Association of Green Finance, Renewable Energy Investments, and Environmental Quality with Sustainable Development: Evidence from ASEAN Economies

Trinh Huu Nguyen

Ho Chi Minh City University of Industry and Trade, Ho Chi Minh City, Vietnam.
Email: trinhnh@hufi.edu.vn

Thanh Dang Nguyen

Thu Dau Mot University, Binh Duong, Vietnam. Email: thanhnd@tdmu.edu.vn

Oanh Thi Kim Thai*

College of Economics, Vinh University, Vietnam. Email: oanhttk@vinhuni.edu.vn

Thuy Ngoc Phung

Hung Vuong Primary School, District 5, Ho Chi Minh City, Vietnam.
Email: ngocthuyht68@gmail.com

Tung Quang Nguyen

Nam Thien Law Office. Email: mr.lancelos@gmail.com

Abstract

Environmental quality holds significant importance due to the global pursuit of achieving net-zero emissions by 2050. This study endeavours to investigate the interplay among green financing, investments in the energy sector, environmental degradation, and the pursuit of sustainable development. Focused on ASEAN economies from 2013 to 2022, we employ a panel fixed effect model to analyse the empirical relationships. Sustainable development is gauged through adjusted net savings, environmental degradation through carbon emissions, and green finance through various investments in green energy, green credit, and green securities. Our findings indicate a positive association between green finance and sustainable development, while environmental degradation negatively impacts sustainable development in ASEAN countries. Employing the system GMM method reaffirms the robustness of our results. These findings offer actionable insights for governments, regulators, and policymakers in the studied nations.

Keywords: Green Finance, Green Energy Investments, Environmental Quality, Sustainable Development, Economic Growth.

Introduction

Mitigating environmental degradation emerges as a critical challenge and a foremost obstacle to achieving Sustainable Development Goals (SDGs) in the forthcoming decades, primarily due to the escalating global CO2 emissions. The Global Risk Report asserts that environmental degradation stands as the most perilous global challenge in the contemporary era (WEF, 2021). Climate variations imperil both economic stability and individual welfare (Lahouel et al., 2021; Zafar et al., 2022), with their intensification presenting formidable difficulties for economies to intervene, preclude, and manage the catastrophic vicissitudes of climate patterns. Nations are presently formulating and executing strategies to alleviate their vulnerability to environmental shifts. Furthermore, they are integrating tactics into their national strategic frameworks to mitigate ecological (Azam et al., 2021; Azam et al., 2022; Hunjra et al., 2022).

In the current milieu, there exists a compelling necessity for investments directed towards Sustainable Development Goals. Investments aimed at averting environmental hazards and formulating sound policies for environmental sustainability stand as pivotal pillars. Consequently, to address these formidable challenges, the financial sector of each nation should assume a pivotal role. However, the scarcity of financial resources impedes efforts to tackle these challenges, exerting adverse effects on governments' capacity to achieve Sustainable Development Goals (SDGs) and ecological sustainability (Bhattacharyya, 2022; Hussain et al., 2022). The Intergovernmental Panel on Climate Change (IPCC) underscores the imperative of bolstering investments in renewable energy projects to limit global warming to 1.5°C or less, thus mitigating its adverse repercussions.

To fulfil the objectives outlined in the Paris Agreement, the UNFCCC contends that funding of US$1.5 trillion for green projects is requisite until 2030. Green investment assumes paramount importance in meeting the escalating energy demands driven by increased energy access, population levels, and rising income levels (Hussain et al., 2022; Lee & Lee, 2022). A robust green finance ecosystem is

imperative across all nations, particularly in ASEAN countries. Financial markets have devised innovative mechanisms and evolved strategies to champion sustainable development, climate action, and green recovery, thereby ensuring adequate capital for environmental and social initiatives. Additionally, financial markets have divested from unsustainable ventures and projects that engender adverse impacts on both people and the environment (Ning, Lin Guo, & Chang, 2022; Wang et al., 2021).

Investments in the energy sector directed towards green initiatives facilitate the generation of societal and corporate value without inflicting harm on the environment (Thomson et al., 2022). There is a heightened awareness of the dynamic and intricate interplay among society, economy, and environmental quality. Green investments stand as a cornerstone of the global financial ecosystem, safeguarding the objectives outlined in the Paris Agreement. The objective of green financing and SDGs is to decouple sustainable economic progress from climate mitigation (Hussain et al., 2022; Lee & Lee, 2022). Sustainable progress entails corporate economic planning, governmental policies, and actions aimed at averting the depletion of natural resources.

Various definitions of sustainable development exist based on spatial variability (Lawn, 2006). Nonetheless, Mawhinney (2008) underscores the philosophical underpinnings of sustainable development, highlighting its three fundamental pillars: economic, social, and ecological development. Ecological sustainability underscores equitable access to natural resources and the long-term sustainability necessary for a healthier lifestyle. The Environmental and Development Commission defines sustainable development as meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.

The importance of aspects of green national accounting is elucidated by Lawn (2006), encompassing ecological footprints, Green GDP, and actual savings. However, the characteristics of sustainable economic progress assume particular significance for emerging economies, especially ASEAN countries, which often grapple with savings deficits. "Adjusted net saving" serves as a suitable tool for gauging the extent of long-term economic progress (Ben Lahouel et al., 2021; Crabtree, 2020; Jha, Sandhu, &

Wachirapunyanont, 2018), providing insights into the feasibility of national investment plans (World Bank, 2019) and regulating trends in genuine savings by adjusting for resource depletion (Greasley et al., 2014).

