Pakistan Journal of Commerce and Social Sciences
2026, Vol. 20(2), 483-504
https://doi.org/10.64534/Commer.2026.683

# Climate Resilience, Green Finance and Sustainable Economic Development: An Evidence from High and Upper-Middle-Income Countries

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**Article History**

Received: 03 Mar 2026 Revised: 19 June 2026 Accepted: 23 June 2026 Published: 30 June 2026

## Abstract

The study provides a comprehensive analysis of the impact of green finance and climate resilience on sustainable economic development. The annual data utilized by the study covers 38 high and upper-middle-income countries during the time-period of 2011 and 2019. This study employs an augmented system GMM estimator to address the issues of endogeneity, dynamic dependence, and simultaneity. The findings show that both climate resilience and green finance have combined and significant impact on sustainable economic development. The results of the study clearly indicate that renewable energy transitions, clean and green infrastructure, and low carbon technologies has significant positive contribution in sustainable development. Green investments offer a pathway for environmental improvements, encourages innovation, and reallocation of financial flows on the way to sustainable sectors. The findings of this study show that there is a significant negative relation between green finance and climate resilience. The findings of the study suggest that both climate resilience and green finance are significant important, but their combined impact should be managed carefully. The study implies that nations with high investment in green finance and climate control projects can enjoy relatively more sustainable economic development. Policymakers should account for fiscal capacity, avoid policies which overlapped and prioritize the integration except duplication.

**Keywords:** climate resilience, green finance, sustainable economic development, ND-GAIN INDEX.

## 1. Introduction

The general debate on sustainable economic development has gained massive popularity over the past years and it is driven largely by the severe necessity to address the climate change, create resilient economies and transition towards sustainable economic activities. Green finance and climate resiliency have become issues of interest to policymakers, business, and scholars alike as nations the world over struggle with more environmental issues. The concept of green finance, making investments in renewable energy sources and environmentally friendly projects and climate resilience, the capacity of economies to adapt and recover to climate related shocks, have been given the center stage in a bid to promote sustainable economic development. However, the intricate interrelationship between these two variables and their mutual impact on sustainable development has not been studied well, especially in high-income countries and upper-middle-income countries.

The justification of the study is that there is need to have a deeper understanding of how green finance and climate resilience contribute to the sustainable development of nations. Sustainable development does not only focus on economic growth, but it involves the establishment of systems that would be sustainable within the environment and have the same prosperity to exist in the next generation. The idea of sustainable development focuses on the intergenerational equity in that the present actions should not affect the future generation in such a way that hinders their ability to fulfill their needs (Bene et al. 2012; Weiss, 2025). Both green finance and climate resilience are important in this prospective. Although green finance is beneficial in financing the shift to low-carbon economies, climate resilience improves the capacity of the country to absorb and regain its normal condition following climate-induced shocks (Li et al. 2024). The green finance and climate resilience interaction is very important in achieving economic stability and growth over the long run.

Additionally, the current literature does not contain an in-depth discussion of the interaction of these two dimensions to determine sustainable economic development. Green finance and climate resilience have been considered separately in previous literature and there is little empirical data on the outcomes of the two. In this way, the knowledge gap that this research aims to fill in is the discovery of individual and interactive impacts of the green finance and climate resilience on sustainable economic development.

The theoretical basis of this study is based on the popular economic and environmental theories. The theory of sustainable development indicates intergenerational equity is relevant and the policies should be sustainable to guarantee economic practices to the future generations (Robert et al. 2005; Bosch & Chalali 2025).In this prospective, green projects and climate adaptation strategies investments are necessary to have resilient economies that can withstand environmental burdens. This school of thought is further unleashed by Capability Approach of Amartya Sen (1999) which places human agency in the realization of well-being and economic development. Sen holds the view that sustainable development is not only on the economic measures, but also on the increasing of the ability of people to

live a good life. Nussbaum (2015) and Zeng & Punjwani (2025) refer to the emphasis on human capital that is particularly significant in the context of the role of climate resilience in the human well-being through enhanced access to resources, education, and health systems.

Furthermore, a theory of green investment by Campiglio (2016) and Giglio et al. (2021), also emphasizes the role of green finance as a way of ensuring the sustainable economic growth in the long-term without jeopardizing the environment. The Environmental Kuznets Curve (Panayotou, 1993) also assumes that economic development at the very beginning causes environmental degradation, as countries grow up, they have cleaner technologies and sustainable practices that minimize the negative effect on the environment.

The role of green finance and climate resilience has been increased, but there is a shortage of empirical studies that investigate the relationship between the two variables and the overall effect on the sustainable economic growth. (Hallegatte et al., 2016) has explored the role of climate resilience (Hallegatte et al., 2016) and green finance individually (Liu et al., 2024; Zhou et al., 2020; Zakari, 2022), but there is a lack of studies that have compared the relationship between these variables on a long-term economic growth. In addition, the vast majority of studies are devoted to high-income countries and few emerging blocks mainly the United States, European nations, and People's Republic of China which creates a vacuum in the insights into the role of these factors in high-income and upper-middle-income countries, where green finance investments and climate resilience activities are more common (Bingxin et al. 2025).

