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Green Finance and Sustainable Economic Growth: Evidence from Emerging Markets

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ABSTRACT
The green finance is the finance which can be employed in the process of sustainable development which is not harmful to the environment. The budget technological section management can indirectly influence the curbation of climate change through the development of environmental tech. Future financial instruments of this sector may be climate bonds, new energy equity and loans. Green finance provides an answer to the market-based solution to the destruction of the environment It provides a means to combat climate change without negatively impacting the economy. Consequently, green is used in markets to achieve growth and green financing significant.It is beneficial to all economic agents. Investors can take control of the risk associated with the green aspect. Financing enables lenders to reduce climate risk by diversifying their assets and enhances their reputation. The regulatory bodies will assist the market to pay more attention to climate action than the rules that the regulators will do. The business will have a superior image by increasing the source of financing. Finally, the product enhances consumer experience further.Green finance project designs may be informed by the study's results, which add to the current literature on the topic. Our research results can significantly assist governments, both regulators and financial institutions, in their sustainability and development.

INTRODUCTION
There are a lot of challenges and issues in the global economy. But global climate change and environmental destruction is one of the grave problems. The increase of carbon emissions, the decline of resources and ecological imbalance are all becoming a threat to long-term economic development, particularly in the emerging markets where the process of industrialization and urbanization are closely interconnected with the environmental strain.

In line with this, a global change is being experienced in the policy arena in terms of sustainability. The Paris Agreement promotes integrating the environment into the economic and financial system.Green finance is the mechanisms that allow money to move in systems that can be deemed as socially responsible. The use of green financial instruments, including green bonds, climate funds, and ESG-based investments, has been encouraged by international financial institutions, including the World Bank and the International Monetary Fund, to help achieve low-carbon transitions. Green finance is one such market mechanism that is vital in assisting the developing world towards environmental enhancement and economic development.

The empirical body of literature on green finance has been unclear on whether it improves economic growth that is environmentally sustainable. According to numerous studies, green finance will enhance the quality of the environment and will boost the development of green technologies. Nonetheless, other studies discovered contradictions based on ineffective institutional framework-financial markets-policy mixes in developing nations. Moreover, most of the existing literature on the subject is either locality-specific or lacks the sufficient rigor, and is generally weak in addressing endogeneity, cross-country heterogeneity and long-run interrelations.The study will address these gaps by offering an in-depth empirical examination of this association using 2010 2024 across the chosen emerging markets. In the research, the correlation between wind power and electricity prices in Spain shall be explored through econometric methods, like panel data and GMM.The initial aim of the study is to investigate how green finance contributes to growth. Second, we will explore the causal nexus between green finance and growth. Lastly, we will comment on the impact of the institutional and macroeconomic factors on this relationship in case of emerging market.

As a result, the following research topics guide this study: (i) Does green financing significantly impact economic development in underdeveloped nations? (i) In what direction does green finance and economic development influence one another? (iii) How does the relationship between SC and the size of the informal sector touch this?

In many ways, this research paper adds to what is already out there. The paper presents the cross-country empirical evidence that uses various dimensions of green finance using recent data. It also employs strict econometric methodology to address methodological problems of earlier researches. The document proposes strategies not only to developing economies, but also to developing countries.

The rest of the paper will cover the Literature in section II; we will establish a theoretical framework in section III; we will establish our data and methodology in section IV; we will present our empirical results in section V; we will discuss policy implications in section VI and we will conclude in section VII.

LITERATURE REVIEW
Green finance is gaining researcher's interest to foster sustainable economic growth to enhance environmental protection in the context of climate change and sustainable development goals. This section reviews the existing literature critically by organizing it thematically, highlighting key findings, methods used, and gaps in the research.

3.1 Conceptual Foundations of Green Finance: Green finance typically refers to the funding of environmentally sustainable activities. Investments in renewable energy, green bonds or eco-friendly lending fall into this category. According to the UN Environment Programme, the transition of economies towards low-carbon and resource-efficient pathways is Green Finance. In addition, World Bank says that any disbursal of funds must take into account environmental problems for sustained success long-run. As per the experts, green finance helps the environment while also making the production systems more efficient and innovative. The conceptual coverage of green finance varies across the studies. There are those who have a focused approach on green bonds and there are others with a broader ESG based framework.