Financial institutions within the financial ecosystem play a pivotal role in advancing SDGs. Financial policies are instrumental in fostering green investments in environmentally friendly enterprises (Jeucken, 2001). Simultaneously focusing on accumulating capital and fostering sustainable progress through natural resource rents poses numerous challenges for ASEAN countries. While green investments enhance societal capabilities (Hargreaves & Fink, 2012), many countries heavily reliant on agriculture contribute to water and air pollution (IPCC, 2014). Robust financial lending strategies and easy access to finances empower agriculturalists to adopt innovative machinery, thereby contributing to sustainable development (Georgopoulou et al., 2017; McKibbin et al., 2020).

Financial inclusion emerges as another critical avenue for sustainable progress (Shobande & Enemona, 2021), enhancing societal welfare by promoting saving and deposit behaviours. However, lower levels of savings present challenges for economies in meeting their financial obligations. Pertinent studies underscore the critical role of the financial sector in achieving sustainable growth through investments in macroeconomic projects (Arora & Chakraborty, 2021), yet often overlook socio-environmental dimensions in their research frameworks.

This study investigates the impact of green investments and environmental quality on sustainable development in ASEAN countries from 2013 to 2022. Sustainable development, proxied by net savings, is the dependent variable, while green finance is represented by green securities, green credit, and green investments. Environmental degradation is measured by carbon emissions. Using a panel fixed effect model, the study validates the hypotheses, revealing the significant roles of environmental degradation and green financing in ASEAN economies' pursuit of SDGs. The SYS-GMM technique further confirms these results, ensuring their robustness. These findings have practical implications for regulators and policymakers in ASEAN nations, informing policy formulation regarding investments and green financing.

The paper follows a structured organization, beginning with theoretical justification in section 2, and methods in section 3. Sections 4 and 5 delve into the empirical findings and draw conclusions, respectively.

Literature Review

Green financing serves to mitigate credit risk and stabilize earnings for sustainable businesses (Miralles-Quirós & Miralles-Quirós, 2019), as lenders leverage borrowers' high credit ratings to mitigate their exposure to credit risks. Financial institutions play a pivotal role in facilitating firms' access to necessary financial assistance (Kim, Wu, & Lin, 2020), thereby fostering lucrative opportunities for businesses. The increased awareness of environmental sustainability has led to a surge in green investments in energy projects (Jinru et al., 2022; Umar et al., 2021), with green financial resources demonstrating superior performance compared to non-green assets (Naqvi et al., 2021). However, investors interested in environmentally friendly green financing encounter barriers (Ji et al., 2021), highlighting the evolving dynamics between the environment and financing (Torras & Boyce, 1998).

The Environmental Kuznets Curve (EKC) illustrates a U-shaped relationship between environmental quality and financial progress, indicating that countries initially prioritize economic development over ecological conservation (Galeotti, Lanza, & Pauli, 2006). Nevertheless, a shift towards sustainable development and natural resource preservation has ensued (Dinda, 2004), despite initial challenges in implementing costly green programs in emerging economies (Dinda, 2004). Green financing for energy and ecological developments can improve environmental quality by enhancing social and environmental performance, reducing carbon emissions and pollution, discouraging reliance on traditional energy sources, and promoting green industrialization (van Veelen, 2021).

The evolution of green finance has macro-mechanistic impacts on environmental effects, with a reduction in capital provision for polluting sectors and increased provision for green energy projects enhancing economic and energy sectors (Srivastava, Dharwal, & Sharma, 2022). Green financing policies influence credit performance and improve ecological integrity, economic advancements, market

liquidity, and fund mobilization (Climate Change Initiative, 2019). Investment in socially responsible securities and energy-efficient commodities is crucial for sustainable development (Shahid, 2022; Shahid et al., 2023; Shahid et al., 2022), yet socially responsible investments in Asian countries remain low compared to global levels (Volz, 2018), partly due to the absence of ESG disclosure requirements.

Banks contribute to sustainable development by providing loans for climate-friendly product manufacturing in developing countries (Hoshen et al., 2017), while green bonds facilitate the development of green infrastructure (UNEP, 2017). Governments and financial institutions collaborate with private and public sector firms to drive green economic development (UNEP, 2017), as the demand for green financing rises in response to heightened concerns about environmental sustainability (Wang & Zhi, 2016). A balanced interaction between finance and climate quality is essential for an efficient green finance ecosystem, as it optimizes resource allocation and mitigates climate risks (Mohd & Kaushal, 2018). Governments play a crucial role in overcoming barriers to green investments (Peng & Zheng, 2021), prompting the formulation of a hypothesis:

H1. *Green financing enhances sustainable development in ASEAN countries*

The scholarly discourse delves into the correlation between environmentally sustainable developments and pollution, emphasizing the imperative of ecological legislation to mitigate carbon emissions and foster sustainability. Lee et al. (2018) highlight that methods for climate assessment and the deployment of clean technologies facilitate the transition to low-carbon economies in Asian nations. Environmental legislation aimed at addressing climate change contributes to improved climate quality across various countries (Ulucak, Danish, & Kassouri, 2020). The enactment of climate laws has enabled nations to progress towards emission reduction targets, with SAARC nations demonstrating evidence of sustainable development following reductions in carbon emissions (Shekhawat et al., 2022). Several other countries have also made strides towards low-carbon economies. Examining social progress, environmental preservation, and economic advancement, Peng and Deng (2021) utilize an entropy approach. Leveraging achievements in low-carbon initiatives and basic urban development, the authors

develop 35 sustainable performance indicators to facilitate adherence to the ESG framework.

H2. Climate mitigation has a significant impact on SDGs in ASEAN countries.

