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Does FinTech Promote or Hinder Climate Action? Evidence from Asian Countries[1]

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Abstract: This study examines the effects of FinTech (FIN), institutional quality (IQ), and renewable energy consumption (REC) on climate action (SDG13) in five major Asian economies (China, India, Indonesia, South Korea, and Japan) over the period 2012–2024. Given the growing role of digital finance in sustainable development, the study investigates whether FinTech acts as a driver or a barrier to climate action. The empirical analysis employs the Augmented Mean Group (AMG) estimator, and the findings are validated using the Common Correlated Effects Mean Group (CCEMG) estimator. The results reveal that the impact of FIN on SDG13 is heterogeneous across countries. FIN significantly hinders progress toward SDG13 in China and India, while it promotes SDG13 in South Korea and Japan. No significant effect is found for Indonesia. In contrast, REC consistently enhances climate action across all countries. IQ also exerts a positive and significant effect in all countries except Japan. Overall, the findings suggest that FIN alone is insufficient to advance climate action, its environmental benefits depend on the quality of institutions and the transition toward renewable energy.

Keywords: FinTech; Climate Action; SDG13; Sustainability; AMG; CCEMG

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1. Introduction

In recent years, concerns about climate change have increased significantly both within the scientific community and on the international policy agenda. The ever-increasing levels of greenhouse gas (GHG) emissions compared to pre-industrial levels are making the goal of keeping the temperature rise within the 1.5–2 °C range an increasingly difficult task with each passing year. This scenario has raised concerns regarding "Climate Action" –which 13th Goal of the United Nations Sustainable Development Goals – and moved climate change to the forefront of the global environmental policy agenda [1]. Nowadays, indeed, the destructive effects of climate change are regarded not only as an environmental problem, but also as a significant risk factor affecting multiple factors such as food security, public health, migration and economic instability concurrently [2]. Hence, the multidimensional structure and cascading effects of this phenomenon require a holistic and rigorous approach to assessing all mechanisms and policies that could promote climate action at both academic and institutional levels. At this point, the rapid development of financial technologies is gaining greater attention due to its potential to reshape financial systems and accelerate sustainability-focused efforts.

Over the past decade, financial technology (hereafter FinTech), which has emerged at the intersection of finance and digital technology, has become a key component of sustainability discussions. Within the wave of digitalization ushered in by the Fourth Industrial Revolution, FinTech is reshaping the way financial services are offered and has become a powerful instrument that facilitates financial inclusion, decreases transaction costs, and redirects capital towards green investments via mobile banking, digital payment systems, online investment platforms, and blockchain-

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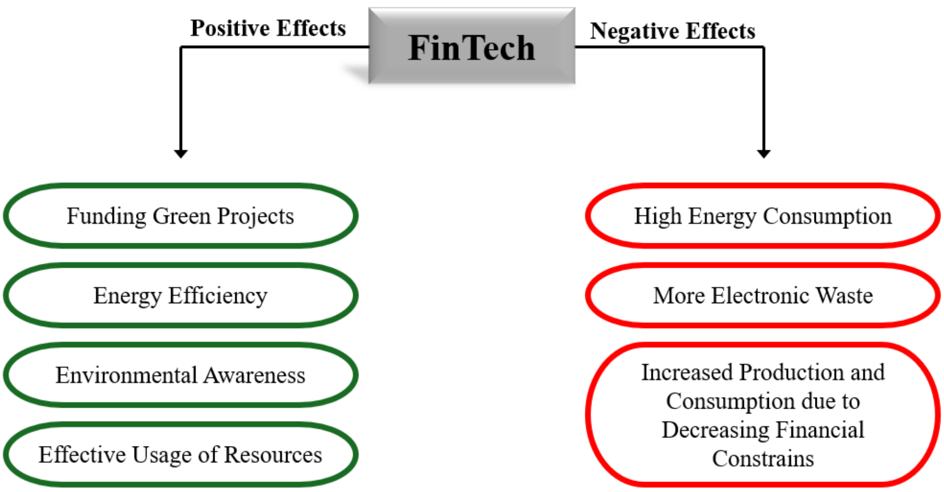
based solutions [3]. The growing literature in this field indicates that FinTech contributes to environmental quality through several channels. One of them is the expansion of access to green financing instruments through digital platforms. This means that green bond issuances and online investment platforms can reach small-scale investors who were previously outside the reach of the traditional banking system, enabling these investors to channel their funds into sustainable projects [4]. Second, big data analytics and artificial intelligence tools contribute to the tracking and reporting of environmental risks. These technologies enable institutions and regulators to monitor indicators such as carbon footprint and natural resource utilization more transparently and to design appropriate action plans accordingly [5]. Third, FinTech increases efficiency in the allocation of green funds by reducing information asymmetry and accelerating access to financing for low-carbon projects [6]. These channels illustrate that FinTech can influence environmental quality not only through indirect effects but also directly through financing, monitoring, and information management mechanisms. Despite this promising background, the environmental impacts of FinTech are still controversial. Whether the development of FinTech will ultimately reinforce efforts to mitigate the effects of climate change, or whether it will generate undesirable environmental costs, is an empirical question that requires additional investigation.