3.2 Green Finance and Sustainable Economic Growth: According to Goldman Sachs, green finance is the most important financial innovation. The presence of private and public instruments is progressively structuring global investment opportunities in ecological infrastructure due to the presence of a variety of regulators and participants. Future Research Topics to Green Finance as a Sustainable Investment. Nonetheless, green finance provides Refinance for commercial and government entities who develop and implement green technology. Lower cost of capital will spur both existing and potential green practices in the infrastructure sector. Climate finance is usually directed towards problems of climate mitigation and adaptation. Climate change mitigation is a human intervention to reduce the sources of greenhouse gases. Modifying the social and ecological systems to lower the vulnerability to climate change impacts is adaptation. This entails establishing transfer systems between two partners, countries or communities in order to manipulate and manage.

3.3 Role of Financial Development and Institutional Quality: Research shows that green financing works better in countries with advanced financial systems and high-quality institutions. To illustrate, the authors make use of data for forty-two countries and show that a more developed system improves the allocation efficiency of green investments and thereby their economic impact. On the other hand, weak regulatory frameworks, policy uncertainty and weak governance will have a dampening effect on green finance. The developing world has been recommended strong governance and sound regulatory frameworks for scaling up green finance by the IMF. Likewise, the evidence from above shows that countries with better institutional quality have stronger and persistent growth effects of green finance.

3.4 Methodological Approaches in Existing Studies: Various econometric techniques, including panel regression model, cointegration and causality tests have been employed in the literature. Earlier studies used simple regression framework but recent studies are more advanced and use Generalized Method of Moments (GMM) due to endogeneity issues. Despite these developments, there are still limitations. Numerous studies utilize short time periods, limited country samples, or single proxies for green finance which may fail to capture its multi-dimensional nature. Cross-country heterogeneity is disregarded sometimes, suggesting a universal and generalized conclusion without appreciating the cross-country variations.

3.5 Research Gap: Based on the above analysis, a number of important gaps can be identified. To begin with, there are no complete studies on all emerging markets in the world. Additionally, existing studies inadequately employ interface indicators of green finance, thereby limiting the robustness of the findings. In addition, many studies fail to adequately address methodological issues such as endogeneity, heterogeneity, and long-run dynamics. This research attempts to fill these voids by employing a multi-country panel dataset, using different indicators of green finance and applying econometrics techniques to arrive at more robust and policy-relevant findings.

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THEORETICAL FRAMEWORK & HYPOTHESIS DEVELOPMENT

Key theories that explain the linking of green finance and sustainable economic growth are incorporated to develop a theoretical frame. It elaborates on the hypotheses created based on various theoretical assumptions.

4.1 Theoretical Framework

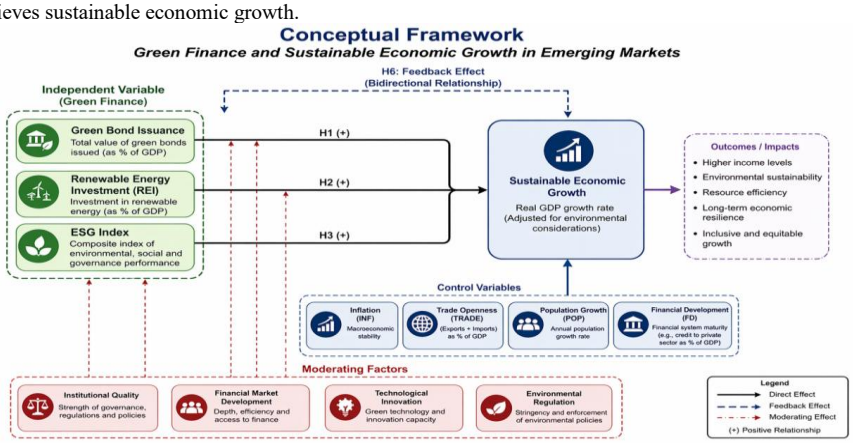
A clearer grasp of the connection between green finance and sustainable economic development may be achieved by using several ideas. The most popular and well-known paradigm is the Environmental Kuznets Curve theory, which states that pollution levels rise in tandem with economic growth at the outset but then begin to fall after a particular income level is reached. Green financing can be a key enabling factor driving the economy towards the next stage beyond progressive erosion.In the same way, endogenous growth theory gives a robust base that the economic growth is the function of money investment in innovation and technology. Green finance refers to an investment that offers a great environmental benefit in terms of sustainable development. Further, it includes investments in renewable energy, energy-efficient technologies, pollution and greener production techniques that are part of technological improvement. Thus, investing in these technologies enhances productivity and economic development.

