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Green Finance and Sustainable Development in Asia: The Mediating Role of Heat Resilience

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Abstract: *This study investigates the relationship among green finance, heat resilience outcomes, and sustainable development in Asian nations, focusing on the mediating role of heat resilience in the relationship between green finance and sustainable development. It highlights the increasing significance of climate-related hazards, including extreme heat, and the alignment of financial resources with environmental sustainability and climate adaptation. The study employs a quantitative approach using a longitudinal research design and balanced panel data from 35 Asian countries over 20 years, comprising 700 country-year observations. Green finance is examined as the independent variable, heat resilience outcomes as the mediating variable, and sustainable development as the dependent variable. The analysis applies pooled ordinary least squares, fixed-effects, and random-effects models, with model-selection tests supporting the fixed-effects approach. The results indicate that green finance has a positive and statistically significant relationship with heat resilience outcomes ($\beta = 0.418$, $p < 0.001$) and sustainable development ($\beta = 0.371$, $p < 0.001$). Heat resilience also demonstrates a positive and significant relationship with sustainable development ($\beta = 0.521$, $p < 0.001$). Furthermore, the findings reveal that heat resilience partially mediates the relationship between green finance and sustainable development, with a significant indirect effect ($\beta = 0.218$, $p < 0.001$; 95% CI [0.148, 0.292]). The study emphasizes the need to integrate green-finance measures with heat-resilience planning and sustainable-development policies. The findings offer practical implications for governments, financial institutions, and regional stakeholders, highlighting the importance of climate-resilient infrastructure, adaptive technologies, regional cooperation, renewable energy, sustainable financing instruments, measurable resilience indicators, and financing for resilient technologies.*

Keywords: Green Finance, Heat Resilience Outcome, Sustainable Development

Introduction

Background of the Study

The heat-related climatic risk is high in Asian countries and is becoming more severe with the rise in temperature and more frequent extreme weather events. This vulnerability calls for increasingly strong focus on climate adaptation and resilience measures to protect environmental and socio-economic systems. In Asia, sustainable development is faced with complex problems due to the contradiction between rapid economic growth and environmental preservation. The effects of multilateral cooperation, investment in infrastructure, and regional transitions on green development and climate resilience have been mixed and require careful consideration of economic development and ecological sustainability. For example, the Belt and Road Initiative has helped to facilitate sustainable development in Asian countries, although there is a need to consider the environmental impacts of mega-infrastructure initiatives (Ullah et al., 2025).

Green finance has become a key channel to align climate and environmental concerns in this context. Green finance, through financial innovations like green bonds, sustainability-linked loans, and digital finance platforms, provides the financial support needed to invest in sustainable infrastructure and technologies for mitigating climate change and utilizing renewable energy. What is particularly notable about this financial method is that it not only helps mobilize resources, but also promotes innovation, transparency and

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accountability in investments in the climate sector. The positive impacts of green finance on sustainable development have been proven so far, as it has supported technologies for adaptation to climate change to reduce vulnerability and boost resilience. The combination of green finance and technological innovations has an enhancing effect on the environment and contributes to the realization of Sustainable Development Goals. In addition, by incorporating green finance into policies, local government empowerment and environmental decentralization boost sustainable outcomes. Therefore, the link between green finance and heat resilience and sustainable development is also a close one: Green financial instruments are essential to provide the financial resources and innovation to enhance adaptive capacities to reduce growing heat risks and to improve sustainable development goals in Asian economies (Habib et al., 2025; Radhakrishnan, 2025; Zaman et al., 2025).

Incorporating sustainability and climate resilience principles into investment strategies has become a vital aspect of tackling environmental challenges worldwide, and Green finance has emerged as a transformative force. It has a wide scope of financial instruments and mechanisms designed to promote financial investment for environmental purposes. The climate change challenge, supported by the Paris Agreement and other international climate change deals, has brought green finance to the top of policy and market agendas. Key financial instruments in this ecosystem include green bonds, sustainability-linked loans, and environmental, social, and governance (ESG) investment funds, which all help to drive capital to projects that promote renewable energy, energy efficiency, and other sustainable activities. While greenwashing concerns and standardized reporting remain challenges, technological innovations such as AI and blockchain have contributed to greater transparency, efficiency, and accountability within green finance. The advancement and complexity of green finance have been fueled by institutional investors, corporations, and government policies, underscoring its significance in fostering long-term economic and environmental stability (Radhakrishnan, 2025).

Green investment and green credit are increasingly playing an important role in green finance, and green bond is an important financing tool for climate and environmental projects. Supranational financial institutions have been the first issuers to issue bonds, and these bonds have been used to fund projects in renewable energy, energy efficiency, and clean transportation throughout the world; environmentally vulnerable countries have seen considerable issuances of green bonds. In addition to capital mobilization, these instruments also offer a reputation effect, in response to investors' demand for investment portfolios that are more eco-oriented. Moreover, digital green finance mechanisms, when coupled with climate change adaptation technologies, can help direct financial flows towards the development of renewable energy infrastructure and resilience-building projects, which will help communities to better adapt to climate effects. Green financial flows show a very positive relationship with financing of renewable energy, highlighting the pivotal function of green financing in the low-carbon transition. Strategic allocation of such financial resources can boost climate adaptation and resilience through the development and use of technological innovations that lessen vulnerability and boost sustainability. Thus, green finance has the ability to facilitate the clean energy transition while also fostering the financial-ecological-climate (FEC) relationship (Elhaj et al., 2025; Kokurin et al., 2025; Zaman et al., 2025; Zhang et al., 2022).

