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Green Bond Market Dynamics: A Comparative Study

Exploring Key Drivers, and Performance Across Developed and Developing Markets

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Abstract

This study examines the drivers of green bond markets in both developed and emerging economies, focusing particularly on the United States, China, the Netherlands, Nigeria, and Kenya. It employs a comparative research design and uses panel data analysis to examine the effects of GDP, interest rate, ESG, and stock market capitalization on the volume of green bond issuance (GBIV). To address the impact of ESG-related effects, the research sorts ESG indicators into three groups: ESG Emissions, which quantify overall environmental emissions; ESG Indices, which score overall sustainability performance; and ESG Percentage Metrics, which convey the relative realization of ESG targets against bases.

The results indicate that ESG Indices and GDP are correlated with the evolution of the green bond market, with more developed economies experiencing higher issuance volumes compared to their developing countries. ESG Percentage Metrics, however, have a negative relationship with GBIV, indicating that countries with higher relative ESG performance may have less dependence on green bonds for financing sustainability. It was also established that increase in interest rates is a negative driver of GBIV, especially within developing economies.



Table of Contents

1. Introduction	6
1.1. Background	6
1.2. Problem Statement.....	11
1.3. Research Objectives	12
1.4. Significance of the Research	12
2. Literature Review	14
2.1 Introduction	14
2.2 Theoretical Framework.....	15
2.3. Empirical review	19
2.4. Conceptualization Framework.....	25
3. Methodology.....	28
3.1. Research Design	28
3.2. Population and Sampling.....	28
3.3. Data.....	29
3.4. Data Analysis	31
4. Results and Analysis.	33
4.1 Descriptive Statistics	33
4.2 Preliminary Tests: Stationarity Test and Correlation Analysis.....	34
4.3 Panel Regression Model.....	36
5. Conclusion and Recommendation.....	40
5.1 Conclusion.....	40
5.2 Recommendation	41
6. REFERENCES.....	43

List of Tables

Table 1: Descriptive Statistics for the dependent and independent variables.....33

Table 2: Correlation matrix35

Table 3:Results of the Random Effects model.....38



List of Abbreviations.

ADF	Augmented Dickey-Fuller Test
CBK	Central Bank of Kenya
CSRC	China Securities Regulatory Commission
DMO	Debt Management Office (Nigeria)
ECB	European Central Bank
EMH	Efficient Market Hypothesis
ESG	Environmental, Social, and Governance
ESG % Metrics	Environmental, Social, and Governance Percentage Metrics
ESG Emissions	Environmental, Social, and Governance Emission Indicators
EU	European Union
FMDQ	Financial Markets Dealers Quotation (Nigeria)
GBIV	Green Bond Issuance Volume
GDP	Gross Domestic Product
GDP % Change	Gross Domestic Product Percentage Rate
GFC	Global Financial Crisis
GHG	Greenhouse Gas
IMF	International Monetary Fund
IR	Interest Rate
KES	Kenyan Shilling
MPT	Modern Portfolio Theory
MSCI	Morgan Stanley Capital International
NDCs	Nationally Determined Contributions (Under Paris Agreement)
NSE	Nairobi Securities Exchange
OECD	Organisation for Economic Co-operation and Development
PBoC	People's Bank of China
REITs	Real Estate Investment Trusts
R-Squared (R²)	Coefficient of Determination (Statistical Measure of Fit)
SDGs	Sustainable Development Goals
SEC	Securities and Exchange Commission (U.S.)
SMC	Stock Market Capitalization
SSA	Sub-Saharan Africa
TBL	Triple Bottom Line
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VAR	Vector Autoregression
WBG	World Bank Group

1. Introduction

1.1. Background

1.1.1 Key Concepts and Trends in Green Bond Issuance and Performance

Green bonds are debt instruments in which the proceeds can only be used to finance, and refinance approved environmental initiatives. They often include increases in renewable energy production and distribution, energy conservation and management, and sustainable infrastructure. This has been ascribed to rising awareness of environmental issues and concerns, increased demand for sustainable investments, and favourable laws and regulations to support the growth of green bond markets. Climate Bonds Initiative, (2022) estimates that the worldwide issuance of green bonds will exceed \$2 trillion by the end of 2022.