Also, the theory of financial development complements the above theory by elucidating the financial system's role in mobilizing savings, pooling of funds, allocation of capital, exercise of corporate control, and risk and liquidity management. The effectiveness of green finance may be improved with a higher degree of financial development.

The study's conceptual framework can be formulated from the above perspectives. This framework indicates that green finance directly affects… through investment in an environment-friendly sector and indirectly through technological development, energy efficiency, and institutional quality.

4.2 Conceptual Model

The conceptual framework shows that green finance leading to green investment boosts Technological Innovation which finally leads to sustainable economic growth. Green finance refers to the type of investment that improves productivity, reduces environmental externality, strengthens technological innovation, and achieves sustainable economic growth.



4.3 Hypothesis Development

These theories are put forward in light of the theoretical framework:

H1: Green finance has a positive and significant impact on sustainable economic growth in emerging markets.

Green finance refers to funding that is environmentally friendly. This eventually improves economic performance on a long-term basis and also enhances environmental degradation. This statement serves as the foundation of the.

H2: There exists a causal relationship between green finance and sustainable economic growth.

The interdependence between economic development and financial development is such that, green finance will be able to influence growth and in turn, economic growth will be able to generate a favourable environment which supports the development of green finance.

H3: Institutional quality moderates the relationship between green finance and sustainable economic growth.

The unique attributes of the countries will influence the positive effect of green finance impact at a large scale. Governance and regulatory frameworks are stronger, as are financial systems around fund flow.

H4: The impact of green finance on sustainable economic growth varies across emerging markets due to structural and macroeconomic differences.

Countries have different financial development, policy environment, economic structure, etc. due to which heterogeneous effects can arise. The following parts of the study employ these hypotheses in empirical analyses.

DATA AND METHODOLOGY

In order to evaluate the hypothesis that green financing is associated with sustainable economic development in developing economies, we employed the following data, variables, and empirical techniques.

5.1 Data Sources and Sample Selection:This study use balanced panel data covering a subset of developing economies from 2010 to 2024. The selection of emerging markets is based on their contribution to global growth as well as global warming and environmental performance. The data is collected from international reputable source. It entails the World Bank, United Nation Environment Programme, OECD data base etc. Major developing economies such as South Africa, China, India, and Brazil, as well as several ASEAN nations, may be included in the emerging market sample, based on the data that is available.

5.2 Variable Definition and Measurement

5.2.1 Dependent Variable:Sustainable economic growth, as measured by the real growth rate of GDP, with environmental adjustments where relevant, is the pertinent statistic. In certain specifications, we apply other measures, such as adjusted net savings or a sustainability index, as robustness tests.

5.2.2 Independent Variables (Green Finance Indicators) Green finance is measured using multiple proxies to capture its multidimensional nature:

Green Bond Issuance (GB): Total value of green bonds issued, representing capital mobilized for environmentally sustainable projects.

Renewable Energy Investment (REI): Investment in renewable energy sectors as a percentage of GDP.

Environmental, Social, and Governance (ESG) Index: Composite index reflecting sustainability-oriented financial practices.

