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The Nonlinear Impact of FDI on Economic Growth and Carbon Emissions: Evidence from RCEP Countries

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Abstract

To investigate the decoupling effect of Foreign Direct Investment (FDI) on carbon emissions, this study employs nonlinear panel models and threshold regression models to analyze the impact of FDI on economic growth and carbon emissions in RCEP member countries from 2000 to 2023. First, the Tapio decoupling model reveals that since 2012, the relationship between economic growth and carbon emissions has predominantly exhibited a weak decoupling state. Second, the results from the nonlinear panel models and threshold models indicate that FDI has a significant "U-shaped" nonlinear relationship with both economic growth and carbon emissions. Specifically, in terms of economic effects, FDI may initially suppress economic growth, but ultimately contribute to it. In terms of environmental effects, FDI initially shows emission reduction benefits, but may eventually intensify carbon emissions. The moderating effect model shows that digital infrastructure significantly weakens these "U-shaped" relationships, reducing the steepness of the original curves. Finally, based on this "U-shaped" relationship and the moderating role of digital infrastructure, policy suggestions are put forward to enhance the synergistic benefits of FDI for both economic development and environmental sustainability. The findings of this study shed new light on the classic debate concerning foreign direct investment (FDI), economic development, and environmental sustainability within the RCEP context.

Keywords: FDI, economic growth, carbon emissions, nonlinearity, RCEP.

1 Introduction

Since the Industrial Revolution, the extensive use of fossil fuels and changes in land-use patterns have led to a continuous increase in atmospheric greenhouse gas concentrations [1]. Greenhouse gas emissions from human activities, particularly carbon dioxide (CO_2), are the primary driver of global warming [2]. Climate change not only poses severe risks to Earth's ecosystems but also threatens economic development and social stability.

To address these challenges, the international community has gradually established a multilateral climate governance framework since the 1990s. From the establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988 to the 28th United Nations Climate Change Conference in 2023, global

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awareness of the climate crisis has deepened. As the world's largest free trade agreement, the Regional Comprehensive Economic Partnership (RCEP) has reached key consensus on regional green and low-carbon development: (1) promoting the transition to low-carbon energy among member countries, (2) advancing carbon neutrality goals, and (3) aligning with the United Nations' 2030 Agenda for Sustainable Development.

However, current economic growth remains the primary driver of global carbon emissions. Meanwhile, controlling emissions poses significant constraints on economic expansion [3]. The RCEP region features a coexistence of high-income and middle-to-low-income countries, with significant disparities in the economic development stages among member states. According to World Bank data, Singapore's per capita GDP exceeded US$60,000 in 2024, while countries such as Cambodia and Laos remained below US$3,000. Despite varying levels of economic development, deep reliance on fossil fuels constitutes a common challenge across the region. This trend is particularly evident in ASEAN, which forms the core of RCEP. As reported in the International Energy Agency's Southeast Asia Energy Outlook 2024, the region's energy demand has more than doubled since 2000, with fossil fuels accounting for the majority of this growth. Specifically, the share of coal in the energy mix surged from 14% in 2000 to 28% in 2023. Although some RCEP members have made progress in renewable energy development, the overall energy structure of the region remains dominated by fossil fuels, leading to economic growth in many member countries that comes at the expense of natural resources and ecological sustainability [4].This context makes achieving decoupling between economic growth and carbon emissions - sustaining economic expansion while stabilizing or reducing total emissions - a critical climate challenge.

Against the backdrop of global economic integration, foreign direct investment (FDI), as a key driver of optimizing the allocation of international production factors, has garnered extensive academic attention and empirical support regarding its distinct impacts on host countries' economic growth and carbon emissions through capital flows and technology transfer. However, achieving synergistic progress in both economic growth and carbon reduction has become a major challenge for nations worldwide, urgently calling for a shift in related research from isolated perspectives to systematic integration. In response to this practical need, this paper aims to construct a unified analytical framework to simultaneously examine the dual effects of FDI on economic growth and carbon emissions, with the goal of providing theoretical insights and empirical evidence for identifying sustainable regional development pathways.

This study addresses three critical research questions: (1) Has economic development in RCEP countries decoupled from carbon emissions? (2) Does FDI exert nonlinear effects on economic growth and carbon emissions? (3) If such nonlinear relationships exist, are they moderated by other factors? To answer these questions, we employ nonlinear panel models and threshold regression analysis to examine FDI's dual impact, while constructing moderation effect models to verify the role of digital infrastructure in reshaping these nonlinear relationships.

The remainder of this paper is organized as follows: Section 2 reviews the relevant literature; Section 3 details the methodology and data; Section 4 presents empirical results and discussion; and Section 5 concludes with policy implications.

2 Literature Review

2.1 The Impact of FDI on Economic Growth

As an important form of international capital flows, foreign direct investment (FDI) has exerted a profound influence on economic growth across countries. However, there is a divergence of views among scholars regarding the impact of FDI on economic growth.

Some studies emphasize the positive effects of FDI, such as capital accumulation, technological spillovers, and managerial expertise, arguing that FDI has a significant positive impact on economic growth. According to the neoclassical growth theory, economic growth primarily depends on the inputs of capital and labor. FDI, as an external capital injection, can compensate for domestic savings shortages, increase the capital stock of the host country, and thereby promote economic growth in the host country [5]. The endogenous growth theory posits that technological progress drives economic growth [6]. As a vehicle for technology transfer, FDI helps improve the production efficiency of the host country, thereby stimulating its economic growth [7]. In addition, some empirical evidence has also shown a significant positive relationship between FDI and economic growth [8, 9].

Other studies, however, argue that FDI has negative impacts on economic growth. First, foreign investors may repatriate excess profits to their home countries, which can have a detrimental effect on the economic growth of the host country [10]. Second, multinational corporations may compete with domestic firms for scarce resources, crowding out the development space of local enterprises and leading to a decline in their productivity [11]. Lastly, multinational companies may exploit natural resources, distort the local economy, and damage local culture, thereby harming the economic development of the host country [12].

As research on foreign direct investment (FDI) and economic growth has deepened, scholars have increasingly focused on the nonlinear relationship between FDI and economic growth. Wang et al. [13] employed a threshold regression model to analyze the impact of FDI on economic growth across 114 countries. Their findings revealed a complex nonlinear effect: FDI initially promotes economic growth, then inhibits it, and finally promotes growth again at higher thresholds.

2.2 The Impact of FDI on Carbon Emissions

With the continuous advancement of economic globalization and regional economic integration, FDI has become a focal topic in sustainable development research. However, existing literature presents mixed conclusions regarding the impact of FDI on carbon emissions—including linear, nonlinear, and insignificant effects—depending on different theoretical assumptions and methodological approaches.

In exploring the impact mechanisms of FDI on carbon emissions, the academic community has accumulated a wealth of research findings. Overall, FDI exerts complex influences on carbon emissions through three main channels: scale effect, technique effect, and composition effect. The scale effect refers to the expansion of economic scale brought about by FDI, which leads to an increase in fossil energy consumption in the host country and thereby increases carbon emissions [14]. The technique effect is reflected in the introduction of cleaner and more energy-efficient production technologies through FDI, thereby reducing carbon emissions by increasing the use of clean energy, among other means [15]. The composition effect refers to the influence of FDI on carbon emissions by altering the economic structure of the host country, that is, the shift of economic activities from high-pollution, high-energy-consuming industries (such as traditional manufacturing) to low-carbon, clean energy or service sectors [16].