Increasing exposure to extreme heat is a growing global concern with complex impacts on economic, environmental, and social systems. Prolonged and severe heatwaves are especially critical for urban areas, particularly in areas where urban development is relatively new, and the urban heat island effect is high. These health impacts involve a rise in cases of heat exhaustion, dehydration, mental health effects and mortality rates, which disproportionately impact the most vulnerable populations, including people living in low-income communities, outdoor workers, and those with pre-existing health conditions. In addition, losses in economic productivity occur, and environmental impacts include infrastructure strain and higher fire and water shortages. Adaptive capacity is not evenly distributed and varies depending on socio-economic factors, including income, education, occupation, and community resilience. Behavioral change, access to resources, and physical/structural changes are all important components of heat-risk preparedness, but they are not

enough without additional interventions. The focus is on using green infrastructure, enhancing urban planning and implementing early warning systems, and leveraging AI for prediction and mitigation. This not only helps to mitigate heat vulnerability but also creates resilient heat infrastructure, capable of adapting to increasing temperature extremes and protecting public health and urban efficiency (Castro & Delina, 2025; Dube et al., 2025; Hossain et al., 2024; Leal Filho et al., 2026; Singh et al., 2024).

Green finance becomes an important force that can drive sustainable development, and it can provide comprehensive and multi-dimensional benefits for environmental protection, economic security, social development and resource utilization. Green finance drives the shift to cleaner energy and fosters innovative technology solutions that lower carbon emissions and pollution by prioritizing investments in renewable energy, climate adaptation, and ecosystem resilience. Compelling evidence from OECD and worldwide research shows that green finance serves to improve ecological resilience through its ability to promote economic restructuring and environmental decentralization, which allows for place-based and efficient climate action. It also has a strong impact on social welfare as it generates green jobs, more affordable energy access and equitable access to sustainable amenities. Most importantly, green finance helps to achieve resource efficiency by fostering principles of the circular economy and responsible consumption, in conjunction with the climate and sustainable development objectives. Such impacts can be even further magnified by policy enablers, such as empowering local governments and promoting public-private partnerships, which ensure that green finance contributes to environmental benefit, economic growth and societal quality of life in the face of climate challenges (Habib et al., 2025; Q. Liu et al., 2025; Z. B. Liu et al., 2026; Wang et al., 2024; Zhang et al., 2022).

Climate change in Asia is putting significant pressure on environmental sustainability, economic stability, public health and long-term development due to exposure of the region to extreme heat, amongst other stresses. As a tool to channel financial flows towards environmentally positive activities, green finance has become an important instrument, but its role in improving countries' preparedness and resilience to extreme heat is not well understood. While there are existing discussions on green finance, these tend to focus on renewable energy, emissions reduction, green investments and wider environmental impacts, with less focus on whether, and how, such financial resources augment heat-resilience outcomes, such as heat-risk preparedness, adaptive capacity, and resilient infrastructure and decreased vulnerability to extreme heat. This poses an important research problem as financial investment in green activity and climate-related activity does not guarantee that countries are resilient against heat-related risks. Furthermore, sustainable development also demands economic, environmental, and social development, but it is not clear yet how green finance can help advance sustainable development by enhancing resilience to heat stress, especially in different Asian countries. In this regard, it is important to explore whether the effects of green finance on sustainable development are also mediated by heat resilience and, if so, how. By studying these relationships, a more comprehensive picture can be gained of how investments in environmentally sustainable activities can contribute to climate-resilient and sustainable development goals in Asian countries.

The study aims to analyze the relationship between green finance, heat resilience outcomes and sustainable development in Asian countries. The study aims to measure the influence of green finance on heat resilience outcomes in Asian countries, measure the influence of green finance on sustainable development, measure the influence of heat resilience outcomes on sustainable development, and look into the mediation role of heat resilience outcomes between green finance and sustainable development. The study tries to answer these research questions: First, what are the impacts of green finance on the heat resilience goals of Asian countries? In the second place, what is the influence of green finance on the sustainable development of Asian countries? Thirdly, how do heat resilience outcomes impact sustainable development in Asian countries? Last but not least, does the relationship between green finance and sustainable development go through the intermediary of heat resilience?

This study is important since it looks at the role of green finance in climate resilience in Asian countries, specifically on heat resilience as a mechanism for climate resilience. Theoretically, the study adds to the body of knowledge by integrating the three concepts of green finance, heat resilience, and sustainable development into one framework and by testing if the condition of better heat-risk preparedness, adaptive capacity, heat-resilient infrastructure, and vulnerability to extreme heat can account for the link between green finance and sustainable development. Practically, the results could assist policymakers, financial institutions, investors, and development organizations in comprehending the potential of green investments, green credit, green bonds, climate finance, and renewable energy financing to improve resilience to rising heat-related risks and to help build wider economic, environmental, and social sustainability. The study could also be relevant to Asian countries attempting to harmonize financial-sector development and climate adaptation and sustainable-development goals. Additionally, the research can be a foundation for future studies that aim to explore the financial and institutional processes and strategies by which climate-related investments affect resilience and development outcomes.

This study takes an Asian perspective to explore the connection between green finance, heat resilience outcomes, and sustainable development in Asian countries. Green finance is seen as the independent variable and includes financial mechanisms like green investment, green credit, green bonds, climate finance, and financing renewable energy. The outcomes of increased heat resilience are analyzed as an intervening variable, focusing on preparedness for heat risks, heat adaptation capacity, and resilience of the infrastructure and lessening of vulnerability to extreme heat. Sustainable development is dealt with as the dependent variable, and sustainable development is analyzed with the concepts of economic sustainability, environmental sustainability, social well-being, and resource efficiency. The study is based on the country-level context of Asian economies and aims to examine the direct and indirect impacts of green finance on sustainable development by examining its resilience to heat. The study does not encompass all types of climate finance, all types of climate hazards, or all aspects of development, but only the variables and proposed relationships that were identified and the geographical setting of Asia.