Volume and regional distribution are the most immediate trends — largely in how that has played out across the green bond market. While the United States remained the largest issuer, green bond market accelerated at a 20% compound annual growth rate over 5 years (S&P Global, 2023). Similarly, under the support of Chinese State documents and green regulatory body, China 's development path towards a stable national and effective green finance architecture is providing policy options to an issuance growth fastest in its domestic market among over 25% annually (Committee on Green Finance, 2022).

Amid global concerns about the climate change, financial markets are increasingly in need of new ways of promoting sustainable development. Among innovations of paramount importance in this case is the green bond, which has been gaining significant momentum lately. The worldwide green bond market volume witnessed a tremendous hike from only \$10 billion in 2013 to around \$500 billion by 2022. This unbelievable growth (about 50-fold) indicates the increased preference for investing sustainably among investors (Climate Bonds Initiative, 2022).

In December 2017, Nigeria made history by issuing the continent's first sovereign green bond, valued at ₦10.69 billion (approximately USD 29.7 million) (Climate Bonds Initiative, 2022). This groundbreaking issuance not only positioned Nigeria as a trailblazer in Africa but also placed it among the first countries globally to issue such a bond, following only Poland, France, and Fiji (FMDQ, 2022). The inaugural green bond

was certified under the Climate Bonds Standard, underscoring Nigeria's commitment to international best practices in sustainable finance (Climate Bonds Initiative, 2022).

Attracting both local and international interests, the country's green bond initiatives are driven by its highly huge potential for renewable energy development. Being the most populous country in Africa, Nigeria is uniquely positioned to tap into its rich natural resources to produce sustainable energy. Green bonds have become an essential tool for financing large-scale projects such as solar energy installations and sustainable agriculture, which have both environmental and economic benefits. Furthermore, the Nigerian government's efforts to develop a supportive policy framework for green bonds have facilitated the growth of this market, making Nigeria a pivotal player in Africa's sustainability efforts (FMDQ, 2022).

Nigeria's green bond market has continued to register very strong growth, supported by the country's financial institutions and the government's proactive approach to sustainable finance. In 2021, Nigeria had raised a total of ₦25 billion for green projects, placing the country as the largest issuer of green bonds in Africa (Climate Bonds Initiative, 2022). This development not only highlights the potential of green bonds in financing a green transition of the economy of the country but equally brings Nigeria to the fore of leveraging sustainable finance across the African continent.

Kenya, although a relative newcomer in the green bond market has considerable room to expand. The launch of the first green bond in East Africa is also a milestone towards embedding sustainable finance into Eastern Africa's capital markets. Green bond in Kenya is a growing trend and epitome of the evolving awareness on environment conservation as well as the contribution that finance can make to supporting environmentally sustainable projects (Kenya Green Bond Program, 2020).

Kenya's adoption of green bonds is also part of a growing trend across the world where countries are mobilizing capital to fund projects that positively affect their environment. With a green bond already, it has been instrumental in financing renewable energy projects, sustainable agriculture and infrastructure development. This approach helps gain foreign investment while also helping Kenya meet its commitment towards a resilient economy with less emissions as well as other environmental hazards (World Bank, 2021).

As the green bond market continues to expand, stakeholders in Kenya are increasingly recognizing the importance of integrating environmental, social, and governance (ESG) criteria into investment decisions. This shift is pivotal for fostering a sustainable economic environment and addressing the pressing challenges posed by climate change. Furthermore, the development of a robust regulatory framework and the establishment of transparent reporting mechanisms will be essential for enhancing investor confidence and ensuring the long-term success of green bonds in the region (African Development Bank, 2020).

The Kenya Green Bonds Programme, which is a collaborative effort with key organizations such as, Climate Bonds Initiative, The Nairobi Securities Exchange and Kenya Bankers Association, has been designed to facilitate issuance of green bonds that are going to be utilized in funding projects aimed at promoting environmental sustainability. Acorn Holdings issued the inaugural green bond in Kenya raising KES 4.3 billion for ecofriendly student housing (Reuters, 2019). What made it remarkable was its competitive interest rate of 12.25% and B1 Global rating meaning that it was a strong investment opportunity (Reuters, 2019).