The potential positive and negative impacts of FinTech on the environment are illustrated in Figure 1.

Figure 1. The Potential Impacts of FinTech on Environment



Source: Uzar et al. (2026) [12]

The current literature focusing on FinTech and its environmental effects includes evidence that these effects are usually favorable. For instance, [7] found that green FinTech practices promote green investments and optimize resource allocation, thereby improving carbon emission efficiency. Similarly, [8] claims that the adoption of FinTech supports environmental performance of corporations and that this effect is further increased by green finance practices. However, the literature also includes findings indicating that the impact of FinTech on the environment is neither linear nor time-invariant. In this line, [9] suggest that the proliferation of digital payment systems in developing Asian countries could lead to higher CO_2 emissions due to increased energy consumption linked to digital infrastructure. Similarly, [10] points out that electricity consumption is rising sharply due to the increase in Bitcoin mining and that this increase could lead to serious environmental degradation in countries where the energy supply relies heavily on fossil fuels. Furthermore, [11] states that there are serious concerns that rising consumer spending—driven by FinTech's role in increasing financial inclusion and alleviating resource constraints—could lead to serious environmental problems. In total, these contradictory findings demonstrate that the relationship between FinTech and the environment is not linear or there is no one-size-fits-all model, but rather changes based on a country's development level and its financial and energy infrastructure.

The potential that FinTech offers in terms of environmental sustainability is particularly significant for the Asian region, which is home to more than half of the world's population and is a major GHG emitter [13]. On the one hand, fossil fuel consumption in this region is quite high and has increased dramatically over the past few decades. Even in terms of global coal consumption alone, Asia accounts for over 80 percent of the total [14]. Of course, such a sharp upward trend is reasonable given the rapid economic growth of Asian countries in recent years. On the other hand, there is remarkable heterogeneity among the region's countries in terms of economic and financial development. For instance, while China and India are characterized by rapid industrialization and high energy demand, Japan and South Korea stand out as economies with developed financial markets and advanced digital infrastructure [15, 16]. Indonesia, on the other hand, is a developing economy where fossil fuels still dominate the energy mix and which has a less developed economic and financial structure compared to others. Furthermore, the rapid industrialization process and growing energy needs make the region's economies both the most critical and the most challenging actors in reducing GHG emissions. Unfortunately, current trajectory indicates that regional emissions will continue to rise in the coming years if effective decarbonization policies are not implemented. Given the heterogeneous structure of Asian countries and their rapid economic growth trends, unlocking the sustainability synergies of FinTech development in these nations serves as a source of motivation.

The current literature on this field has some gaps, particularly regarding Asian countries. For instance, studies on ASEAN countries [17], Central Asian economies [18], or the BRICS group [19], demonstrate that FinTech shapes environmental quality through its interactions with financial inclusion, renewable energy use, and natural resource management. However, a significant part of this research remains limited to a specific subregion, and studies that collectively address large economies at varying levels of development —representing East, South, and Southeast Asia— remain relatively few. Furthermore, there is no clear consensus in the literature regarding the indicators used to measure FinTech. Some studies use digital financial inclusion indices, others rely on composite indicators based on mobile and internet access, and still others use the volume of FinTech investments as the primary measure. This methodological diversity limits the comparability of findings while also opening the space for exploring different measurement strategies in future studies.

Considering the literature gap presented above, this study aims to examine the effect of FinTech on Sustainable Development Goal 13 (Climate Action) via a panel data consisting of China, Indonesia, India, South Korea, and Japan. The justification for analyzing these five economies simultaneously is to incorporate the region's heterogeneity in terms of development levels and energy consumption patterns into the analysis, thereby providing a more comprehensive perspective on the relationship between FinTech and climate action. To do this, this study employs the Augmented Mean Group (AMG) coefficient estimator. The findings reveal that FinTech's impact on SDG 13 is negative for China and India, yet positive for South Korea and Japan. However, the coefficients for Indonesia are not statistically significant. Furthermore, the Common Correlated Effects Mean Group (CCE) estimator, which was used to robust the findings, confirms the results obtained from the AMG estimator. In light of these findings, the study provides insightful implications for both climate policymakers and practitioners.

