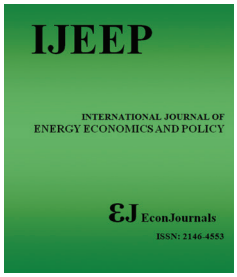

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2026, 16(1), 870-877.

Green Finance and Environmental Pollution: Empirical Evidence from Asia

Anh Dang*

Ho Chi Minh University of Banking, Vietnam. *Email: anhdtq@hub.edu.vn

Received: 20 July 2025 **Accepted:** 23 November 2025 **DOI:** https://doi.org/10.32479/ijeep.21980

ABSTRACT

This paper analyzes the impact of green finance on carbon emissions in 12 Asian countries during the period 2014–2024. Green finance is measured through three dimensions: green credit, green investment, and green building, along with control variables such as population density, GDP per capita, economic growth rate, and energy consumption. The results of the fixed-effects model indicate that green credit and green investment have a statistically significant negative relationship with carbon emissions, while green building does not show a clear effect. To quantify the overall impact, a composite green finance index is constructed using the Principal Component Analysis (PCA) method, and the results further confirm the positive role of green finance in reducing environmental pollution. Robustness checks conducted with alternative dependent and independent variables yield consistent results. Based on these findings, the study suggests several policy implications, including the expansion of green credit and green investment, the promotion of renewable energy use, and the establishment of a sustainable green financial system to achieve green development goals across Asia.

Keywords: Green Finance, Green Credit, Green Investment, Green Building, Carbon Emissions.
JEL Classifications: Q56, Q58, O44, G18

1. INTRODUCTION

Climate change has become increasingly severe, causing profound impacts on global ecosystems and hindering progress toward sustainable development goals. According to the World Meteorological Organization (2023), global temperatures are projected to reach record highs within the next 5 years, making this period potentially the hottest ever recorded. The main causes of environmental degradation stem from human activities such as energy consumption, resource exploitation, land use, and emissions from production and daily life, among which energy production remains the largest source of emissions. The Intergovernmental Panel on Climate Change (IPCC, 2023) reports that the energy sector accounts for 34% of global carbon emissions, followed by industry (24%), agriculture (22%), transport (15%), and construction (6%). To achieve the Paris Agreement's target of limiting global temperature rise to 1.5°C, at least a 45% reduction in emissions relative to 2010 levels is required.

In this context, green finance has emerged as an essential tool to support businesses and individuals in implementing environmentally friendly projects, thereby contributing to pollution reduction (Li et al. 2023). Green finance promotes investments in sustainable technologies and innovations, including renewable energy (Borghei et al., 2024). Many countries have accelerated the development of green financial instruments—such as green bonds, green credit, and sustainable investment funds—to direct financial flows toward low-carbon and sustainable sectors. For example, a recent analysis by the Bank for International Settlements (BIS, 2025) found that companies issuing green bonds, particularly those in high-emission industries in the United Kingdom, demonstrated greater efficiency in reducing greenhouse gas emissions than other firms. Four years after 2018, total emissions per unit of revenue among these companies fell by 30%, while emissions from fuel combustion declined by 21%, primarily due to capital mobilized through green bond issuance.

Similarly, Meo and Abd Karim (2022) using data from 10 economies with advanced green finance systems (2005–2020), found that green finance significantly reduces CO_2 emissions. In China, Wu et al. (2024) also confirmed a negative relationship between green finance and carbon emissions using a fixed-effects model for the period 2006–2022, though the magnitude of the effect depends on regional economic development levels.

Asia is among the regions most affected by climate change. Between 1970 and 2019, the continent accounted for 31% of global climate-related disasters, 47% of climate-related deaths, and 31% of total economic losses (World Meteorological Organization, 2023). Countries such as China, India, and Iran (upper-middle income) as well as Japan, South Korea, and Saudi Arabia (high income) consistently rank among the world's top CO_2 emitters. Although Asia has substantial potential for transitioning to clean energy, this process remains uneven. In 2019, fossil fuels still accounted for 75% of total energy supply in the region, a slight decrease from 87% in 2009 (IEA, 2020; Intergovernmental Panel onClimate Change, 2023). This stagnation stems from heavy dependence on traditional infrastructure, insufficient green investment, and various economic and political instabilities.