Governmental financial policies play a pivotal role in fostering business expansion and incentivizing investments in climate-related green initiatives (Jeucken, 2001), thereby bolstering economic progress (Hargreaves & Fink, 2012). Given the inadequate infrastructure in developing countries, coupled with their heavy reliance on the agriculture sector (IPCC, 2014), governments must formulate robust financing strategies to enable farmers to adopt advanced technologies for sustainable development (Georgopoulou et al., 2017; McKibbin et al., 2020), necessitating the adoption of financial inclusion measures (Shobande & Enemona, 2021; Singh & Dhadse, 2021). Climate mitigation efforts in low-income countries are often associated with rising prices and diminished living standards. Financial inclusion promotes savings habits and facilitates increased deposits towards achieving SDGs. Furthermore, the financial sector facilitates heightened levels of investment in developing countries, as evidenced by select macroeconomic studies (Arora & Chakraborty, 2021; Crotty, 1990). However, while existing literature largely overlooks the climate and social dimensions, the present study endeavours to address this gap.

Table 1: Description of Variables, their Proxies, Symbols, and Data Sources.

Variables	Proxies	Symbol	Data Source
Independent Variables	Green Credit	GCR	Central Banks of respective countries
	Green Securities	GSEC	
	Green Investments in Energy Projects	GINE	Central Banks of respective countries
	Environmental Deterioration	END	Central Banks of respective countries
Control Variable	Foreign Direct Investment	FDI	WDI
	Economic Developments	ED	WDI
	Trade-Openness	TradeOP	WDI
	Natural-Resource Rents	NRR	WDI
Dependent Variable	Sustainable Development	SD	WDI

Note: The methodology encompasses a description of green investments in energy-related projects, green securities, green credit, and sustainable development. Carbon emissions are measured in kg/2010 US$ of GDP, while trade and natural resource rents are expressed as percentages of GDP. FDI denotes the net inflow of

investments from other countries. Dependent variables are selected based on the study by Kamoun, Abdelkafi and Ghorbel (2019). The first three independent variables draw from the research of Wang et al. (2021), while the fourth independent variable, environmental deterioration, is grounded in the works of Solarin (2019) and Ntarmah et al. (2020). All control variables, except for trade openness, stem from Solarin's study (2019), with the latter variable informed by the research of Ramzan et al. (2019).

Table 2: Summary Statistics: Variables, their Proxies, Symbols, and Data Sources.

Variables	SD	GCR	GSEC	GINE	END	FDI	ED	TradeOP	NRR	Mean	St. Dev.
SD	1									4.7545	1.9773
GCR		1								6.0716	2.5516
GSEC	0.0834	0.0753	1							8.8449	2.1161
GINE	0.0869	0.0643	0.6193	1						7.5707	2.7133
END	0.4825	- 0.03	- 0.31	- 0.31	1					31.458	2.0655
FDI	0.4772	- 0.03	- 0.03	- 0.08	- 0.042	1				9.5951	9.0687
ED	0.0983	0.0735	0.3627	0.0973	- 0.049	0.0653	1			6.8949	11.256
Trade OP	0.0368	0.0664	0.0294	0.3083	- 0.021	0.4947	0.1382	1		11.493	7.5089
NRR	0.0994	0.0843	0.0863	0.0539	- 0.318	0.0750	0.1499	0.0372	1	4.6632	2.7004

Note: The mean and standard deviation (St. Dev) are provided in the last two columns.

Empirical Methods

To investigate the impact of green financing on sustainable development, annual data from ASEAN countries spanning from 2013 to 2022 is employed. Both dynamic and static panel estimations are utilized to validate the hypothesis, with the robustness of results further elaborated through the SYS-GMM approach, based on panel fixed effects estimations.

In this study, sustainable development serves as the dependent variable, while environmental degradation and green finance act as the primary independent variables. Sustainable development is proxied by "net savings per capita," calculated by dividing adjusted savings by the population, as recommended in existing literature (Azam et al., 2021; Castro & Lopes, 2022; Kamoun et al., 2019; Ullah et al., 2022). To derive "adjusted net savings," education expenditures are added to national savings, and emission damages (including CO2 depletion, mineral depletion, and forest depletion) are subtracted from this sum.

Green finance encompasses the flow of capital assets into development projects and ecological goods, as well as regulations fostering the creation of more sustainable economies. It comprises three components: green investments, green credit, and green

securities, which are combined into a single variable. Green credit is determined by the ratio of green to total credit, while green securities are proxied by the value obtained by dividing the value of all firms by that of environmental-friendly enterprises. The ratio of spending on environmental protection to composite public expenditure is used to proxy green investments. Environmental deterioration is measured using carbon emissions. Control variables include trade openness, FDI, economic development, and natural resource availability. Further details on these variables are provided in Table 1, while Equation 1 is utilized to test the hypothesis;

$$SD_{i,t} = \alpha + \beta_1(GCR)_{i,t} + \beta_2(GSEC)_{i,t} + \beta_3(GINE)_{i,t} + \beta_4(END)_{i,t} + \beta_5(TradeOP)_{i,t} + \beta_6(FDI)_{i,t} + \beta_7(ED)_{i,t} + \beta_8(NRR)_{i,t} + \varepsilon\, i_{,t} \quad (1)$$