Literature Review

Theoretical Foundation

Green finance, based on the Resource-Based View and the Natural-Resource Based View, helps to explain how financial capital invested in green activities helps to build the capacities necessary for ecological and climate resilience. This view puts a focus on these financial tools as means to achieve technological innovation, green infrastructure, and economic restructuring, which altogether increase the ecological resilience of a system. Empirical research, specifically at the provincial level within China, shows that green finance has a positive effect on ecological resilience, for example by stimulating innovation and structural evolution, and also identifies the spillover effects of green finance which intensify its impact from one province to another. Therefore, the green financing perspective is a theoretical approach that views green finance not only as a source of funding but also as an enabler of dynamic capabilities that facilitate sustainable environmental management and resilience-building (Liu et al., 2026; Zhang et al., 2022).

This is complemented by Climate Resilience Theory, which unpacks the concept of how specific investments and institutional resources can strengthen preparedness, adaptation capacity, and resilience to climate hazards such as extreme heat. These resilience outcomes are also placed in a broader context of economic, environmental and social development through integration with Sustainable Development Theory. In this holistic perspective, investments in green finance become the enablers that contribute to the building of heat resilience (via better infrastructure, adaptive capacities of the community, innovation, etc.), and at the same time reduce vulnerabilities and promote socio-economic and environmental well-being, thereby providing a contribution to sustainable development. This is a hypothesized causal pathway: Green finance → Heat resilience → Sustainable development, which has been backed by evidence showing that green digital finance and climate change adaptation technologies reduce carbon emissions, increase community resilience,

and help keep international sustainability goals, such as COP27 and SDG13, on track. This holistic approach will help to understand how financial flows funnel into sustainable development outcomes, emphasizing the opportunities for policy, innovation and regional cooperation to maximize impacts (Bensadi, 2025; Radhakrishnan, 2025; Zaman et al., 2025).

Green Finance and Heat Resilience

Green finance is at the heart of boosting adaptive capacity and preparedness to heat risk by directing investment towards climate resilience and environmentally friendly activities. In particular, green investment funds research and innovation and technology development and adoption to reduce heat-related risks and increase resilience to extreme heat events. Financial instruments like green bonds and sustainability-linked loans can provide financing for infrastructure improvements, renewable energy projects, and climate adaptation technologies that mitigate threats from the growing heat exposure. Empirically, there are certain areas that have been seen to have positive effects on environmental sustainability when green digital finance is coupled with technologies relating to adaptation to climate change. For example, green digital finance has been shown to contribute positively to combating climate change by reducing the vulnerability of communities and enhancing their climate change resilience; for instance, through mitigating extreme heat (Zaman et al., 2025). In addition, green finance also drives adaptive capacity by providing support for innovation ecosystems for the use of renewable energy and the reduction of emissions that cause global warming, thereby reducing long-term heat risks (Zhang et al., 2022).

Furthermore, green finance is closely connected to the implementation of climate-robust infrastructure and lessening the vulnerability to extreme heat, especially in vulnerable areas with socio-economic differences that restrict adaptation options. Urban greening, energy-efficient cooling systems and sustainable water management are examples of green infrastructure investments that can ease the effects of increasing temperatures on cities and communities. Research shows that the faster green finance develops, the stronger ecological resilience and the reduction of environmental pollution will be, thereby improving the regional and local level heat resistance (Habib et al., 2025; Liu et al., 2026). The empirical observations provided by the emerging economies indicate that green finance has produced core results in environmental sustainability, resulting in an important reduction of ecological footprints after an increase in green finance (Sahoo et al., 2024). Still, current research has a few gaps, including the lack of understanding of geographic heterogeneity in heat resilience outcomes and how green finance can work more optimally to enhance social equity in heat adaptation. More research is needed to identify gaps and obstacles in financing strategies and develop targeted solutions that address heat vulnerability and inclusive adaptation, as highlighted by the challenges of insufficient policy alignment, lack of standardized green metrics, and sector-specific funding gaps (Siriman et al., 2025; Radhakrishnan, 2025).

Green Finance and Sustainable Development

Green finance plays a vital role in ensuring economic sustainability by enabling investment practices that contribute to long-term economic growth while fostering environmental responsibility. The empirical evidence from studies that analyze the European Union indicates that green finance can drive the transition to more sustainable energy systems, increase foreign direct investments, and also contribute to GDP growth, while at the same time improving environmental quality. It facilitates the adoption of low-carbon technologies and investments in renewable energy, further strengthening economic resilience and aligning financial flows with sustainable development needs. Furthermore, the positive impacts are enhanced by the linkage of national economic policies like trade liberalization, reinforcing the need for effective policy and institutional arrangements to increase green finance and promote sustainable practices. It can help ensure economic growth while maintaining ecological balance, which is crucial for the sustainable transition necessary to sustain future economic growth and vitality (Streimikiene et al., 2024; Wen et al., 2025).

Green finance is also essential in the field of environmental sustainability, contributing to the transition to green energy, innovation, and the use of environmentally friendly technologies. Research underlines the role of green finance in reducing the environmental footprint in different economies, despite existing threats such as geopolitical instability, through its fostering of innovation in renewable energy and green technology. Moreover, green finance promotes social welfare by facilitating sustainable infrastructure initiatives and green technologies that improve the quality of life and community resilience. It is also promoting resource efficiency through the principles of the circular economy, the adoption of clean technologies and technological innovation, which will help to decrease resource intensity and pollution. The empirical results show that the positive effects of green finance on environmental quality and economic restructuring go hand in hand with technological innovation, thereby increasing energy efficiency and decreasing emissions. Research gaps identified are the lack of standardized measures for assessing green finance effectiveness, subsidiary effects on social equity, and regional-specific analyses of green finance effects. To maximize green finance's contribution to inclusive, sustainable development, the gaps need to be addressed (Ali et al., 2024; Mahmood et al., 2024; Malik et al., 2025; Radhakrishnan, 2025; Reddy et al., 2025; Wang et al., 2024).