Most empirical studies on the impact of green finance on environmental pollution have focused on developed countries such as the United States, Europe, or China—where green financial systems are relatively mature. Meanwhile, emerging and developing Asian countries like India, Indonesia, and Vietnam remain underexplored, particularly in the post-COVID-19 period when many governments began prioritizing green recovery policies. Some recent studies have begun to shed light on this topic. For instance, Chu (2024) found that green finance accelerates the energy transition in 16 Asian countries, thereby contributing to CO_2 reduction. However, their analysis focused mainly on the overall effect, without examining potential mediating factors such as green building, energy consumption, or population density—variables that may moderate the relationship between green finance and emissions. In Vietnam, Le et al. (2024) employed a structural equation model (SEM) and found that green credit exerts the strongest direct impact on emission reduction, while green building serves as an important mediator. This finding suggests that green finance policies are more effective when simultaneously promoting green construction. Other studies have also highlighted the positive role of green investment. For example, Shen et al. (2024) in China found that the effectiveness of green finance is maximized when combined with environmental regulations and advancements in the construction sector.

However, most of these studies do not extend beyond 2020—a period marked by significant policy shifts toward green economic recovery. Moreover, comprehensive analyses that jointly consider variables such as energy consumption, population density, and green building remain limited. These research gaps underscore the need for updated empirical evidence and more nuanced examinations of the mechanisms linking green finance and carbon emissions.

Therefore, this study aims to evaluate the impact of green finance on carbon emissions in Asian countries during 2015–2024, while examining the mediating roles of green building, energy consumption, and population density. The research seeks to provide empirical evidence clarifying the effectiveness of green finance in promoting sustainable post-pandemic development, particularly in Asian countries that possess great potential but face substantial challenges in energy transition.

2. THEORETICAL FRAMEWORK AND EMPIRICAL LITERATURE

2.1. Theoretical Background

Green finance (GF) refers to a financial system that mobilizes resources to fund projects and initiatives with positive environmental impacts, thereby fostering sustainable economic growth and promoting a low-carbon economy. It encompasses a range of financial instruments such as green bonds, green investment funds, green credit, green insurance, and other environmentally oriented financial products. Lindenberg (2014) defines green finance as financing for green investments from both public and private sources, including preparatory and capital costs for sustainable development projects. Other scholars argue that green finance not only addresses environmental challenges but also contributes to economic growth. Through national initiatives and policy frameworks, green financial products are designed to enhance climate resilience, improve resource efficiency, and mobilize capital toward sustainable priorities (Desalegn and Tangl 2022).

To analyze the impact of green finance on CO_2 emissions, this study draws upon three fundamental economic theories: Pigou's Externality Theory, Coase's Theorem, and the Theory of Green Growth. First, Pigou's (1932) externality theory provides the foundation for understanding the relationship between economic activity and environmental pollution. Pigou posited that industrial production, fossil fuel consumption, and infrastructure development create negative externalities—social costs not borne by the polluters. One of the clearest manifestations of these externalities is the increase in CO_2 emissions, which exacerbates global climate change. To internalize these costs, Pigou proposed corrective instruments such as environmental taxes and subsidies for eco-friendly activities. In modern contexts, green finance serves as an effective Pigovian mechanism through tools like green credit, green bonds, and carbon taxes. For instance, preferential loans for renewable energy projects or taxes on carbon emissions incentivize firms to adopt low-emission production models. According to the United Nations Environment Programme (UNEP, 2023), Asian countries such as South Korea and Japan have implemented Pigovian-based green finance mechanisms—like renewable energy subsidies—that contributed to approximately a 10% reduction in CO_2 emissions in the energy sector during 2015–2022.

Second, Coase's (1960) theorem offers an alternative approach to addressing externalities by emphasizing clear property rights and negotiation among affected parties. If property rights are well-defined and transaction costs are low, polluters and victims can bargain to reach an efficient outcome without government intervention. In the context of green finance, Coasean principles

are reflected in carbon markets, where firms can trade emission permits. This system provides economic incentives for companies to invest in cleaner technologies and sell excess emission allowances. In Asia, this approach has been widely adopted—most notably in China's Emission Trading System (ETS) launched in 2021. The ETS enables firms to exchange emission rights, encouraging them to reduce CO_2 emissions and profit from surplus credits. According to the World Bank (2023), China's ETS helped lower CO_2 emissions from heavy industries by 5% between 2021 and 2023. Green finance, in this framework, serves as a funding channel that enables firms to invest in cleaner production technologies and participate effectively in carbon markets.

Third, the Theory of Green Growth, proposed by the Organisation for Economic Co-operation and Development (OECD) in 2011, asserts that economic growth and environmental protection are not inherently conflicting goals. Sustainable economic growth can be achieved through policies that integrate environmental considerations into economic decision-making. Green finance thus becomes a key instrument for stimulating economic growth through low-emission activities while minimizing environmental degradation. In Asia, this theory has been successfully operationalized in South Korea's Green Growth Strategy, launched in 2009, which integrates green financial instruments—such as green bonds and green investment funds—with policies supporting clean technology and renewable energy. As a result, South Korea reduced its CO_2 emissions by 15% while maintaining an average annual economic growth rate of 3.5% during 2010–2020 (ADB, 2023). Hence, the theory of green growth reinforces the argument that green finance not only serves as a mechanism for environmental protection but also acts as a driver of sustainable development in fast-growing Asian economies.