5.2.3 Control Variables

The model contains many control factors widely seen in growth research to help prevent omitted variable bias:

Inflation (INF): Indicator of macroeconomic stability

Trade Openness (TRADE): The ratio of total exports and imports to gross domestic product

Population Growth (POP): Reflecting labor force dynamics

Financial Development (FD): Proxy for overall financial system maturity

5.3 Model Specification

This link may be objectively examined using the following baseline panel regression model:

$$Growth_{it} = \alpha + \beta_1 GF_{it} + \beta_2 X_{it} + \mu_i + \lambda_t + \epsilon_{it}$$

where:

$Growth_{it}$ represents sustainable economic growth for country i at time t

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GF_{it} denotes green finance indicators
X_{it} is a vector of control variables
μ_i captures unobserved country-specific effects
λ_t represents time effects
ε_{it} is the error term

5.4 Econometric Techniques

The research utilizes a variety of estimating strategies to guarantee reliability and handle any econometric concerns:

(A) Fixed Effects (FE) and Random Effects (RE) Models

These models account for cross-national variation that has not been directly measured. To find the right specification, the Hausman test is used.

(B) Generalized Method of Moments (GMM)

This research makes use of the dynamic panel GMM estimator because of the possible endogeneity of green financing and GDP growth. This approach considers :Reverse causality

Omitted variable bias
Measurement errors

(C) Panel Cointegration Analysis

To examine long-run relationships, Pedroni and Kao cointegration tests are applied, ensuring that variables move together over time.

(D) Granger Causality Test

In order to determine whether green financing contributes to economic development or not, panel Granger causality tests are used.

5.5 Robustness Checks

To validate the reliability of results, several robustness checks are performed.

Use of alternative proxies for green finance
Sub-sample analysis across regions
Inclusion/exclusion of specific control variables
Lag structure adjustments

5.6 Diagnostic Tests

Diagnostic tests are also carried out in the research to guarantee the validity of the models:
Multicollinearity (Variance Inflation Factor)
Heteroskedasticity tests
Autocorrelation checks
Cross-sectional dependence tests

To analyze how green financing affects long-term economic growth in the Sub-Saharan African emerging market, this article draws on a wide range of data, indexes, and econometric methods.

RESULTS AND ANALYSIS: The empirical results on the link between green financing and sustainable economic development in developing nations are discussed and interpreted in this portion of the article. The section is organized into descriptive statistics, correlation analysis, regression results and robustness studies.

6.1 Descriptive Statistics: Table 1 displays the descriptive statistics of the primary proxies used in this research. Since all the variables are distributed widely as there are many emerging countries, the average value of each proxy can only be the half-way of the minimum and maximum. Furthermore, the descriptive statistics of the distributions of the important variables show how the political economy is evolving.

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Sustainable Growth (GDP)	4.215	2.103	-2.10	9.85
Green Bonds (GB)	1.842	1.765	0.00	7.50
Renewable Energy Inv. (REI)	3.126	2.214	0.45	10.30
ESG Index (ESG)	52.37	10.52	30.10	75.80
Inflation (INF)	5.48	3.12	0.90	15.60
Trade Openness (TRADE)	65.21	22.45	25.10	120.30
Population Growth (POP)	1.35	0.82	-0.50	3.10
Financial Development (FD)	0.58	0.21	0.20	1.10

6.2 Correlation Analysis: The correlation features (table 2) matrix represents the first piece of evidence when it comes to the dependence of the variables. The green finance indica-tors have been linked to a positive relationship with sustainable economic growth on the one hand and macroeconomic on the other hand and structural factors are also critical determinants of growth. There is no intolerable multicollinearity among the independent variables, to be more precise, the correlation coefficient between the variables is not too high (table 2).

Table 2: Correlation Matrix

Variable	GDP	GB	REI	ESG	INF	TRADE	POP	FD
GDP	1.00							
GB	0.42	1.00						
REI	0.55	0.48	1.00					
ESG	0.38	0.51	0.46	1.00				
INF	-0.21	-0.15	-0.18	-0.10	1.00			
TRADE	0.33	0.29	0.35	0.22	-0.12	1.00		
POP	0.12	0.08	0.10	0.05	0.18	0.09	1.00	
FD	0.49	0.44	0.40	0.52	-0.25	0.38	0.11	1.00

6.3 Regression Results: The key insights have been obtained by using the panel regression model. Three regression models that present the result are the FE, RE, and GMM models. The findings reveal that green finance had a positive and significant impact on sustainable economic growth in all of the indicator cases. Specifically, application of any other indicators of green finance like renewable energy investment, green bond, ESG, etc. has the same effect of greening an economy. The greatest impact is on investment in renewable energy, then the issuance of green bonds and ESG. As the control variables were found, the trade and financial development dummy has a positive and significant effect. Inflation dummy had a significant impact on a few specifications and a non-significant impact on the majority of specifications. Also, we discover that the finding is corroborated by the result GMM with lagged dependent variable as an independent variable. The model can also be endogenous as was observed during the empirical analysis Trade and finance.