The current theories regarding the relationship between FDI and carbon emissions mainly include the Pollution Haven Hypothesis and the Pollution Halo Hypothesis. In 1979, Walter et al. [17] first introduced the concept of a "pollution haven" in their work Environmental Policies in Developing Countries. The Pollution Haven Hypothesis, also known as the Pollution Paradise Hypothesis, posits that differences in environmental regulation levels across countries lead multinational corporations to shift pollution-intensive industries to countries with lower environmental standards in order to evade strict environmental oversight and reduce production costs. These countries, in turn, become " pollution paradises"for multinational companies [18]. During the process of globalization, some developing countries, in their quest for rapid economic development, have resorted to lowering environmental standards to attract foreign investment [19, 20]. However, these countries often have weak environmental management systems and outdated production technologies, which further exacerbate pollution problems [21]. Therefore, the strict enforcement of existing environmental policies or the introduction of new policies is crucial for ensuring environmental quality [22].

In contrast to the Pollution Haven Hypothesis, the Pollution Halo Hypothesis argues that FDI can help improve the environmental quality of the host country [23]. This is because multinational corporations often possess cleaner production technologies [24] and more advanced environmental management practices [25]. When these corporations invest directly in the host country, they can reduce carbon emissions and enhance environmental quality through technological spillover effects [26] and industrial upgrading effects [27].

Many scholars support the Pollution Haven Hypothesis, arguing that FDI not only increases carbon emissions through the scale effect [28–30], but also that the mechanism by which it reduces carbon emissions through the technique effect does not hold [31]. Meanwhile, some scholars have proposed that the impact of FDI on carbon emissions exhibits sectoral and country-specific heterogeneity. Doytch et al. [32] argue that the Pollution Haven Hypothesis typically applies to polluting sectors such as agriculture, mining, and industry, while the Pollution Halo Hypothesis applies to the service sector. Shahbaz et al. [33] found that the Pollution Haven Hypothesis holds for low-income and middle-income countries, whereas the Pollution Halo Hypothesis is applicable to high-income countries. Adeel-Farooq et al. [34] used a fixed-effects model to estimate the impact of FDI on the overall environmental quality of 76 countries and found that FDI from developed countries improves the overall environmental performance of the host countries, while FDI from developing countries degrades the environmental performance of low-income, lower-middle-income, and upper-middle-income host countries.

In addition, some scholars have explored the nonlinear relationship between FDI and carbon emissions, arguing that there is an inverse "U-shaped" nonlinear relationship between the two, meaning that FDI initially exacerbates pollution but later promotes emission reductions [35–37] found that with the increase in the level of industrialization, FDI and carbon emissions exhibit an inverse "N-shaped" nonlinear relationship. This suggests that only when industrialization reaches a certain level does energy consumption gradually decrease, leading to a reduction in carbon emissions.

In addition to the aforementioned clear relationships, a significant number of studies have failed to find a significant impact of FDI on carbon emissions [38].

2.3 The Moderating Effect of Digital Infrastructure

As the cornerstone of digital economic development, the conceptual scope of digital infrastructure continues to expand and deepen with technological iterations. According to the definition provided at the 2022 "Digital Infrastructure: Interconnectivity and Innovative Development" forum, it constitutes an infrastructure system driven by data innovation, grounded in communication networks, and centered on data computing facilities. It encompasses a range of new-generation information and communication technologies—such as 5G, data centers, cloud computing, artificial intelligence, the Internet of Things, and blockchain—along with various digital platforms derived from them. In terms of measurement, academia often employs comprehensive indicator systems for evaluation, examples include the European Union's Digital Economy and Society Index (DESI), the World Economic Forum's Network Readiness Index (NRI), and the International Telecommunication Union's ICT Development Index (IDI).

The mechanism through which digital infrastructure exerts its moderating effect on FDI can be elucidated across three levels:

At the macro level, digital infrastructure provides governments with technological support for constructing precise energy and environmental governance systems [39]. Through accurate carbon quota allocation and energy market regulation, it can steer the technological spillovers of FDI more towards green directions, thereby mitigating its potential "pollution haven" effect.

At the meso level, digital infrastructure drives industrial digitalization and the optimized reorganization of production factors [40]. This not only helps amplify the technological spillover effects of FDI on economic growth but also facilitates the embedding of FDI into more efficient and cleaner regional industrial chains.

At the micro level, well-developed digital infrastructure enables enterprises to utilize precise management tools such as carbon accounting and intelligent energy scheduling [41]. This directly enhances their environmental governance capabilities and energy efficiency. For host-country enterprises introducing FDI, robust digital capabilities allow them to more effectively imitate, learn from, and assimilate the green technologies associated with FDI.

2.4 Summary of Literature Review

This paper reviews the existing literature to analyze the viewpoints and research findings of different scholars, and explores the relationships between FDI and economic growth, as well as FDI and carbon emissions.

Existing literature has laid a solid foundation for understanding the economic and environmental effects of FDI; however, three main shortcomings remain, providing the entry point for this study. First, while the relationships between FDI and economic growth, and between FDI and carbon emissions, have been sufficiently explored separately in academia, most studies analyze these two effects in isolation, lacking a systematic examination of their synergistic impacts and inherent trade-offs within a unified framework. Second, methodologically, existing research predominantly relies on linear analysis paradigms, making it difficult to capture the potential nonlinear driving mechanisms or threshold effects of

FDI at different developmental stages. Finally, in terms of the research object, studies have largely focused on country-specific cases, with a significant lack of targeted research on RCEP as an emerging and crucial regional economic integration organization.

Compared with previous studies, this paper aims to make the following marginal contributions to enrich research in this field:

In response to the common shortcoming of isolated examination of the two effects of FDI in existing literature, this paper constructs a unified analytical framework to simultaneously investigate the impact of FDI on economic growth and carbon emissions, with the goal of exploring pathways to achieve carbon neutrality while maintaining economic growth.

Moving beyond simple linear assumptions, this paper employs nonlinear panel models and threshold regression models to reveal the complex mechanisms underlying the dual effects of FDI. Furthermore, it introduces a moderating effects model to empirically test how digital infrastructure shapes this nonlinear relationship, thereby deepening the understanding of the boundary conditions of FDI's impact.

By focusing specifically on the RCEP region, the conclusions can provide more targeted insights for sustainable development within the context of regional economic integration.

3 Econometric methodology and data collection

3.1 Tapio Decoupling Model

This study employs the Tapio decoupling model to calculate the decoupling elasticity coefficient, thereby analyzing the decoupling status of RCEP member countries. According to Tapio [42], the decoupling elasticity coefficient is defined as the ratio of the rate of change in carbon emissions to the rate of change in economic growth. The formula is as follows:

$$t_{C,E} = \frac{\Delta C/C_0}{\Delta E/E_0} = \frac{t_C}{t_E} \tag{1}$$

where $t_{C,E}$ represents the elasticity coefficient of decoupling between economic growth and carbon emissions, C_0 represents the base period carbon emissions, E_0 represents the base period GDP, ΔC represents the total change in carbon emissions from the base period to the end period, and ΔE represents the total change in GDP associated with carbon emissions from the base period to the end period.

