International Journal of Management and Sustainability
2026 Vol. 15, No. 4, pp. 858-870
ISSN(e): 2306-0662
ISSN(p): 2306-9856
DOI: 10.18488/11.v15i4.5345
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Does green finance promote environmental sustainability equally across Asia? The moderating role of government effectiveness

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Article History
Received: 17 July 2026
Revised: 28 August 2026
Accepted: 16 September 2026
Published: 3 November 2026

Keywords
Asia
Consumption-based CO_2 emissions
Environmental sustainability
Government effectiveness
Green finance.

ABSTRACT

This study investigates whether the link between green finance and consumption-based CO_2 emissions differs when considering the conditional emissions distribution and whether government effectiveness conditions this relationship. Annual data for 18 Asian economies from 2003 to 2023 are analysed using the Method of Moments Quantile Regression, while Bootstrap Quantile Regression is used as an alternative estimator check. Consumption-based CO_2 is viewed as an inverse measure of environmental carbon sustainability. The green finance coefficients are statistically significant at all reported quantiles and negative in the baseline model, ranging from -0.102 at Q25 to -0.111 at Q90. The relationship between green finance and government effectiveness is also negative and significant, ranging from -0.150 to -0.223. The results suggest that the negative green finance–emissions correlation becomes stronger as government effectiveness increases and is most significant at the higher quantiles of conditional emissions. Generally, information and communication technology is associated with decreased emissions, whereas economic growth and trade openness are associated with increased emissions. The main coefficient signs and the increasingly negative interaction pattern are maintained in the bootstrap estimates. The results indicate that institutional implementation capacity partially influences the environmental performance associated with financial resources for greening. The empirical analysis is not fully exogenous; therefore, its results cannot be interpreted as demonstrating a cause-and-effect relationship.

Contribution/Originality: This study extends the literature on green finance by integrating consumption-based emissions and panel quantile estimation, while incorporating an explicit institutional moderator. It demonstrates that governmental effectiveness strengthens the negative relationship between green finance and emissions, particularly at higher conditional-emission quantiles in Asian economies.

1. INTRODUCTION

Climate change remains a limiting factor in environmental quality and longer-term economic development. Global mean surface temperature was found to be around 1.45°C warmer than the mean for 1850–1900, and fossil-fuel CO_2 emissions were expected to peak again in 2025 (Friedlingstein et al., 2026; World Meteorological Organization, 2026). Rapid industrialisation, urbanisation, increasing consumption and fossil fuel use are occurring in Asia at the same time as the risks of extreme heat, flooding, droughts, glacier loss and sea-level rise are increasing,

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making Asia particularly exposed (World Meteorological Organization, 2025). The mobilisation of finance for low-carbon investment has thus become a key regional policy issue.

Green finance focuses on financing renewable energy, clean production, energy efficiency and low-carbon infrastructure. Carbon should not simply be considered a territorial emission, since Asian production networks spread carbon across borders. An alternative approach is consumption-based CO_2 emissions, which account for emissions at final demand and embodied trade (Davis & Caldeira, 2010; Peters & Hertwich, 2008). The current literature is largely consistent in linking green finance to emissions reduction, although the link is weaker in some countries, for some tools and under certain emissions conditions (Al Mamun, Boubaker, & Nguyen, 2022; Meo & Abd Karim, 2022; Ran, Liu, Razzaq, Meng, & Yang, 2023). Another dimension of sustainable finance implementation is institutional readiness and stakeholders' ability to translate policy commitments into operational practices.

Three gaps remain. First, much of the evidence comes from China or groups of advanced countries, with little comparable evidence for a heterogeneous sample of Asian countries. Second, the carbon footprint of economies with high import dependence could be understated by studies that focus on production emissions. Third, institutional variables are typically included as independent controls, although the success of policies in coordinating, enforcing, appraising, and monitoring the implementation of green financial commitments can influence whether such commitments result in tangible environmental benefits.

One of the other shortcomings concerns estimation. Mean-based models summarize an average coefficient and can mask differences between lower and higher emission scenarios. While quantile approaches are more appropriate for detecting distributional heterogeneity, few studies integrate consumption-based emissions with a governance variable that explicitly influences the green-finance slope. This is not trivial because the same amount of green financial resources can have different environmental impacts when implemented at low or high levels of capacity.

This study aims to address these gaps by analyzing annual data for 18 Asian economies spanning 2003–2023. The Method of Moments Quantile Regression (MMQR) is used to estimate the relationship between green finance and emissions at specific quantiles of the conditional distribution, while the interaction term captures the moderating effect of government effectiveness. Alternatively, Bootstrap Quantile Regression (BSQ) provides an additional estimator check. The study offers a consumption-focused view of carbon, an Asian cross-country context, and quantile-specific evidence on institutional moderation. The coefficients represent conditional associations, as they are not causal identifiers.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

2.1. Theoretical Background

The theoretical underpinnings are the economics of externalities, sustainable development, and institutional economics. Pigou (1920) was the first to prove the existence of a divergence between private and social costs, which means that there is reason to implement policy and financial strategies to steer resources towards activities that have lower social costs. The concept of sustainable development builds on this idea, in that the current economy must be compatible with protecting the environment and maintaining natural capital for future generations (Pearce, Barbier, & Markandya, 1990; World Commission on Environment and Development, 1987).