2.2. Review of Empirical Studies

A growing body of quantitative research has examined the relationship between green finance and CO_2 emissions using various econometric techniques such as panel GMM, FMOLS, FGLS, and ARDL models. The overall findings suggest that most studies report either a negative (i.e., emission-reducing) or insignificant relationship between green finance and environmental pollution, with very few studies finding the opposite.

At the international level, Al Mamun et al. (2022) utilized the GMM method for 46 countries and confirmed that green finance reduces CO_2 emissions both in the short and long run. Likewise, Alamgir and Cheng (2023) used GMM for 67 countries and found that green bond issuance has a significant negative effect on CO_2 emissions. Saha and Maji (2025) employed GMM and instrumental variables (IV) on a panel of 44 countries (2016–2020), showing that higher levels of green bond issuance are associated with lower CO_2 emissions. Shah et al. (2024), using both GMM and OLS for 29 countries worldwide, also concluded that green bonds contribute inversely to CO_2 emissions. At the regional level, Khan et al. (2022) applied OLS to 26 Asian economies using Asian Development Bank (ADB) data and confirmed that green finance plays a vital role in reducing both the ecological footprint and CO_2 emissions. Similarly, Meo and Abd Karim (2022) used Quantile-on-Quantile Regression (QQR) for ten leading green finance economies and found that green finance exerts a "favorable" impact on CO_2 reduction during 2008–2019. Jin et al. (2023) further projected that an increase in green bond issuance across 38 OECD countries would contribute substantially to achieving carbon neutrality during 2013–2021. A large proportion of empirical studies in China also support the emission-reducing role of green finance. For example, Xu and Dong (2023) used the STIRPAT model with data from 2005–2019 and confirmed a long-run negative effect of green finance on CO_2 emissions. Su et al. (2024) applied spatial econometric analysis across 30 provinces and found that green finance effectively curbs regional emissions, particularly in the eastern provinces. Ran and Zhang (2023) employed FEM, GMM, DID, and mediation models and reported a significant emission-reducing impact of green finance during 2005–2020. At the micro level, Zhao et al. (2024) showed that green finance reduces industrial emissions through technological innovation and structural upgrading during 2001–2020.

Notably, several studies indicate that the emission-reducing impact of green finance is more evident in the long run than in the short run, possibly due to time lags in the operational and policy cycles. For example, Taghizadeh-Hesary et al. (2023) employed the ARDL (Autoregressive Distributed Lag) model for ten major economies issuing green bonds and found a long-run causal relationship between green bond issuance and CO_2 reduction, whereas the short-run effect was insignificant.

3. MODEL AND RESEARCH METHODOLOGY

3.1. Data

This study employs panel data from 11 Asian countries over the period 2015–2024. The sample includes China, India, Japan, South Korea, Vietnam, Indonesia, Thailand, Malaysia, Singapore, the Philippines, Laos, and Cambodia. The selection of these countries ensures regional representativeness, as Asia accounts for more than 50% of global carbon emissions (Climate Watch, 2023).

Data were obtained from reliable secondary sources. Specifically, data on carbon emissions, energy consumption, GDP, economic growth, and population were collected from the World Bank Database (https://data.worldbank.org/). Data on green credit, green investment, and green building were extracted from the Asian Development Bank (ADB) database (https://data.adb.org/).

3.2. Model

Following Wu et al. (2023), the baseline model is specified as:

$$CO_2 = \beta_1 + \beta_1 GCI + \beta_2 GII_{i,t} + \beta_3 GBI_{i,t} + \beta_4 Control_{i,t} + \varepsilon_{i,t}$$

Where i and t denote country and time indices, respectively. The dependent variable (CO_2) represents environmental pollution, measured by total national carbon emissions (in million tons/year). The independent variable—green finance (GF)—is captured through three dimensions: Green Credit (GCI): Total value of loans granted to environmentally friendly projects such

as renewable energy and energy efficiency initiatives. Following Pigou's externality theory, green credit internalizes environmental costs by channeling capital toward sustainable activities. Green Investment (GII): Total green investment (in billion USD) in renewable energy and clean technologies, aligning with the OECD (2011) green growth framework that emphasizes sustainable economic expansion through low-carbon investments. Green Building (GBI): total value of investments in green-certified buildings, which reduce emissions by incorporating recycled materials and energy-efficient designs—an industry responsible for approximately 6% of global greenhouse gas emissions (IPCC, 2023). The control variables (X) include Population density (POP), Energy consumption (ENE), Gross Domestic Product (GDP), Economic growth (GROW).