The following sections of this study are structured as follows: The second section provides an overview of the literature and presents empirical evidence regarding the link between FinTech and SDG 13. The third presents data sources and methodological prescription. The fourth and fifth present empirical findings and conclusions, respectively. Finally, in the sixth section, a discussion is carried out based on the empirical findings and the previous literature relevant to FinTech and environmental sustainability.

2. Literature Review

In recent decades, the accelerating melting of glaciers, rising land temperatures and their catastrophic disasters have elevated the combating climate change to the top of the global agenda as a foremost challenge of the 21st century [20]. Governments and global organizations across the world are striving to mitigate the effects of climate change and to achieve the target set out in the Paris Climate Agreement of limiting global temperature rise to between 1.5-2 °C [21]. In this regard, reducing GHG emissions, the main cause of climate change, is crucial and is closely associated with the increased use of renewable energy and improvements in resources and energy efficiency [22]. As such, UN Climate Change Conference, a call was made for "all countries to stop providing funding or subsidies for new coal-fired power plants" [23]. However, renewable energy transition and eco-friendly technologies require substantial investment in deployment, maintenance, and R&D. Yet, there is a huge funding gap, and it is a roadblock to mitigate effects of climate change [24].

Against this backdrop, FinTech is receiving greater attention as a new catalyst for tackling climate change in the recent literature. On the one hand, for instance, Sreenu (2024) [25] indicates that FinTech and green bonds are among the key drivers in advancing the renewable energy transition in India. Especially, it underscores that FinTech has highly leveraged the financial efficiency of renewable energy projects, eased access to finance, and increased investor confidence. In the same vein, Li et al. (2022) [26] emphasize that FinTech platforms create new opportunities for financing renewable energy projects through green bonds and can improve resource allocation for these projects. From another perspective, Dar and Jaiswal (2025) [27] suggest that FinTech can reduce resource consumption and carbon emissions arising from financial transactions by promoting digital payment systems, internet banking and online financial services as alternatives to cash and hard copy-based financial transactions. Moreover, they point out that FinTech can promote sustainable economic transition and foster environmental awareness by encouraging eco-friendly practices. Indeed, these arguments are supported by empirical studies. Kashif et al. (2026) [28], found that FinTech contributed to climate action and the achievement of net-zero carbon objectives in their study focusing on G-20 countries over the period 2010–2022. Similarly, the findings of Eyuboglu and Uzar (2026) [29], revealed that FinTech improves resources efficiency, facilitates access to eco-friendly investments and encourages sustainable financial behaviour in Brazil. The findings of Qin and Tan (2025) [30] shown that FinTech improves renewable energy transition in China, especially developed eastern and midland cities. Ayaydın et al. (2025) [31] findings indicate that FinTech indirectly decrease ecological footprint by facilitating green energy transition in BRICS-T countries.

On the other hand, the environmental effects of FinTech are not entirely favorable. The widespread use of digital financial services requires more energy consumption for data centers, cloud computing infrastructure and high-speed communication networks, which may lead to higher carbon emissions [32]. Also, energy-intensive activities like blockchain-based applications and cryptocurrency mining reduce the service life of electronic devices and cause more electronic waste [33]. If these wastes cannot be properly managed, hazardous chemicals could become additional strain sources for the environment and natural resources [34]. For instance, in their study using data from 2013 to 2023, Liu et al. (2024) [35] found that the growing FinTech ecosystem has led to environmental degradation. The authors imply that this is particularly associated with energy-intensive cryptocurrency mining. Similarly, investigating the relationship between FinTech and CO_2 emissions from 2000 to 2021 across 17 developed countries Ali et al. (2025) [36], reported that FinTech has an upward effect on CO_2 emissions in the short-run. As another study, Lisha et al. (2023) [32] found that FinTech and natural resources adversely affect environmental sustainability across all quantiles in BRICS. Similar findings confirmed by Bai et al. (2025) [33], their findings reveal that FinTech negatively affect environmental quality and this effect more apparent especially at higher quantiles.

The current literature is far from reaching a broad consensus on the impact of FinTech on environmental sustainability or climate change and paints a polarized picture around two opposing viewpoints. These mixed findings indicate that the environmental impacts of FinTech change depending on the sample, countries' development levels, time, and how FinTech variable is structured. Indeed, many studies use proxy variables like number of ATMs per 100,000 people, the number of broadband or mobile subscribers to establish a FinTech index. However, these are mostly linked to digital infrastructure and not adequately proper to represent FinTech. In this sense, this study adds also cashless payments and SWIFT participation in the FinTech index to more accurately capture FinTech adoption. By doing this, the study introduces a novel FinTech index to the literature. On the other hand, this study uses countries' SDG13 scores as a proxy for environmental sustainability. Compared with conventional environmental indicators (e.g. CO_2 emissions, ecological footprint, etc.), SDG 13 provides a more comprehensive assessment by reflecting not only environmental quality but also climate policies, institutional capacity, and climate finance. Furthermore, by focusing on five major Asian economies with different levels of FinTech development and institutional quality, this study provides new evidence on whether the relationship between FinTech and climate action differs across heterogeneous economic and institutional contexts. To sum up, this study is original because it uses SDG 13 as a proxy for environmental sustainability, proposes a new FinTech index and examines Asian countries that have received relatively less attention, and thus has the potential to make a significant contribution to the literature.