Green finance can be used to overcome financing obstacles that hinder renewable energy, cleaner technologies, energy efficiency, and low-carbon infrastructure. According to the Porter hypothesis, a carefully thought-out environmental policy can induce innovations and resource efficiencies, rather than merely create compliance costs (Porter & van der Linde, 1995). Emissions from domestic final demand and international trade should be lowered through successful low-carbon investment in a consumption-based accounting system.

Institutional economics is the mechanism behind differences in outcomes that can occur from the same financial commitment in different countries. Incentives and resource allocation are influenced by formal rules, enforcement mechanisms, and administrative capacity (North, 1990). The screening, policy implementation, allocation, and post-

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financing monitoring of green projects must be credible, consistent, and transparent. Effective government coordination of agencies, enforcement of standards, reduction of greenwashing, and rectification of implementation shortcomings are more achievable outcomes for a well-functioning government, which can help ensure the environmental benefits of nominally green finance.

These views suggest a negative relationship between green finance and consumption-based emissions, alongside a conditional institutional mechanism: the more positive the relationship becomes, the more effective the government is.

2.2. Literature Review and Hypothesis Development

Two dimensions separate the empirical literature: geography and estimation approach. The findings of country- and city-level studies, especially those focusing on China, are broadly consistent in showing that green finance is associated with lower emissions, either through the use of cleaner energy, green innovation, industrial upgrading, and/or improvements in the carbon efficiency of the financial sector (Guo, Wang, Cao, & Hou, 2022; Li & Fan, 2023; Ran et al., 2023; Wang & Ma, 2022). Studies on green banking technology also reveal that utility, trust, and user acceptance affect the sustainability value generated by green financial services. The conclusions from these studies do not necessarily apply to economies with different energy structures and administrative capacities.

Cross-country studies extend the comparison but focus on OECD or global samples. Safi, Kchouri, Elgammal, Nicolas, and Umar (2024) and Wang, Umar, Li, and Shan (2023) found an inverse relationship between green finance and consumption-based emissions. This relationship varies across the emissions distribution, according to Umar and Safi (2023), while an emissions-reducing association was found for green-bond issuance by Baştürk (2024). These studies strengthen the international evidence but might not represent Asia's institutional and developmental diversity, given their samples of advanced economies. Average estimators can mask heterogeneity, whereas evidence based on quantiles is directly related to it. Under various emission scenarios, Meo and Abd Karim (2022) find that the relationships between different green-finance coefficients differ. Li, Mirza, Safi, Umar, and Su (2025) find a distribution-sensitive relationship between green finance, digitalization, energy efficiency, and low-carbon transition. However, the quality of institutions is usually represented as an independent factor rather than as a factor that alters the green-finance coefficient. There is thus little evidence in the literature to support a systematic weakening or strengthening of this relationship across the conditional emissions distribution, and considerable uncertainty remains.

The evidence gathered suggests that there is generally a negative correlation, but nothing suggests uniformity across individual economies, quantiles, or institutional contexts. Consumption-based CO_2 emissions are an inverse measure of environmental sustainability, which means that a negative coefficient is associated with improved environmental performance in terms of CO_2 emissions. Thus, the first hypothesis is presented as follows:

H_1: There is a negative relationship between green finance and consumption-based CO_2 emissions.

This is expected to be moderated by government effectiveness. Good administrative capacity can help enhance project selection, policy coherence, regulatory enforcement, transparency, and post-financing monitoring. The relevance of these implementation functions is supported by evidence that governance systems complement green initiatives to improve sustainability outcomes. A weak governance framework can weaken the negative green finance–emissions correlation through misallocation, implementation delays, and greenwashing.

H_2: The negative association between green finance and consumption-based CO_2 emissions becomes stronger as government effectiveness increases.

3. METHODOLOGY

3.1. Empirical Model

Consumption-based CO_2 emissions (CBE) are defined as a negative indicator of environmental sustainability, while green finance (GF) is the main explanatory variable. The direct and indirect effects of government effectiveness

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(GE) are included. The control variables are information and communication technology (ICT), economic growth (EG), and trade openness (OPE). The empirical models are as follows:

$$CBE_{it} = \beta_0 + \beta_1 GF_{it} + \beta_2 ICT_{it} + \beta_3 GE_{it} + \beta_4 EG_{it} + \beta_5 OPE_{it} + \varepsilon_{it} \quad (1)$$

$$CBE_{it} = \beta_0 + \beta_1 GF_{it} + \beta_2 ICT_{it} + \beta_3 GE_{it} + \beta_4 (GE_{it} \times GF_{it}) + \beta_5 EG_{it} + \beta_6 OPE_{it} + \varepsilon_{it} \quad (2)$$

In Model 1, the baseline conditional association between green finance and emissions is estimated while controlling for other factors related to technology, institutions, and the economy, as well as trade. Model 2 includes GE×GF but leaves the rest of the specification unchanged. The interaction model includes the GF association, β_1, as well as the marginal association at any value of GE other than zero, $\beta_1 + \beta_4$GE.

