represent a critical research frontier closely linked to the just transition agenda. Finally, mixed-methods research that combines econometric analysis with case studies from investment promotion agencies would yield deeper insights into the causal mechanisms connecting foreign investment and renewable energy outcomes on the ground.

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