3. Data, Model and Methodology

3.1. Data and Model Specification

The current study aims to uncover the impact of FinTech, institutional quality, and renewable energy consumption on SDG 13 in Asian countries (China, India, Indonesia, Korea, and Japan) from 2012 to 2024. To realize this, secondary data was obtained from various sources. The 12-year time span of the study is justified by data availability. All data are taken from the publicly available World Development Indicators (WDI), Bank for International Settlements (BIS) and Sustainable Development Solutions Network (SDSN) databases. Table 1 presents detailed information on the variables.

In this study, SDG13 score of Asian countries using as proxy for environmental sustainability instead of CO_2 emissions or ecological footprint. Because CO_2 emissions [34,35,36] and the ecological footprint [37,38,39] are single-dimensional indicators that measure specific aspects of environmental sustainability, whereas the SDG13 score is a multidimensional indicator that assesses performance in combating climate change alongside its economic, institutional and governance dimensions. Therefore, usage of SDG13 as a proxy for environmental sustainability reflects not only current environmental outcomes but also countries' capacity to formulate and implement sustainable climate policies. Particularly, when assessing the impacts of phenomena with multiple impact mechanisms like FinTech, the comprehensive approach offered by SDG13 enables a more effective analysis of the climate dimension of environmental sustainability [40].

Table 1. Data Description

Abb.	Variable	Description	Source
SDG13	Sustainable Development Goal 13 Country Rankings	SDG 13 progress scores for each country	SDSN
IQ	Institutional Quality	Arithmetic means of World Governance Indicators (from -2.5 to 2.5)	WDI
REC	Renewable Energy Consumption	Per capita renewable energy consumption (kWh)	Our World in Data
FIN	FinTech	Volume of cashless payments and withdrawal/ deposit transactions (millions; total for the year)	BIS
		Participation in SWIFT by domestic institutions (total number of SWIFT users)	BIS
		Automated teller machines (ATMs) (per 100,000 adults)	WDI
		Mobile cellular subscriptions (per 100 people)	WDI
		Individuals using the Internet (% of population)	WDI

On the other hand, the main explanatory variable, FinTech, was generated through Principal Component Analysis (PCA). It is a data reduction method that transforms many interrelated variables into a smaller number of independent variables, while maintaining as much of the information in the data as possible. In this way, it eliminates the multicollinearity problem and makes the analyses easier to interpret [41]. To structure a composite FinTech index, volume of cashless payments and withdrawal/ deposit transactions (millions; total for the year) [12], Participation in SWIFT by domestic institutions (total number of SWIFT users) [12], Automated teller machines (ATMs) (per 100,000 adults) [42], Mobile cellular subscriptions (per 100 people) [43], and individuals using the Internet (% of population) variables [44] are used. These are common variables that are used to construct for FinTech index in literature.

The environmental degradation caused by economic growth in a country is closely linked to environmental protection policies implemented by policymakers. In fact, environmental regulation prompts companies and individuals to adopt eco-friendly practices to protect the environment. However, strict environmental regulations must be maintained at an optimal level to avoid hindering economic growth, thereby requiring a higher-level institutional quality [45]. Thus, IQ variable, representing institutional quality, was also adopted as another explanatory variable.

Finally, in line with the broad consensus in the literature on environmental and energy economics, REC is employed as a control variable as a proxy for renewable energy consumption. Numerous studies in the literature affirm the positive relationship between renewable energy consumption and environmental sustainability [46,47].

In this respect, the empirical model of the study is formulated as shown in Eq. (1):

$$SDG13_{it} = \alpha_0 + \beta_1 FIN_{it} + \beta_2 IQ_{it} + \beta_3 REC_{it} + \varepsilon_{it} \quad (1)$$

where $SDG13$ is Climate Action scores, FIN is financial technologies, IQ is institutional quality and REC is per capita renewable energy consumption (kWh) of countries. $i = 1, \dots, N$ indicate countries; $t = 1, \dots, T$ symbolize time span; $\beta_1, \dots, \beta_3$ are parameters the coefficients that quantify the impact of the explanatory variables on the exploratory variable; and ε_{it} denote error term for country i at time t. Also, to eliminate heteroscedasticity and get more reliable coefficients, the REC variable was incorporated into the model with natural logarithm transform.