If the interaction coefficient is negative, the association between government effectiveness and CBE becomes more negative as government effectiveness increases. The empirical structure is summarized in Figure 1. ICT and EG are controls, while GE has both a direct relationship with CBE and a moderating role in the relationship between GF and CBE.

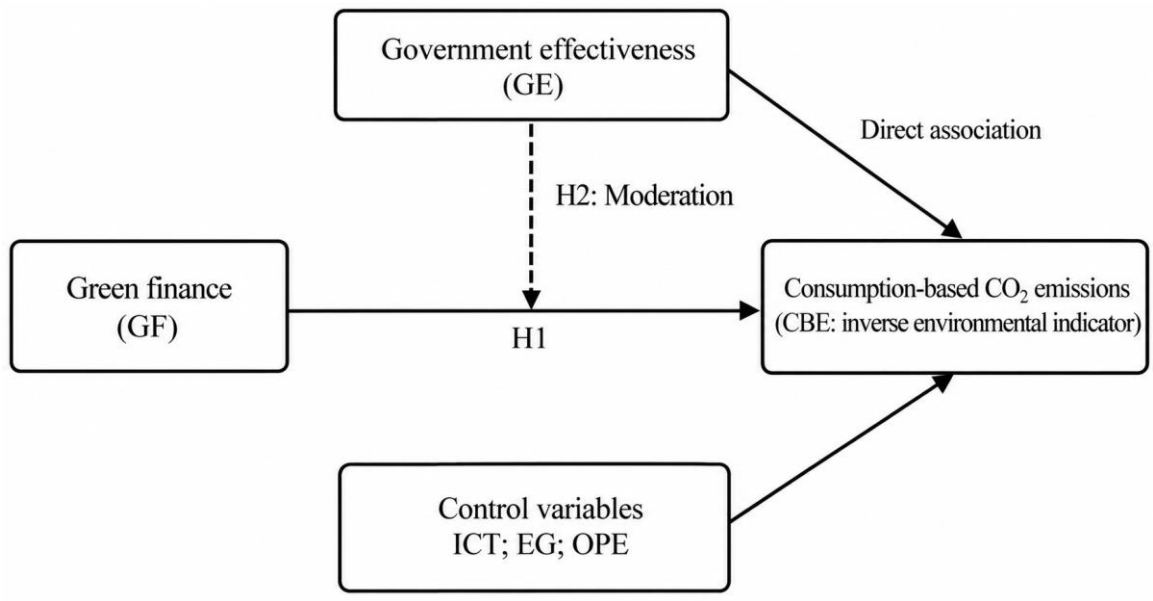


Figure 1. Empirical model.

3.2. Variable Description and Data

The analysis relies on annual panel data for 18 Asian economies over the period 2003–2023. Economies were retained when the necessary series were available in multiple datasets from the Global Carbon Atlas, International Renewable Energy Agency, Worldwide Governance Indicators, and World Development Indicators. This common coverage criterion makes comparisons between the two models easier, but it might be more advantageous for economies with more developed statistical systems. Consumption-based CO_2 emissions are expressed in millions of tonnes of CO_2 and are natural-log-transformed. GF is proxied by public investment in renewable-energy technologies (in millions of constant 2019 US dollars), and it is also log-transformed. The proxy does not reflect all private green credit, green bonds, and sustainable investment, but only public renewable-energy finance. The range of GE is from −2.5 to +2.5. ICT is ICT service exports/total service exports; EG is the natural log of GDP per capita; and OPE is (exports + imports)/GDP.

The final analytical sample consists of 18 economies, with the same coverage for the variables used in the estimation. Before constructing the panel, country identifiers were harmonized across the four source databases.

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3.3. Methods of Analysis

The empirical procedure starts with descriptive statistics and the Jarque–Bera normality test (Jarque & Bera, 1987). Slope homogeneity is tested using the Pesaran and Yamagata (2008) test, while cross-sectional dependence is tested using the Pesaran (2004) CD statistic. The Im, Pesaran, and Shin (2003) panel unit-root test (Im et al., 2003) is applied to test for stationarity, followed by the Kao (1999) and Pedroni (2004) cointegration tests. The estimated coefficients are interpreted conservatively as conditional associations because the diagnostics show that some variables are cross-sectionally dependent.

The main estimator is the Method of Moments Quantile Regression developed by Machado and Santos Silva (2019). Coefficients can vary across the conditional CBE distribution, and country-specific location and scale heterogeneity are accounted for in MMQR. The lower, median, and upper conditional-emission conditions are represented by the values of Q25, Q50, and Q75. Q90 is added to explore the high-emission tail, where mitigation is most relevant, without depending on the highest-emission observations of a moderate-sized panel. All estimates are from Stata 17.0.

An alternative estimator check is bootstrap quantile regression. Robustness is assessed by comparing the signs of the coefficients, their statistical significance, and the overall pattern across quantiles. Different point estimates are not expected because the two estimators use different procedures to characterize conditional quantiles.

Table 1. Descriptive statistics.