Moreover, the idea of diminishing returns to green finance, especially in countries where the resilience to climate is already high, has not been adequately investigated. This paper will address this gap with empirical evidence on the extent to which green finance together with climate resilience can strengthen sustainable economic development in high-income countries and upper-middle-income countries.

This study contributes to the available literature in a number of new ways. First, it examines how green finance and climate resilience when applied together impact sustainable economic development, which is a gap in the existing body of academic discussion. Second, the paper will utilize a dynamic panel data model with augmented system GMM estimation to 38 high-income and upper-middle-income countries and 2011-2019 to estimate the data. This type of methodology will result in being able to fully comprehend the cause-effect interaction of green finance, climate resilience, and sustainable economic development and surpass the shortcomings of the conventional cross-sectional analysis. Third, the research provides the notion of the interactive effects between green finance and climate resilience and reveals that whereas both attributes have a positive effect on sustainable development under independent conditions, the joint impact could be reduced or even negative in some situations. This result compromises old concepts in the literature

that green finance and climate resilience are complementary factors. It implies that policymakers should carefully consider the development stage and resource allocation in the development of policies to promote climate adaptation and green investments.

The study also serves to inform the larger sustainable development debate by concentrating on the issues and opportunities that are encountered by wealthier countries in their quest to weigh the environmental objectives against economic development. The implications of these results on the policymakers, financial institutions and development organizations are enormous since they have clarified the need of integrated policies such that green finance and climate resilience measures can be undertaken in a bid to achieve long term sustainability.

In short, this study will address the existing gap in the literature that is critical in terms of it being missing on the intersection between green finance and climate resilience in relation to sustainable economic development. The study is an excellent addition to the knowledge of personal and interactive implications of the two factors in promoting sustainable development by ensuring better alignment of environmental and economic policies of the countries. The novelty of the study is that it is empirical research that is well developed and in addition to describing the positive effects of both green finance and climate resilience, it also mentions the potential barriers concerning the co-existence of both. Lastly, it includes the research to the current work on sustainable development and provide it as practical policy recommendations to ensure resiliency and sustainability in the perspective of climatic changes.

## 2. Literature Review

Sustainable economic development has never been more of an urgent requirement with the looming specter of climate change. Two key elements comprise the sustainability discussion and these are green finance and climate resilience. They both have become central topics in the discussion and policy-making concerning the long-term sustainable development. Green finance comprises the financial flows that are used to fund environmental sustainability initiatives (Giglio et al., 2021). Conversely, climate resilience is the capacity of countries, communities, and environments to endure, and improve the negative effects of climate change, including extreme weather, rise in sea level, and environmental disturbances (Hallegatte, 2016 and Niu et al. 2023). The two factors have been generally recognized to be central to attain sustainable development in the fast-evolving global world. Sustainable development as defined in the Brundtland Report (1987) focuses on the fact that the policies and strategies should address the needs of the current generation without jeopardizing the future generations to fulfill their needs. Green finance has a critical role to play in facilitating this through making investments in low-carbon technologies and climate-resilient infrastructure. At the same time, the concept of climate resilience is a part of ensuring the sustainability of economies in the context of climate-driven factors (Zhengzheng 2026). Nevertheless, even with the increasing acknowledgment of the significance of green finance and climate resilience, the connection

between them has not been an extensively studied field of research, particularly in high-income and upper-middle-income nations, where the latter is highly industrialized (Zhang et al., 2022).

The concept of green finance has now also been identified as one of the critical themes of sustainable economic development. The transition to the low-carbon economy would imply that the green projects, including renewable energy, energy efficiency, and sustainable agriculture, would be highly costly to invest in, as well as the climate change adaptation measures (Campiglio, 2016). Green finance would facilitate these investments and therefore economic growth would not be exposed on the sustainability of the environment (Qamri et al. 2025). Giglio et al. (2021) state that green finance has the potential to contribute to the economic growth and to the development of the green technologies and innovations and therefore come up with more sustainable and resilient economy. There are different frameworks and theories erected in an attempt to determine the linkage between economic growth and environmental sustainability. The environmental Kuznets Curve (EKC) is a theory that was established by Panayotou (1993) and is based on the fact that the economy will be polluted in its initial stages as the income level will shoot up but as the income level sky-rockets the economies will be able to employ cleaner technologies and approaches to curb pollution. So, the idea can be aligned with the notion that the negative environmental impacts of economic growth can be balanced through green finance in respect to such transitions. Green finance is not just interested in the decrease of the emission, but also in the establishment of the sustainable system of economy, which regards the environmental and social factors as the financial market (Dinda 2004;Giglio et al. 2021).

The effectiveness of green finance, however, in facilitating environmental sustainability is mixed evidence. Xu (2023) has emphasized the beneficial role of green finance in promoting green innovations and decarbonization, some other researchers have indicated the challenges and limitations of financing green projects. Zhou et al. (2020) maintain that the real environmental effects of green finance usually depend on the institutional structure, forms of governance, and quality of the funded projects. The ability of green finance to produce good environmental results may be compromised in nations that have weak governance structures, which implies that green finance is not the silver bullet to producing sustainability (Eyraud et al., 2013).