Where SD in equation 1 presents the dependent variable, which is sustainable development and is measured through adjusted net savings. the independent variables, GCR, GSEC, GINE, and END are green credit, green securities, green investment in energy projects, and environmental deterioration (CO_2 emission) respectively. Moreover, the Trade OP, FDI, ED, and NRR represent trade openness, FDI, economic development (GDP), and natural-resource rents respectively. We ascertain the relationships by systematically incorporating these independent variables into the equations;

$$SD_{i,t} = \alpha + \beta_1(GCR)_{i,t} + \beta_2(FDI)_{i,t} + \beta_3(ED)_{i,t} + \beta_4(TradeOP)_{i,t} + \beta_5(NRR)_{i,t} + \varepsilon\, i_{,t} \quad (2)$$

$$SD_{i,t} = \alpha + \beta_1(GSEC)_{i,t} + \beta_2(FDI)_{i,t} + \beta_3(ED)_{i,t} + \beta_4(TradeOP)_{i,t} + \beta_5(NRR)_{i,t} + \varepsilon\, i_{,t} \quad (3)$$

$$SD_{i,t} = \alpha + \beta_1(GINE)_{i,t} + \beta_2(FDI)_{i,t} + \beta_3(ED)_{i,t} + \beta_4(TradeOP)_{i,t} + \beta_5(NRR)_{i,t} + \varepsilon\, i_{,t} \quad (4)$$

$$SD_{i,t} = \alpha + \beta_1(END)_{i,t} + \beta_2(FDI)_{i,t} + \beta_3(ED)_{i,t} + \beta_4(TradeOP)_{i,t} + \beta_5(NRR)_{i,t} + \varepsilon\, i_{,t} \quad (5)$$

Table 2 presents summary statistics, including correlation analysis and checks for multicollinearity. These statistics offer insights into the basic characteristics of the variables employed in the study. The correlation matrix illustrates the associations between these variables. The relationship between green financing and sustainable development is investigated through panel regression analysis. Both fixed and random panel data models are utilized, with the Hausman test confirming the suitability of fixed

effects for hypothesis validation. Robustness is further assessed using the SYS-GMM approach, as recommended by González (2013), which effectively addresses autoregressive features, endogeneity issues, and omitted variable problems.

Table 3: Multicollinearity Issue for the Variables Under Study.

Variable	VIF	1/VIF
GCR	1.999	0.50025
GSEC	1.919	0.521105
GINE	1.859	0.537924
END	1.839	0.543774
FDI	1.799	0.555864
ED	1.779	0.562114
Trade OP	1.699	0.588582
NRR	1.649	0.606428

Note: Multicollinearity is mitigated as the VIF values are below 2, and the reciprocal of VIF values exceeds 0.5

Results and Discussion

The summary of basic descriptive statistics is provided in the final two columns of Table 2. Among the variables, trade openness exhibits the highest mean value, whereas natural resource rents display the lowest mean value. Sustainable development shows the lowest standard deviation, while economic development has the highest standard deviation.

Table 2 also presents the correlation results between the variables under examination. Notably, the highest correlation (0.6193) is observed between GSEC and GINE. However, this correlation does not surpass the predefined threshold of 0.70, indicating the absence of multicollinearity issues. Similarly, none of the other variables exhibit problematic correlations.

Table 3 illustrates the absence of multicollinearity between the independent and control variables, as evidenced by VIF values below 2 and reciprocal VIF values exceeding 0.5.

In Table 4, redundant fixed effect estimates are summarized. The significance level (P-value < 0.05) favours the utilization of the fixed effect technique, consistent with recommendations in the literature (Shahid et al., 2018) for panel data analysis. The Hausman test further supports the preference for fixed effect estimation, indicating its robustness in the current study context.

Four different models are run, each incorporating one independent variable: Model 1 with GCR, Model 2 with GSEC, Model 3 with GINE, and Model 4 with END. All models yield R2 values exceeding 0.60, indicating substantial explanatory power. These outcomes underscore the significant contribution of independent variables to sustainable development across all models.

Table 4: Estimations for Fixed Effects.

Variable	M1	M2	M3	M4
GCR	0.604**			
GSEC		0.406***		
GINE			0.519***	
END				− 0.315***
FDI	0.691**	0.682***	0.084**	0.718***
ED	0.743**	0.613*	0.902	0.626**
Trade OP	0.583	0.774*	0.263**	0.473*
NRR	0.844**	0.059**	− 0.710	0.062*
C	0.485***	− 0.258**	− 0.393	− 0.395**
Year Fixed Effect	Y	Y	Y	Y
Country Fixed Effect	Y	Y	Y	Y
R^2	0.7154	0.7024	0.6583	0.6849
Adjusted-R^2	0.7084	0.6846	0.6274	0.6683
F statistic	20.01***	21.45***	18.50***	24.90***

Note: The dependent variable, denoted as SD (sustainable development), is analysed across four models. Model 1 (M1) integrates GCR as an independent variable, Model 2 (M2) includes GSEC, Model 3 (M3) comprises GINE, and Model 4 (M4) features ED as an independent variable. All control variables are incorporated into each model, with significance levels indicated by *** for 1% confidence, ** for 5%, and * for 10%. The presence of significance is denoted by "Y" in each cell.

The results presented in Table 5 demonstrate that all proxies of green finance and environmental degradation significantly impact the sustainable development of ASEAN economies. Sustainable development is positively influenced by green financing while being negatively affected by environmental deterioration. Moreover, the findings reveal that green credit and green investment in energy projects, as proxies for green finances, exert a significant and positive influence on sustainable development. Green financial strategies, such as environmentally friendly credit policies, stimulate investments in green and renewable energies, aiming to safeguard the natural environment. This aligns with the observations of Liu et al. (2019) and the

implementation of laws promoting green practices in credit cards, directing funds towards investment in renewable energies, thereby fostering positive impacts on sustainable development (Taghizadeh-Hesary & Yoshino, 2020). Berensmann and Lindenberg (2016) note a significant and positive impact of green financial securities on environmental quality and sustainable development, consistent with the findings of Ahmed et al. (2022).