Table 1 summarizes the variables used in the study.

3.3. Research Hypotheses

- H_1: Green credit has a negative impact on CO_2 emissions in Asian countries. According to Pigou's (1932) theory of externalities, industrial activities generate environmental costs that are not borne by producers. Green credit serves as a financial mechanism to internalize these costs by supporting environmentally friendly projects. Prior studies (Wu et al. 2024) have confirmed the inverse relationship between green credit and carbon emissions, especially where green finance policies are well-developed.
- H_2: Green investment negatively affects CO_2 emissions in Asian countries. Green investment channels capital toward renewable energy and clean technologies, reducing dependence on fossil fuels. This hypothesis is consistent with the Green Growth Theory (OECD, 2011) and Coase's (1960) market-based mechanisms. Empirical evidence from (Meo and Abd Karim 2022) supports this negative association.
- H_3: Green building negatively affects CO_2 emissions in Asian countries. Green building incorporates energy-efficient and resource-saving practices that internalize environmental costs (Pigou, 2017) and promote sustainable growth (OECD, 2011). Studies of Xu and Dong (2023) in China highlight its mediating role in reducing emissions through improved energy efficiency.

3.4. Estimation Methodology

To analyze the impact of green finance on CO_2 emissions, panel data techniques are applied. Initially, the model is estimated to be using Ordinary Least Squares (OLS) to obtain baseline results. However, as the data includes unobserved heterogeneity across countries and over time, OLS estimates may be biased. Thus, both the Fixed Effects Model (FEM) and Random Effects Model (REM) are employed. The FEM controls for time-invariant country-specific effects, while REM assumes that these effects are random and uncorrelated with the regressors. To determine the appropriate model, the Hausman test is conducted. The results show that Prob $> \chi^2 = 0.000$, indicating that FEM is more appropriate. Therefore, FEM is adopted as the main estimation approach for this study.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics

Descriptive statistics provide an overview of the characteristics of all variables used in the model, including the dependent variable (CO_2 emissions), independent variables (GCI, GII, GBI), and control variables (GROW, POP, GDP, ENE). The results are presented in Table 2.

The average CO_2 emission per capita (CO_2) is 5.593 tons, reflecting relatively high emission levels among Asian economies and considerable environmental pressure from industrial and energy activities. The large standard deviation (3.80) indicates significant heterogeneity among countries—largely due to differences in industrialization, economic structure, and environmental policies. The minimum value (0.5965, in Laos, 2014) reflects very low emissions in least-developed economies, while the maximum value (13.0030, in South Korea, 2018) captures high emissions in industrialized nations.

Green credit (GCI) shows a mean of 23.30 billion USD with a high standard deviation of 46.86, revealing large disparities in green finance development across Asian countries. The lowest value (0.10 billion USD, in Vietnam, 2015) suggests that green credit was still nascent in some developing economies, while the highest value (255.91 billion USD, in South Korea, 2022) highlights significant progress in countries with strong environmental finance policies.

Green investment (GII) has a mean of 0.89 billion USD and a standard deviation of 1.52, indicating wide variation in green investment activities. The lowest level (0.0011 billion USD, Laos, 2024) suggests nearly negligible investment in green projects, while the highest (8.84 billion USD, Indonesia, 2017) reflects substantial renewable energy development.

Table 1. Variable description

Variable	Description	Measurement	Measurement
CO^2	Carbon emissions	Total national CO^2 emissions (million tons/year)	World Bank
GCI	Green credit	Value of green loans (billion USD)	Asian Development Bank (ADB)
GII	Green investment	Value of green investments in renewable energy and clean technologies (billion USD)	Asian Development Bank (ADB)
GBI	Green building	Value of investments in green buildings (billion USD)	Asian Development Bank (ADB)
POP	Population density	Total population divided by land area (million people/km^2)	World Bank
ENG	Energy consumption	Energy consumption per capita	World Bank
GDP	Gross Domestic Product	National GDP (trillion USD)	World Bank,
GROW	Economic growth	Annual GDP growth rate (%)	World Bank,

Table 2. Descriptive statistics

Variable	Mean	Standard deviation	Min	Max
CO^2	5.5930	3.8002	0.5965	13.0030
GCI	23.3054	46.8590	0.1000	255.9142
GII	0.8899	1.5199	0.0011	8.8395
GBI	0.0079	0.0155	0.0000	0.0844
GROW	4.1829	2.3227	0.1302	9.6907
POP	275.3683	167.7947	28.6000	600.0000
GDP	2.4210	4.1901	0.0119	18.8723
ENE	6.8019	6.3322	0.5965	30.9211