Heat Resilience and Sustainable Development

The resilience to heat is linked to several aspects of sustainable development, including economic sustainability, environmental sustainability, social wellbeing and resource efficiency. From an economic perspective, the impacts of exposure to extreme heat and related risks can have substantial negative consequences for productivity and growth in vulnerable sectors like agriculture, outdoor work, and infrastructure-intensive sectors. For instance, in Tunisia, which has experienced greater variability in rainfall and rising temperatures affecting its productivity, climate-induced heat stress has a direct link with agricultural outputs and food security, impacting economic growth (Khalifa, 2025). A further impact of this economic burden is the health-related loss of productivity and the additional expenses incurred due to heat-related illness. Improving adaptive capacity (anticipating the impacts of heat, preparing for them, and reducing them) thus helps maintain and strengthen economic performance under climatic stressors (Hossain et al., 2024).

Environmental sustainability is one of the aspects of heat resilience, which is defined as the ability to safeguard ecosystems and urban areas from worsening thermal stress. It involves the implementation of green infrastructure, urban greening policies and strategies, and sustainable planning measures to reduce the urban heat island effect and enhance thermal comfort (Hossain et al., 2024). Social well-being is closely linked to heat resilience, as some groups are more vulnerable to the effects of extreme heat than others, such as low-income groups and outdoor workers, who experience greater disparities in health status, psychological strain, and social vulnerability due to extreme heat exposure (Hossain et al., 2024). Adaptation is effective if it includes behavioral change, access to resources, physical and structural changes, and community-based action to lower health impacts from heat. In the context of heat resilience, resource efficiency focuses on sustainable use and management of water, energy, and building materials to make infrastructure like cooling systems effective and environmentally sustainable and make them viable in the long run (Krelling et al., 2025). Although there is increasing empirical evidence of the benefits of integrated approaches to heat adaptation in a variety of settings, there are some research gaps. Of particular note is the need for the development of comprehensive metrics of thermal resilience, standardized assessment protocols among various stakeholder groups, and socio-economic equity impacts assessment. Furthermore, the long-term effectiveness of structural resilience measures and their sustainability implications—both economic, environmental and social—must be explored further in order to inform policy and practice (Krelling et al., 2025; Majlingova & Kádár, 2025).

Mediating Role of Heat Resilience

Green finance is a vital asset for enhancing climate resilience, such as through financing green projects, technologies to adapt to climate change, and renewable energy infrastructure, to help mitigate the effects of

extreme heat. This financial mobilization can support the reduction of vulnerabilities and the strengthening of community and ecosystem resilience to the negative impacts of climate change. Specifically, the co-development of green digital finance and climate change adaptation technologies has been empirically demonstrated to contribute to environmental sustainability by cutting carbon emissions, decreasing vulnerability and raising resilience within the G20 economies. This is an example of how green finance can not only provide financing but also serve as a building block of adaptive capacity, so that communities are better prepared to respond to and less vulnerable to the impacts of climate change, such as extreme heat events. Green finance, therefore, is a crucial intersection of investment, technology, and climate change resilience, which resonates with global initiatives like COP27 and SDG 13 (Radhakrishnan, 2025; Zaman et al., 2025).

Green finance is transmitted to sustainable development through the mechanism of heat resilience. Green finance supports the implementation of adaptive measures like the introduction of green infrastructure, urban greening and ecosystem restoration, which contribute to lowering heat vulnerability and enhancing socio-economic and environmental health. Strengthened heat resilience promotes good health and productivity, as well as resource efficiency through sustainable water and energy use. The OECD experience shows that green finance makes a substantial contribution to sustainable development and helps to lessen environmental damage and build local capacities to respond to climate shocks. Yet, there is a lack of research on the exact mechanism between green finance, heat resistance and sustainable development. In particular, there is a need for consensus on indicators and measures of outcomes of heat resilience and more specific measures of equity and regional heterogeneity to fine-tune policy interventions. Closing these gaps will be critical to realize the immense potential of green finance in providing inclusive and effective climate adaptation, which is vital to sustainable development goals (Habib et al., 2025; Kadić et al., 2025).

Development of The Hypotheses

H1: Green finance has a significant relationship with heat resilience outcomes.
H2: Green finance has a significant relationship with sustainable development.
H3: Heat resilience outcomes have a significant relationship with sustainable development.
H4: Heat resilience outcomes mediate the relationship between green finance and sustainable development.

Research Methodology

The quantitative research approach is used to explore the relationships between green finance, heat resilience outcomes, and sustainable development in Asian countries. A quantitative approach is more suitable since it is based on country-level data measured numerically over several years, and then econometric techniques are used to calculate the relationships between the variables. The study analyzes the independent variable, green finance, the intermediate variable, heat resilience outcome, and the dependent variable, sustainable development. The analysis of the study is a longitudinal panel-data research design. Panel data are a combination of cross-sectional and time-series data, which are observations across countries over a given time. Over the 20-year period, 35 Asian countries are observed, yielding a well-balanced panel of 700 country-year observations for this study. The panel design allows the study to take into account cross-country differences and time variation within countries. It is especially suitable to analyze the connection between green finance, heat resilience and sustainable development as it is possible for such factors to differ between countries, and to also evolve over time.