As shown in Figure 1, the Tapio decoupling model categorizes decoupling states into eight distinct types based on the decoupling elasticity values. Among these, strong decoupling represents the most desirable state, characterized by absolute decline in total carbon emissions alongside sustained economic growth. In contrast, weak decoupling indicates a relative improvement, where both the economy and carbon emissions grow, but the increase in emissions occurs at a slower rate than economic growth. However, expansive negative decoupling signifies that economic expansion is accompanied by an even faster rise in carbon emissions, reflecting a deterioration in energy efficiency. Additionally, there is recessive decoupling, where an economic recession leads to a more pronounced decline in carbon emissions—an environmental improvement achieved at the expense of economic performance, which is unsustainable. Among the undesirable states, strong negative decoupling is the most severe, marked by an increase in carbon emissions during an economic recession. Weak negative decoupling refers to a decline in both the economy and carbon emissions, but with emissions decreasing at a slower rate than the economic contraction, indicating persistently low efficiency. Finally, there are two coupling states: expansive coupling describes synchronous growth of the economy and carbon emissions at comparable rates, while recessive coupling describes a synchronous decline of both at similar magnitudes.

3.2 Nonlinear Panel Model

This study investigates the nonlinear effects of FDI on economic growth and carbon emissions by incorporating an FDI quadratic term into nonlinear panel regression models (2) and (3), respectively.

$$\begin{aligned} \ln E_{it} &= \alpha_0 + \alpha_1 \ln FDI_{it} + \alpha_2 (\ln FDI_{it})^2 \\ &\quad + \sum_{k=3}^{6} \alpha_k \ln X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \end{aligned} \tag{2}$$

$$\begin{aligned} \ln C_{it} &= \alpha_0 + \alpha_1 \ln FDI_{it} + \alpha_2 (\ln FDI_{it})^2 \\ &\quad + \sum_{k=3}^{6} \alpha_k \ln X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \end{aligned} \tag{3}$$

where i and t represent the country and year, respectively. E denotes economic growth, C represents carbon emissions, FDI stands for foreign direct investment, and $(\ln FDI)^2$ is its squared term. X represents a set of control variables that have a significant impact on economic growth and

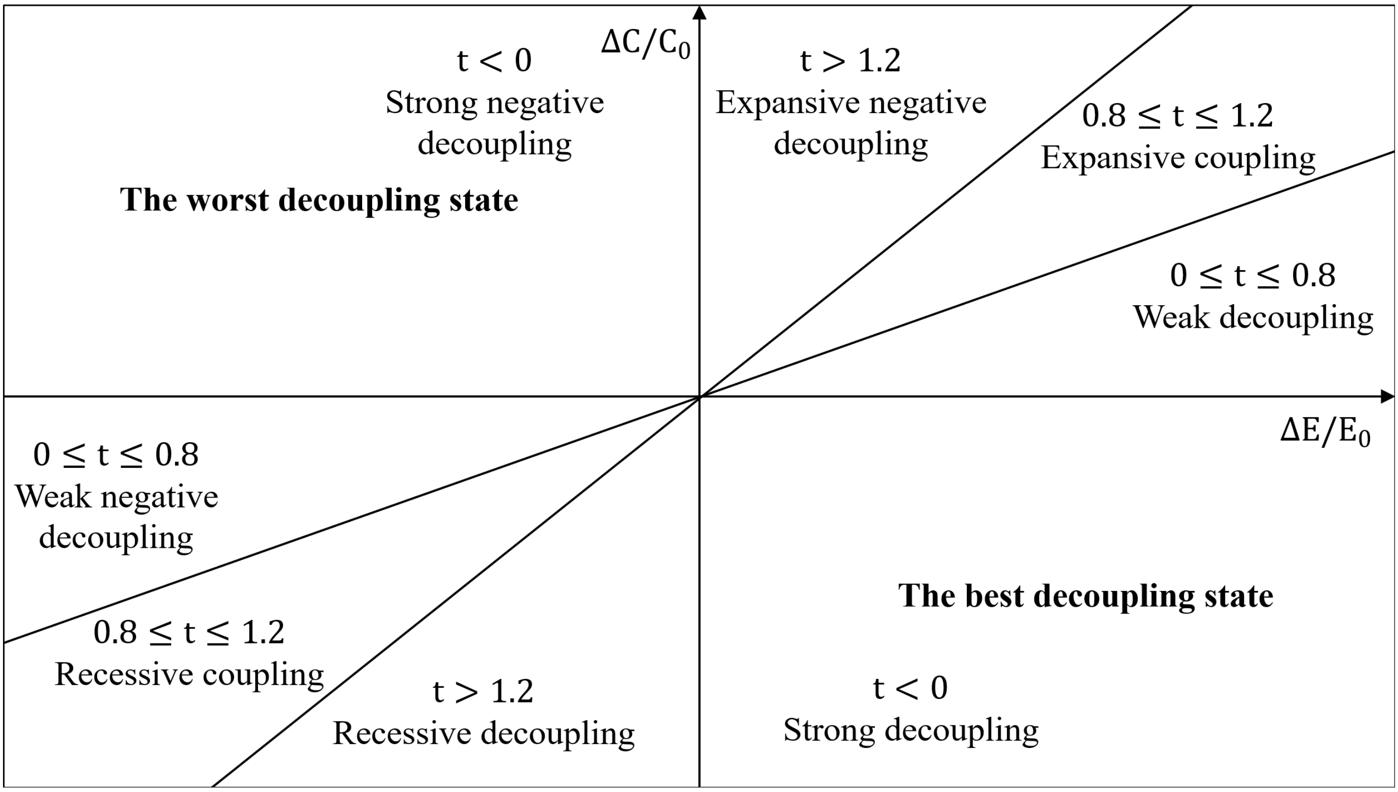

Figure 1. Eight decoupling states of carbon emissions in the tapio model.

carbon emissions, including the level of urbanization, industrial structure, trade openness, and energy intensity. μ_i denotes the individual fixed effects, λ_t represents the time fixed effects, and ε_{it} is the random disturbance term.