Statistics	CBE	GF	ICT	EG	OPE	GE
Mean	18.365	2.857	10.451	8.090	81.072	-0.120
Std. Dev.	1.907	3.108	12.004	0.773	39.391	0.508
Min.	13.480	-4.636	0.174	6.303	24.650	-1.182
Max.	25.036	7.782	52.088	9.611	210.374	1.238
p1	13.758	-4.605	0.326	6.382	25.472	-1.142
p99	23.595	7.379	48.965	9.432	194.195	1.054
Skew.	0.250	-0.727	1.913	-0.270	0.779	0.141
Kurt.	3.508	2.632	5.984	2.389	2.916	2.885
J-B	7.996	35.01	371	10.48	38.36	1.461
J-B p-value	0.018	0.000	0.000	0.005	0.000	0.482

4. RESULTS AND DISCUSSION

4.1. Preliminary Analysis

There is considerable variation in GF, ICT, and OPE, as shown in Table 1. ICT is highly positively skewed and has the greatest kurtosis, while GF and EG are negatively skewed. The Jarque–Bera test does not support normality for CBE, GF, ICT, EG, and OPE, but does for GE. These distributional differences facilitate the analysis of coefficients other than the conditional mean.

Table 2. Slope heterogeneity test.

Model	Variables	Stat.	p-value
Model-1	CBE GF ICT EG OPE GE	1.508 1.851*	0.132 0.064
Model-2	CBE GF ICT EG OPE GE GExGF	0.572 0.730	0.567 0.466

Note: * denotes statistical significance at the 10% level.

There is mixed evidence regarding the homogeneity of slopes in Table 2. The statistic for Model 1 is significant at the 10% level, but the statistics for Model 2 are not significant. Hence, the evidence of slope heterogeneity is not uniform but rather model-dependent. Together with the non-normal distributions, this finding reinforces the use of quantile estimates as an alternative form of representing conditional heterogeneity.

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Table 3. Cross-sectional dependence analysis.

Variables	Pesaran's CD Stat.	p-value	Abs.(corr.)
CBE	0.79	0.432	0.189
GF	6.45	0.000	0.222
ICT	11.32	0.000	0.407
EG	46.12	0.000	0.876
OPE	10.41	0.000	0.453
GE	5.57	0.000	0.369

Table 3 indicates that cross-sectional independence is not rejected for CBE, but it is rejected for GF, ICT, EG, OPE, and GE. The strong average absolute correlation for EG suggests that several economies are experiencing the same shock at the same time, either regionally or globally. This dependence is important for the accuracy of the estimates and is also taken into account when concluding the regression results.

Table 4. Panel unit-root analysis.

Variables	At Level	At I(1)
	T-bar Stat.	t-bar Stat.
CBE	-4.3290***	
GF	-3.5983***	
ICT	-1.3936	-3.5682***
EG	-1.1045	-2.9559***
OPE	-1.4332	-4.0430***
GE	-1.4894	-5.2053***

Note: *** denotes statistical significance at the 1% level.

The results of Table 4 show that CBE and GF do not change, while the first differences of ICT, EG, OPE, and GE are stationary. There are no second-order integrated variables. The combination of I(0) and I(1) variables provides an incentive to consider a stable joint relationship between the series.

Table 5. Panel cointegration analysis.

Pedroni (2004) Analysis	Model-1		Model-2	
	Stat.	p-value	Stat.	p-value
Modified Phillips-Perron t	0.3324	0.3698	1.9631	0.0248
Phillips-Perron t	-18.9373	0.0000	-16.2183	0.0000
Augmented Dickey-Fuller t	-16.6149	0.0000	-14.6109	0.0000
Kao (1999) Analysis				
	Stat.	p-value	Stat.	p-value
Modified Dickey-Fuller t	-14.7842	0.0000	-15.0479	0.0000
Dickey-Fuller t	-14.0736	0.0000	-14.2673	0.0000
Augmented Dickey-Fuller t	-8.2720	0.0000	-8.9537	0.0000
Unadjusted modified Dickey-Fuller t	-21.8675	0.0000	-22.3742	0.0000
Unadjusted Dickey-Fuller t	-15.1511	0.0000	-15.3717	0.0000

The Pedroni results in Table 5 are mostly significant, with the exception of the modified Phillips–Perron statistic for Model 1. All reported Kao statistics reject the null hypothesis of no cointegration. Taken as a whole, the tests support a stable relationship between the two joints under both specifications, although this evidence must be considered in light of the cross-sectional dependence found in Table 3.

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Table 6. MMQR estimates for Model 1.

Variables	Location	Scale	Q25	Q50	Q75	Q90
GF	-0.105***	-0.004	-0.102***	-0.105***	-0.109***	-0.111***
	(0.025)	(0.015)	(0.029)	(0.025)	(0.027)	(0.033)
ICT	-0.019***	0.001	-0.020**	-0.019***	-0.019**	-0.018**
	(0.007)	(0.004)	(0.008)	(0.007)	(0.007)	(0.009)
EG	0.459***	-0.058	0.508***	0.457***	0.414***	0.371**
	(0.135)	(0.085)	(0.158)	(0.135)	(0.146)	(0.180)
OPE	0.010***	0.001	0.009***	0.010***	0.011***	0.012***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
GE	1.445***	-0.087	1.519***	1.443***	1.379***	1.315***
	(0.203)	(0.127)	(0.236)	(0.203)	(0.219)	(0.270)
Constant	14.499***	1.370	13.328***	14.542***	15.550***	16.552***
	(1.191)	(0.748)	(1.387)	(1.191)	(1.289)	(1.587)

Note: Standard errors are reported in parentheses. *** and ** denote statistical significance at the 1% and 5% levels, respectively.