Investments in renewable energies, particularly in the insurance sector, have favourable effects on economic impressions and sustainable development (Ping, Chun, & Yi, 2014). Green investment in energy projects plays a pivotal role in achieving sustainable goals and advancing climate-friendly initiatives (Mills, 2012). Nesta, Vona and Nicolli (2014) argue that the growth of a green financial ecosystem enhances the financial strength and capabilities of enterprises engaged in renewable energy projects and climate protection initiatives. The outcomes of this study regarding sustainable advancement and climate degradation resonate with the findings of Rehman et al. (2021), who assert that climate deterioration exacerbates greenhouse gas emissions, leading to degradation in climate quality. Additionally, sustainable development is strongly influenced by the control variables employed in this study, including economic advancements, trade openness, natural resource rents, and FDI. These findings are consistent with previous studies (Ben Cheikh & Ben Zaied, 2021; Shobande & Enemona, 2021; Ziolo et al., 2017).

The study confirms the robustness of its findings through SYS-GMM analysis. It reveals a negative impact of climate degradation on sustainable development, while green finance significantly promotes sustainable development. Proper implementation of investment policies, along with enhancing green credit and issuing green financial securities, fosters a better financial ecosystem and financial development. This, in turn, encourages investment in green energy-related projects and sustainable development in ASEAN economies. These findings align with recent research by Berensmann and Lindenberg (2016), Liu et al. (2019), and Taghizadeh-Hesary and Yoshino (2020), emphasizing the favourable role of the variables studied in promoting green and sustainable development.

Table 5: SYS-GMM Estimation: (Dynamic Panel with Two Steps).

Variable	M1	M2	M3	M4
L1.	0.307***	0.094*	0.812*	0.046*
L2.	0.209*	- 0.826***	0.583***	- 0.965***
GCR	0.723**			
GSEC		0.472**		
GINE			0.084***	
END				− 0.384***
FDI	0.201*	0.850**	0.434***	0.743***
ED	0.723*	0.621*	0.995	0.408**
Trade OP	0.137	0.631*	0.246*	0.629*
NRR	0.449**	0.166*	− 0.836	0.082*
C	0.461***	-0.492**	− 0.362	− 0.343**
Year Fixed Effects	Y	Y	Y	Y
Country Fixed Effect	Y	Y	Y	Y
Sargan	8.719	9.287	8.263	7.699
P-values	0.188	0.182	0.141	0.194
P-values (AR-1)	0.057	0.014	0.006	0.027
P-values (AR-2)	0.830	0.792	0.765	0.861

Note: The dependent variable is SD (sustainable development). Models 1 to 4 (M1 to M4) incorporate different independent variables: GCR, GSEC, GINE, and ED, respectively. All control variables are included in each model. Significance levels are denoted by *** for 1%, ** for 5%, and * for 10%. "Y" indicates significance in each cell.

Conclusions, Recommendations and Policy Implications

Focusing on sustainable development is vital for mitigating climate deterioration in developing nations. Socially responsible finance, green finance, and climate finance play crucial roles in addressing human-induced environmental deterioration. Enterprises should separate economic advancements from climate degradation. This study examines the impact of green finances on climate quality in ASEAN countries from 2013 to 2023, contributing novel findings to the field. Sustainable development is the dependent variable, proxied with Adjusted net savings, while a green finance ecosystem is formed using green securities, green financing, and green investments in energy projects. Carbon emissions indicate environmental quality. Two hypotheses are developed and validated using a panel fixed effect approach. The study finds that environmental quality and climate-friendly investments are vital for long-term sustainable development in ASEAN economies. Green financing positively contributes to sustainable development, while

environmental degradation negatively impacts it. The robustness of the findings is confirmed with dynamic panel system GMM. Practical implications suggest financial institutions incorporate study findings into policies. Governments and regulators can introduce reforms like taxing CO2 emissions from conventional energy use. Enterprises can reduce climate hazards based on study findings. The study highlights the benefits of a green financial ecosystem in combating climate deterioration. Carbon emission policy resolutions and investment in green businesses and technologies are recommended. Financial institutions should invest in enterprises with feasible green energy plans. Future research could explore other economies and analyse sub-sample periods based on economic cycles and market conditions.

References

Ahmed, Z., Ahmad, M., Rjoub, H., Kalugina, O. A., & Hussain, N. (2022). Economic growth, renewable energy consumption, and ecological footprint: Exploring the role of environmental regulations and democracy in sustainable development. *Sustainable Development, 30*(4), 595-605. https://doi.org/10.1002/sd.2251

Arora, J., & Chakraborty, M. (2021). Does the ease of reading of financial disclosures influence investment decision? *Economics Letters, 204*, 109883. https://doi.org/10.1016/j.econlet.2021.109883

Azam, M., Hunjra, A. I., Bouri, E., Tan, Y., & Al-Faryan, M. A. S. (2021). Impact of institutional quality on sustainable development: Evidence from developing countries. *Journal of Environmental Management, 298*, 113465. https://doi.org/10.1016/j.jenvman.2021.113465

Azam, M., Younes, B. Z., Hunjra, A. I., & Hussain, N. (2022). Integrated Spatial-Temporal decomposition analysis for life cycle assessment of carbon emission intensity change in various regions of China. *Resources Policy, 79*, 103062. https://doi.org/10.1016/j.resourpol.2022.103062

Ben Cheikh, N., & Ben Zaied, Y. (2021). A new look at carbon dioxide emissions in MENA countries. *Climatic Change, 166*(3), 27. https://doi.org/10.1007/s10584-021-03126-9