3.2. Methodology

A four-stage estimation methodology was employed to investigate the influence of FIN, IQ and REC on SDG13 in Asian countries. The methodological flowchart is illustrated in Fig. 2.

3.2.1. Preliminary Tests

In the first stage of the empirical procedure, the multicollinearity problem amongst the independent variables, cross-sectional dependence (CSD), and slope heterogeneity are checked. In this respect, initially, Variance Inflation Factor (VIF) was carried out to check whether there is a multicollinearity problem amongst the variables. The VIF produces a value from 1 to 10 for each variable. According to the literature, if the VIF values obtained for each independent variable are less than 5, this indicates that these variables have a unique effect on the dependent variable and that there is no problem of multicollinearity [48].

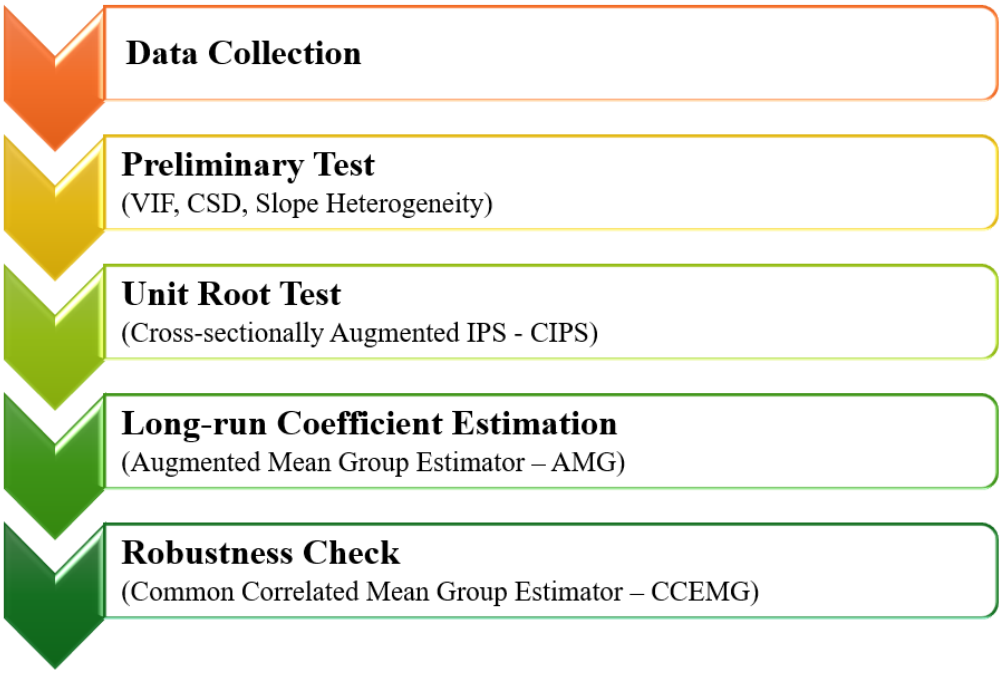


Figure 2. Methodological Flowchart

Secondly, to investigate whether there is cross-sectional dependence (CSD) amongst the units composing the panel. Early econometric literature largely assumed the independence of cross-sections [49]. However, interactions across countries, institutions and even individuals have increased significantly. Hence, spatial factors, spillover effects or unobserved common factors may arise amongst the units [50]. For this reason, Pesaran (2004) CD LM [51] and Friedman (1937) [52] rank test employed to check CSD.

Finally, to test slope heterogeneity, the tests proposed by Pesaran and Yamagata (2008) [53] and Blomquist and Westerlund (2013) [54] are applied to test for slope heterogeneity. As is well known, standard panel data regression models, such as those with fixed effects and random effects, assume that the parameter of interest is homogeneous. However, this is often not real, and a shock occurring in any one unit does not affect all the others to the same degree. Therefore, testing for heteroscedasticity is essential in panel data analysis.

3.2.2. Unit Root Test

Stationarity of series plays a vital role in panel data and time series analysis. In fact, analyses performed with non-stationary series can lead to spurious regression and biased results. Therefore, the CIPS unit root tests, introduced by Pesaran (2007) [55], are employed to identify the integration order of the series.

In the CADF unit root test introduced by Pesaran (2007), test statistics are calculated for each unit separately using Monte Carlo simulation. Then, the CIPS test statistics are calculated by taking the arithmetic mean of the CADF critical values calculated for each unit, as shown in Eq. (2).

The calculated test statistics are compared to critical values given in Table II(a), II(b) or II(c) in Pesaran's (2007) study to decide whether the series are stationary. If the calculated CIPS test statistics are lower than the critical values given in the tables, the null hypothesis is rejected and concluded that the series are stationary.