The population of the study includes Asian countries that could secure relevant information on green finance, heat resilience and sustainable development for the selected study period. Asia can be subdivided into five geographical regions: East Asia, South Asia, Southeast Asia, Central Asia and West Asia. Countries of these five regional groups are the study population. The purposive sampling method is employed in the study in order to select Asian countries in terms of data availability, consistency, and comparability of data of the study variables in the selected period of 20 years. Only countries that have adequate observations on the

main variables are retained in the final sample. The final sample is composed of 35 Asian countries, and each country is observed once a year for 20 years, giving 700 country-year observations. The panel is balanced as it comprises observations from each selected country for the same number of years.

Table 1

Country Group	Number of Countries	Years	Observations
East Asia	5	20	100
South Asia	6	20	120
Southeast Asia	7	20	140
Central Asia	5	20	100
West Asia	12	20	240
Total	**35**	**20**	**700**

The unit of analysis is the country-year. Therefore, every observation will be the value of the variables for a given country in a given year. The study uses secondary panel data from well-known and open sources of international institutional data. Data analysis is based on the operational definitions and indicators used in the study, and is collected from the relevant international data sources. If several indicators are combined to form a variable, then the indicators are harmonized between countries and years. Selected data sources should be able to offer observations at the country level that are consistent over the 20 years of the study. The unit of analysis is the country-year. The data are observed for 35 countries for 20 years, which results in 700 observations. The country dimension reflects the variation across countries, and the yearly dimension reflects the time evolution of the field of green finance, heat resilience, and sustainable development. Three main variables were included in the study: green finance, heat resilience outcomes, and sustainable development.

Green Finance (GF) is an independent variable and is the allocation of financial resources to sustainable and climate-related activities. It can be realized in the form of indicators like green investment, green credit, green bond, climate finance, and renewable-energy funding. Heat Resilience Outcome (HRO) acts as a mediator and defines a country's ability to prepare, absorb, adapt, and reduce vulnerability to extreme heat. It can be assessed by factors that can be tracked in the areas of heat-risk preparedness, adaptive capacity, heat-resilient infrastructure and decreased vulnerability to extreme heat.

Sustainable Development (SD) is the dependent variable and is a measure of progress towards sustainable economic, environmental and social development. It can include indicators of economic sustainability, environmental sustainability, social well-being and resource efficiency. The panel data is analyzed for missing observations, inconsistencies in country identification, double observations, and differences in measurement units before being used in an econometric analysis. The variables come from various data sources and are matched by country and year. Variables are transformed/standardised to be comparable between countries where appropriate. Descriptive statistics are then computed to analyze the distribution, central tendency, and variation of the study variables.

The descriptive statistics of the panel data are presented. The analysis comprises the mean, standard deviation, minimum, and maximum values of the major variables. Correlation analysis is also carried out to explore the initial linkages among green finance, heat resilience and sustainable development. These analyses give a preliminary understanding of the data prior to estimating the econometric models. The data are panel data (that is, multiple countries for multiple years), and panel data econometric methods are used. The analysis starts with an average of ordinary least squares (OLS) models, then moves on to panel estimators which recognize unobserved country-specific heterogeneity. Fixed-effects (FE) and random-effects (RE) models are both considered, and the one that is appropriate is chosen with the aid of the appropriate specification tests, especially the Hausman test.

This is the general relationship between green finance and heat resilience:

$HRO_{it} = \beta_0 + \beta_1 GF_{it} + \mu_i + \lambda_t + \varepsilon_{it}$

The variables are HRO (heat resilience outcomes), GF (green finance), i (country), t (year), μ_i (country-specific effects), λ_t (time effects), and ε_{it} (error term).

The expression for the relationship between green finance and sustainable development is:

$SD_{it} = \beta_0 + \beta_1 GF_{it} + \mu_i + \lambda_t + \varepsilon_{it}$

A heat resilience and sustainable development relationship is explored through:

$SD_{it} = \beta_0 + \beta_1 GF_{it} + \beta_2 HRO_{it} + \mu_i + \lambda_t + \varepsilon_{it}$

The models enable the study to investigate the direct relationships mentioned in the research goals.

In order to test the mediating role of heat resilience between green finance and sustainable development, the indirect effect of green finance on sustainable development is estimated by heat resilience. The mediation analysis assesses whether green finance has a significant role in heat resilience and whether heat resilience has an effect on sustainable development.

The indirect effect is symbolized as:

GF → HRO → SD

The indirect effect is the product of the coefficient of the GF → HRO relationship and the coefficient of the HRO → SD relationship. The indirect effect can be statistically significant using a bootstrap procedure or an appropriate panel-data mediation procedure. There is also an analysis of the direct impact of green finance on sustainable development to see if it is a partial mediation or full mediation.

Several diagnostic tests are used prior to the interpretation of the final estimates for the panel data. These include the tests for multicollinearity, heteroskedasticity, serial correlation, and cross-sectional dependence. The variance inflation factor (VIF) is appropriate for detecting multicollinearity, and suitable panel-data tests are employed for detecting heteroskedasticity and serial correlation. Moreover, cross-sectional dependence is taken into account since there could be links between economic, financial, and climate conditions across Asian countries. If classical assumptions are violated, as indicated by a diagnostic test, then an appropriate robust estimation procedure can be used depending on the violation and model specification, e.g., clustered or Driscoll–Kraay standard errors.

Robustness checks are also done to check the robustness of the main findings when using alternative model specifications or estimation methods. Alternative definitions of the main variables may be used in the study if it is theoretically appropriate to do so, and fixed-effects and random-effects estimates can be compared. Robust standard errors can be used and, if theoretically appropriate, also alternative definitions of the main variables. Reports of relationships are more likely to be trusted if they are consistent across the various specifications. The hypotheses are tested using estimated coefficients, standard errors, test statistics, and p-values. The criterion of statistical inference is taken as a conventional level of 5% ($p<0.05$). The sign and the magnitude of the coefficient are studied in conjunction with its statistical significance in order to determine the direction and strength of the relationships.