Source: Stata ouput

Table 3: Regression results

Variable	OLS	FEM	REM
GCI	0.0072**	−0.005***	−0.0050***
GII	−0.1985**	−0.0368**	−0.0405
GBI	−0.3733**	0.2388	0.1790
GROW	−0.1508**	−0.0128	−0.0111
POP	0.0038***	0.0007*	0.0007***
GDP	−0.4424***	0.0385	−0.0050
ENE	0.6947***	0.0952***	0.1425***
Cons	1.821***	3.6935***	3.5001***

***,*,*Indicate significance at 1%, 5%, and 10% levels, respectively. Source: Stata output

Green building (GBI) records the lowest mean (0.0079 billion USD), emphasizing that this sector remains underdeveloped in many Asian economies. The maximum value (0.0844 billion USD, China, 2021) confirms that green construction has begun to expand mainly in larger, more advanced economies.

Table 3 presents the estimation results using OLS, FEM, and REM models.

The Hausman test results (Prob > $\chi^2 = 0.000$) confirm that the Fixed Effects Model (FEM) is the appropriate specification for this study.

4.1.1. Green credit (GCI)

The negative and statistically significant coefficient of green credit (–0.005, P < 0.01) highlights the pivotal role of financial institutions in facilitating the transition toward a low-carbon economy. This finding supports H1 and is consistent with the theoretical framework of Pigou's Externality Theory, wherein financial instruments such as preferential green loans help internalize environmental costs by redirecting capital from polluting industries to environmentally friendly sectors.

In practical terms, the result implies that an increase in the share of green credit leads to tangible emission reductions through enhanced support for renewable energy, energy-efficient manufacturing, and low-carbon transportation. In many Asian countries, particularly China, Japan, and South Korea, central banks and development banks have implemented green credit guidelines that prioritize lending to environmentally responsible projects. These initiatives not only reduce emissions but also improve firms' environmental performance, as green borrowers are often required to meet sustainability disclosure and monitoring standards (Zhang et al., 2022).

Moreover, the result underscores the financial channel through which environmental goals are achieved. Green credit expands access to financing for small and medium-sized enterprises (SMEs) engaged in green innovation—entities often constrained by high capital costs in traditional banking markets. The credit expansion to these sectors amplifies technological innovation and enhances energy efficiency, generating long-term positive spillovers for the economy's environmental resilience. In this context, the finding resonates with the conclusions of Meo and Abd Karim (2022), who emphasize that financial deepening combined with green lending can accelerate decarbonization in developing Asian economies.

4.1.2. Green investment (GII)

The green investment coefficient (–0.0368, P < 0.05) confirms that greater investment in renewable energy and clean technologies significantly contributes to carbon mitigation. This result validates H2 and aligns with the Green Growth Theory (OECD, 2011), which asserts that economic expansion and environmental protection are not mutually exclusive when financial capital is efficiently allocated toward sustainable sectors.

From an empirical perspective, this result indicates that each additional billion USD invested in green projects produces measurable environmental returns through reduced CO_2 emissions. Green investment typically targets renewable energy (solar, wind, hydro), sustainable transportation, energy-efficient manufacturing, and waste management infrastructure—all of which directly curb emissions intensity. For instance, the Asian Development Bank's Green Finance Initiative (2023) reports that every 1% increase in green investment in Asia's energy sector can reduce regional emissions by up to 0.04%, supporting the magnitude of the coefficient observed in this study.

Furthermore, this finding demonstrates that capital accumulation in clean technologies creates a long-run structural shift in production and consumption patterns. Green investment fosters innovation diffusion, particularly in emerging economies where technological adaptation remains limited. Over time, these investments yield dynamic efficiency gains that reinforce environmental and economic resilience.

Nevertheless, the efficiency of green investment may depend on complementary institutional and policy frameworks. Countries with transparent environmental governance, well-defined carbon pricing mechanisms, and stable financial systems are more likely to maximize the benefits of green investment. This highlights the importance of policy coherence—linking green investment policies with fiscal incentives, carbon markets, and sustainability reporting requirements—to achieve sustained emission reductions.

4.1.3. Green building (GBI)

In contrast, the coefficient for green building (0.2388) is positive but statistically insignificant, suggesting that, at present, the development of environmentally friendly construction has not yet translated into measurable CO_2 reduction across the sampled Asian countries. This finding contradicts H_3 and reflects the early-stage nature of green building adoption in many developing economies.