Ben Lahouel, B., Ben Zaied, Y., Yang, G.-l., Bruna, M.-G., & Song, Y. (2021). A non-

parametric decomposition of the environmental performance-income relationship: Evidence from a non-linear model. *Annals of Operations Research, 313*, 525–558. https://doi.org/10.1007/s10479-021-04019-x

Berensmann, K., & Lindenberg, N. (2016). *Green Finance: Actors, Challenges and Policy Recommendations* (Briefing Paper No. 23/2016). Deutsches Institut für Entwicklungspolitik (DIE), Bonn. https://hdl.handle.net/10419/199787

Bhattacharyya, R. (2022). Green finance for energy transition, climate action and sustainable development: overview of concepts, applications, implementation and challenges. *Green Finance, 4*(1), 1-35. https://doi.org/10.3934/GF.2022001

Castro, C., & Lopes, C. (2022). Digital government and sustainable development. *Journal of the Knowledge Economy, 13*(2), 880-903. https://doi.org/10.1007/s13132-021-00749-2

Climate Change Initiative. (2019). *Green Infrastructure Investment Opportunities Indonesia, Update Report*. https://www.climatebonds.net/files/reports/giio_indonesia_2019_update_report.pdf

Crabtree, A. (2020). Sustainability indicators, ethics and legitimate freedoms. *Sustainability, Capabilities and Human Security*, 51-74. https://doi.org/10.1007/978-3-030-38905-5_3

Crotty, J. R. (1990). Owner–manager conflict and financial theories of investment instability: a critical assessment of Keynes, Tobin, and Minsky. *Journal of Post Keynesian Economics, 12*(4), 519-542. https://doi.org/10.1080/01603477.1990.11489816

Dinda, S. (2004). Environmental Kuznets curve hypothesis: a survey. *Ecological Economics, 49*(4), 431-455. https://doi.org/10.1016/j.ecolecon.2004.02.011

Galeotti, M., Lanza, A., & Pauli, F. (2006). Reassessing the environmental Kuznets curve for CO2 emissions: A robustness exercise. *Ecological Economics, 57*(1), 152-163. https://doi.org/10.1016/j.ecolecon.2005.03.031

Georgopoulou, E., Mirasgedis, S., Sarafidis, Y., Vitaliotou, M., Lalas, D., Theloudis, I., Giannoulaki, K.-D., Dimopoulos, D., & Zavras, V. (2017). Climate change impacts and adaptation options for the Greek agriculture in 2021–2050: A monetary assessment. *Climate Risk Management, 16*, 164-182. https://doi.org/10.1016/j.crm.2017.02.002

González, V. M. (2013). Leverage and corporate performance: International evidence. *International Review of Economics & Finance, 25*, 169-184. https://doi.org/10.

1016/j.iref.2012.07.005

Greasley, D., Hanley, N., Kunnas, J., McLaughlin, E., Oxley, L., & Warde, P. (2014). Testing genuine savings as a forward-looking indicator of future well-being over the (very) long-run. *Journal of Environmental Economics and Management, 67*(2), 171-188. https://doi.org/10.1016/j.jeem.2013.12.001

Hargreaves, A., & Fink, D. (2012). *Sustainable leadership*. John Wiley & Sons. https://psycnet.apa.org/record/2005-13851-000

Hoshen, M. S., Hasan, M. N., Hossain, S., Al Mamun, M. A., Mannan, A., & Al Mamun, A. (2017). Green financing: an emerging form of sustainable development in Bangladesh. *IOSR Journal of Business and Management, 19*(12), 24-30. https://doi.org/10.9790/487X-1912072430

Hunjra, A. I., Azam, M., Bruna, M. G., & Taskin, D. (2022). Role of financial development for sustainable economic development in low middle income countries. *Finance Research Letters, 47*, 102793. https://doi.org/10.1016/j.frl.2022.102793

Hussain, M., Mir, G. M., Usman, M., Ye, C., & Mansoor, S. (2022). Analysing the role of environment-related technologies and carbon emissions in emerging economies: a step towards sustainable development. *Environmental Technology, 43*(3), 367-375. https://doi.org/10.1080/09593330.2020.1788171

IPCC. (2014). *Climate Change 2014 Synthesis Report*. IPCC: Geneva, Szwitzerland. https://greenunivers.com/wp-content/uploads/2014/11/Synth%C3%A8se-Rapport-Giec.pdf

Jeucken, M. (2001). *Sustainable finance and banking: The financial sector and the future of the planet*. Routledge. https://doi.org/10.4324/9781849776264

Jha, S., Sandhu, S. C., & Wachirapunyanont, R. (2018). *Inclusive green growth index: A new benchmark for quality of growth*. Asian Development Bank. https://doi.org/10.22617/TCS189570-2

Ji, X., Zhang, Y., Mirza, N., Umar, M., & Rizvi, S. K. A. (2021). The impact of carbon neutrality on the investment performance: Evidence from the equity mutual funds in BRICS. *Journal of Environmental Management, 297*, 113228. https://doi.org/10.1016/j.jenvman.2021.113228

Jinru, L., Changbiao, Z., Ahmad, B., Irfan, M., & Nazir, R. (2022). How do green financing and green logistics affect the circular economy in the pandemic situation: key

mediating role of sustainable production. *Economic research-Ekonomska istraživanja, 35*(1), 3836-3856. https://doi.org/10.1080/1331677X.2021.2004437

Kamoun, M., Abdelkafi, I., & Ghorbel, A. (2019). The impact of renewable energy on sustainable growth: Evidence from a panel of OECD countries. *Journal of the Knowledge Economy, 10*, 221-237. https://doi.org/10.1007/s13132-016-0440-2

