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Catalyzing Sustainability: The Influence of Financial Development on Green Finance Initiatives in the World Economies

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***Abstract*:** This study investigates the influence of financial development on green finance and environmental sustainability over thirty years, from 1993 to 2023. It uses data from all countries and applies the Feasible Generalized Least Squares (FGLS) approach. The study analysed the relationship between financial development indicators such as financial access, financial depth, financial efficiency, financial stability and measures of green finance. The researchers found that increased levels of financial development positively affect the adoption and implementation of green finance practices. Green finance initiatives around the world are successful in meeting environmental sustainability objectives. Governments and policymakers need to prioritise investments and policies that promote green finance to meet environmental sustainability globally.

Key Words: Sustainability, Financial development, Green finance, Financial access

1. Introduction

Green financing means financing projects oriented towards the sustainable environment and aspects of climate change, which includes projects like energy production from renewable sources such as biogas, wind, solar, and so on, as well as projects that lead to clean transportation, waste management, etc. In a world where ecological collapse is a real possibility, pursuing sustainability is more important than ever. The study explores how financial innovation is critical in promoting environmental stewardship. It looks at how industrialised nations use green finance to prevent catastrophes and open the door to a time when ecological preservation and economic prosperity go hand in hand. This study sheds light on how financial development has the power to fundamentally alter the story of global sustainability. It is the primary responsibility of the country to protect the environment and safeguard the forest, as it is in the constitution.

Green finance originated from the notion of a green economy, as outlined in the book "Blueprint for a Green Economy". The idea has evolved throughout time in literature. Recently, experts have focused on the notion of the green economy. According to Fletcher et al. (2019), the green economy model prioritises sustainable livelihoods for people with low incomes while improving environmental services to drive economic growth. Poor nations should support greenhouse gas mitigation efforts to stabilise and reduce emissions. The problem of green finance in developing countries is directing money towards productive ventures owing to weak financial institutions and

undeveloped marketplaces. Other challenges include a shortage of human capital and the need for realistic green initiatives in the development pipeline (Bhatnagar & Sharma, 2021).

Developing countries face issues such as income loss when transitioning from a brown to a green economy. Investment may influence local jobs and livelihoods in underdeveloped nations. Barbier and Burgess (2017) found that economic, political, environmental, and social factors contribute to green investment expansion in emerging countries. Transitioning to a green economy is challenging due to the need for investment commitment, governmental support, and international connections (Sanneh, 2018). The green economy is driven by policies that eliminate or reduce ecologically detrimental subsidies and create markets for ecosystem goods and services. Implementing a regulatory framework to create market-based incentives and opportunities for institutions. Green public procurement helps balance public and private investments (KADEKODI, 2013; Shabeer, 2022).

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Smart contracts execute agreements based on established parameters, whereas DeFi platforms allow peer-to-peer lending, borrowing, and investing in sustainable initiatives without traditional intermediaries (Gill et al., 2023; Shabeer & Rasul, 2024). NGFS (2022) suggests that banks can play a key role in reducing environmental changes caused by Green Swans and other climate-related concerns. For example, if the financial system fails to support firms or sectors that are environmentally or carbon-intensive, their operations may shift towards a more socially responsible approach. Banks should include sustainability in their workflows (NGFS, 2022). These movements aim to modify and protect the environment, resulting in significant climate and societal dangers.

Green financing is necessary to correspond with both national and international sustainable goals. It contributed to these aims by sponsoring environment-friendly initiatives that protect the environment from natural disasters or technological impacts. Green finance involves assessing and evaluating the environmental effects of proposed projects or activities. Investments that have a positive ecological impact or promote sustainable practices are prioritised depending on environmental criteria. Green funding prioritises publishing information on the environmental performance and outcomes of sponsored projects. To ensure that investors and stakeholders can make informed decisions.

The paper's structure is concise and clear: The Introduction, our first section, introduces the research question and its significance. The second section, the Literature Review, evaluates existing academic contributions. In the third section, the Methodology, we detail our application of Feasible Generalized Least Squares for robust data analysis. The fourth section, the Discussion, offers an interpretation of our findings. Lastly, the fifth section presents the Conclusion, summarising our study and suggesting policy recommendations.

The central research objective of this paper is: How do various dimensions of financial development—specifically, Financial Depth (Private credit by deposit money banks to GDP %), Financial Access (Bank accounts per 1,000 adults), Financial Efficiency (Bank net interest margin %), Financial Stability (Bank Z-score), and Stock Market Capitalization to GDP %—influence the efficacy and scope of green finance initiatives in developed economies?