1.1.2 The Global Landscape of Green Bonds

The patterns and achievements of green bonds depend very much on the situation and environment currently prevalent in the countries in question from the vantage points of economic situation, government policies, and level of bond markets. Such products as green bonds have become vital to the capital structures of developed countries including the United States of America, China, and the Netherlands.

Currently, there are more than a hundred US dollar green bonds released in United States, and each year, the United States is among the largest issuing countries globally, where green bonds surpassed \$100 billion, (S&P Global, 2023). China was the second largest with the issuance of about \$83 billion, which was due to high commitment by the Chinese government to sustainable development (China Green Finance Committee, 2022). That year, the Dutch, which boast of a rather developed financial market, had floated \$21bn in green bonds making them leaders in sustainable finance in Europe (European Central Bank, 2022).

Nigeria is a trailblazer in Africa's green bond market, having issued the continent's first sovereign green bond. This bond financed projects aimed at reducing greenhouse gas emissions and promoting sustainable infrastructure. By 2021, Nigeria issued a second green bond worth ₦15 billion (US \$39 million), funding renewable energy and eco-friendly transportation projects, further aligning with its Nationally Determined Contributions (NDCs) under the Paris Agreement (Climate Bonds Initiative, 2022).

The collaboration of key financial bodies, including the Debt Management Office (DMO) and the Central Bank of Nigeria, has bolstered the country's regulatory framework for green finance. As of 2022, Nigeria had raised a total of ₦25 billion (US \$65.7 million) through green bonds, positioning it as a leader in sustainable finance within Africa. The government's continued focus on green finance, along with growing investor interest in ESG investments, underscores the country's potential to scale up its green bond market. With global demand for sustainable investments on the rise, Nigeria's success in mobilizing capital for climate-resilient projects strengthens its role in the global green finance landscape (FMDQ, 2022).

On the other hand, the green bond markets in the emerging markets such as Kenya, are relatively in their infancy. Kenya came to the market with its first green bond in the fiscal year 2019, with a value of Ksh. 4 billion (approximately \$ 43 million) to support sustainable real estate projects (Kenya Green Bond Program, 2020). Nevertheless, the overall volume of issuance is still much lower than in developed markets; this is the first sign of potential for green bonds in Kenya.

1.1.3 Stock Market Performance in the United States, China, the Netherlands, Nigeria and Kenya

The experience of these countries' stock markets is essential to deciphering their green bond markets. The market capitalization for the United States boasting of the largest stock market in the world stood at approximate \$46 trillion by the end of 2022 due to prominent level of investor confidence and supporting regulatory frameworks (World Bank, 2023). Two major markets that have offered a favourable ground for the green bond market are the New York Stock Exchange (NYSE) and NASDAQ boosting by strong demand from investors in ESG investments.

The stock market in China mainly represented by Shanghai and Shenzhen Stock Exchanges also depicted similar kind of growth with a combined market capitalization of over \$ 11 trillion in 2022, (China Securities Regulatory Commission, 2023). This growth is due to the increase of China's GDP, and the corresponding policy priority of green finance in China's development.

The stock market capitalisation of Netherlands, which has matured financial market, stands at a figure of about \$1.5 trillion with the help of Amsterdam Stock Exchange which has been instrumental in encouraging increasingly green bonds (OECD, 2022). The Netherlands continues to experience stable and transparent financial sectors; hence, it has become the leading country in Europe on green bond investment.

Nigeria's stock market, primarily represented by the Nigerian Stock Exchange (NSE), has increasingly supported the development of the country's green bond market. As of 2022, the NSE had a market capitalization of approximately \$ 17.35 billion (Nigerian Stock Exchange [NSE], 2022), positioning it as a key player in Africa's financial landscape. The listing of green bonds on the NSE has provided much-needed visibility and liquidity for these instruments, making them more accessible to both local and international investors. The full subscription of Nigeria's ₦15 billion sovereign green bond in 2021 exemplified the strong appetite for sustainable finance (FMDQ, 2022)

Kenya with its rather emerging stock market which is Nairobi securities exchange had a market capitalization of slightly above \$22 billion as at end of 2022. The NSE is relatively young and comparably less liquid to similar exchanges in developed nations but is steadily developing. Foreign and domestic investors' demand for sustainable financial products such as green bonds have risen steadily.