3.2.3. Augmented Mean Group Estimator

Finally, we apply the Augmented Mean Group (AMG) coefficient estimator proposed by Eberhardt and Bond (2009) [56] and Eberhardt and Teal (2010) [57] to estimate long-run coefficients.

The choice of the AMG coefficient estimator is justified by several advantages. Firstly, it allows for CSD, and slope heterogeneity issues frequently encountered in panel data [58]. By incorporating common dynamic processes into the model via time-dummy coefficients derived from first-difference regression, it controls for the effects of unobservable common factors and thus allows for CSD. Secondly, the AMG estimator can provide reliable results even when the variables are non-stationary and have a robust structure that is resilient to whether the panel is cointegrated [59].

The AMG procedure is applied in three steps: In the first step, a pooled regression model augmented with year dummy variables is estimated using first-difference OLS, and the coefficients relating to the (differenced) year dummy variables are aggregated; Next, the group-specific regression model is extended using this estimated process; and the group-specific model parameters are averaged across the panel (weights may be applied) [60].

4. Results and Discussion

Before the presentation of the empirical findings, it is essential to explain the statistical properties of the variables. Descriptive statistics are presented in Table 2.

Table 2. Descriptive Statistics

	SDG13	FIN	IQ	REC
Mean	83.56813	1.54E-07	61.56409	7.223735
Max.	96.84933	3.84658	81.94857	8.69412
Min.	66.32367	-0.52446	44.75792	5.6151
Std. Dev.	10.67765	2.212811	12.79515	0.944296
Skewness	-0.29283	2.595739	0.482193	-0.16619
Kurtosis	1.612387	8.824255	1.49803	1.5463
Jarque-Bera	6.143793	164.8655	8.628628	6.022589
Prob.	(0.0463)	(0.0000)	(0.0133)	(0.0492)
Obs.	65	65	65	65

As shown in Table 2, SDG13 and IQ exhibit a relatively wide distribution around the mean, while FIN and REC have more limited variability. The skewness and kurtosis values indicate that, except FIN, the series have close to a normal distribution, and the Jarque-Bera test statistics also support this. As a results, the data are appropriate for further econometric estimation.

The pairwise correlation matrix is presented in Table 3.

Table 3. Pairwise Correlation Matrix

Variable	SDG13	FIN	IQ	REC
SDG13	1.0000			
FIN	0.0884	1.0000		
IQ	0.7992	0.3015	1.0000	
REC	0.5673	0.4504	0.4753	1.0000

According to Table 3, there is a high level of positive correlation between IQ and SDG13, which indicates that institutional quality may be a significant determinant of climate action performance, as expected. Similarly, the relatively positive correlation between REC and SDG13 is consistent with the literature. However, FIN is found to have a weak correlation with SDG13, which implies that the effect of FinTech on climate action may occur through indirect or interactive mechanisms rather than a linear relationship.

Following the identification of the statistical properties of the variables, the VIF test results, which were carried out to test for multicollinearity, are reported in Table 4.

Table 4. Variance Inflation Factors

Variable	VIF	1/VIF
FIN	2.20	0.4537
IQ	2.27	0.4405
REC	2.59	0.3863
Mean VIF	2.35	

Regarding the concern of multicollinearity, VIF values of 10 or higher are usually considered an indication of serious multicollinearity. However, based on Table 4, the VIF values for all independent variables are lower than 5. These results clearly suggest that there is no multicollinearity problem in the empirical model.

Table 5. Cross-sectional Dependency and Slope Heterogeneity

Test	Cross-Sectional Dependency			
Pesaran	28.732 [a]		(0.000)	
Friedman	52.992 [a]		(0.000)	
	Pesaran and Yamagata (2008)		**Blomquist and Westerlund (2013)**	
Delta	3.376 [a]	(0.001)	2.786 [a]	(0.005)
Delta adj.	4.304 [a]	(0.000)	3.552 [a]	(0.000)

Note: [a] and [b] symbolize 0.01 and 0.05 statistical significance, respectively. Critical values are presented in parentheses.

The results presented in Table 5 indicate the existence of a high degree of CSD among the units. This means that the countries in the panel are not independent of one another and are affected by common shocks. Furthermore, Delta and adjusted Delta adj. test statistics obtained from Pesaran and Yamagata (2008) and Blomquist and Westerlund (2013) tests were statistically significant at the 1% and it indicates that the slope coefficients are heterogeneous across the units in the panel and that a shock occurring in one country affects the others to different degrees. These findings suggest that further tests, such as unit root and cointegration, must be second-generation which consider CSD and slope heterogeneity.

Relying on CSD and slope heterogeneity results, we use a second-generation unit root test, CIPS, to check stationary properties of variables. The CIPS test results are tabulated in Table 6.