3.3 Threshold Model

The threshold regression model can divide the sample into different intervals based on a critical value (threshold parameter) of the threshold variable and establish different regression models within each interval to capture the nonlinear relationships between variables [43]. This paper constructs Equations (4) and (5), which are single-threshold regression models, to explore the potential nonlinear impacts of FDI on economic growth and carbon emissions.

$$\ln E_{it} = \beta_0 + \beta_1 \ln FDI_{it} \cdot \mathbb{I}(q_t \leq \lambda) + \beta_2 \ln FDI_{it} \cdot \mathbb{I}(q_t \geq \lambda) + \sum_{k=3}^{6} \beta_k \ln X_{it} + \varepsilon_{it} \quad (4)$$

$$\ln C_{it} = \beta_0 + \beta_1 \ln FDI_{it} \cdot \mathbb{I}(q_t \leq \tau) + \beta_2 \ln FDI_{it} \cdot \mathbb{I}(q_t \geq \tau) + \sum_{k=3}^{6} \beta_k \ln X_{it} + \varepsilon_{it} \quad (5)$$

where λ and τ are the threshold parameters, and ε_{it} is the random disturbance term. When $q_t \leq \lambda$, the impact coefficient of FDI on E is β_1; when $q_t \geq \lambda$, the impact coefficient of FDI on E is β_2. Similarly, when $q_t \leq \tau$, the impact coefficient of FDI on C is β_1; when $q_t \geq \tau$, the impact coefficient of FDI on C is β_2.

3.4 The Moderating Effect Model

This paper constructs Equations (6) and (7) to examine the moderating role of digital infrastructure, which are formulated as follows:

$$\ln E_{it} = \omega_0 + \omega_1 \ln \mathrm{FDI}_{it} + \omega_2 (\ln \mathrm{FDI}_{it})^2 + \omega_3 \mathrm{Dig}_{it} \times \ln \mathrm{FDI}_{it} + \omega_4 \mathrm{Dig}_{it} \times (\ln \mathrm{FDI}_{it})^2 + \omega_5 \mathrm{Dig}_{it} + \sum_{k=6}^{9} \omega_k \ln X_{it} + \mu_i + \lambda_t + \epsilon_{it} \quad (6)$$

$$\ln C_{it} = \omega_0 + \omega_1 \ln \mathrm{FDI}_{it} + \omega_2 (\ln \mathrm{FDI}_{it})^2 + \omega_3 \mathrm{Dig}_{it} \times \ln \mathrm{FDI}_{it} + \omega_4 \mathrm{Dig}_{it} \times (\ln \mathrm{FDI}_{it})^2 + \omega_5 \mathrm{Dig}_{it} + \sum_{k=6}^{9} \omega_k \ln X_{it} + \mu_i + \lambda_t + \epsilon_{it} \quad (7)$$

Dig represents the moderating variable of digital infrastructure, and $\text{Dig} \times \text{FDI}_i$, $\text{Dig} \times \text{FDI}_i^2$ represent the interaction terms between digital infrastructure and the linear and quadratic terms of FDI, respectively.

3.5 Variables and Data

This paper aims to investigate the impact of FDI on economic growth and carbon emissions in RCEP member countries. Considering the availability of data, this study excludes countries with severe data deficiencies and extracts panel data for 12 RCEP member countries, excluding Brunei, Myanmar, and Laos, from the World Bank database. This paper selects economic growth (E) and carbon emissions (C) as the dependent variables, foreign direct investment (FDI) as the core explanatory variable, urbanization (UR), industrial structure (IDS), trade openness (TRA), and energy intensity (ET) as control variables, and digital infrastructure (Dig) as the moderating variable. The time span of the panel data is mainly from 2000 to 2023. However, it should be specifically noted that due to severe data deficiencies in statistics, the time range for digital infrastructure data is only from 2005 to 2021. Table 1 presents the descriptive statistics of the variables.

(1) Economic Growth (E). Gross Domestic Product (GDP) is a core indicator for measuring the economic scale and growth of a country. This study uses the GDP of each country (in constant 2015 US dollars) to represent economic growth, in order to eliminate the impact of factors such as inflation and more accurately reflect the actual trend of economic growth.

(2) Carbon Emissions (C). Carbon dioxide (CO_2), as the most significant greenhouse gas, contributes to global warming by enhancing the Earth's greenhouse effect. This study selects the total amount of CO_2 emissions (kt) to represent carbon emissions.

(3) Foreign Direct Investment (FDI). Net inflows of foreign direct investment reflect a country's ability to attract international capital. This study uses the percentage of FDI net inflows to GDP (%) as the measurement indicator.

(4) Urbanization (UR). Urbanization is an inevitable trend in socio-economic development, characterized by the concentration of population from rural to urban areas. This study measures the degree of urbanization by the proportion of urban population to the total population.

(5) Industrial Structure (IDS). Industrial structure reflects the status and development trend of different industries in the economy. This study represents industrial structure with the percentage of industrial value added to GDP (%).

(6) Trade Openness (TRA). Trade openness is an important indicator for measuring the level of foreign trade activity of a country or region. This study uses the volume of trade per unit of GDP to measure trade openness.

(7) Energy Intensity (ET). Energy intensity is an important indicator for measuring energy use efficiency. This study uses the amount of primary energy consumption per unit of GDP as the measurement indicator.

(8) Digital Infrastructure (Dig). Digital infrastructure is the solid foundation supporting the development of the digital economy in various regions. Referring to the study by Nduibusi et al. [44], this paper constructs an evaluation system with five dimensions: fixed telephone subscriptions (per 100 people), mobile cellular subscriptions (per 100 people), fixed broadband subscriptions (per 100 people), the percentage of the population using the Internet, and the proportion of ICT product exports. The entropy method is used for comprehensive weighting and evaluation.

4 Results and Discussion

4.1 Decoupling Analysis of Carbon Emissions and Economic Growth

The decoupling trend of economic growth and carbon emissions for the 12 countries in the RCEP region is shown in Figure 2. From 2000 to 2023, five types of decoupling states existed in the RCEP region, namely Expansion Coupling (25%), Expansion Negative Decoupling (25%), Weak Decoupling (33.33%), Strong Decoupling (4.17%), and Strong Negative Decoupling (12.5%). Overall, during the period from 2000 to 2005, as the economy grew rapidly and environmental pressures increased, the decoupling state shifted from Expansion Coupling to Expansion Negative Decoupling. From 2006 to 2007, the growth rate of environmental pressures slowed down, and in 2008, the decoupling state even exhibited Strong Decoupling, which may have been due to the brief economic downturn caused by the global financial crisis. From 2009 to 2011, the economy recovered and environmental pressures rebounded. In 2011, the strong earthquake in Japan triggered a tsunami and nuclear leakage, prompting a global re-examination

Table 1. Descriptive statistics of variables.

Variable	Obs	Mean	Std. Dev.	Max	Min
LNE	288.000	26.873	1.584	30.475	22.733
LNC	288.000	5.362	1.798	9.492	0.694
LNFDI	288.000	0.804	1.233	3.554	-4.742
$LNFDI^2$	288.000	2.162	2.902	22.488	0.000
LNUR	288.000	4.049	0.468	4.605	2.922
LNIDS	288.000	3.478	0.233	3.882	2.853
LNTRA	288.000	4.419	0.693	6.081	2.973
LNET	288.000	1.516	0.308	2.390	0.747
DIG	204.000	0.399	0.201	0.803	0.000

Table 2. Regression results of the nonlinear panel model.