Climate resilience has become a topic of more and more attention as one of the essential components of the economic stability over the long term. Resilience refers to the capability to be ready, react, and improve climate-related incidence. Hallegatte et al. (2016) opine that it is important to improve climate resilience in order to prevent the economic and social impacts of climate change on the economy. Resilience is not a physical infrastructural only phenomenon but is also inclusive of social, institutional, and governance systems that help countries to adjust to the changing environmental conditions. Adger (2010) and Acharya

(2025) explain that social capital and collective action is very important in creating resilience since the community and nations that have stronger governance systems and social networks cope better with climate induced shocks. According to Denton et al. (2014), climate resilience is essential to the sustainable economic growth because resilient economies can more effectively absorb and adjust to the effects of climate change and, thus, will have a more stable economic growth over the long term. Resilience is considered a crucial addition to green finance since it guarantees that nations are able to sustain the financial disruptions that could occur with climate change such as infrastructure destruction, loss of agricultural power and rise in health care expenditures. Countries with well-developed climate resilience mechanisms are able to grow despite the effects of environmental shocks hence leading to a smoother and more inclusive development process Liu et al. (2024).

Climate resilience has the capacity to promote intergenerational equity by resilient countries having a higher capacity to reduce long-term effects of climate change, thus the future generation will not have to bear the cost of the present environmental degradation Bene et al. (2012). In this prospective, climate resilience does not just imply the ability to endure the immediate shocks but also the ability to make sure that future generations will be in a position to prosper in a volatile and unpredictable environment. Climate resilience and green finance is a relatively under-researched literature topic. Both factors are considered to be critical towards the attainment of sustainable economic growth, but little empirical studies have been done to establish the combined influence of the two factors. The interaction between green finance and climate resilience can either enhance or undermine the economic development sustainability in a specific situation and the level of development of a specific country Zhang et al. (2022).The green finance have a significant positive contribution in countries that are less climate resilient, because they fund climate adaptation projects and enhance climate change resilience (Zhou et al., 2020; Nasir et al., 2026;Zaman et.al.,2026).The marginal utility of increased green finance may be lower and the probability of lower returns to further investment in green projects may exist in high level resilience countries. The fact that the so-called diminishing returns occur is an issue that Zhang (2022) briefly mentions in the context of green finance and in the countries where the system of climate resilience is already developed, the growth in green finance investments may not result in a corresponding sustainable development outcome.

Additionally, the relationship between climate resilience and green finance does not necessarily need to be complementary Zhou et al. (2020). In other situations, the emphasis on one of the factors can diminish the other, resulting in suboptimal results. As an example, a greater emphasis on green finance can cause a deficit in attention to climate resilience, and the opposite to happen as well, so there is a mismatch between the goals of climate adaptation and goals of green finance. It shows that a more subtle conceptualization must be made on how these two aspects interrelate; particularly in the framework of high-income and upper-middle-income nations where both green finance and climate resilience is extremely developed.

There are still some gaps in the literature despite the increasing number of studies on green finance and climate resilience. Significant part of the current research sees green finance and climate resilience as two distinct phenomena, with less emphasis on their inter-generative impact on sustainable development. Giglio et al. (2021) and Zhou et al. (2020) have conducted research based on the individual impact of green finance and climate resilience, there is no empirical research that investigates the interaction between the two variables in high-income and upper-middle-income nations. Second, the declining returns of green finance in states with high climate resilience are not well-researched. Even though certain researchers, including Zhang et al. (2022), have briefly mentioned this problem, there is no thorough examination of the circumstances of the diminishing returns. This discontinuity is especially applicable in relation to rich countries, in which both green finance and climate resilience are more evolved, and additional investments in such spheres can result in low marginal benefits. Third, a significant portion of current studies has been in the quantitative analysis field, with less attention on qualitative aspects that include institutional capacity, policy frameworks, and governance structures that will determine the success of green finance and climate resilience. The importance of these institutional factors in policy design is to ensure that the policies incorporate both the concept of green finance and climate resilience in a manner that will contribute the greatest towards sustainable development. Future research must investigate the ways that policy frameworks, regulatory environments and forms of governance can make the effective integration of green finance and climate resilience possible or impossible.

The existing studies on green finance, climate resilience, and sustainable economic development have proved useful in understanding how the three can be relevant to long-term sustainability. There are however still huge gaps especially in how the integrated impact of green finance and climate resilience on economic development can be understood. The proposed study will address these gaps through examining the interactive impacts of these two factors in high-income and the upper-middle-income countries. The study will help to further understand the relationship between green finance and climate resilience as a means of achieving sustainable development and will therefore be important in guiding policy makers, financial institutions and development agencies by addressing the shortcomings of the current research to provide a comprehensive understanding of how these two can be used to achieve sustainable development.