Table 3: Panel Regression Results

Variables	Fixed Effects	Random Effects	GMM Estimation
Green Bonds (GB)	0.215**	0.198**	0.241***
Renewable Energy (REI)	0.342***	0.310***	0.365***
ESG Index (ESG)	0.128*	0.115*	0.142**
Inflation (INF)	-0.076	-0.068	-0.082*
Trade Openness (TRADE)	0.094**	0.088**	0.101**
Population Growth (POP)	0.041	0.038	0.052
Financial Development (FD)	0.267***	0.251***	0.289***
Constant	1.842	2.015	1.624
Observations	210	210	210
R^2	0.62	0.58	—

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Notes:
***p < 0.01, **p < 0.05, *p < 0.1

6.4 Causality Analysis: Green financing and long-term economic growth are positively and negatively correlated, according to the results of a panel Granger causality test. In the process of economic development, green finance strongly supports more environmentally friendly production and consumption patterns. The findings substantiate the hypothesis of a two-way feedback effect of finance on growth in the context of sustainability.

Table 4: Panel Granger Causality Results

Null Hypothesis	F-Statistic	Probability	Decision
Green Finance does not cause Growth	4.87	0.009	Reject
Growth does not cause Green Finance	3.92	0.021	Reject

Conclusion: Bidirectional causality exists

6.5 Long-Run Relationship:There is a long-run equilibrium link between green financing and sustainable economic development in BRICS nations, according to the Pedroni and Kao panel cointegration tests. So, there will be a long term impact on us.

6.6 Robustness Checks:The strength of the results is justified by a number of alternative specifications. The manipulation of various proxies of the green finance, omitting some countries, and alteration of the model structure do not change the key results significantly.

These findings enhance the validity of the research and affirm that the positive correlation among green finance, sustainable economic growth is stable across various model specifications.

Table 5: Robustness Check Results

Variables	Alternative Proxy Model
Green Finance Index	0.298***
Financial Development	0.254***
Trade Openness	0.089**
Inflation	-0.071
Observations	210

Notes: Results remain consistent across model specifications

6.7 Key Insights: The practical implications are to provide three significant implications. Firstly, they define that green finance can be a potential instrument to reach the sustainable economic growth in the emerging markets. Secondly, the relationship between green finance and economic growth is moderated by institutions and development to some extent with heterogeneity across countries. Third, we find that green finance works both ways as a moderator of economic development and as a source of feedback between the two.Generally, the results provide a good empirical support to the opinion that green finance emergence and evolution can be regarded as an enabling factor that can eventually become a key success factor.

DISCUSSION AND POLICY IMPLICATIONS

This section interprets the empirical findings in a broader economic and policy context, highlighting their implications for emerging markets and sustainable development strategies.

7.1 Discussion of Findings: The results of the empirical study show that green financing has the potential to significantly contribute to the promotion of sustainable economic growth in developing economies. This is the result of theoretical forecasts made by the endogenous growth theory and environmental economics, according to which investment into innovation and resource efficiency will be the most important in the context of sustainable economic development. However, the empirical findings also indicate that there is a high level of heterogeneity between countries. There is a much more positive correlation between growth and green finance in some countries than there is in others. This might be because of the variations in the quality of institutions and development of financial markets. In other countries, due to the well-established financial systems and regulatory frameworks, we observe that green finance is more successful in raising funds in productive and sustainable investments. Actually, green finance may have less of an effect in poorly regulated markets because of issues with efficiency, difficulties in distributing resources, and a lack of available funds. The researchers find that green finance and economic growth are positively correlated, which is a perfect fit. As a result of more developed financial markets, more investor confidence, and more capacity on the part of the general public and individual savers, green finance emerged alongside economic growth. The long-run association formulated implies that the green finance implications are not short-run only but have a beneficial effect on the economic supply-side performance. In this regard, the benefits of green finance and economic growth cannot be considered as independent entities but as complementary ones.