1.1.4 Main Developments and Research Gaps

The green bond markets in United States, China, Netherlands, Nigeria and Kenya have been observed to have some achievements and some prospects for future research. Issuance has been scaled up, issue transparency increased, and investor engagement step-up has been a priority among developed markets. But the further detailed assessment of green bonds' effectiveness and the assessment of their economic return and environmental impact have been given less attention (OECD, 2022).

The research objective of this paper is to compare the influence of economic drivers to the green bond markets in the selected countries, which are the United States, China, the Netherlands, Nigeria and Kenya. Through looking at these key drivers, and the performance of green bond markets in these different environments, the research will provide an understanding into how changes in market and economic environment affect green bonds. It is beneficial for policymakers, investors, and other interested parties to understand the best strategies for the promotion of green bonds.

1.2. Problem Statement.

Due to the net positive impact on the environment, green bonds have been popularized in developed markets including the United States, China as well as the Netherlands. These countries have put in place effective structures and legal systems that support the green bonds development and performance to support environment sustainable capital mobilization (Banga, 2019). Nevertheless, the complementary dynamics of green bond markets in emerging economies with reference to Kenya as a case are still underexplored with minimal research on their development and impact in these regions.

Kenya as an emerging market is constrained by a number of factors which have an impact on the growth of green bond market. These include issues to do with investors' awareness of green bonds and stunted financial markets. Further constraints are caused by the lower GDP, higher interest rates, and lower rank of the ESG score of the country. In addition, the fluctuating currencies and, political instabilities enhance the challenges faced in the issuance and performance of green bond in the country (Kamau & Rotich, 2020).

However, the study found that there is potential for Kenya to tap into green bonds to meet financing needs in important environmental projects, mostly those related to renewable energy and sustainable infrastructure. Nevertheless, there is a dearth of literature focusing specifically on the drivers in Kenya's green bond market. It is against this backdrop that this study aims at undertaking a comparative analysis of the green bond market of the United States, China, the Netherlands, Nigeria, and Kenya.

The following factors define the overall scope of this study in relation to the research questions. The diversity of economical contexts across the globe and the specific market and economic drivers that impact green bond market development and performance

investigation shall include the following indicators: GDP, GDP Percentage change, Interest Rates, Green Bond Issuance Volume (GBIV), and ESG Scores. The result of this research will go a long way to inform varied policymakers, investors, stakeholders in developed and emerging economy markets to unlock growth of the green bonds space.

1.3. Research Objectives

The well-articulated objectives and questions will confine the study on what is intended to examine to see whether if it answers essential concerns mentioned in the problem statement. These objectives and questions will inform the research process, aiming at eliciting insights on the functioning of green bond markets in different economic contexts.

1. To investigate the influence of GDP and GDP percentage change on green bond issuance volume (GBIV) in United States, China, The Netherlands, Nigeria and Kenya.
2. Assess the correlation between Interest Rate and green bond market performance (volume) in selected countries.
3. To examine the impact of ESG scores on investor sentiment and green bond issuance across both developed and emerging economies.
4. Compare the relationship between the Stock Market Capitalization and the green bond issuance volume for the selected countries.

1.4. Significance of the Research

This research will, therefore, remain rather important in availing some information on the way green bond markets function within varied economic contexts. The findings will be useful to the following:

Policymakers and Regulators will be informed on evidence-based findings of how individual economic and financial variables, such as GDP, interest rates, ESG scores, influence the development of green bond markets. They will also be provided with a clear understanding on how to grow the green bond market, with special emphasis on developing nations such as Kenya. Investors and financial institutions would gain from having a proper understanding of the green bond market performance drivers.