## 3. Theoretical Background and Methodology

This section explains the theoretical linkages between climate resilience, green finance, and sustainable economic development under prominent theories. The Environmental Kuzet Curve (EKC) theory reveals that a country has to compromise on environmental quality in initial tages of the development. Therefore green finance can help nations to mitigate initial adverse effects of pro growth policies. The theory of sustainable development focuses on intergenerational equity. Countries engaged in efforts to boost

their climate resilience successfully develop their capabilities to absorb climate. These capabilities are not limited to administration and governance. They develop in communities and systems and economies in a way that their future generations don't still pay the cost of the actions of the current generations (Béné et al.2012; Robert et al.2005). Amartya Sen introduces the capability approach theory, which focuses on people's freedom to implement those ideas that can provide them with a better health system, access to food, and better living quality, resulting in sustainable and equitable growth (Sen, 1999; Nussbaum, 2015; Adger, 2010).

Green investment theory explains the beneficial role of investment in green projects for an economy. Green projects promote economic growth without compromising environmental quality as a result of energy efficiency and renewable energy (Campiglio, 2016; Giglio et al., 2021; Eyraud et al., 2013). According to the theory of the environmental Kuznets curve revisited, countries with green finance have different growth paths than former industrial nations. The adoption of green technology and green infrastructure and decarbonizing existing infrastructure either shifts the curve downward or flattens the curve (Panayotou, 1993; Dinda, 2004).

Both climate resilience and green finance are crucial determinants of sustainable economic development, as the former enhances capabilities and abilities to reduce climate and environmental vulnerabilities, and the latter promotes decarbonizing, innovations, and clean energy (Xu, 2023; Tran et al., 2024). However, these two pillars of sustainable economic development are interdependent, and their effect on economic development is conditioned on each other.

Therefore, the current study has the following benchmark regression equation:

$$SDP_{it} = \alpha SDP_{it-1} + \beta_0 + \beta_1 CLR_{it} + \beta_2 GRF_{it} + \beta_3 CLR * GRF_{it} + \beta_4 LBF_{it} + \beta_5 PCP_{it} + \beta_6 HCP_{it} + \beta_7 TROP_{it} + \varepsilon_{it} \ldots\ldots 1$$

Where $SDP$ is sustainable economic development, $CLR$ is climate resilience, $GRF$ is green financing, $CLR * GRF$ is the interactive term to capture combined effect of climate resilience and green financing, $LBF$ is labor force, $PCP$ is physical capital stock, $HCP$ represents human capital, $TROP$ is trade openness, $\varepsilon$ is Gaussian term, $i$ and $t$ shows nations and years respectively.

Equation 1 contains the lag of dependent variables, namely SDP, as an explanatory variable; therefore, it is a dynamic panel model. To empirically estimate this dynamic panel model, the current research uses the data of 38 high-income and upper-middle-income nations over the period of 2011-2019 based on the availability of the data on green finance and climate resilience. Furthermore, to estimate the individual and combined effect of green finance and climate resilience on sustainable economic development, this study uses augmented system GMM proposed by Kripfganz (2019), which the augmented version of Arellano and Bond (1991) followed by Arellano, M., & Bover, O. (1995) and Blundell and Bond (1998) respectively.

Arellano and Bond (1991) estimator can be explained by following equations;

$$y_{it} = x_{it}^{'}\beta + e_{it} \quad \text{where } e_{it} = \alpha_i + \mu_{it} \qquad (2)$$
$$\text{for } t = 1, \ldots\ldots, T \text{ and } i = 1, \ldots\ldots, N.$$
$$y_{it} = \lambda y_{i,t-1} + x_{it}^{'}\beta + e_{it} \qquad (3)$$
$$\text{for } t = 1, \ldots\ldots, T \text{ and } i = 1, \ldots\ldots, N.$$

The correlation between $\lambda$ and $\alpha_i$ may lead to inconsistent estimates of OLS, fixed, and random effect models. To avoid this correlation and biased estimates, both Arellano and Bond (1991) and Anderson and Hsiao (1981) transform equation 3 into first-differenced form and recommend the use of lags as an instrumental variable to avoid the issue of endogeneity.

$$\Delta y_{it} = \lambda \Delta y_{i,t-1} + \Delta x_{it}^{'}\beta + \Delta e_{it} \qquad (4)$$

Thus, the associated moment conditions are:

$$E\left[Z_i^{D'} \Delta e_i\right] = 0 \qquad (5)$$

Where $\Delta e_i = (\Delta e_{i2}, \Delta e_{i3}, \ldots, \Delta e_{iT})^{'}$ , and $Z_i^D = \left(Z_{yi}^D,\ Z_{Xi}^D\right)$, with GMM type instruments. However, the use of GMM type instruments may overfit the model, therefore, to avoid it Roodman (2009a, 2009b) and Pesaran & Smith (1995) suggest the use of standard instruments to avoid the use of too many instruments.