4.2. Main Results

The baseline MMQR estimates are shown in Table 6 and in Figure 2. GF is negative and statistically significant at the 1% level across all reported quantiles. The coefficient increases from -0.102 at Q25 to -0.111 at Q90, suggesting a slight rise in absolute value at the upper end of the conditional-emissions range. This is consistent with quantile evidence of the relationship between green finance and emissions under different emission conditions (Meo & Abd Karim, 2022) and with empirical country-level studies based on consumption-based emissions (Safi et al., 2024; Wang et al., 2023). The estimates support H1.

The results of the correlation analysis showed a negative correlation between ICT and CBE in the distribution, whereas EG and OPE were positive and statistically significant. GE was also positive in Model 1, declining from 1.519 at Q25 to 1.315 at Q90. This sign is opposite to the anticipated direct environmental impact of effective government. This may be because economies with better administrative capacity are also more likely to have high consumption levels, import demand, and other development features that are not measured by the controls. The interaction model is therefore significant because it allows for a distinction between the direct conditional association between GE and the change in the GF slope.

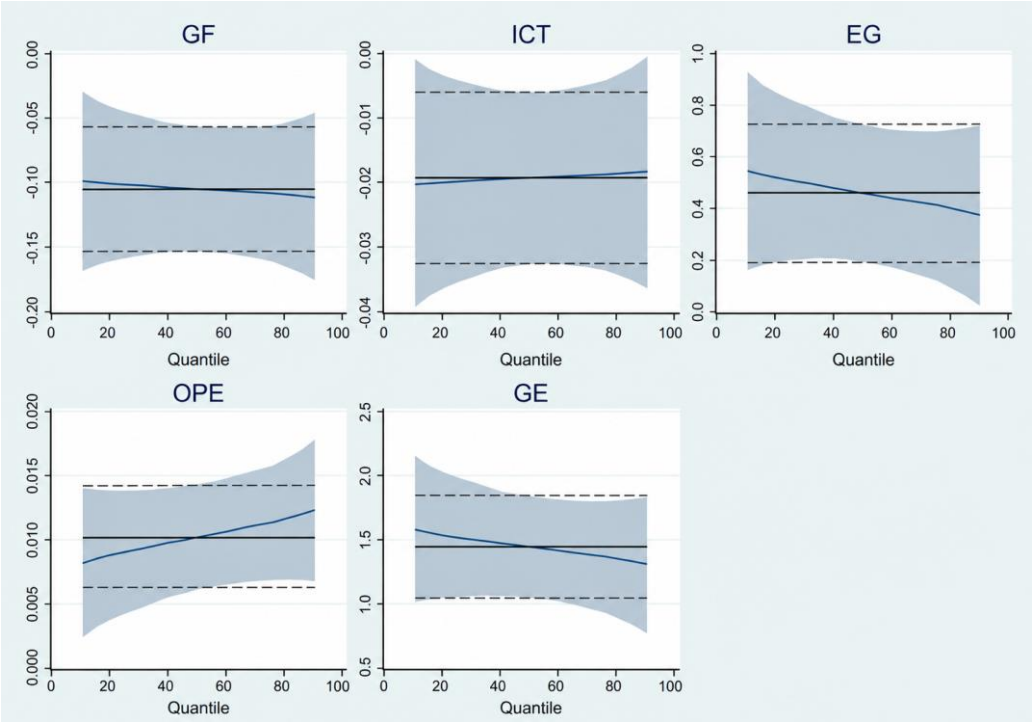


Figure 2. MMQR coefficient estimates for Model 1.

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Table 7. MMQR estimates for Model 2.

Variables	Location	Scale	Q25	Q50	Q75	Q90
GF	-0.091***	-0.003	-0.088***	-0.091***	-0.093***	-0.095***
	(0.024)	(0.015)	(0.028)	(0.024)	(0.026)	(0.031)
ICT	-0.017**	0.001	-0.018**	-0.017***	-0.017**	-0.017**
	(0.006)	(0.004)	(0.008)	(0.006)	(0.007)	(0.008)
EG	0.560***	-0.019	0.576***	0.559***	0.544***	0.532***
	(0.133)	(0.081)	(0.155)	(0.132)	(0.144)	(0.172)
OPE	0.009***	0.001	0.008***	0.009***	0.010***	0.011***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
GE	1.140***	-0.137	1.257***	1.132***	1.027***	0.936***
	(0.207)	(0.126)	(0.241)	(0.207)	(0.223)	(0.268)
GExGF	-0.177***	-0.031	-0.150***	-0.178***	-0.202***	-0.223***
	(0.042)	(0.026)	(0.049)	(0.042)	(0.045)	(0.054)
Constant	13.667***	1.044	12.780***	13.728***	14.526***	15.225***
	(1.165)	(0.708)	(1.356)	(1.164)	(1.257)	(1.509)

Note: Standard errors are reported in parentheses. *** and ** denote statistical significance at the 1% and 5% levels, respectively.