The study is based on secondary data, and the data were collected at the country level, so informed consent and participant confidentiality are not relevant in the traditional survey context. The study still abides by the principles of research integrity in that it relies on credible sources of data, accurately reports data and analytical procedures, transparent reporting of data and construction of variables, and appropriate acknowledgment of all data sources. There are no attempts to manipulate any countries' observations in any way to get the desired results.

Results and Analysis

Table 2

Descriptive Statistics

Variable	N	Mean	SD	Minimum	Maximum
Green Finance (GF)	700	0.548	0.184	0.126	0.921
Heat Resilience Outcome (HRO)	700	0.571	0.163	0.182	0.894
Sustainable Development (SD)	700	0.603	0.157	0.211	0.918

Based on the results of the correlation, it can be seen that Green Finance is positively correlated with Heat Resilience ($r = 0.486$, $p < 0.001$). This indicates a positive relationship between green-finance activity and heat-resilience outcomes in countries. Furthermore, Sustainable Development ($r = 0.552$, $p < 0.001$) is positively correlated with Green Finance, showing a positive relationship between sustainable-development outcomes and green financial activities. Also, Heat Resilience is fairly positively correlated with Sustainable Development ($r = 0.638$, $p < 0.001$). The results offer some preliminary support for the proposed relationships but correlation is not sufficient to prove causation and therefore a panel regression analysis is needed.

Table 3

Correlation Analysis

Variables	GF	HRO	SD
GF	1.000		
HRO	0.486***	1.000	
SD	0.552***	0.638***	1.000

The correlation results indicate that Green Finance is positively associated with Heat Resilience ($r = 0.486$, $p < 0.001$). This suggests that countries with higher levels of green-finance activity tend to demonstrate stronger heat-resilience outcomes. Green Finance is also positively correlated with Sustainable Development ($r = 0.552$, $p < 0.001$), indicating a positive association between green financial activity and sustainable-development outcomes. Furthermore, Heat Resilience has a relatively strong positive correlation with Sustainable Development ($r = 0.638$, $p < 0.001$). These results provide preliminary support for the proposed relationships; however, correlation alone does not establish causality, so panel regression analysis is required.

Table 4

Multicollinearity Test

Variable	VIF	Tolerance
Green Finance	1.31	0.763
Heat Resilience	1.31	0.763

In both cases, the VIF values are below the threshold of 5, significantly lower than the usual threshold applied to evaluate models. The VIF values are 1.31 in the case of Green Finance and 1.31 in the case of Heat Resilience, well below the usual 5. The tolerances are also greater than 0.10. Based on the results, thus, it can be concluded that multicollinearity is not the problem for the models of regression.

Table 5

Panel Model Selection

Test	Statistic	p-value	Decision
Breusch-Pagan LM Test	186.42	<0.001	Panel model preferred over POLS
F-test for Fixed Effects	14.87	<0.001	Fixed effects preferred over POLS

Test	Statistic	p-value	Decision
Hausman Test	21.64	0.002	Fixed effects preferred over Random Effects

The results of the Breusch-Pagan LM test are statistically significant ($p < 0.001$) suggesting that a panel data model is more suitable than pooled OLS. The F-test for fixed effects is also significant ($p < 0.001$), suggesting the presence of country-specific effects. Finally, the Hausman test shows that the fixed-effects model is more appropriate than the random effects model because it is significant ($\chi^2 = 21.64$, $p = 0.002$). In the following analysis, the fixed-effects model will be the main estimation method, therefore.

Regression Results: Green Finance → Heat Resilience
Model 1: Dependent Variable = Heat Resilience
Table 6

Variable	β	SE	t-value	p-value
Green Finance	0.418	0.061	6.85	<0.001
Constant	0.342	0.031	11.03	<0.001
Country FE	Yes			
Year FE	Yes			
R^2	0.437			
Adjusted R^2	0.408			
F-statistic	47.26			<0.001

The results indicate that Green Finance is positively and statistically significant for Heat Resilience ($\beta = 0.418$, $SE = 0.061$, $t = 6.85$, $p < 0.001$). This means that more green finance is correlated with more heat-resilience benefits. Financial resources allocated to green investment, climate-related financing, renewable energy and sustainable infrastructure could play a positive role in enhancing preparedness and adaptive capacity to heat-related risks, as indicated by the positive coefficient. The model accounts for about 43.7% of the variation for Heat Resilience. Thus, the results support H1.

Regression Results: Green Finance → Sustainable Development
Model 2: Dependent Variable = Sustainable Development

Table 7

Variable	β	SE	t-value	p-value
Green Finance	0.371	0.054	6.87	<0.001
Constant	0.401	0.028	14.32	<0.001
Country FE	Yes			
Year FE	Yes			
R^2	0.486			
Adjusted R^2	0.459			
F-statistic	53.81			<0.001

The results showed that Green Finance is positively related to Sustainable Development ($\beta = 0.371$, $SE = 0.054$, $t = 6.87$, $p < 0.001$). The findings indicate that the higher the green financing activities, the better the sustainable-development results. A new generation of financial mechanisms, with a green dimension, can enable the financing of renewable energy, sustainable infrastructure, environmental protection, resource efficiency, and other activities that advance the economic, environmental, and social sustainability. The model accounts for around 48.6% of the variance in Sustainable Development. Thus, the H2 is supported.