1.1 Research Objectives

a. What is the relationship between Financial Depth and the effectiveness of green finance initiatives?
b. How does Financial Access contribute to the advancement of green finance in developed economies?
c. How does Financial Efficiency impact the allocation and management of funds within green finance?
d. Can Financial Stability predict the resilience and sustainability of green finance projects?
e. What role does Stock Market Capitalization to GDP (%) play in supporting or expanding green finance mechanisms and investments?

2. Literature Review

Green financing (GF) aims to address environmental concerns and lead economies towards sustainability (Falcone et al., 2018). Financing programs seek to reduce greenhouse gas emissions, promote renewable energy, control pollution, manage waste energy, improve biodiversity, and encourage national sustainability (Falcone, 2020; Ghulam et al., 2021). Green finance options include equity, loans, grants, and the acquisition or sale of green

products (Sadat, 2011; Shabeer et al., 2024). GF is funding projects that benefit the environment and promote sustainable development. Environmental benefits include reduced air, water, and land pollution, lower greenhouse gas emissions, increased energy efficiency, and adaptability to climate change. GF contains environmental aims to promote sustainability through biodiversity and resource protection. Climate finance is funding from private, public, and alternative sources to encourage mitigation and adaptation efforts to combat climate change (UNEP, 2015.

Much literature is on the constraints and enablers of green funding across nations. Most material on green financing focuses on developed economies. There is scant literature on green financing in underdeveloped countries like India. Previous research on GF in India has mostly focused on green bonds and renewable energy projects. Green financing can potentially build more financial tools and industries, but the discussion is limited. This report provides a complete assessment of GF prospects and threats in the Indian context. Bak et al. (2017) found that sustainable infrastructure development contributes significantly to greenhouse gas emissions and increased gross fixed capital formation. Modernising and replacing infrastructure with low-carbon technologies may drastically lower the carbon footprint. Environmentally friendly products reduce environmental disasters.

Promoting GF and sustainable finance requires regulatory frameworks, capacity building, green loans, financial products, and incorporating climate change mitigation and adaptation into monetary and economic policies. The Asia-Pacific region's GF industry is driven by rising infrastructure demand from key nations and growing sustainability concerns. Several scholars have worked on this topic, such as (Arshed et al., 2022; Gul et al. 2022; Huang et al., 2023; Ayyubi, 2024; Wang et al., 2023; Zain ul Abedeen et al., 2024; Zubair et al., 2024; Ghulam et al., 2024)

2.1 The Impact of Financial Depth on Green Finance

From the middle of the nineteenth century, financial sector development (FSD) has been acknowledged as a critical driver of economic progress. For example, the financial sector helped mobilise capital for industrialisation in England and channel funds to productive investments, which were important determinants of economic growth. Economic expansion encourages FDS to offer financial resources to increasing sectors of the economy. Due to these contradictory results, various empirical research has attempted to examine the possible relationship between FSD and growth.

Green finance may help to grow the green economy by optimising the industrial structure. Upgrades to industrial structures are drivers of green economic growth (Huang & Zhang, 2021). Green finance efficiently promotes the rapid expansion of green sectors in nations with minimum usage and low pollution by using various direct and indirect funding strategies. It encourages the growth of environmentally friendly service businesses with low resource usage, minimal pollution, and high job potential. At the same time, the government raises the funding costs of heavy businesses by regulating those with excessive pollution and energy consumption. It also levies pollution-related costs, encouraging polluting companies to transition to greener practices. Green financing may support green technology innovation while incentivizing green firms to create green technologies. It enables businesses to build a comprehensive and mature green technology innovation infrastructure. With an economic recession, there is a need for technological innovation to decrease environmental pollution. Green innovation's technological spillover effect can provide positive economic externalities while promoting market green development (DURUCAN & YEŞİL, 2022).