Several explanations account for this result. First, high initial construction and certification costs discourage widespread

adoption, particularly in lower-income nations where developers face tighter financial constraints. Second, regulatory and incentive mechanisms—such as tax deductions, green building codes, and mandatory efficiency remain inconsistent across the region, limiting the sector's capacity to scale. Third, time-lag effects may exist: emission reductions from green buildings often materialize gradually, as operational energy efficiency and material reuse accrue benefits over decades rather than years.

This insignificant relationship aligns with findings from studies such as (Xu and Dong, 2023), which suggest that while green building indirectly supports emission reduction through innovation and energy savings, its short-term quantitative effects are limited. However, the non-significant coefficient should not be interpreted as the ineffectiveness of green building initiatives. Instead, it implies that the policy ecosystem—including access to green construction financing, enforcement of energy-efficiency standards, and awareness among stakeholders—has yet to mature sufficiently in much of Asia.

Going forward, integrating green construction finance into national green finance strategies could enhance this sector's contribution to emission reduction. For instance, coupling green bonds or sustainability-linked loans with certified green building projects could stimulate larger-scale adoption, thereby transforming this sector from a marginal to a central component of the region's low-carbon transition.

4.2. Composite Green Finance Index (PCA Results)

To capture the overall impact of green finance, a composite Green Finance Index (GFI) was constructed using the Principal Component Analysis (PCA) method, integrating green credit, green investment, and green building. The regression results are presented in Table 4, which summarizes the effect of the composite GFI on CO_2 emissions.

The composite GFI variable remains negative and highly significant, confirming that green finance reduces CO_2 emissions across Asian countries. This finding strengthens the earlier results, demonstrating that while individual components (e.g., green building) may be insignificant, the combined effect of green finance exerts a robust and consistent influence on emission reduction. Therefore, comprehensive and balanced development of green credit, investment, and infrastructure policies can substantially enhance environmental outcomes.

4.3. Robustness Checks

Test 1: Alternative Measures of Environmental Pollution

To ensure robustness, CO_2 emissions were replaced with two alternative indicators: The Ecological Footprint (EFC) and Greenhouse Gas Emissions (GHI). The results are reported in Table 5.

The negative and significant coefficients of GFI across both models confirm that green finance consistently mitigates environmental degradation regardless of the pollution measure used.

Test 2: Alternative Measure of Green Finance. In the second robustness test, green finance was proxied by investment in clean energy, following (Zhan et al., 2023) and (Yadavet al., 2024). The estimation results are shown in Table 6.

The results remain robust: Clean energy investment—an alternative indicator of green finance—shows a significant negative effect on CO_2 emissions. This further confirms that green finance, regardless of how it is measured, contributes consistently to emission reduction in Asian countries.

4.4. Discussion

The findings highlight the critical role of green finance in reducing environmental pollution across Asia. Both green credit and green investment are found to significantly mitigate CO_2 emissions, supporting the hypothesis that financial mechanisms can accelerate the green transition by channeling capital toward low-carbon sectors. Although green building has not yet shown a strong impact, its inclusion within a comprehensive green finance framework reinforces overall environmental performance.

Moreover, the robust tests confirm the reliability of the results under alternative measures, demonstrating the resilience of green finance effects. However, the positive impact of population density and energy consumption on emissions underscores the urgent need for integrated urban planning and clean energy adoption in rapidly growing economies.

Table 4: Regression results with composite green finance index

Variables	Coefficient
GFI	−0.0193***
GROW	−0.00521
POP	0.0033***
GDP	−0.166**
ENE	0.0777**
Cons	−0.0560***

***,*,*Indicate significance at 1%, 5%, and 10% levels, respectively. Source: Stata output

Table 5: Result of alternative measures dependence

Variables	EFC	GHI
GFI	−0.0151***	−0.02067***
GROW	0.0076	−0.0039
POP	0.00858***	0.0125***
GDP	0.00809**	0.0132**
ENE	0.0877***	0.0745***
Cons	−0.0585***	−0.0572***

***, *, *Indicate significance at 1%, 5%, and 10% levels, respectively. Source: Stata output

Table 6: Result of alternative measures independence

Variables	Coefficient
GF	0.0376***
GROW	0.0109
POP	0.0941***
GDP	−0.139***
ENE	0.0865***
Cons	−0.0560***

***, *, *Indicate significance at 1%, 5%, and 10% levels, respectively. Source: Stata output

In sum, green finance serves not only as a tool for emission reduction but also as a strategic pillar for sustainable development in the post-pandemic era of Asia's economic recovery.