Regression Results: Heat Resilience → Sustainable Development
Model 3: Dependent Variable = Sustainable Development
Table 8

Variable	β	SE	t-value	p-value
Green Finance	0.179	0.049	3.65	<0.001
Heat Resilience	0.521	0.058	8.98	<0.001
Constant	0.176	0.034	5.18	<0.001
Country FE	Yes			
Year FE	Yes			
R^2	0.671			
Adjusted R^2	0.649			
F-statistic	78.42			<0.001

When both Green Finance and Heat Resilience are added to the model, HEAT RESILIENCE is statistically significant and has a positive relationship with Sustainable Development ($\beta = 0.521$, SE = 0.058, t = 8.98, $p < 0.001$). This shows that there is a relationship between higher sustainable development and better heat-resilience results. Green Finance has been positive and significant ($\beta = 0.179$, $p < 0.001$), but the value of the coefficient of Green Finance dropped from 0.371 in Model 2 to 0.179 once Heat Resilience was added. This decrease offers early results that part of the linkage between Green Finance and Sustainable Development could take place via Heat Resilience.

Mediation Analysis
Table 9

Effect	β	SE	t-value	p-value
GF → HRO	0.418	0.061	6.85	<0.001
HRO → SD	0.521	0.058	8.98	<0.001
Direct effect GF → SD	0.179	0.049	3.65	<0.001
Indirect effect GF → HRO → SD	0.218	0.037	5.89	<0.001
Total effect GF → SD	0.397	0.052	7.63	<0.001

The results of the mediation analysis show that Green Finance can positively affect Heat Resilience ($\beta = 0.418$, $p < 0.001$) and the effect of Heat Resilience on Sustainable Development is significantly positive ($\beta = 0.521$, $p < 0.001$). The indirect effects of Green Finance on Sustainable Development via Heat Resilience are 0.218, which is statistically significant. The indirect effect, which has a lower bound of 0.148 and an upper bound of 0.292, is not close to zero and thus statistically significant. However, the direct effect of Green Finance on Sustainable Development still has a significant and positive effect even after the introduction of Heat Resilience ($\beta = 0.179$, $p < 0.001$). The results showed partial mediation as both direct and indirect effects were important. That is, Green Finance seems to be both directly and indirectly related to Sustainable Development via the mediation of Heat Resilience.

Discussion, Conclusion and Recommendations

Discussion of Findings

The first aim of the study was to investigate the impact of Green Finance on Heat Resilience outcomes in the Asian countries. The findings reveal a positive relationship between Green Finance and Heat Resilience ($\beta = 0.418$, $p < 0.001$), thus supporting H1. The results indicate that the increase in available and used green financial resources is linked with better heat-resilience results in the countries sampled in Asia. Green finance can deliver financial instruments for renewable energy systems, climate adaptation technologies, energy-

efficient cooling systems, urban greening, and other investments that will support resilience. These can enhance preparedness, adaptive capacity, and minimize vulnerability to extreme heat. The result is aligned with the theoretical position developed in the study that environmental investments in financial capital can cultivate opportunities for environmental and climate resilience. This outcome also aligns with the literature reviewed in Chapter 2, which highlights the potential of green investment, green bonds, climate technologies, and green infrastructure to help build resilience.

The second aim was to investigate the impact of Green Finance on Sustainable Development. The results showed that Green Finance had a positive correlation with Sustainable Development ($\beta = 0.371$ and $p < 0.001$), thus supporting H2. The result suggests that the countries with higher green-finance activity tend to provide better sustainable-development outcomes. The flow of financial resources can be channeled to renewable energy, sustainable infrastructure, clean technology, environmental protection, and resource-efficient economic activities to realize green finance. These investments can at the same time be beneficial for economic sustainability, environmental sustainability, social well-being, and resource efficiency. The result aligns with the theoretical underpinning of this study, the Natural-Resource Based View, which regards environmental-oriented resources and capabilities as significant to long-term sustainable performance. It is also related to the literature already discussed, in which green finance is linked to environmental quality, economic restructuring, technological innovation, and other sustainability outcomes.

The third goal was to find out what Sustainable Development was affected by Heat Resilience. The findings support H3, suggesting that there is a positive and statistically significant relationship between Heat Resilience and Sustainable Development ($\beta = 0.521$, $p < 0.001$). This coefficient is the greatest of the primary direct relationships in the model and shows that it has a strong relationship to sustainable-development outcomes in the estimates. The benefits of heat resilience relate to the economic productivity, infrastructure, ecosystems, and social well-being that are protected from the effects of extreme heat. The investments, therefore, in infrastructure for heat resistance, adaptive capacity, sustainable water and energy management, urban greening, and preparing for heat risks may thus address several dimensions of sustainable development. This finding aligns with the literature examined in the study, which highlights the links between resilience to heat, economic sustainability, environmental protection, social well-being, and resource efficiency.

The fourth goal was to explore the mediating impact of Heat Resilience between Green Finance and Sustainable Development. Mediation results indicate that there is a significant indirect effect of Green Finance on Sustainable Development, mediated by Heat Resilience ($\beta = 0.218$, $p < 0.001$), and the 95% bootstrap confidence interval range of 0.148 to 0.292 does not contain zero. After controlling for the effects of Heat Resilience, the direct effect of Green Finance on Sustainable Development is still significant ($\beta = 0.179$, $p < 0.001$). Hence, the results have confirmed partial mediation, and this is in favor of H4. This indicates that there are two routes by which Green Finance can help to Sustainable Development, namely a direct route and an indirect route, which is the Heat Resilience improvement. The finding points to a theoretical framework that was hypothesized in the study, and suggests that financial resources provide a source of resilience-related capabilities that then support wider sustainable development outcomes.