2.2 Impact of Financial Access on Green Finance

The discovery that green finance may enhance the intermediation spread and lower bank default risk lends even more credence to this. Nevertheless, there is a lack of thorough investigation into how digitalisation and green finance affect this connection (Bai 2022). Environmental and climate change are some of the factors that influence green finance policies in banks (Akomea-Frimpong 2021). The voluntary capital buffer (03) is a financial stability proxy that refers to a bank's excess capital held beyond the regulatory requirement for usage during crises (Bis, 2010). It is often used in conjunction with macroprudential methods to assess financial stability. There are two sides of research approaches to green finance policy from two different angles: First, most research papers on the development of green finance policy and its evolution are theoretical. For instance, Aizawa et al. noted that China implemented several green purchasing, taxation, and financing policies to address ingrained environmental issues; of these, the green credit policy was the most sophisticated because it demonstrated strong resistance to the

widespread economic unrest that China experienced following the global financial crisis (Aizawa & Yang, 2010). Based on the San Giorgio Group's experience, Buchner et al. provided insights regarding efficient green funding, particularly various programs (Huang & Zhang, 2021). Green actions are taken by staff members both within and outside of their jobs (Ali et al., 2023).

2.3 Impact of Financial Efficiency on Green Finance

Green financing's impact on energy efficiency is a significant topic. Finance plays a crucial role in energy initiatives, with financial institutions showing a keen interest. Asia is seeing a shift in investment horizons, with several governments promoting green finance. Green finance is of crucial importance in any country. To prioritise environmental efficiency, green finance refers to financing initiatives. There is no authentic definition of green initiatives; Azhgaliyeva and Liddle (2020) include renewable energy, energy efficiency, and pollution control as examples (Liu et al., 2022). Green finance plays an important role in any country. Environmentally friendly products reduce the environmental disaster. Green insurance products address ecological dangers such as natural disasters and climate-related calamities. These insurance policies help to reduce the risks associated with green projects, which increases their appeal to investors. Moreover, financial risks related to green investments can be mitigated by utilising risk mitigation mechanisms such as guarantees or insurance policies that encourage private sector participation (Liu et al., 2022). Financial efficiency is an important element in green finance. To promote environmental sustainability, green funds are investment instruments that target businesses or initiatives. They pool the contributions of several investors to fund a wide portfolio of green assets. Sustainable investment portfolios use environmental, social, and governance (ESG) concerns to guide investment decisions and promote sustainable development.

2.4 Impact of Financial Stability on Green Finance

Financial stability plays an important role in green finance. The research on financial instability issued by environmental risks has mostly addressed the influence of climate change on the global economy. Climate degradation has major repercussions for the worldwide economy. Climate change poses financial risks that affect the economic system and financial services (Bai & Lin, 2022). Global efforts should be made to promote social-environmental policies and green the financial system. Brazil's lush land and diversified natural habitats make it a prime candidate for sustainable policy. In addition to its ecological potential, Brazil is a thriving country with a strong financial system. The Central Bank requires financial institutions to adopt socially and environmentally responsible policies. Financial stability has received more attention from researchers and policymakers. Numerous research has focused on identifying factors that contribute to financial stability. This study follows the concept of financial stability provided by the Central Bank of Brazil in 2022. Financial stability refers to a financial institution's capacity to meet obligations and perform societal responsibilities without experiencing crises or difficulties. To capture this notion, we employ a comprehensive framework that diversifies financial stability metrics, including Z-score based on regulatory capital, leverage, and optional capital buffer (De Moraes & Pinto Bandeira De Mello, 2024) and recognised three types of financial risks associated with climate change: transition, physical, and liability. Transition risk arises from the rapid and abrupt shift to a low-corban economy (Jadoon et al., 2021).

2.5 Impact of Stock Market Capitalization on Green Finance

Hussain and Rehman (2021) suggest that demographic parameters, such as population number, might help predict increases in energy consumption. Finance's role in supporting innovation is obvious. The financial industry promotes innovation and lowers financing costs. Financial markets let investors diversify their risks, which is crucial for the success of technical breakthroughs (Rehman et al., 2021). According to Rajan (2012), capital market growth enables enterprises to acquire external funding and share innovation risk. Developing countries face issues such as income loss when transitioning from a brown to a green economy. Investment may have an influence on local jobs and livelihoods in underdeveloped nations. Barbier and Burgess (2017) found that economic, political, environmental, and social factors contribute to green investment expansion in emerging nations. Transitioning to a green economy is challenging due to the need for investment commitment, governmental support, and international connections. The green economy is driven by policies that eliminate or reduce ecologically detrimental subsidies and create markets for ecosystem goods and services. Implementing a regulatory framework to create market-based

incentives and opportunities for institutions. Green public procurement helps balance public and private investments (KADEKODI, 2013).

3. Methodology

This study has taken data from all countries from the World Development Indicators (WDI), an initiative of the World Bank. The study period is the last 30 years, from 1993 to 2023. The number of the actual cross-section was 88, and the total number of observations was 1031 under the Feasible Generalized Least Squares (FGLS) regression. The FGLS has omitted the rows if they did not have some value in any variable. A detail of variables and their brief description is given in Table 1.