Kim, D.-H., Wu, Y.-C., & Lin, S.-C. (2020). Carbon dioxide emissions and the finance curse. *Energy Economics, 88*, 104788. https://doi.org/10.1016/j.eneco.2020.104788

Lahouel, B. B., Taleb, L., Zaied, Y. B., & Managi, S. (2021). Does ICT change the relationship between total factor productivity and CO2 emissions? Evidence based on a nonlinear model. *Energy Economics, 101*, 105406. https://doi.org/10.1016/j.eneco.2021.105406

Lawn, P. A. (2006). *Sustainable development indicators in ecological economics*. Edward Elgar Publishing. https://www.e-elgar.com/shop/gbp/sustainable-development-indicators-in-ecological-economics-9781845420994.html

Lee, C.-C., & Lee, C.-C. (2022). How does green finance affect green total factor productivity? Evidence from China. *Energy Economics, 107*, 105863. https://doi.org/10.1016/j.eneco.2022.105863

Lee, C. T., Lim, J. S., Van Fan, Y., Liu, X., Fujiwara, T., & Klemeš, J. J. (2018). Enabling low-carbon emissions for sustainable development in Asia and beyond. *Journal of Cleaner Production, 176*, 726-735. https://doi.org/10.1016/j.jclepro.2017.12.110

Liu, R., Wang, D., Zhang, L., & Zhang, L. (2019). Can green financial development promote regional ecological efficiency? A case study of China. *Natural Hazards, 95*, 325-341. https://doi.org/10.1007/s11069-018-3502-x

Mawhinney, M. (2008). *Sustainable development: Understanding the green debates*. John Wiley & Sons. https://doi.org/10.1002/9780470758564

McKibbin, W. J., Morris, A. C., Wilcoxen, P. J., & Panton, A. J. (2020). Climate change and monetary policy: issues for policy design and modelling. *Oxford Review of Economic Policy, 36*(3), 579-603. https://doi.org/10.1093/oxrep/graa040

Mills, E. (2012). The greening of insurance. *Science, 338*(6113), 1424-1425. https://doi.org/10.1126/science.122935

Miralles-Quirós, J. L., & Miralles-Quirós, M. M. (2019). Are alternative energies a real alternative for investors? *Energy Economics, 78*, 535-545. https://doi.org/10.1016/j.eneco.2018.12.008

Mohd, S., & Kaushal, V. K. (2018). Green finance: a step towards sustainable development. *MUDRA: Journal of Finance and Accounting, 5*(1), 59-74. https://doi.org/10.17492/mudra.v5i01.13036

Naqvi, B., Mirza, N., Rizvi, S. K. A., Porada-Rochoń, M., & Itani, R. (2021). Is there a green fund premium? Evidence from twenty seven emerging markets. *Global Finance Journal, 50*, 100656. https://doi.org/10.1016/j.gfj.2021.100656

Nesta, L., Vona, F., & Nicolli, F. (2014). Environmental policies, competition and innovation in renewable energy. *Journal of Environmental Economics and Management, 67*(3), 396-411. https://doi.org/10.1016/j.jeem.2014.01.001

Ning, Q. Q., Lin Guo, S., & Chang, X. C. (2022). Nexus between green financing, economic risk, political risk and environment: evidence from China. *Economic Research-Ekonomska Istraživanja, 35*(1), 4195-4219. https://doi.org/10.1080/1331677X.2021.2012710

Ntarmah, A. H., Kong, Y., Cobbinah, E., Gyan, M. K., & Manu, E. K. (2020). Analysis of the responsiveness of environmental sustainability to non-performing loans in Africa. *Applied Economics Journal, 27*(2), 77-109. https://doi.org/10.22004/ag.econ.334399

Peng, J., & Zheng, Y. (2021). Does environmental policy promote energy efficiency? Evidence from China in the context of developing green finance. *Frontiers in Environmental Science, 9*, 733349. https://doi.org/10.3389/fenvs.2021.733349

Peng, T., & Deng, H. (2021). Research on the sustainable development process of low-carbon pilot cities: The case study of Guiyang, a low-carbon pilot city in south-west China. *Environment, Development and Sustainability, 23*(2), 2382-2403. https://doi.org/10.1007/s10668-020-00679-0

Ping, Y. J., Chun, J., & Yi, P. (2014). China green financial development present situation and countermeasure research. *Special Zone Economy, 5*.

Ramzan, M., Sheng, B., Shahbaz, M., Song, J., & Jiao, Z. (2019). Impact of trade openness on GDP growth: Does TFP matter? *The Journal of International Trade & Economic*

Development, 28(8), 960-995. https://doi.org/10.1080/09638199.2019.1616805

Rehman, A., Ma, H., Ozturk, I., Murshed, M., & Dagar, V. (2021). The dynamic impacts of CO2 emissions from different sources on Pakistan's economic progress: a roadmap to sustainable development. *Environment, Development and Sustainability, 23*(12), 17857-17880. https://doi.org/10.1007/s10668-021-01418-9

Shahid, M. N. (2022). COVID-19 and adaptive behavior of returns: evidence from commodity markets. *Humanities and Social Sciences Communications, 9*(1), 1-15. https://doi.org/10.1057/s41599-022-01332-z

Shahid, M. N., Azmi, W., Ali, M., Islam, M. U., & Rizvi, S. A. R. (2023). Uncovering risk transmission between socially responsible investments, alternative energy investments and the implied volatility of major commodities. *Energy Economics, 120*, 106634. https://doi.org/10.1016/j.eneco.2023.106634