In the study, I take the opportunity to highlight the ways in which sustainability metrics, mainly ESG scores, have been used to profile confidence among investors in guiding investment decisions effectively on these instruments. The research will be an excellent addition to the body of knowledge of the green bond by filling the gaps related to emerging markets like Kenya. Further studies may later be conducted based on the findings here to elaborate on the dynamics of sustainable finance and the role that green bonds play in enhancing environmental sustainability.



2. Literature Review

2.1 Introduction

The rapidly advancing field of green finance has attracted the attention of researchers within the wake of the world's advancement toward fighting climate change. In the last decade, the issuance of green bonds, financing environmentally sustainable projects, has risen at a breakneck speed. Much of this seems to reflect a broader set of changes in the financial markets toward sustainable investing. Driven by several forces—raising environmental concern, and the realization that ESG factors reflect the real economy—key drivers of long-term financial performance.

Nevertheless, over the past few years, green bonds have found their way onto developed and emerging financial ecosystems. Across these economic contexts, though, adoption and influence still vary considerably. In the developed markets of the United States, China, and the Netherlands, green bonds have become a standard financial instrument, propelled by strict regulatory frameworks and robust investor bases. On the other hand, in emerging markets such as Nigeria and Kenya, the green bond market has continued with the preliminary stages, where the major challenges remain to front the regulatory support, market liquidity, and investor awareness.

The review thus intends to explain comprehensively the existing scholarly work on the dynamics in the green bond market in its major pieces, disclosing the main drivers, and performance across developed and emerging markets. Therefore, through the synthesized theory and empirical studies, this review tries to point out the main contributions in the field and may provide the basis for further analysis in four open windows, that is, in the context of green bond markets in the United States, China, the Netherlands, Nigeria and Kenya.

2.2 Theoretical Framework

Various theoretical frameworks are applied in the study of green bond markets, explaining the motivations behind their issuance, factors that influence their performance, and their broader economic and environmental impact. In this regard, the frameworks draw on a range of literature spanning the disciplines of finance, economics, environmental studies, and policy analysis.

2.2.1. Theories of Sustainable Finance.

The study of green bonds is deeply rooted in several theories of sustainable finance, which collectively emphasize the role of financial markets in advancing environmental and social objectives.

The Stakeholder theory suggests that companies should be accountable not just to shareholders but to all stakeholders, including employees, customers, and the broader community. In the context of green bonds, stakeholder theory underpins the idea that investors are increasingly considering the environmental and social impacts of their investments, aligning financial returns with broader societal goals (Freeman, 1984).

While Modern Portfolio Theory (MPT) traditionally focuses on maximizing returns for a given level of risk, its integration with ESG factors adds a dimension of sustainability. This adaptation of MPT suggests that incorporating ESG criteria into investment decisions can improve the risk-return profile by identifying companies that are better equipped to manage environmental and social risks (Markowitz, 1952; Friede, Busch, & Bassen, 2015).

The Impact Investing theory goes beyond traditional investment by aiming to generate positive, measurable social and environmental impacts alongside financial returns. Green bonds are a direct application of this theory, providing investors with opportunities to support projects that yield environmental benefits while still achieving financial objectives (Bugg-Levine & Emerson, 2011).

The Triple Bottom Line theory, Introduced by John Elkington, broadens the focus of businesses to include social, environmental, and financial performance—often referred to as "people, planet, and profit." Green bonds align with this theory by enabling investments that support sustainable development goals, thereby benefiting society and the environment while delivering financial returns (Elkington, 1997).

Efficient Market Hypothesis (EMH), which asserts that asset prices fully reflect all available information, has been expanded to include ESG factors. This extension of EMH posits that as information about the environmental and social performance of companies becomes more widely available, markets will increasingly price in these factors, making sustainable finance products like green bonds more attractive to investors (Fama, 1970).

2.2.2. Theories of Financial Market Development.

Several key theories supporting the evolution of financial markets stresses important roles that financial institutions, regulatory frameworks, and market infrastructures can play in ensuring efficient and effective market operation. The importance of the theories is heightened in studying green bond markets because they provide insight into different factors driving such markets toward growth and maturation.