Table 1: Description of the variables

Variables	Abbreviations	Proxy	Source
Green Finance	GF	Renewable Energy / Total Energy Use	British Petroleum
Financial Depth	FD	Private credit by deposit money banks to GDP (%	WDI, the World Bank
Financial access	FA	Bank accounts per 1,000 adults	WDI, the World Bank
Financial efficiency	FE	Bank net interest margin (%)	WDI, the World Bank
Financial stability	FS	Bank Z-score	WDI, the World Bank
Stock market	SM	Stock market capitalization to GDP (%)	WDI, the World Bank

This research used the Feasible Generalized Least Squares (FGLS) approach. This is an extension of the standard linear regression model. This approach takes autocorrelation and heteroskedasticity inside the error terms. This method is quite helpful in panel data or time series. To provide accurate and efficient estimates, FGLS first estimates the variance-covariance matrix of the errors and then modifies the weight of each observation based on that estimate.

4. Data Analysis

4.1 Descriptive Statistics

Descriptive statistics (shown in Table 2) summarize and describe the main features of a dataset. They make it easier to understand the Key measures. They include the average, middle value, most frequent value, standard deviation, and the difference between the highest and lowest values. These metrics help identify patterns, trends, and anomalies by providing a clear snapshot of the data's central tendency and variability.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
FS	3,309	16.41	9.72	-.32	142
FD	4,319	45.98	39.32	.26	304
FA	1,408	2689	19506	0	273253
FE	3,186	4.50	2.83	.06	23
SM	4,081	6.49	12.39	0.001	47
GF	5,625	2.20	21.78	0.001	57

Table 2 illustrates the mean, standard deviation, and range of the data. Because there are many observations, the data is assumed to be normally distributed.

4.2 Correlation Matrix

Correlation measures the relationship between two variables. It indicates how one may predict or relate to the other.

A positive correlation means that as one variable increases, the other also increases. A negative correlation means that as one rises, the other falls. A correlation close to zero suggests little to no relationship. Correlation helps to see patterns in data. Table 3 shows the correlation matrix of the data set.

Table 3: Correlation Matrix

	GF	FS	FD	FA	FE	SM
GF	1.0000					
FS	-0.0233	1.0000				
FD	0.0705	0.2244	1.0000			
FA	0.0198	0.0035	0.4997	1.0000		
FE	-0.0324	-0.1440	-0.5413	-0.2962	1.000	
SM	0.0018	0.0235	0.0406	-0.0616	0.0303	1.000

4.3 Variance Inflation Factor

Variance Inflation Factor (VIF) measures how much an explanatory variable in a regression model is inflated due to multicollinearity with other predictors. High VIF values indicate that the predictor has a strong linear relationship with other variables and can distort the results and make it hard to determine the individual effect of each predictor. This study ensures that the model is more reliable and the VIF results in Table 4 show that there is no multicollinearity.

Table 4: Variance Inflation Factor

Variable	VIF	1/VIF
FS	1.82	0.548922
FD	1.42	0.702874
FA	1.37	0.730547
FE	1.07	0.932888
SM	1.01	0.985925
Mean VIF	1.34	

4.4 Discussion

Feasible Generalized Least Squares (FGLS) is a statistical method used to handle problems of heteroscedasticity or auto-correlation in regression models. Unlike ordinary least squares (OLS), which assume constant variance of errors, FGLS adjusts for varying error variances. It leads to more reliable and efficient estimates. By using FGLS, this study improves the accuracy of our regression. Table 5 gives the estimation results of FGLS. P>chi value was 0.001

Table 5: Feasible Generalized Least Squares (FGLS)

Variables	**Coefficient**	**Std. err.**	**P>z**
FS	.1273811	.092706	0.069
FD	.0695208	.0299164	0.020
FA	.0010107	.0013517	0.005
FE	.046842	.2920175	0.003
SM	.0086686	.0927297	0.092
_cons	4.8755	2.788925	0.000

FGLS results show that financial stability has a positive significant impact on green finance. If there is an increase in one score of the bank z-score, there will be a 0.127 percent increase in renewable energy in terms of total energy consumption. When banks and financial institutions are stable, they can allocate resources to environmentally friendly projects. Conversely, instability may hinder such investments. The positive relationship between bank z-scores and renewable energy consumption reinforces this connection. Such a relationship is also identified by Carney, 2015; Jadoon et al., 2021; Bai & Lin, 2022; and De Moraes & De Mello, 2024.