The interaction model is shown in Table 7 and Figure 3. GE×GF is negative and statistically significant at the 1% level across all quantiles, ranging from −0.150 at Q25 to −0.223 at Q90. The negative association between government effectiveness and CBE becomes more pronounced at higher conditional-emission quantiles, suggesting that the moderating effect is strongest at the top of the distribution. This result is consistent with H2.

The GF coefficient remains negative and statistically significant, ranging from -0.088 at Q25 to -0.095 at Q90. However, this coefficient is valid only for GE = 0; likewise, the GE coefficient is valid only for GF = 0. The GF association is not represented by the GF coefficient, but rather by the marginal GF association: $\beta GF + \beta GE \times GFGE$. ICT remains negative, while EG and OPE remain positive and statistically significant. The findings therefore support a governance-contingent relationship, rather than a one-size-fits-all GF coefficient at all governance levels.

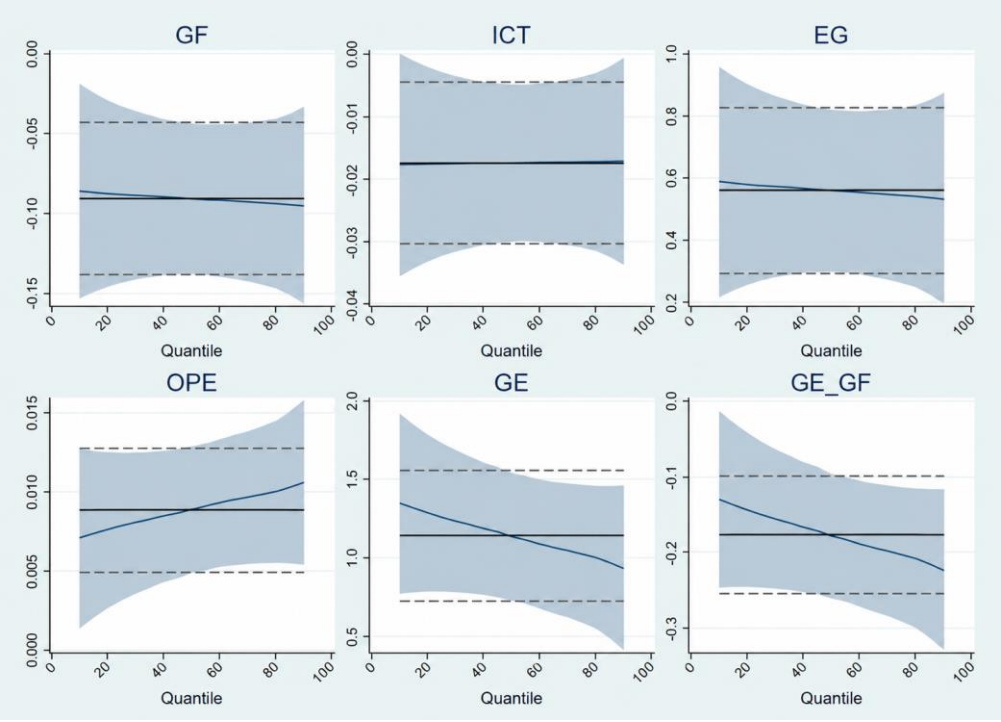
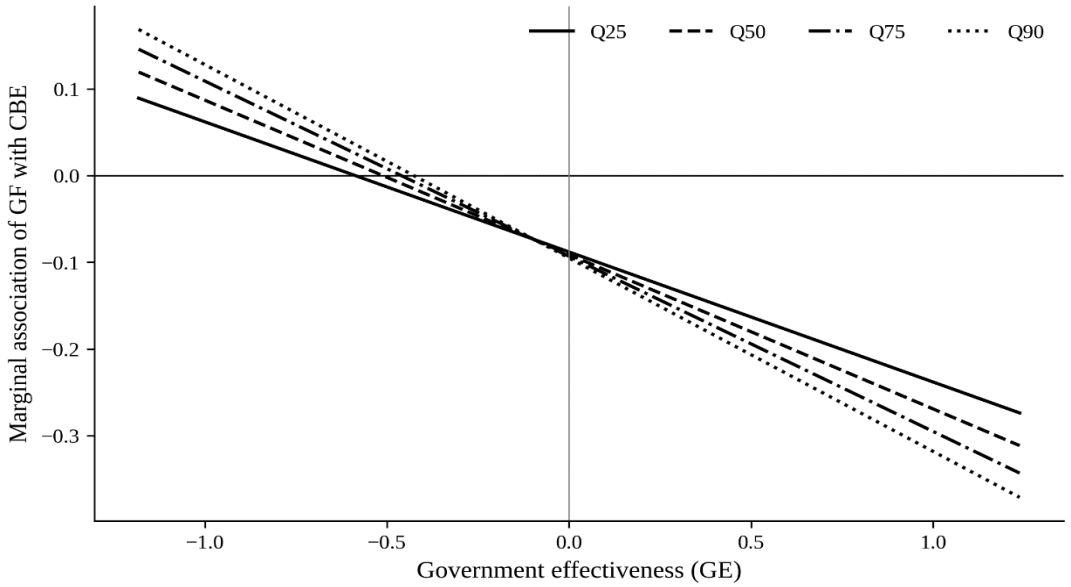


Figure 3. MMQR coefficient estimates for Model 2.