$$Z_{yi}^D = \begin{pmatrix} y_{i0} & 0 & 0 & 0 & 0 & 0 & \ldots \\ 0 & y_{i0} & y_{i1} & 0 & 0 & 0 & \ldots \\ 0 & 0 & 0 & y_{i0} & y_{i1} & y_{i2} & \ldots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{pmatrix} \begin{matrix} \leftarrow t = 2 \\ \leftarrow t = 3 \\ \leftarrow t = 4 \\ \vdots \end{matrix}$$

$$Z_{xi}^D = \begin{pmatrix} x_{i0} & 0 & 0 & 0 & 0 & 0 & \ldots \\ 0 & x_{i0} & x_{i1} & 0 & 0 & 0 & \ldots \\ 0 & 0 & 0 & x_{i0} & x_{i1} & x_{i2} & \ldots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{pmatrix} \begin{matrix} \leftarrow t = 2 \\ \leftarrow t = 3 \\ \leftarrow t = 4 \\ \vdots \end{matrix}$$

$$Z_{yi}^D = \begin{pmatrix} y_{i0} & 0 & \cdots & 0 \\ y_{i1} & 0 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ y_{i,T-2} & y_{i,T-3} & \cdots & y_{i0} \end{pmatrix} \begin{matrix} \leftarrow t = 2 \\ \leftarrow t = 3 \\ \vdots \\ \leftarrow t = T \end{matrix}$$

After the use of a standard instrument, we can use instruments for both level and first difference at a time; nonetheless, in level form, the assumption of joint stationarity may be violated due to the possible correlation with $\alpha_i$ (Blundell and Bond ,1998 Blundell *et al.*, 2001).

Therefore, stacked moment conditions are

$$E\left[\begin{pmatrix} Z_i^{D'}\Delta e_i \\ Z_i^{L'} e_i \end{pmatrix}\right] = 0 \qquad (8)$$

where $e_i = (e_{i2}, e_{i3}, \ldots, e_{iT})'$ and $\Delta e_i = D_i e_i$ and D is the first-difference transformation matrix.

$$E\left[\begin{pmatrix} Z_i^{D'} D_i e_i \\ Z_i^{L'} e_i \end{pmatrix}\right] = E\left[\begin{pmatrix} Z_i^{D'} D_i \\ Z_i^{L'} \end{pmatrix} e_i\right] = E\left[Z_i' e_i\right] = 0$$

where $Z_i = \left(\tilde{Z}_i^D, Z_i^L\right)$ are instruments for level after transformation, $\tilde{Z}_i^D = D_i' Z_i^D$. The augmented version of system GMM also integrates non-linear moment conditions suggested by Frazier et al. (2019) along with the use of Windmeijer (2005) corrected standard errors to ensure efficiency of estimates and identification of instruments in case of two step system GMM. Thus, the current study uses two step system GMM and use instrument both t level and first difference.

**4. Results and Discussion**

The purpose of this study is to empirically identify the combined effect of green finance and climate resilience for the sustainable economic development of upper-middle-income and high-income nations. Table 1 shows the definitions of the variables and the sources from which we collected the data for these variables. SDP is sustainable development measured by the SEDA index constructed by the Boston Group. It consists of various indicators that reflect the sustainable development of a nation. GRF is green financing proxies by international financial flows to countries in support of clean energy, R&D, and renewable energy projects in million USD. This data is obtained from the IRENA database. CLR is a climate resilience index used to measure countries' resilience to climate change, prepared by the University of Notre Dame, USA. The rest of the variables are control variables where labor force (LBF), physical capital (PCP), and human capital (HCP) are fundamental inputs of the production function, and trade openness (TROP) is used to control the effect of the level of economies' openness to international trade. The data on human capital and physical capital are obtained from the Penn World Table, and the data on trade openness and labor force are collected from WDI.

Table 2 presents a summary of the data used by this study. The mean value of the natural log of SDP in this current panel is 3.99 with a standard deviation and range of 0.249 and 1.41, respectively, which shows a moderate level of variation in terms of the sustainable development of nations over time. Similarly, the average value and standard deviation of the natural log of the climate resilience index belonging to the current panel are 3.99 and 0.156, respectively, demonstrating a high but relatively low level of dispersion compared to sustainable development. In contrast, in terms of natural logarithmic form, green finance has substantial variation among nations covering the period of 2011-2019, as the value of standard deviation (2.69) and range are significantly larger.

Table 3 reports the degree and nature of linear dependence among the variables of the model constructed by this study. Green financing has a positive linear association with sustainable development; however, the magnitude of this linear dependence is low. In contrast, climate resilience not only has a positive linear dependence on sustainable development, but the degree of linear association is very strong. It implies that countries with high investment in green finance projects and climate control programs can enjoy relatively more sustainable economic development compared to countries with less focus on green financing and climate control. All control variables have a positive correlation with sustainable economic development, except the labor force, which has a negative correlation.