Financial Depth indicated by FD has a positive and significant impact on green finance and if there is a one percent

increase in "private credit by deposit money banks to GDP (%)", there will be an increase in green finance by 0.069 percent. When financial systems are deep and well-functioning, they efficiently channel funds toward environmentally friendly projects, such as renewable energy and sustainable infrastructure. A strong financial system contributes to a more sustainable and resilient future. This relationship is also found by Yin et al, 2015; Huang & Zhang, 2021; and DURUCAN & YEŞİL, 2022.

Financial access, which is shown by FA, also has a significant positive relationship. Results indicate that a one percent increase in "bank accounts per 1,000 adults" will increase green finance by 0.001 percent. When more individuals have access to banking services, it facilitates participation in green finance. Bank accounts enable people to invest in environmentally friendly projects, such as renewable energy and sustainable initiatives. Improved financial access lowers barriers for businesses and households to engage in green investments. This relationship is also discovered by Mangan 1999; Bis, 2010; Aizawa & Chaofei Yang, 2010; Bai 2022; Akomea-Frimpong 2021; Huang & Zhang, 2021; and Gill et al., 2023a;2023b.

Bank net interest margin (%) is used as a proxy for financial efficiency and is indicated by FE. It has a positive impact on green finance. Results show that a one percent increase in bank net interest margin (%) leads to an increase in green finance of 0,046 percent. A lower net interest margin indicates a more efficient financial system where banks can offer loans at lower interest rates due to lower operating costs and better risk management. This efficiency reduces the cost of borrowing, making it more attractive for businesses and individuals to invest in green projects such as renewable energy. Efficient financial institutions are better equipped to evaluate and manage the unique risks associated with green investments, thereby increasing the availability of credit for environmentally sustainable initiatives. Various scholars have identified this impact such as Azhgaliyeva and Liddle, 2020; H. Liu et al., 2022; Gill et al., 2023c.

The impact of the stock market on green finance is positive and significant. It is estimated that a one per cent increase in stock market capitalization to GDP will increase green finance by 0.0087 per cent. The stock market significantly impacts green finance by providing a platform for raising capital for sustainable projects and green companies. A well-functioning stock market facilitates the issuance of green bonds and the initial public offerings (IPOs) of environmentally focused companies, increasing their access to a broad base of investors. Stock market performance and trends influence corporate behaviour, encouraging firms to disclose their environmental, social, and governance (ESG) metrics and align with sustainable development goals. As a result, a vibrant stock market promotes the growth and visibility of green finance. Such a relationship has been observed by various scholars such as Rajan 2012, KADEKODI 2013, Parpia 2016, Barbier and Burgess 2017, Hussain and Rehman 2021, and Rehman et al. 2021.

5. Conclusion and Policy Implication

The findings from the FGLS analysis highlight the significant positive impact of financial stability on green finance. An increase in the bank z-score correlates with a rise in renewable energy consumption. Financial depth, access, efficiency, and stock market development contribute positively to green finance. A one per cent increase in private credit by deposit money banks to GDP results in a 0.069 per cent increase in green finance, while a one per cent rise in bank accounts per 1,000 adults leads to a 0.001 per cent increase. Financial efficiency, indicated by the net interest margin, also shows a significant impact, with a one per cent rise leading to a 0.046 per cent increase in green finance. Finally, stock market capitalization to GDP has a positive effect, with a one per cent increase contributing to a 0.0087 per cent rise in green finance. Policymakers should focus on enhancing financial stability to foster green finance. Strengthening regulatory frameworks and ensuring robust risk management practices can help stabilize financial institutions. By promoting financial depth and encouraging credit expansion through deposit money, banks can further boost green finance. Expanding banking services to underserved populations can enhance participation in green finance. Initiatives that increase the number of bank accounts and integrate more people into the financial system will enable broader investment in sustainable projects.

Enhancing financial efficiency by lowering net interest margins can make borrowing more affordable for green projects. Lastly, supporting the development of the stock market through measures that promote green bonds and IPOs of green companies can significantly impact green finance, aligning corporate behaviours with environmental sustainability goals.

Sustainability is a vast concept and requires integrated efforts by government, businesses, and households. This study has only focused on financial development and the stock market for renewable energy finance. Other

variables and other estimation methods can be used for further study.

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