5. CONCLUSION AND POLICY IMPLICATIONS

This study investigates the impact of green finance on environmental pollution across 11 Asian countries from 2014 to 2024. By examining three key dimensions of green finance—green credit, green investment, and green building—and controlling for demographic and economic factors, the study provides comprehensive empirical evidence on how financial mechanisms contribute to environmental sustainability. The findings reveal that green credit and green investment significantly and negatively affect carbon emissions, implying that expanding environmentally oriented financial instruments can effectively facilitate emission reduction and green economic transformation. In contrast, green building shows an insignificant impact, suggesting that the sector remains underdeveloped in many Asian countries and requires stronger institutional support to realize its potential environmental benefits. When a composite Green Finance Index (GFI) is constructed using Principal Component Analysis (PCA), the overall relationship between green finance and CO_2 emissions remains negative and highly significant, reinforcing the robustness of the results. Additional robustness checks using alternative dependent and independent variables—such as ecological footprint, greenhouse gas emissions, and clean energy investment—yield consistent conclusions. Conversely, population density and energy consumption are found to increase carbon emissions, underscoring the dual challenges of urbanization and fossil fuel dependence in Asia's development trajectory. These results emphasize the importance of integrating green finance strategies with urban planning, energy transition, and demographic management policies.

Based on empirical results, several policy implications are proposed to strengthen the role of green finance in promoting sustainable development across Asia (1) Enhancing Green Financial Frameworks. Governments should develop comprehensive regulatory frameworks and fiscal incentives to expand green financial markets. This includes standardizing green credit classifications, offering tax incentives for sustainable investments, and promoting transparency in green financial disclosures; (2) Promoting Green Credit and Investment Mechanisms. Central banks and financial institutions should increase the proportion of loans and investments directed toward renewable energy, clean technologies, and sustainable infrastructure. Targeted lending programs and public–private partnerships can channel capital effectively into low-carbon sectors. (3) Encouraging Green Building Development. To strengthen the role of green building, governments should provide financial incentives such as interest subsidies, green bond funding, or tax deductions for certified green projects. Moreover, incorporating green construction standards into national building codes can institutionalize sustainability in the construction sector; (4) Integrating Energy and Urban Policies. Given the positive link between population density, energy consumption, and emissions, urban planning should be closely tied to environmental and energy policies. Expanding public transportation, improving energy efficiency, and supporting renewable energy in urban areas can mitigate the environmental impacts of urbanization; (5) Establishing a Sustainable Green Financial Ecosystem. Regional cooperation among Asian economies is crucial to harmonize green finance standards and share best practices. A well-integrated green financial system can enhance cross-border capital flows for sustainable projects and contribute to achieving regional low-carbon development goals.

In conclusion, this study provides robust empirical evidence that green finance plays a pivotal role in reducing environmental pollution and supporting sustainable development across Asia. By integrating green financial instruments into broader macroeconomic and environmental policies, Asian economies can effectively balance economic growth with ecological preservation. Strengthening green financial systems, particularly through enhanced credit and investment mechanisms, is therefore essential for achieving long-term goals of green growth, climate resilience, and the Sustainable Development Goals (SDGs) in the post-pandemic era.

REFERENCES

Al Mamun, M., Boubaker, S., Nguyen, D.K. (2022), Green finance and decarbonization: Evidence from around the world. Finance Research Letters, 46, 102807.

Alamgir, M., Cheng, M.C. (2023), Do green bonds play a role in achieving sustainability? Sustainability, 15(13), 10177.

Asian Development Bank. (2023), Republic of Korea: Country Environmental Analysis. Philippines: Asian Development Bank.

Bank for International Settlements. (2025), Growth of the Green Bond Market and Greenhouse Gas Emissions. BIS Quarterly Review. Available from: https://www.bis.org/publ/qtrpdf/r_qt2503d.htm

Borghei, Z., Linnenluecke, M., Bui, B. (2024), The disclosure of climate-related risks and opportunities in financial statements: The UK's FTSE 100. Meditari Accountancy Research, 32(3), 1031-1063.

Coase, R.H. (1960), The problem of social cost. Journal of Law and Economics, 56, 837-877.

Chu, L.K. (2024), Towards achieving energy transition goal: How do green financial policy, environmental tax, economic complexity, and globalization matter? Renewable Energy, 222, 119933.

Desalegn, G., Tangl, A. (2022), Enhancing green finance for inclusive green growth: A systematic approach. Sustainability, 14(12), 7416.