7.2 Policy Implications: This research has important implications to policy makers, financial institutions and regulatory bodies in the emerging economies. To start with, the governments must have robust green finance frameworks. This will be to reduce uncertainties and improve the transparency of the markets by setting up systematic definitions, standards and taxonomies of green investments. Global agencies such as World Bank and International Monetary Fund have urged the world to adopt a single global platform that would harness green finance on a much bigger platform.Infrastructure of financial markets must be strengthened as well. When a financial system is properly functioning and controlled, it can enhance the allocation of capitals and achieve greater efficiency of green finance. Policies that enhance capital markets, guarantee improved access to finance and stimulate institutional investment are of special interest.Green financing should be attained by providing favourable incentives by the policymakers. These are tax allowances, subsidies and risk sharing in regard to renewable energy and environmentally friendly projects. It can break the cost barrier of the initial cost and boost the incentive of the private sector.The fourth institution will have to improve the quality and efficiency of the institution. Greenwashing can be reduced by regulatory mechanisms, well-developed enforcement mechanisms, and efficient monitoring to keep the resources redirected to sustainable activities.The awareness and capacity building is required in order to promote the adoption of green finance. Assessment and deployment of green investment opportunities in an appropriate manner will only be made possible with sufficient knowledge and technical skills of the concerned institutions like investors and businesses.Finally, global cooperation and information exchange may play a key role in improving the green finance in emerging markets. The transfer of technology, best practices, financing can be encouraged through collaboration between countries, multilateral institutions, and the industry.Overall, findings point to the fact that a significant green finance may offer sustainable economic growth yet the efficacy of the opportunity relies on the policies, institutions and finances.

8.1 Conclusion: The purpose of this research was to examine developing market economies' (EMEs) 2010–2024 green financing and economic development patterns. This study presents the findings of a large-scale panel data analysis employing sophisticated econometric methods, including GMM and fixed effects, to shed light on long-term green financing.The results show that green financing significantly affects GDP growth. Economic development and environmental benefit are both achieved via the use of renewable energy, green bonds, and ESG financial practices. It seems that green finance and economic development promote each other, as shown by the bidirectional causation between the two.Additionally, the research emphasizes that development finance and institutional quality play a part in how successful green financing is. In a nation with strong financial institutions and good governance, green financing may have a greater effect. Nonetheless, green financing is essential to development, not only a band-aid solution, according to a long-run equilibrium connection.In developing nations, green financing is a critical factor in promoting sustainable development, according to the research. However, the benefits of this economic paradigm can only be harvested with the help of policy, efficient financial systems and a sound institutional framework.

8.2 Limitations: Despite the contribution, the study has many limitations. First, it uses secondary data which might be measurement errors that have not equally varied over different countries. Second, other indicators measuring green finance such as green bond issuance and ESG indices are also not all-inclusive.

Third, as the focus is on some emerging economies, this might hamper the generalisation of the results. In addition, although sophisticated econometric techniques are used to address endogeneity, there might be some unobservables at play. Finally, data constraints do not allow the inclusion of more specific factors such as firm-level green investment or industry specification which can provide more insight into the link between green finance and economic growth.

8.3 Future Research Directions: This work can be applied in a large number of ways in future research. By furthering the analysis to firm-level or industry-level data, a more differentiated picture of the relationship between green finance and economic performance may be achieved.

In addition to this, the analysis can be improved by adding additional variables, such as technology, carbon emissions, climate risk indicators, and others. Third, comparative research on developed and emerging economies can be useful in illuminating the structural aspects of the effectiveness of green finance.

Furthermore, the role of digital finance and financial technologies in supporting sustainable investment in emerging market economies could be researched in the future. The green finance involving the combination of AI with data analytics also promises future research.

In conclusion, there has been a lot of development when it comes to green finance and sustainable economic growth. However, additional studies are required to address the required gaps to achieve sustainable economic growth.