**Table 1: Description of Variables**

| Series | Variable | Description | Source |
|---|---|---|---|
| SDP | Sustainable development | Index of sustainable development | Boston Consulting Group |
| GRF | Green financing | International financial flows to countries in support of clean energy research and development and renewable energy production | IRENA |
| CLR | Climate resilience | ND-GAIN INDEX | University of Notre Dame, USA |
| LBF | Labor force | Total labor force (age 15+) | WDI |
| PCP | Physical capital | Capital stock | Penn World Table |
| TROP | Trade openness | Trade (% of GDP) | WDI |
| HCP | Human capital | Penn World Table | Penn World Table |

**Table 2: Descriptive Statistics**

| Series | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| SDP | 380 | 3.992 | .249 | 3.077 | 4.490 |
| GRF | 357 | 3.608 | 2.69 | -4.605 | 9.372 |
| CLR | 380 | 3.995 | .156 | 3.709 | 4.337 |
| LBF | 380 | 15.951 | 1.590 | 12.404 | 20.475 |
| PCP | 380 | 13.738 | 1.900 | 10.295 | 18.416 |
| TROP | 380 | 72.994 | 25.828 | 22 | 162 |
| HCP | 350 | 2.7857 | .5483 | 1.97 | 3.96 |

**Table 3: Correlation Matrix**

| Series | SDP | GRF | CLR | LBF | PCP | TROP | HCP |
|---|---|---|---|---|---|---|---|
| SDP | 1 | | | | | | |
| GRF | 0.1041 | 1 | | | | | |
| CLR | 0.7666 | 0.1976 | 1 | | | | |
| LBF | -0.0413 | 0.3604 | 0.0575 | 1 | | | |
| PCP | 0.185 | 0.31 | 0.2936 | 0.5662 | 1 | | |
| TROP | 0.1493 | -0.2604 | 0.1757 | -0.4129 | -0.4111 | 1 | |
| HCP | 0.3749 | 0.2663 | 0.3678 | 0.0658 | 0.2889 | -0.0348 | 1 |

Figure 1 provides a comprehensive analysis of the linear association among sustainable economic development, green financing, and climate resilience. The top left cell shows the correlation between sustainable economic development and green financing. According to this cell, both variables are positively and linearly correlated, indicating that countries with more investment in green projects enjoy sustainable economic development. The top right cell corner shows the correlation between sustainable economic development and climate resilience. This also demonstrates a positive linear association between sustainable economic development and climate resilience. Similarly, the bottom left cell represents the correlation between climate resilience and green financing, showing that countries with green investment have more resilience to climate change.

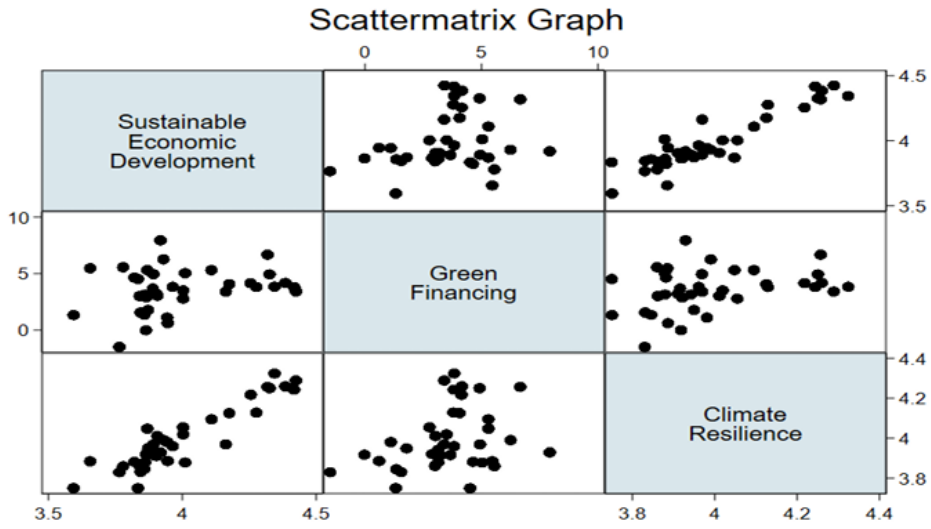


**Figure 1: Scattermatrix Graph**

This study aims to explore the combined effect of green finance and climate resilience for the sustainable development of nations. Table 4 provides the estimates of our empirical models estimated with system GMM. Model 1 (2) is estimated to capture the individual and isolated effect of climate resilience (green finance) on sustainable economic development. According to the coefficient of climate resilience (CLR),1 percent increase in the climate resilience index is associated with a 0.487 percent increase in the sustainable economic development index. The CLR is highly significant in Model 1. In model 2, the coefficient of green finance is 0.003, which implies that a 1 percent increase in green finance funding leads to an increase in the sustainable economic development index by 0.003 percent. This variable is also highly significant. In sum, both variables have a positive and significant effect on climate resilience in isolation. Model 3 is used to empirically estimate the individual effect of climate resilience and green financing on sustainable economic development in the presence of each other. The magnitude of the coefficient of climate resilience in model 3 is relatively smaller than in model 1, which implies that in the presence of investment in green projects, the favorable effect of climate resilience on sustainable economic development reduces; however, the effect of green finance remains the same as its isolated effect in model 3.