Model	Variable	(a)	(b)	(c)	(d)	(e)
Model (2)	LNFDI	0.178***	0.027**	0.121**	0.010	0.010
		(3.500)	(2.320)	(2.370)	(0.930)	(0.880)
	$LNFDI^2$	0.079***	0.020***	0.097***	0.017***	0.017*
		4.010	4.440	4.950	4.360	1.740
	LNUR	2.178***	1.940***	2.104***	1.225***	1.225***
		19.500	19.430	19.290	11.980	25.960
	LNIDS	3.472***	0.251**	3.378***	0.469***	0.469***
		14.770	2.410	14.730	5.280	11.210
	LNTRA	-1.561***	-0.147***	-1.473***	-0.291***	-0.291***
		-15.860	-2.700	-15.150	-5.810	-5.250
	LNET	0.239	-1.152***	0.739***	-0.449***	-0.449***
		1.380	-16.170	4.000	-5.290	-3.420
	Year FE	No	No	Yes	Yes	Yes
	Country FE	No	Yes	No	Yes	Yes
	N	288	288	288	288	288
	R^2	0.761	0.867	0.794	0.996	0.917
Model (3)	LNFDI	0.196***	0.067***	0.140**	0.065***	0.065***
		3.500	4.450	2.470	4.250	5.200
	$LNFDI^2$	0.057***	0.037***	0.074***	0.038***	0.038***
		2.590	6.420	3.430	6.490	2.840
	LNUR	2.120***	2.483***	2.046***	1.997***	1.997***
		17.150	19.560	16.940	13.230	18.480
	LNIDS	5.368***	1.186***	5.280***	1.362***	1.362***
		20.630	8.980	20.800	10.400	17.150
	LNTRA	-1.554***	-0.183***	-1.456***	-0.219***	-0.219***
		-14.260	-2.640	-13.530	-2.970	-3.280
	LNET	0.615***	-0.450***	1.159***	0.015	0.015
		3.220	-4.970	5.660	0.120	0.090
	Year FE	No	No	Yes	Yes	Yes
	Country FE	No	Yes	No	Yes	Yes
	N	288	288	288	288	288
	R^2	0.773	0.765	0.804	0.994	0.803

Notes: The values in parentheses are t statistics. ***, **, and * indicate significance at the confidence levels of <0.01, <0.05, and <0.1 .

of environmental issues. In November of the same year, the 17th Conference of the Parties to the United Nations Framework Convention on Climate Change was held in Durban, South Africa, and many countries

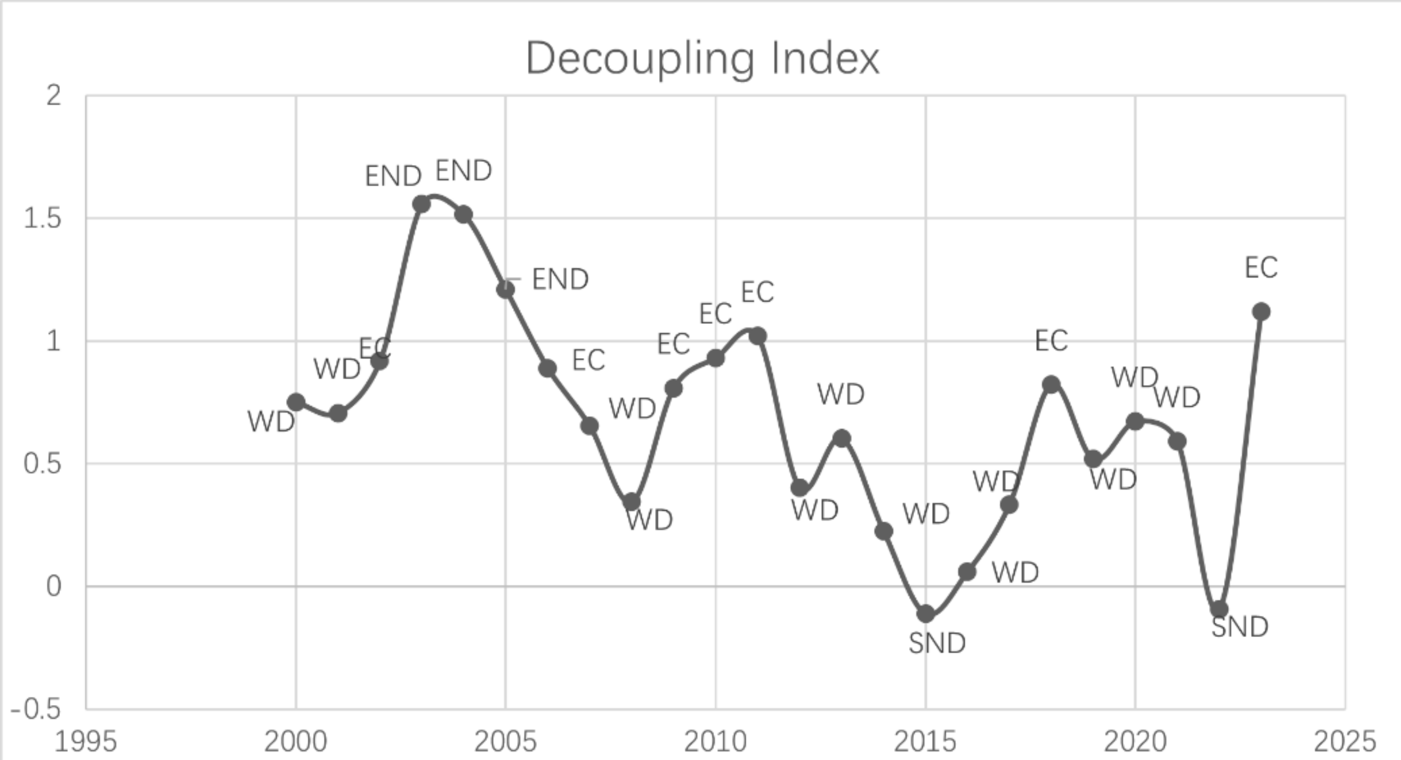

Figure 2. Overall decoupling trend of economic growth and carbon emissions.

began to take practical actions to control carbon emissions. Due to stricter environmental policies, from 2012 to 2023, the decoupling state in the RCEP region was mainly maintained as Weak Decoupling and Expansion Coupling. It is worth noting that during this period, there were several extreme cases where the decoupling state exhibited Strong Negative Decoupling. The "double deterioration" of economic growth and environmental quality in 2020 may have been due to the economic recession caused by the pandemic, while carbon emissions increased due to industrial inertia or emergency production (such as medical supplies).

4.2 Nonlinear Panel Model Regression Analysis

First, a pooled ordinary least squares (POLS) estimation was conducted on the panel data, as shown in column (a) of Table 2. Subsequently, a Hausman test was performed to determine the use of a fixed-effects model for regression analysis. To control for individual heterogeneity that does not vary over time, individual fixed effects were included, with results presented in column (b) of Table 2. To account for time trends and common shocks, time fixed effects were added, and the results are shown in column (c) of Table 2. A two-way fixed-effects model, which controls for both individual and time dimensions, was employed for estimation, with results displayed in column (d) of Table 2. Finally, to address the issues of heteroscedasticity and autocorrelation in panel data, Driscoll-Kraay standard errors were used for adjustment, and the results are presented in column (e) of Table 2. The signs and significance levels of the coefficients for each variable remained largely unchanged, indicating that the estimation results from the two-way fixed-effects model are robust.