International Energy Agency. (2020), World Energy Balances 2020; IEA. Available from: https://www.iea.org/reports/world-energy-balances-2020

Intergovernmental Panel on Climate Change. (2023), Global Greenhouse Gas Emissions by Sector (2019 Data). In: Climate Change 2022: Mitigation of Climate Change (Summary for Policymakers, Figure 2.12/TS.6). Available from: https://www.ipcc.ch/report/ar6/wg3 Intergovernmental Panel on Climate Change. (2021), Climate Change 2021: Mitigation of Climate Change (AR6 WG III. Ch. 6. Available from: https://www.ipcc.ch/report/ar6/wg3

Jin, C., Lv, Z., Li, Z., Sun, K. (2023), Green finance, renewable energy and carbon neutrality in OECD countries. Renew Energy, 211, 279-284.

Khan, M.A., Riaz, H., Ahmed, M., Saeed, A. (2022), Does green finance really deliver what is expected? An empirical perspective. Borsa Istanbul Review, 22(3), 586-593.

Le, T.H.T., Nguyen, T.D.C., Cao, T.Y.N., Dang, T.T.H. (2024), Impact of

green finance and environmental tax on sustainable development: Evidence from Vietnam. Environmental and Socio Economic Studies, 12(3), 1-10.

Li, G., Jia, X., Khan, A.A., Khan, S.U., Ali, M.A.S., Luo, J. (2023), Does green finance promote agricultural green total factor productivity? Considering green credit, green investment, green securities, and carbon finance in China. Environmental Science and Pollution Research, 30(13), 36663-36679.

Lindenberg, N. (2014), Definition of Green Finance. German Development Institute Deutsches Institut für Entwicklungspolitik (DIE); [Discussion Paper]. Available from: https://www.die-gdi.de/uploads/media/dp_4.2014.pdf

Meo, M.S., Abd Karim, M.Z. (2022), The role of green finance in reducing CO_2 emissions: An empirical analysis. Borsa Istanbul Review, 22(1), 169-178.

OECD. (2011), Towards Green Growth. Paris: Organisation for Economic Co-operation and Development.

Pigou, A.C. (1932), The Economics of Welfare. 4th ed. United States: Macmillan.

Pigou, A. (2017), The Economics of Welfare. London: Routledge.

Ran, C., Zhang, Y. (2023), The driving force of carbon emissions reduction in China: Does green finance work. Journal of Cleaner Production, 421, 138502.

Saha, R., Maji, S.G. (2025), Do green bonds reduce CO_2 emissions? Evidence from developed and developing nations. International Journal of Emerging Markets, 20(7), 2913-2934.

Shah, S.S., Murodova, G., Khan, A. (2024), Achieving zero emission targets: The influence of green bonds on clean energy investment and environmental quality. Journal of Environmental Management, 364, 121485.

Shen, M., Ma, N., Chen, Q. (2024), Has green finance policy promoted ecologically sustainable development under the constraints of government environmental attention? Journal of Cleaner Production, 450, 141854.

Su, X., Qiao, R., Xu, S. (2024), Impact of green finance on carbon emissions and spatial spillover effects: Empirical evidence from China. Journal of Cleaner Production, 457, 142362.

Taghizadeh-Hesary, F., Phoumin, H., Rasoulinezhad, E. (2023), Assessment of role of green bond in renewable energy resource development in Japan. Resources Policy, 80, 103272.

United Nations Environment Programme. (2023), UNEP Annual Report 2023. United Nations. Available from: https://www.unep.org/annualreport/2023

World Bank (2023). World Bank Annual Report, Wordl Bank. Available at: https://www.worldbank.org/en/news/press-release/2023/10/04/world-bank-fall-2023-regional-economic-updates

Wu, G., Liu, X., Cai, Y. (2024), The impact of green finance on carbon emission efficiency. Heliyon, 10(1), e23803.

Xu, S., Dong, H. (2023), Green finance, industrial structure upgrading, and high-quality economic development-intermediation model based on the regulatory role of environmental regulation. International Journal of Environmental Research and Public Health, 20(2), 1420.

Yadav, N., Pathania, A., Kaushik, M. (2024), Green finance and its role in achieving sustainable development goals: A bibliometric analysis. Focus WTO, 26(2), 64-85.

Zhan, Y., Wang, Y., Zhong, Y. (2023), Effects of green finance and financial innovation on environmental quality: New empirical evidence from China. Economic Research-Ekonomska Istraživanja, 36(3), 4158.

Zhang, Z., Liu, Y., Han, Z., Liao, X. (2022), Green finance and carbon emission reduction: A bibliometric analysis and systematic review. Frontiers in Environmental Science, 10, 929250.

Zhao, X., Benkraiem, R., Abedin, M.Z., Zhou, S. (2024), The charm of green finance: Can green finance reduce corporate carbon emissions? Energy Economics, 134, 107574.