Table 6. CIPS Unit Root Test

Variable	Level	First Diff.	Results
SDG13	-0.512	-3.003 [a]	I_1
FIN	-1.119	-2.394 [b]	I_1
IQ	-2.175	-3.378 [a]	I_1
REC	-1.506	-2.748 [a]	I_1

Note: Critical values are -2.66, -2.37 and -2.22 for 0.01, 0.05 and 0.1, respectively

According to Table 6, as none of the variables in the model are lower than the critical value of -2.22, which denotes a 10% statistical significance, they are non-stationary at level. However, all variables become stationary at %1 statistical significance, as their critical values are less than the critical value of -2.66 at the first difference, except FIN. The FIN is stationary at 5%, as its critical value is between -2.22 and -2.37.

After identifying the integration orders of the variables, we run the AMG estimator to estimate the long-run coefficients. The results are tabulated in Table 7.

Looking at the results in Table 7, a 1-unit increase in FIN decreases SDG13 by -0.678 and -0.557 in China and India, respectively. By contrast, in Korea and Japan, it raises SDG13 by 8.265 and 7.419. As for Indonesia, even though the coefficient is 6.086, it is not statistically significant as the critical value is 0.192. On the other hand, the effect of IQ on SDG13 is positive in all countries except Japan. Finally, as expected, REC also has a positive effect on SDG13 in all countries.

Table 7. AMG Coefficient Estimations

Country	FIN	IQ	REC
China	-0.678 [a]	0.072 [b]	0.486 [a]
	(0.008)	(0.037)	(0.003)
Indonesia	6.086	0.062 [a]	0.641 [a]
	(0.192)	(0.006)	(0.006)
India	-0.557 [b]	0.087 [a]	0.609 [a]
	(0.021)	(0.003)	(0.009)
Korea	8.265 [b]	0.112 [c]	1.904 [a]
	(0.025)	(0.076)	(0.002)
Japan	7.419 [b]	-0.016	4.087 [b]
	(0.011)	(0.900)	(0.023)
Panel	0.534 [b]	0.002 [b]	0.064 [a]
	(0.033)	(0.048)	(0.005)

Note: [a], [b] and [c] denote 0.01, 0.05 and 0.1 statistical significance, respectively.

To get deeper insight and ensure the robustness of the findings, robustness analysis was conducted using the Common Correlated Effects Mean Group (CCEMG) estimator proposed by Pesaran (2006) [61], which accounts for CSD and slope heterogeneity. The CCEMG results are shown in Table 8.

Table 8. CCEMG Coefficient Estimations

Country	FIN	IQ	REC
China	-1.086 [b]	0.087 [b]	2.362 [c]
	(0.041)	(0.019)	(0.054)
Indonesia	8.613	0.096 [b]	0.629 [c]
	(0.726)	(0.016)	(0.053)
India	-0.622 [b]	0.006 [c]	1.947 [b]
	(0.032)	(0.092)	(0.024)
Korea	6.723 [c]	0.091 [b]	2.852 [b]
	(0.071)	(0.045)	(0.027)
Japan	11.216 [b]	0.146	1.967 [b]
	(0.031)	(0.246)	(0.049)
Panel	6.192 [c]	0.013 [c]	0.061 [c]
	(0.082)	(0.079)	(0.065)

Note: See in Table 7

The coefficients obtained from the CCEMG estimator are shown in Table 8. According to this, FIN has a negative effect on SDG 13 in China and India, while the opposite is found in Korea and Japan. Also, the coefficient is insignificant in Indonesia. Furthermore, the whole panel result indicates that FIN promotes SDG13. Moreover, IQ has a positive impact on climate action in all countries except Japan. Similarly, the contribution of REC to climate action is also verified by the CCEMG model.

The findings suggest that FinTech hinders climate action in China and India but acts as a catalyst in Korea and Japan. In this regard, they are partly consistent with Sreenu (2024) [25], who argues that FinTech supports renewable energy by providing greater accessibility, transparency, and lower transaction costs. However, as pointed out by Liang and George (2024) [62], although FinTech has a stimulating effect on economic activity, if the increase in production and consumption is not balanced by improved efficiency, it can also lead to adverse effects such as higher energy consumption and CO_2 emissions. In fact, FinTech's potential in the context of climate action is closely linked to countries' energy mix and the stringency of their environmental regulations [63]. As Ali et al. (2019) [64] suggests, this highlights institutional quality as a balancing and regulatory factor in the relationship between FinTech and climate action.