In model (2), the coefficient of the quadratic term of FDI is significantly positive at the 1% level in the two-way fixed effects model (column d). Even after addressing potential heteroscedasticity and autocorrelation using Driscoll-Kraay standard errors (column e), the coefficient remains positive and marginally significant at the 10% level. This overall pattern suggests a "U-shaped" relationship between FDI and economic growth. This suggests that in the initial stage of FDI inflows, due to the host country's relative backwardness in infrastructure and technology, foreign enterprises, with their significant technological advantages and mature business models, quickly capture market share from local firms, exerting a negative impact on the economy [45]. As FDI continues to flow in, the advanced technology and management experience brought by foreign enterprises gradually diffuse, improving the technological level and production efficiency of local firms, thereby driving rapid economic growth.

In model (3), the coefficient of the quadratic term of FDI is also significantly positive, indicating a "U-shaped" relationship between FDI and carbon emissions. The possible reason is that when the inflow of FDI is low, it brings advanced and clean production technologies, which improve overall energy efficiency and help reduce carbon emissions [46]. However, once the inflow of FDI reaches a certain threshold, the marginal contribution of FDI to carbon reduction gradually weakens, and with the influence of the scale effect, carbon emissions increase.

To further confirm this relationship, this study conducted a "U-shaped" test. According to the test results, the lower-bound slopes of models (2) and (3) are significantly negative, while the upper-bound slopes are significantly positive, passing the "U-shaped" test at the 1% significance level. In addition, the inflection point of model (2) is -0.278, and that of model (3) is -0.938, both of which fall within the range of FDI values, thus allowing the complete "U-shaped" curve to be observed.

4.3 Robustness Analysis

4.3.1 Lagging the Core Explanatory Variable

Considering that the impact of FDI on economic growth and carbon emissions may be subject to time lags, this paper conducts regressions after lagging the linear and quadratic terms of the core explanatory variable FDI. Columns (a) and (b) in Table 3 report the regression results after lagging by one period and two periods, respectively. The regression results show that the coefficients of the lagged quadratic terms of FDI in models (2) and (3) are significantly positive at the 1% level, thus confirming the robustness of the conclusions.

4.3.2 Replacing the Dependent Variables

To avoid biases caused by inappropriate selection of dependent variables, this paper conducts robustness tests by replacing the dependent variables. The dependent variable in model (2) is replaced with per capita GDP (in constant 2015 US dollars), while the dependent variable in model (3) is replaced with per capita CO_2 emissions. The regression results are shown in column (c) of Table 3. After replacing the dependent variables, the coefficients of the quadratic terms of FDI in models (2) and (3) remain significantly positive at the 1% level, further confirming the robustness of the conclusions.

4.3.3 Adjusting the Time Window

To more accurately reflect long-term trends and exclude the interference of the COVID-19 pandemic on economic and environmental indicators, this paper changes the sample period to 2000–2019. The adjusted regression results are shown in column (d) of Table 3. The significance and signs of the coefficients of the quadratic terms of FDI in models (2) and (3) remain unchanged, demonstrating that the regression results are robust.

4.4 Threshold Model Regression Analysis

To further explore the nonlinear impact of FDI on economic growth and carbon emissions, this study employs the panel threshold model constructed earlier and follows the approach of Hansen et al. [47], using the Bootstrap resampling method with 300 replications to test the existence and number of panel thresholds. According to the results, in models (2) and (3), FDI itself, as a threshold variable, passes the significance test for a single threshold but fails the significance test for a double threshold. The regression results for the single-threshold effect of FDI on economic growth and carbon emissions are presented in Table 4.

According to the regression results in Table 4, in model (4), when the level of FDI is below the threshold value, the impact coefficient of FDI on economic growth is significantly negative, indicating that FDI has a significant inhibitory effect on economic growth. Conversely, when the level of FDI is above the threshold value, the impact coefficient of FDI on economic growth is significantly positive, indicating that FDI has a significant promoting effect on economic growth. Similarly, in model (5), FDI first inhibits and then promotes carbon emissions, which is consistent with the previous conclusion that there is a "U-shaped" relationship between FDI and economic growth, as well as between FDI and carbon emissions.

4.5 Moderating Effect Analysis of the “U-shaped” Relationship

This study employs a moderating effect model, namely models (6) and (7), to investigate the moderating effect of digital infrastructure on the "U-shaped" relationship between FDI and economic growth, as well as between FDI and carbon emissions. Due to the severe data deficiency in digital infrastructure, the sample period is limited to 2005–2021. To reduce multicollinearity, this paper conducts de-meaning (centering) processing. The regression results of the

Table 3. Robustness tests.

Model	Variable	(a)	(b)	(c)	(d)
Model(2)	LNFDI	0.011	0.014	0.001	0.011
		(0.276)	(0.147)	(0.872)	(1.090)
	$LNFDI^2$	0.015***	0.014***	0.013***	0.013***
		4.010	3.910	3.670	3.270
	Control	Yes	Yes	Yes	Yes
	Year FE	Yes	Yes	Yes	Yes
	Country FE	Yes	Yes	Yes	Yes
	N	276	264	288	240
	R^2	0.997	0.997	0.996	0.997
Model(3)	LNFDI	0.066***	0.066***	0.057**	0.056***
		4.400	4.510	4.160	3.730
	$LNFDI^2$	0.039***	0.036***	0.033***	0.030***
		6.860	6.470	6.390	5.450
	Control	Yes	Yes	Yes	Yes
	Year FE	Yes	Yes	Yes	Yes
	Country FE	Yes	Yes	Yes	Yes
	N	276	264	288	240
	R^2	0.994	0.994	0.987	0.995

Notes: The values in parentheses are t statistics. ***, **, and indicate significance at the confidence levels of <0.01, <0.05, and < 0.1.

Table 4. Regression results of single-threshold effects.

Model	Variable	Coefficient
Model(4)	LNFDI≤0.5936	-0.046***
		-3.03
	LNFDI>0.5936	0.091***
		4.98
Model(5)	LNFDI≤0.8224	-0.048***
		(-2.77)
	LNFDI>0.8224	0.169
		(7.91)

Notes: The values in parentheses are t statistics. ***, **, and * indicate significance at theconfidence levels of <0.01, <0.05, and < 0.1.

Table 5. Regression results of moderating effect.

	Model(6)	Model(7)
LNFDI	0.110***	0.046***
	(5.84)	(3.92)
$LNFDI^2$	0.023***	0.008***
	(5.00)	(2.75)
DIG*LNFDI	0.882***	0.604***
	(6.83)	(7.60)
DIG*$LNFDI^2$	-0.151*	-0.116**
	-1.92	-2.40
Dig	0.928***	0.634***
	(3.69)	4.10
Control	Yes	Yes
Year FE	Yes	Yes
Country FE	Yes	Yes
N	204	204
R^2	0.9973	0.9986

Notes: The values in parentheses are t statistics. ***, **, and * indicate significance at the confidence levels of <0.01, <0.05, and < 0.1.

moderating effect are shown in Table 5.