Shahid, M. N., Islam, M. U., Alam, N., & Ali, M. (2022). Time-Varying Return Predictability and Adaptive Behavior in The US Commodity Markets During COVID-19. *International Journal of Economics & Management, 16*(S1), 59-80. https://doi.org/10.47836/IJEAMSI.16.1.005

Shahid, M. N., Siddiqui, M. A., Qureshi, M. H., & Ahmad, F. (2018). Corporate governance and its impact on firm's performance: evidence from cement industry of Pakistan. *Journal of Applied Environmental and Biological Sciences, 8*(1), 35-41. https://www.researchgate.net/publication/322419298

Shekhawat, K. K., Yadav, A. K., Sanu, M. S., & Kumar, P. (2022). Key drivers of consumption-based carbon emissions: empirical evidence from SAARC countries. *Environmental Science and Pollution Research, 29*(16), 23206-23224. https://doi.org/10.1007/s11356-021-17413-6

Shobande, O. A., & Enemona, J. O. (2021). A multivariate VAR model for evaluating sustainable finance and natural resource curse in West Africa: evidence from Nigeria and Ghana. *Sustainability, 13*(5), 2847. https://doi.org/10.3390/su13052847

Singh, A. P., & Dhadse, K. (2021). Economic evaluation of crop production in the Ganges region under climate change: A sustainable policy framework. *Journal of Cleaner*

Production, 278, 123413. https://doi.org/10.1016/j.jclepro.2020.123413

Solarin, S. A. (2019). Convergence in CO 2 emissions, carbon footprint and ecological footprint: evidence from OECD countries. *Environmental Science and Pollution Research, 26*, 6167-6181. https://doi.org/10.1007/s11356-018-3993-8

Srivastava, A. K., Dharwal, M., & Sharma, A. (2022). Green financial initiatives for sustainable economic growth: a literature review. *Materials Today: Proceedings, 49*, 3615-3618. https://doi.org/10.1016/j.matpr.2021.08.158

Taghizadeh-Hesary, F., & Yoshino, N. (2020). Sustainable solutions for green financing and investment in renewable energy projects. *Energies, 13*(4), 788. https://doi.org/10.3390/en13040788

Thomson, A., Price, G., Arnold, P., Dixon, M., & Graham, T. (2022). Review of the potential for recycling CO2 from organic waste composting into plant production under controlled environment agriculture. *Journal of Cleaner Production, 333*, 130051. https://doi.org/10.1016/j.jclepro.2021.130051

Torras, M., & Boyce, J. K. (1998). Income, inequality, and pollution: a reassessment of the environmental Kuznets curve. *Ecological Economics, 25*(2), 147-160. https://doi.org/10.1016/S0921-8009(97)00177-8

Ullah, A., Pinglu, C., Ullah, S., & Hashmi, S. H. (2022). The dynamic impact of financial, technological, and natural resources on sustainable development in Belt and Road countries. *Environmental Science and Pollution Research, 29*(3), 4616-4631. https://doi.org/10.1007/s11356-021-15900-4

Ulucak, R., Danish, & Kassouri, Y. (2020). An assessment of the environmental sustainability corridor: Investigating the non-linear effects of environmental taxation on CO2 emissions. *Sustainable Development, 28*(4), 1010-1018. https://doi.org/10.1002/sd.2057

Umar, M., Ji, X., Mirza, N., & Naqvi, B. (2021). Carbon neutrality, bank lending, and credit risk: Evidence from the Eurozone. *Journal of Environmental Management, 296*, 113156. https://doi.org/10.1016/j.jenvman.2021.113156

UNEP. (2017). *Emissions Gap Report 2017*. https://wedocs.unep.org/bitstream/handle/20.500.11822/22070/EGR_2017.pdf

van Veelen, B. (2021). Cash cows? Assembling low-carbon agriculture through green finance. *Geoforum, 118*, 130-139. https://doi.org/10.1016/j.geoforum.2020.12.008

Volz, U. (2018). Fostering green finance for sustainable development in Asia. In *Routledge handbook of banking and finance in Asia* (pp. 488-504). Routledge. https://doi.org/10.4324/9781315543222-27

Wang, X., Huang, J., Xiang, Z., & Huang, J. (2021). Nexus between green finance, energy efficiency, and carbon emission: Covid-19 implications from BRICS countries. *Frontiers in Energy Research, 9*, 786659. https://doi.org/10.3389/fenrg.2021.786659

Wang, Y., & Zhi, Q. (2016). The role of green finance in environmental protection: Two aspects of market mechanism and policies. *Energy Procedia, 104*, 311-316. https://doi.org/10.1016/j.egypro.2016.12.053

WEF. (2021). *Global risks Report 2022*. World Economic Forum. https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2022.pdf

World Bank. (2019). *Estimating the World Bank's Adjusted Net Saving: Methods and Data*. Washington, DC: World Bank. https://datacatalogfiles.worldbank.org/ddh-published/0037653/DR0045503/ANS%20Methodology%20-%20April%202023.pdf

Zafar, M. W., Saleem, M. M., Destek, M. A., & Caglar, A. E. (2022). The dynamic linkage between remittances, export diversification, education, renewable energy consumption, economic growth, and CO2 emissions in top remittance-receiving countries. *Sustainable Development, 30*(1), 165-175. https://doi.org/10.1002/sd.2236

Ziolo, M., Fidanoski, F., Simeonovski, K., Filipovski, V., & Jovanovska, K. (2017). Sustainable Finance Role in Creating Conditions for Sustainable Economic Growth and Development. In W. Leal Filho, D. M. Pociovalisteanu, & A. Al-Amin (Eds.), *Sustainable Economic Development: Green Economy and Green Growth* (pp. 187-211). Springer, Cham. https://doi.org/10.1007/978-3-319-45081-0_11