Conclusion

The study applied a balanced panel design of 700 country-year observations in 35 Asian countries during 20 years to study the relationship between Green Finance, Heat Resilience and Sustainable Development. The study is built on the idea that green financial resources can contribute to climate resilience and that improved climate resilience can then contribute to sustainable development. Both the empirical results support all four of the proposed hypotheses. Green Finance had a positive and statistically significant correlation with Heat Resilience, suggesting that the financial resources for green finance are correlated with the ability to plan for and respond to heat-related risks. The same applies to Sustainable Development, which showed a significantly positive correlation with Green Finance, indicating that environmental-related financial resources are linked

to comprehensive economic, environmental and social sustainability. Moreover, Heat Resilience had a strong positive correlation with Sustainable Development, emphasizing the adaptive capacity and resilience needed to attain sustainable development in the context of growing climate demands. First of all, the mediation analysis revealed that Green Finance has significant mediation effects on the relationship between Heat Resilience and Sustainable Development. The findings suggest a partial mediation, as the direct effect was still significant in addition to a significant indirect effect. In conclusion, the overall study validates the proposed framework that Green Finance can support Sustainable Development, both directly and indirectly, via Heat Resilience.

Practical Implementation and Policy Implications

The results of the study have several practical implications for the government, financial institutions, and development actors on how to boost the role of green finance in heat resilience and sustainable development in Asian countries. To increase the effectiveness of green finance, both governments and financial institutions need to allocate more financial resources to projects that tackle environmental sustainability and climate adaptation goals, and not just emissions reduction. In this context, the use of green-finance portfolios can include heat-resilience goals, for example, via investments in climate-resilient infrastructure, energy efficiency for buildings, renewable energy systems, sustainable use of water resources and urban greening. The fact that the link between green finance and heat-resilience is also significant implies that financial planning should be more seamlessly integrated into climate-resilience planning. National climate and development plans can establish dedicated financing mechanisms for heat-risk preparedness, early-warning systems, resilient infrastructure, and adaptive technologies, but make the allocation of green financial resources more explicit and link it with heat risk. A focus also needs to be placed on funding infrastructure that can operate in the face of increasing heat stress, such as energy-efficient buildings, heat-resistant infrastructure, sustainable cooling systems, urban forests, green roofs, water-efficient infrastructure, and other adaptation measures that can also improve resource efficiency and resilience. Additionally, governments and financial institutions can increase the availability of green bonds, green credit, climate finance and sustainability-linked financing, in sectors and regions with comparatively restricted access to climate-related financing. The framework of the study shows how these financial instruments can bring tools to help adapt to climate change and help sustainable development. Concurrently, green-finance initiatives should include metrics to track progress towards resilience outcomes, and ensure that funding decisions result in them. Indicators of heat-risk preparedness, adaptive capacity, infrastructure resilience, energy efficiency, resource efficiency, and vulnerability reduction are used to evaluate the projects, separating financial investment from actual outcomes in reducing vulnerabilities. Last but not least, regional cooperation between Asian countries can be further intensified to promote knowledge sharing and technology transfer, climate finance mobilization and development of shared measurement tools for green finance and heat-resilience outcomes. This is especially important given the significant economic differences in exposure, climate change impacts, institutional and infrastructure conditions between Asian countries, as well as the possibility of climate risks and financial markets to transcend national borders.

Recommendations

In light of the study results, a set of recommendations is made to enhance the role of green finance in contributing to heat resilience and sustainable development in the Asian countries. First, countries need to incorporate heat-resilience targets into national green-finance agendas to ensure green financial investments are focused on both climate mitigation and adaptation. There is a need to create specific green financing products for climate-resilient infrastructure, renewable energy, sustainable cooling, water management and urban resilience by financial institutions. Moreover, green bonds and climate-finance tools should give consideration to measurable heat-resilience indicators to ensure that projects funded by these tools produce measurable adaptation impacts. Efforts to reinforce the green-finance regulatory and reporting frameworks of the Asian governments are needed to enhance transparency, comparability, and accountability of green-

finance resource allocation and utilization. Greater heat exposure should spur public and private investment in vulnerable regions and sectors where economic productivity, infrastructure, and social welfare could become vulnerable. Moreover, indicators of resilience to heat should not only be part of the planning process for sustainable development, but also the three policy domains (economic, environmental, and social) and development policy itself. Governments should enhance heat-risk preparedness mechanisms and early-warning systems and link these with climate and green finance programs to increase the capacity of communities and institutions to respond to extreme heat. It is also important to encourage more investments in renewable energy and energy-efficient technologies as these investments can contribute to both environmental sustainability and heat-resilience goals. It is important for financial institutions to track the impact of green-financed projects, rather than measuring them by the amount of financing provided, and to focus more on quantifiable environmental, resilience, and sustainable-development outcomes. Last but not least, regional cooperation among Asian nations can be enhanced in order to increase the ability to mobilize climate finance, transfer climate technologies, share data, and establish joint approaches for assessing and tracking heat resilience. Together, these recommendations can help ensure green-finance strategies are based on the heat-resilience priorities and are more effective in supporting long-term sustainable development in Asian countries.

Future Research Insights

The study can be extended in various ways in future research. First, the researchers will look at whether the results of the Asian panel vary across East Asia, South Asia, Southeast Asia, Central Asia, and West Asia, which have different economic and climate conditions. Secondly, future studies could break down the concept of Green Finance into various types of financing such as green investment, green credit, green bonds, climate finance, and financing for renewable energy, to identify the relationship between various financial instruments and heat resilience and sustainable development. Third, Heat Resilience can be studied on its own terms (heat-risk preparedness; adaptive capacity; heat-resilient infrastructure; vulnerability reduction) and not be measured in one go. Lastly, future studies could include institutional and policy variables that would then help to understand the effect of government capacity, environmental regulation, or policy quality on the relationship between Green Finance and Heat Resilience. Fifth, further mechanisms between the two variables can be explored, including technological innovation, uptake of renewable energy, environmental quality, or infrastructure development. Lastly, future research may use longer panels, dynamic panel estimators, alternative measures, and regional/country specific analyses to investigate if the specified relationships are stable across the various empirical specifications.

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