Climate resilience enhances capacity of countries to get rid of vulnerability to shocks such as floods, heatwaves, and droughts. Further, it promotes intergenerational equality as it enhances environmental quality and economic stability. In addition, climate resilience requires strong enforcement of environmental regulations and policies backed by good

governance and well-performed institutions, resulting in sustainable economic development. Moreover, people's preferences to adopt and adapt practices to avoid and mitigate shocks such as floods and droughts enhance their capabilities, which are the vital source of sustainable economic development. The findings of this study are in line with Hallegatte et al.2016), Hallegatte (2016), Liu et al. (2024), and Denton et al. (2014).

Similarly, green financing promotes initiatives and the execution of environmentally friendly projects such as renewable energy and transportation with zero or low carbon emissions. Consequently, either the turning point of the Environmental Kuznets Curve comes earlier or the whole curve may shift. In addition, green finance leads to green innovations and financial stability of a financial sector, resulting in sustainability of economic development. These findings are according to the findings of Zhou et al. (2020), Zakari (2022), and Wang (2022).

Model 4 is estimated to capture the combined effect of green finance and climate resilience on sustainable economic development. The coefficient of their interaction term is significant and negative (-0.059), indicating an adverse combined effect for SDP. It means that when nations simultaneously focus on climate resilience and green financing, the sustainability of their economic development hurts because of their combined effect. These two variables both weaken the effect of each other on sustainable economic development in upper- and high-income nations.

The possible reason for this adverse interactive (combined) effect is the diminishing returns to green finance, as after a certain point of climate resilience, further investment in green finance does not contribute to economic sustainability significantly. The substitution effect also creates this adverse combined effect of climate resilience and green finance for sustainable economic development. For example, green finance may be diverted to mitigation in countries that already have strong climate resilience mechanisms. Similarly, climate resilience-oriented policies in countries with already high rates of green finance may overlap with green projects-oriented policies. Consequently, short-run economic development affected adversely. As nations have limited resources due to scarcity of resources, aggressive efforts to boost climate resilience and green financing crowd out other sectors that play a positive role in the economic development of nations (Zhang, 2022).

The negative sign of the lag of SDP in all models indicates that sustainable economic development is path-dependent and follows conditional convergence and a self-correcting dynamic. In addition the negative sign also shows the stability of the model. Physical and human capital both have a positive and significant effect on sustainable economic development in each model, possibly due to machinery, infrastructure development, and skill sets that increase the level of productivity and growth. However, the labor force has a significant but negative effect on SDP in models 1 to 4, possibly due to the high dependency ratio, which creates inefficiency and pressure in the economy. Unlikely, economies' level of openness to international trade is creating a beneficial effect for the

sustainability of economic development as a result of technology transfer and access to international markets that enhance countries' competitiveness of the countries.

**Table 4: GMM Results**

| | (Model 1) | (Model 2) | (Model 3) | (Model 4) |
|---|---|---|---|---|
| Regressors | SDP | SDP | SDP | SDP |
| $SDP_{(-1)}$ | -0.528*** (0.00323) | -0.519*** (0.00283) | -0.521*** (0.00341) | -0.517*** (0.0068) |
| LBF | -0.560*** (0.0462) | -0.796*** (0.0692) | -0.819*** (0.0773) | -0.633*** (0.1005) |
| PCP | 0.319*** (0.0173) | 0.336*** (0.0392) | 0.339*** (0.0408) | 0.274*** (0.0555) |
| TROP | 0.00337*** (0.000338) | 0.00360*** (0.000270) | 0.00352*** (0.000284) | 0.0033*** (0.0005) |
| HCP | 0.525*** (0.0663) | 0.423*** (0.156) | 0.416*** (0.156) | 0.376** (0.1639) |
| CLR | 0.487*** (0.0424) | N. A | 0.133** (0.0604) | 0.282*** (0.1134) |
| GRF | N. A | 0.00309*** (0.000818) | 0.00347*** (0.00101) | 0.236*** (0.0644) |
| CLR_GRF | | | | -0.059*** (0.0163) |
| Constant | 6.992*** (0.716) | 12.85*** (0.688) | 12.69*** (0.854) | 11.15*** (1.163) |
| Test of AR (2) | 0.05 | 0.06 | 0.06 | 0.07 |
| Sargan Test of overidentification | 0.37 | 0.46 | 0.48 | 0.66 |
| No. of countries | 38 | 38 | 38 | 38 |
| No. of Instruments | 17 | 17 | 19 | 21 |

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

## 5. Conclusion

This study offers to unleash the combined effect of green finance and climate resilience for the sustainable development. The data used by the study is covers 38 high and upper-middle-income countries during the time-period of 2011 and 2019. The study is carried out to address a major gap in the literature concerning interaction between these two key aspects of green finance and climate resilience in ensuring long-term sustainability. It

captures the individual and isolated impact of green finance on sustainable economic development. This paper aimed to fill this gap by empirically investigating the effect of green finance and climate resilience individually and in combination, and provided useful information on how this aspect facilitates the realization of sustainable development objectives. The major contribution of the study is that it tries to combine green finance and climate resilience by applying the augmented system GMM. Key variables are Sustainable Development Performance (SDP), Green Finance (GRF), and Climate Resilience (CLR) and control variables are labor force, physical capital, human capital, and trade openness.