According to the study by Haans et al. [48], the coefficient of the interaction term between digital infrastructure and the quadratic term of FDI, w4, will alter the shape of the nonlinear relationship. Specifically, if this coefficient is significantly positive, it will enhance the U-shaped effect, increasing the steepness of the curve. Conversely, if the coefficient is significantly negative, it will weaken the U-shaped effect, making the curve flatter. Based on the regression results in Table 5, the coefficient w4 is negative at the 10% significance level in both sets of models. This indicates that digital infrastructure mitigates the U-shaped relationship between FDI and economic growth, as well as between FDI and carbon emissions.

5 Conclusions and Policy Implications

This paper employs panel data from 12 RCEP member countries over the period of 2000–2023 to construct nonlinear panel models and threshold models to explore the nonlinear impact of FDI on economic growth and carbon emissions, and to analyze the moderating role of digital infrastructure using a moderating effect model. The main findings are as follows.

First, there is a "U-shaped" relationship between FDI and economic growth. In the initial stage of foreign capital inflows, the negative impact of FDI outweighs its positive impact, exerting an adverse effect on economic growth. As FDI continues to flow in, the positive impact of FDI will gradually surpass its negative impact, driving rapid economic growth.

Second, there is also a "U-shaped" relationship between FDI and carbon emissions. When the inflow of FDI is low, the effect of technological spillover plays a role in suppressing carbon emissions. Once the inflow of FDI reaches a certain threshold, the promoting effect of FDI on carbon emissions will gradually exceed its suppressing effect, leading to an increase in carbon emissions. Finally, digital infrastructure has a moderating effect on the "U-shaped" relationship between FDI and economic growth, as well as between FDI and carbon emissions. Digital infrastructure makes the original “U-shaped” relationship flatter.

Based on the above conclusions, this paper proposes the following policy recommendations to fully leverage the positive impact of FDI on economic growth while mitigating its negative effects on carbon emissions. First, in the left side of the "U-shaped" relationship between FDI and economic growth, where FDI inhibits economic growth, the host country should strengthen infrastructure construction to reduce the logistics and energy costs of foreign-funded enterprises, thereby creating favorable conditions for the inflow of FDI. Additionally, the host country should promote cooperation between higher education institutions and foreign-funded enterprises in industry-academia-research collaboration, and establish talent introduction and incentive mechanisms to enhance technical training and education. This will enable the full utilization of the technological spillover and capital accumulation effects brought by FDI.

Second, in the right side of the "U-shaped" relationship between FDI and carbon emissions, where FDI promotes carbon emissions, the host country should formulate and implement phased and differentiated environmental regulation policies. It should clarify the pollution emission control indicators and treatment measures for foreign-funded enterprises. For enterprises that exceed emission standards, the host country should increase penalties and raise the costs of environmental violations. The host country should also focus on optimizing and upgrading industrial structures and promoting green transformation. It should provide policy incentives for enterprises that meet environmental protection standards and guide FDI to flow into low-carbon and high value-added industries.

Third, the host country should accelerate the layout of digital infrastructure to empower the green transformation of FDI. The application of digital technology can help foreign-funded enterprises achieve greener and lower-carbon development in their investment and operations. Digital infrastructure is the cornerstone of the digital economy. Strengthening the construction of digital infrastructure and promoting the deep integration of digital and green development can help the host country achieve a virtuous interaction between economic development and environmental protection.

6 Research Limitations and Future Directions

Although this study has revealed the nonlinear impact of FDI on economic growth and carbon emissions, it also has certain limitations. This study focuses on the empirical analysis of the RCEP region, and future research can conduct comparative studies targeting different regional economic integration organizations (such as CPTPP, EU, USMCA, etc.). In addition, while this study mainly focuses on carbon emissions as a key environmental indicator, it should be noted that the environmental system is a complex, multidimensional whole. Future research can further expand to other important environmental variables.

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Data will be made available on request.

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The author declares no conflicts of interest.

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References

[1] Li, L., Awada, T., Zhang, Y., & Paustian, K. (2024). Global land use change and its impact on greenhouse gas emissions. *Global Change Biology, 30*(12), e17604. [CrossRef]

[2] Cook, J., Oreskes, N., Doran, P. T., Anderegg, W. R., Verheggen, B., Maibach, E. W., ... & Rice, K. (2016). Consensus on consensus: a synthesis of consensus estimates on human-caused global warming. *Environmental research letters, 11*(4), 048002. [CrossRef]

[3] Feng, W., Min, W., & Wen, Z. (2023). What are the impacts of the carbon peaking and carbon neutrality target constraints on China's economy? *Environmental Impact Assessment Review, 101*, 107107. [CrossRef]

[4] Zhou, S., & Xu, Z. (2022). Energy efficiency assessment of RCEP member states: A three-stage slack based measurement DEA with undesirable outputs. *Energy, 253*, 124170. [CrossRef]

[5] Solow, R. M. (1956). A contribution to the theory of economic growth. *The quarterly journal of economics, 70*(1), 65-94. [CrossRef]

[6] Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of political economy, 94*(5), 1002-1037. [CrossRef]

[7] Borensztein, E., De Gregorio, J., & Lee, J. W. (1998). How does foreign direct investment affect economic growth?. *Journal of international Economics, 45*(1), 115-135. [CrossRef]

[8] Latif, Z., Latif, S., Ximei, L., Pathan, Z. H., Salam, S., & Jianqiu, Z. (2018). The dynamics of ICT, foreign direct investment, globalization and economic growth: Panel estimation robust to heterogeneity and cross-sectional dependence. *Telematics and informatics, 35*(2), 318-328. [CrossRef]

[9] Qamri, G. M., Sheng, B., Adeel-Farooq, R. M., & Alam, G. M. (2022). The criticality of FDI in Environmental Degradation through financial development and economic growth: Implications for promoting the green sector. *Resources Policy, 78*, 102765. [CrossRef]

[10] Brecher, R. A., & Alejandro, C. F. D. (1977). Tariffs, foreign capital and immiserizing growth. *Journal of International Economics, 7*(4), 317–322. [CrossRef]

[11] Doytch, N., & Uctum, M. (2011). Does the worldwide shift of FDI from manufacturing to services accelerate economic growth? A GMM estimation study. *Journal of International Money and Finance, 30*(3), 410–427. [CrossRef]

[12] Seyoum, M., Wu, R., & Lin, J. (2015). Foreign direct investment and economic growth: The case of developing African economies. *Social Indicators Research, 122*(1), 45–64. [CrossRef]

[13] Wang, Q., Wang, L., & Li, R. (2024). Trade openness helps move towards carbon neutrality—Insight from 114 countries. *Sustainable Development, 32*(1), 1081–1095. [CrossRef]

[14] Behera, S. R., & Dash, D. P. (2017). The effect of urbanization, energy consumption, and foreign direct investment on the carbon dioxide emission in the SSEA (South and Southeast Asian) region. *Renewable and Sustainable Energy Reviews, 70*, 96–106. [CrossRef]

[15] Khan, M. T. I., Yaseen, M. R., & Ali, Q. (2017). Dynamic relationship between financial development, energy consumption, trade and greenhouse gas: Comparison of upper middle income countries from Asia, Europe, Africa and America. *Journal of Cleaner Production, 161*, 567–580. [CrossRef]

[16] Bakhsh, K., Rose, S., Ali, M. F., Ahmad, N., & Shahbaz, M. (2017). Economic growth, CO2 emissions, renewable waste and FDI relation in Pakistan: New evidences from 3SLS. *Journal of Environmental Management, 196*, 627–632. [CrossRef]

[17] Walter, I., & Ugelow, J. L. (1979). Environmental policies in developing countries. *Ambio, 8*(2/3), 102–109.