The point estimates in Table 7 are shown in a plot of the marginal GF–CBE association in Figure 4 across the GE range observed in Table 1. All quantile lines slope downward, indicating a negative association between the

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estimated GF and GE. The point estimate is attenuated and could be zero at the lowest observed GE values. The plot is descriptive because the covariance terms needed to construct confidence intervals are not reported in the output.



Note: The lines are calculated from the Q25, Q50, Q75, and Q90 coefficients reported in Table 7. Confidence intervals are not displayed because the required coefficient covariance terms are unavailable.

Figure 4. Marginal association between green finance and CBE across government effectiveness.

4.3. Robustness Analysis

Tables 8 and 9 and Figures 5 and 6 provide a comparison between the MMQR and Bootstrap Quantile Regression estimates. The objective is to determine whether the principal coefficient signs and moderation inference remain consistent under an alternative quantile estimator.

The absolute values of GF increase from Q25 to Q90 in Model 1, while the GF values remain negative and statistically significant between Q25 and Q90. The significance of ICT and EG is positive but decreases at a few upper quantiles, and OPE is also positive. Thus, the basic negative GF relationship is maintained, but the control variables are not equally stable throughout the distribution.

GE×GF is negative and statistically significant throughout the distribution and becomes even more negative, from -0.122 at Q25 to -0.303 at Q90, in Model 2. This pattern confirms the moderation result. The GF coefficients have the same sign as before and are significant, but they are not monotonic, as the highest absolute estimate occurs at Q50. Thus, the robustness analysis confirms the principal coefficient signs and the stronger upper-quantile interaction, but not necessarily the exact replication of each point estimate.

Table 8. Bootstrap quantile regression estimates for Model 1.

Variables	Q25	Q50	Q75	Q90
GF	-0.106***	-0.113***	-0.121***	-0.144***
	(0.033)	(0.029)	(0.037)	(0.032)
ICT	-0.020**	-0.024***	-0.014	-0.002
	(0.009)	(0.008)	(0.009)	(0.016)
EG	0.624***	0.479***	0.424**	0.369
	(0.182)	(0.152)	(0.195)	(0.278)
OPE	0.011***	0.010***	0.014***	0.013***
	(0.002)	(0.003)	(0.003)	(0.004)
GE	1.358***	1.353***	1.346***	1.247***
	(0.283)	(0.251)	(0.303)	(0.381)
Constant	12.246***	14.392***	15.276***	16.482
	(1.533)	(1.312)	(1.757)	(2.553)

Note: Standard errors are reported in parentheses. *** and ** denote statistical significance at the 1% and 5% levels, respectively.

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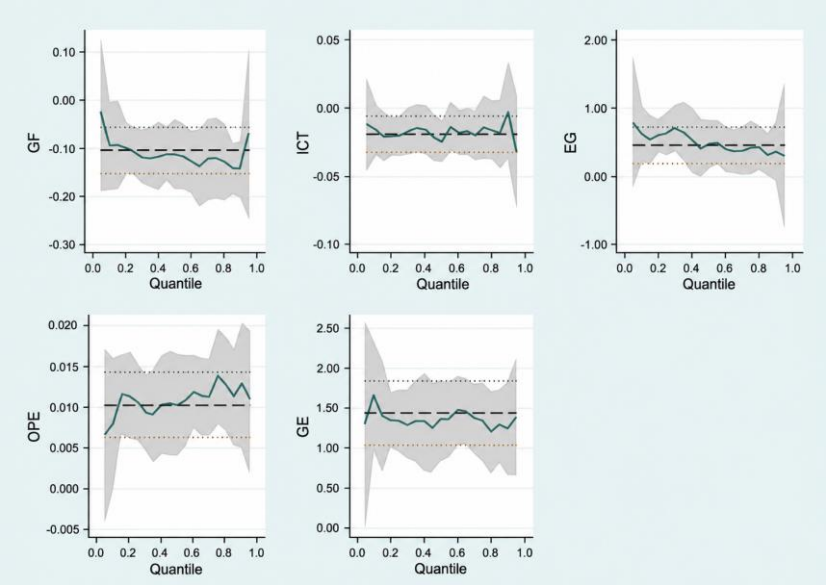


Figure 5. Bootstrap quantile regression coefficients for Model 1.

Table 9. Bootstrap quantile regression estimates for Model 2.