The study provided a number of significant results that are helpful in understanding the relationships between the green finance, climate resilience, and sustainable economic development. Green finance and climate resilience both are found to have positive and significant influence on sustainable economic development when both variables are discussed separately. In particular, a rise in climate resilience is found to be linked with sustainable development, which highlights the critical importance of climate resilience in the economic stability during the environmental challenges. Climate resilience is of great importance especially to the high-income countries that are becoming vulnerable to the adverse effects of climate change which include extreme weather, flooding and an increase in temperature. The more resilient country is better to absorb the climate shock, resulting the lower economic costs and sustained growth.

Green finance on the other hand had a small impact on sustainable economic development. Although the influence of green finance is statistically significant, its strength is not that high as compared to the influence of climate resilience. This finding implies that despite its importance, green finance is not the only source of sustainable development and its effects are determined by other factors, including institutional environment, governance frameworks and general scale of environmental awareness and efficiency of the current environmental regulations. The finding also suggests that growth in green finance and climate resilience might decline when these two concepts are pursued simultaneously. This observation disapproves the hypothesis that the two factors are complement and indicates that much emphasis on the two may be crowded with other areas of economic development that are very fundamental. The study introduce new empirical evidence of the multidimensions of climate adaptation and green financing on sustainable economic development in high and upper-middle-income countries and it provides crucial policy application that can be applied in the future activities.

### *5.1 Policy Implications*

There are several policy implications of this study. One of the determinants of sustainable economic development is climate resilience that is especially high, and therefore, states should continue investing in climate adaptability mechanisms. However, the findings also help to prove that in the countries, where the degree of climate resilience is already high, more investments in the given sphere may not be so rewarding. The policymakers of the countries should focus on utilizing the resilience systems at their maximum and direct other

policies that will supplement the resilience efforts which involve uptake of renewable energy, technological progress and social welfare programs.

The study underlines that additional investment is needed in green finance and it advises that one must analyze the outcome of green finance in the context of systematic changes. The green finance is indeed needed in order to promote sustainable activities and finance the transition to the low-carbon economy, but we cannot rely on green finance as the remedy of the sustainable development. Policymakers must ensure that green finance is included in a more comprehensive policy that will include regulatory enforcement, innovation incentives, and a capacity-building procedure within sustainable sectors.

The relationship between the green finance and the climate resilience is a bonus so, the resources, should be managed carefully by the policymakers. There could be a more effective approach to a more gradual process and focus on some segments of sustainability, instead of implementing green finance and climate resilience in parallel, in accordance with the condition of the countries and their developmental needs. This would ensure effective distribution of the resources and would have fewer chances of crowding out other sectors which would contribute to economic growth.

*5.2 Limitation of the study*

The study has contributed significantly to the body of knowledge on sustainable economic development, but it possesses some limitations. First, the study focuses exclusively on the high-income and upper-middle-income countries thus limiting the generalizability of the study to low-income countries. The future research might extend to cover low-income countries, which might have distinct challenges and resources and also climate resilience levels. It would enable obtaining a better overview of the interaction between green finance and climate resilience in various economic settings.

Second, the study employed primarily quantitative research to investigate the association of the variables. Even though the mentioned approach provides the robust estimates of the effects of the green finance and climate resilience on the sustainable development, the follow-up research would be based on the qualitative methods to help gain a complete picture of the institutional, social, and governance relationship existing between the efficacies of these policies. The detailed institutional analysis, case studies, and interviews with policymakers may introduce helpful information regarding the mechanisms of the observed outcomes.

Third, the study did not address the long-term feedback processes that may be potentially existent between the green finance and climate resilience and sustainable economic development. The future research should consider the impacts of these factors on the long-term basis and the interaction of these factors with other factors of long-term development such as technology development, demographic change, and change of the economic situation in the world. This study is also limited by data availability. The ND-GAIN Index

data is available till the year 2019. Future studies can extend it with more recent data of ND-GAIN index.

In short, the study will add value to the already known information on the co-effectiveness of green finance and climate resilience on sustainable economic development. The results demonstrate that both the concepts of green finance and climate resilience have beneficial effects on sustainable development, although the net effect of the two concepts may be more complex and that there may be a reduction in the returns in the case that the two are pursued excessively. The findings of the research have important policy implications to the high-income and upper-middle-income nations, and the need to create a middle ground approach to a green finance and climate resilience. The weaknesses of the research can be addressed in the future research by involving a bigger sample of nations, exploring the qualitative side of the topic, and also looking at the long-term impact of these variables in relation to sustainable growth. The study bridges the literature gaps hence providing a much-needed insight into how countries should plan on how to incorporate green and climate resilience into their sustainability principles that will result in the larger goal of achieving economic stability in the long term despite the climatic changes.

**Research Funding**

The authors received no research grant or support for this research study.

**Declaration of AI Use**

No generative AI was used in conducting the research or writing this manuscript. Only Grammarly was used to improve the write up of the paper.

**Data Availability**

The datasets are available from the corresponding author upon reasonable request.

**Declaration of Conflict of Interest**

The authors declare no conflict of interest / no competing interests.

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