5. Conclusion

The study analyzed how FinTech (FIN), institutional quality (IQ), and renewable energy consumption influenced progress toward climate action (SDG13) in five major Asian countries (China, India, Indonesia, South Korea and Japan) during the 2012–2024 period. Results from the AMG coefficient estimator, proposed by Eberhardt and Bond (2009) and Eberhardt and Teal (2010), indicate that the effect of FinTech on climate action is mixed. As such, while it has a significantly negative effect on SDG13 in China and India, it has positive effect in Korea and Japan. In Indonesia, however, there is no statistically significant effect. In addition, the AMG estimator results are also validated by the CCEMG.

On the other hand, the effects of institutional quality and renewable energy consumption are much more consistent. In fact, institutional quality has a positive and statistically significant effect on SDG13 in all countries except Japan. We attribute the insignificant result in Japan to the fact that the already high level of institutional quality limits the marginal effect on climate actions. Meanwhile, renewable energy consumption improves climate actions across the whole panel. To sum up, these results imply that only FinTech cannot ensure progress on climate actions, and that its environmental contributions heavily depend on countries' energy mix and the effectiveness of the institutional environment that drives it.

6. Policy Implications and Limitations

The results of the study, which examines the impact of FinTech on climate action in Asian countries, provide some insightful policy implications. Firstly, the country-specific effects of FinTech demonstrate that FinTech policies must be tailored to each country's unique conditions rather than relying on a one-size-fits-all model. For instance, in China and India, where FinTech has a negative impact on climate action, policymakers can reduce GHG emissions by easing financial constraints on companies that prioritize sustainability and by incentivizing green innovation. To achieve this, they could introduce regulations that encourage FinTech platforms to finance projects that reduce carbon emissions. Also, the credit scoring systems used in digital banking applications provided by FinTech can be re-arranged to support companies with better environmental practices. In this way, FinTech development in these countries can be aligned with climate goals. Furthermore, policymakers could impose fiscal instruments on energy-intensive activities like cryptocurrency mining, which generate large amounts of e-waste. The revenue yielded in this way could be allocated to eco-friendly projects to mitigate the adverse environmental effects [65]. In South Korea and Japan, where FinTech has shown a positive impact on SDG 13, further incentivizing green financing tools and providing greater support for eco-friendly R&D projects will enhance the synergy between FinTech and climate action. In Indonesia, where FinTech has no significant impact on SDG 13, priority should be made to establishing infrastructure for basic digital financial access. Indeed, increasing financial inclusion through FinTech has the potential to advance climate action in the long-term.

The progressive effect of institutional quality on SDG 13 implies that environmental regulations are a primary climate policy tool rather than a secondary one. Indeed, Wang et al. (2023) [66] point out that weak environmental regulations and poor institutional quality increase the ecological footprint resulting from consumption, whereas stronger institutions and technological innovation improve environmental quality. This indicates that, in addition to regulations related to FinTech in China, India, and Indonesia, environmental regulations must also be enforced more rigorously. Therefore, the formulation of strict environmental regulations is crucial for ensuring that FinTech and green finance policies function as planned.

As renewable energy consumption improves SDG 13 performance across all five Asian countries, regardless of FinTech adoption or levels of institutional development, sustained investment in clean energy must remain one of the top priorities across the region. However, considering that reliance on natural resource revenues can harm environmental quality, Asian countries with developed mining sectors could allocate a part of their revenues specifically towards renewable energy projects, combating deforestation, and increasing soil quality [67]. To sum up, all countries must empower regulatory authorities, increase investments in renewable energy, and use natural resource revenues to finance eco-friendly projects.

Furthermore, to turn into these macro-level insights into operational instruments, regional policymakers should establish standardized Green FinTech Taxonomies and mandatory ESG-integrated algorithm audits for digital financial institutions. Specifically, central banks and financial regulatory authorities in fast-growing digital economies (e.g. China and India) can mandate that FinTech providers integrate automated carbon footprint tracking APIs into corporate digital payment platforms. This would enable real-time tracking of emissions associated with funded projects and allow commercial banks to adjust credit interest rates dynamically based on verified climate compliance. Additionally, to prevent regulatory arbitrage across heterogeneous Asian economies, regional framework agreements should be established to facilitate cross-border green data sharing, harmonize green digital asset standards, and allocate targeted subsidies for FinTech startups operating in emerging markets like Indonesia.

Like any study, this study suffers from several limitations. First, the panel consist of five Asian countries, and time frame is 2012–2024. Although this reflects a meaningful diversity in financial and institutional development, the generalizability of the findings is poor. Second, institutional quality was calculated as the arithmetic mean of the WGI's six sub-components. This may obscure the effects of factors such as regulatory quality and control of corruption that could have varied importance for climate actions. Finally, while the AMG and CCEMG estimators effectively account for CSD and slope heterogeneity in panel data, they cannot adequately deal with potential reverse causality. Therefore, further studies can contribute to literature by employing cutting-edge panel data techniques that address the limitations of these methods, as well as by conducting research that addresses other limitations.

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