[18] Copeland, B. R., & Taylor, M. S. (2017). North-South trade and the environment. In *International trade and the environment* (pp. 205–238). Routledge.

[19] Sapkota, P., & Bastola, U. (2017). Foreign direct investment, income, and environmental pollution in developing countries: Panel data analysis of Latin America. *Energy Economics, 64*, 206–212. [CrossRef]

[20] Wu, H., Hao, Y., & Weng, J. H. (2019). How does energy consumption affect China's urbanization? New evidence from dynamic threshold panel models. *Energy policy, 127*, 24-38. [CrossRef]

[21] Sarkodie, S. A., & Strezov, V. (2019). Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. *Science of the Total Environment, 646*, 862–871. [CrossRef]

[22] Opoku, E. E. O., & Boachie, M. K. (2020). The environmental impact of industrialization and foreign direct investment. *Energy Policy, 137*, 111178. [CrossRef]

[23] Zarsky, L. (1999). Havens, halos and spaghetti: Untangling the evidence about foreign direct investment and the environment. *Foreign Direct Investment and the Environment, 13*(8), 47–74.

[24] Zugravu-Soilita, N. (2017). How does foreign direct investment affect pollution? Toward a better understanding of the direct and conditional effects. *Environmental and Resource Economics, 66*(2), 293–338. [CrossRef]

[25] Demena, B. A., & Afesorgbor, S. K. (2020). The effect of FDI on environmental emissions: Evidence from a meta-analysis. *Energy Policy, 138*, 111192. [CrossRef]

[26] Opoku, E. E. O., Adams, S., & Aluko, O. A. (2021). The foreign direct investment-environment nexus: Does emission disaggregation matter? *Energy Reports, 7*, 778–787. [CrossRef]

[27] Stavropoulos, S., Wall, R., & Xu, Y. (2018). Environmental regulations and industrial competitiveness: Evidence from China. *Applied Economics, 50*(12), 1378–1394. [CrossRef]

[28] Zhang, Y., & Zhang, S. (2018). The impacts of GDP, trade structure, exchange rate and FDI inflows on China's carbon emissions. *Energy Policy, 120*, 347–353. [CrossRef]

[29] Nasir, M. A., Huynh, T. L. D., & Tram, H. T. X. (2019). Role of financial development, economic growth & foreign direct investment in driving climate change: A case of emerging ASEAN. *Journal of environmental management, 242*, 131-141. [CrossRef]

[30] Gyamfi, B. A., Agozie, D. Q., & Bekun, F. V. (2022). Can technological innovation, foreign direct investment and natural resources ease some burden for the BRICS economies within current industrial era? *Technology in Society, 70*, 102037. [CrossRef]

[31] Petrović, P., Filipović, S., & Radovanović, M. (2018). Underlying causal factors of the European Union energy intensity: Econometric evidence. *Renewable and Sustainable Energy Reviews, 89*, 216–227. [CrossRef]

[32] Doytch, N., & Uctum, M. (2016). Globalization and the environmental impact of sectoral FDI. *Economic Systems, 40*(4), 582–594. [CrossRef]

[33] Shahbaz, M., Nasreen, S., Abbas, F., & Anis, O. (2015). Does foreign direct investment impede environmental quality in high-, middle-, and low-income countries? *Energy Economics, 51*, 275–287. [CrossRef]

[34] Adeel-Farooq, R. M., Riaz, M. F., & Ali, T. (2021). Improving the environment begins at home: Revisiting the links between FDI and environment. *Energy, 215*, 119150. [CrossRef]

[35] Acheampong, A. O. (2019). Modelling for insight: does financial development improve environmental quality?. *Energy Economics, 83*, 156-179. [CrossRef]

[36] Wang, Y., Liao, M., Xu, L., & Malik, A. (2021). The impact of foreign direct investment on China's carbon emissions through energy intensity and emissions trading system. *Energy Economics, 97*, 105212. [CrossRef]

[37] Nie, Y., Liu, Q., Liu, R., Ren, D., Zhong, Y., & Yu, F. (2022). The threshold effect of FDI on CO2 emission in Belt and Road countries. *International Journal of Environmental Research and Public Health, 19*(6), 3523. [CrossRef]

[38] Haug, A. A., & Ucal, M. (2019). The role of trade and FDI for CO2 emissions in Turkey: Nonlinear relationships. *Energy Economics, 81*, 297–307. [CrossRef]

[39] Zhang, H., Gao, S., & Zhou, P. (2023). Role of digitalization in energy storage technological innovation: Evidence from China. *Renewable and Sustainable Energy Reviews, 171*, 113014. [CrossRef]

[40] Ahn, S. J. (2020). Three characteristics of technology competition by IoT-driven digitization. *Technological Forecasting and Social Change, 157*, 120062. [CrossRef]

[41] Ma, D., Hu, J., & Yao, F. (2021). Big data empowering low-carbon smart tourism study on low-carbon tourism O2O supply chain considering consumer behaviors and corporate altruistic preferences. *Computers & Industrial Engineering, 153*, 107061. [CrossRef]

[42] Tapio, P. (2005). Towards a theory of decoupling: Degrees of decoupling in the EU and the case of road traffic in Finland between 1970 and 2001. *Transport Policy, 12*(2), 137–151. [CrossRef]

[43] Li, R., Wang, X., & Wang, Q. (2022). Does renewable energy reduce ecological footprint at the expense of economic growth? An empirical analysis of 120 countries. *Journal of Cleaner Production, 346*, 131207. [CrossRef]

[44] Ndubuisi, G., Otioma, C., & Tetteh, G. K. (2021). Digital infrastructure and employment in services: Evidence from Sub-Saharan African countries. *Telecommunications Policy, 45*(8), 102153. [CrossRef]

[45] Danakol, S. H., Estrin, S., Reynolds, P., & Weitzel, U. (2017). Foreign direct investment via M&A and domestic entrepreneurship: Blessing or curse? *Small Business Economics, 48*(3), 599–612. [CrossRef]

[46] Herzer, D. (2025). The impact of FDI-and import-related technology spillovers from government-funded green energy R&D in developed countries on CO2 emissions in developing countries. *Energy Policy, 203*, 114635. [CrossRef]

[47] Hansen, B. E. (2000). Sample splitting and threshold estimation. *Econometrica, 68*(3), 575–603. [CrossRef]

[48] Haans, R. F., Pieters, C., & He, Z. L. (2016). Thinking about U: Theorizing and testing U-and inverted U-shaped relationships in strategy research. *Strategic Management Journal, 37*(7), 1177–1195. [CrossRef]

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