Variables	Q25	Q50	Q75	Q90
GF	-0.094***	-0.151***	-0.090***	-0.082***
	(0.033)	(0.035)	(0.030)	(0.032)
ICT	-0.013	-0.019**	-0.017***	-0.001
	(0.009)	(0.008)	(0.007)	(0.015)
EG	0.747***	0.448***	0.562***	0.566*
	(0.170)	(0.163)	(0.149)	(0.306)
OPE	0.009***	0.007**	0.011***	0.013***
	(0.002)	(0.003)	(0.002)	(0.004)
GE	1.050***	1.395***	0.850***	0.879**
	(0.307)	(0.266)	(0.258)	(0.436)
GExGF	-0.122**	-0.186***	-0.195***	-0.303***
	(0.057)	(0.071)	(0.049)	(0.077)
Constant	11.233***	15.037***	14.245***	14.643***
	(1.455)	(1.366)	(1.295)	(2.672)

Note: Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

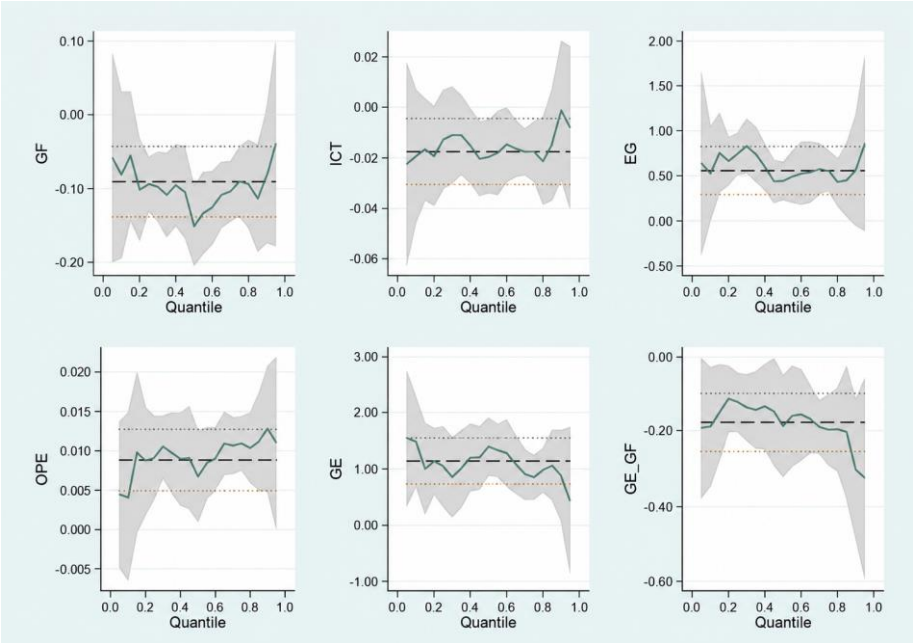


Figure 6. Bootstrap quantile regression coefficients for Model 2.

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5. CONCLUSION AND POLICY IMPLICATIONS

This paper investigates the link between green finance and consumption-based CO_2 emissions in 18 Asian economies from 2003–2023 and assesses whether government effectiveness affects that link. Heterogeneity across the conditional emissions distribution is identified using MMQR, while BSQ provides an alternative-estimator check.

The negative and statistically significant GF coefficient is observed at all reported quantiles, and the magnitude of GF becomes larger at higher quantiles, particularly at Q90. Most importantly, GE×GF is negative and significant across the distribution, with a stronger effect at higher quantiles. The point estimates therefore suggest a stronger negative green finance–emissions relationship when government effectiveness is higher. The main coefficients (GF and GE) in the model are conditional and should not be interpreted without considering the interaction. The main signs and interaction pattern are preserved in the bootstrap results, but the GF sequence in Model 2 is not the same as the MMQR sequence.

It is generally believed that ICT is associated with a decrease in CBE, while EG and OPE are associated with increases in emissions. These patterns suggest that digital service capacity can help achieve resource efficiency, whereas growth and trade can increase carbon pressure from energy consumption and carbon-intensive supply chains. These interpretations remain associative rather than causal.

The findings suggest that developing and advancing green finance require strict taxonomies, transparent disclosure, credible project-screening criteria, and environmental monitoring after financing. Such mechanisms can help direct public funding for renewable energy projects toward those with quantifiable environmental benefits and prevent resources from being misallocated or "greenwashed." Public finance need not be a silver bullet; it can instead help unlock private capital for broader green financial markets.

It is important, too, that the institution has the capability. Financial, energy, industry, and environmental regulatory agencies need common goals, enforceable standards, and a common monitoring process. Implementation capability is particularly important at the higher conditional-emission quantiles, as suggested by the larger interaction coefficients.

Economic and trade strategies should be designed to achieve the same goal: using cleaner energy, producing with fewer resources, transferring green technology, and developing supply chains with lower carbon footprints. These measures should be tailored to the national context, since the quantile positions represent conditional emission states and do not assign fixed country groups.

The results are limited by a number of restrictions. The common-coverage criterion narrows the sample to 18 economies and may cause coverage-based selection bias. GF does not include the entirety of private green credit, bonds, or sustainable investment. The ease with which ICT services are exported is a limited indicator of digital development.

The current design cannot fully address cross-sectional dependence, omitted variables, reverse causality, or endogeneity. The estimates thus do not imply causal effects. Future studies could use broader green-finance indicators, cross-sectionally sound specifications, and full-margin inference across the range of government effectiveness.

Funding: This study received no specific financial support.
Institutional Review Board Statement: Not applicable.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Acknowledgement: The authors thank Ho Chi Minh City University of Industry and Trade for its academic and institutional support.

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