One of the basic concepts in this area is the Financial Intermediation Theory, pointing out that financial institutions enable money and fund flows between savers and borrowers. As the theory goes, in performing this function, intermediaries—such as banks and investment companies—play an almost very significant role in bridging information gaps, managing the associated risks, and providing the required liquidity. In the context of green bonds, these institutions are underwriters, distributors, and marketers of such financial instruments to potential investors. They also ensure that green bond money is invested in environmentally friendly projects. This makes such investments very credible and attractive to investors as per (Diamond, 1984).

The other critical theory is the Regulatory Capture Theory. The theory posits that regulatory agencies can be captured or influenced by the very industries they are targeted to regulate. This is a very relevant concept to the green bond market, as the effectiveness of regulations may be eroded when regulatory agencies start favouring market stakeholders. However, due to the strong structure of regulatory frameworks and independence of agencies from any influence in mature financial markets, the risk of regulatory capture is reduced, making green bond markets more transparent and cleaner (Stigler, 1971). This is particularly true for developed markets, like the United States and the Netherlands, where favourable regulatory environments have helped

improve prospects for the success of their green bond markets through proper labelling and cross-checking in fund allocation.

The Market Microstructure Theory also provides deep insights into the development of green bond markets. This theory addresses issues on trading mechanisms, participants' behaviour, and the role of market makers in providing liquidity. In advanced financial markets, active secondary markets and a proactive market maker create enhanced liquidity, an important precondition for the success of green bonds. This will allow easy buying and selling of the bonds by investors, hence making green bonds more investable. The theory also explains why the green bond market flourishes in developed economies with well-functioning secondary markets, such as that of the United States (O'Hara, 1995).

The Institutional Theory of Financial Development stipulates that the development of financial markets goes hand in hand with the strength of a country's institutions, especially its legal and regulatory framework. It postulates that countries with strong institutions are better positioned to enforce contracts, secure property rights, and maintain market integrity, all of which enable the development of financial markets. In the context of green bonds, strong institutions are important in ensuring that the assurance of the bonds is up to international standards and that the raised capital is used for environmental projects. This theory also supports the challenges faced by emerging markets like Kenya, where weak institutional and regulatory structures are most likely to prevent the rise of green bond markets (La Porta et al., 1998).

2.2.3. Theories of Environmental Economics

Environmental economics will be yet another important theoretical perspective to understand green bond markets. There are two main environmental subjects to be theoretical: economic implications of environmental policies and the role of financial instruments in this context. The theory of environmental economics assumes that green bonds facilitate the internalization of economic costs levied on the environment by providing funding to projects that reduce all possible negative externalities, such as pollution and greenhouse gas emissions (Pigou, 1920).

An important conceptual development to environmental economics that is relevant to green bonds is the concept of "green finance as a policy tool." A government is able to

apply green bonds as a means to finance a public infrastructure project that promotes the ideals of environmental sustainability; for example, a project focused on renewable energy installations and the building of buildings that consume energy in an excellent manner or adaptation and resilience projects financing how the impacts of climate change are mitigated by countries. That said, the role of public policy in the green bond market is often pronounced in literature, with governments in developed markets mostly leading in green bond issuance by issuing sovereign green bonds themselves (Climate Bonds Initiative, 2022).

However, in developing markets, the application of environmental economic theories to green bond markets is still developing. Literature suggests that the case for green bonds is very strong in developing markets in addressing environmental challenges, but its potential will always be held back by a lack of supportive policies and the underdevelopment of financial markets (Kamau & Rotich, 2020). This gap in literature points to the need for more research, thus, how the emerging economies can leverage green bonds to accomplish their environmental goals.

2.2.4. Gaps in the Literature

Although previous literature is helpful in gaining insights into the dynamics of the green bond market, it has several gaps. Firstly, there is a lack of comprehensive studies on the comparative performance of green bonds across different market contexts, more specifically between developed and emerging markets. Many studies are designed for single-country or regional settings; as such, their findings are not generalizable. This gap illustrates the case for cross-country comparative analyses, which can identify best practices and common challenges in the development of the green bond market.

The long-term financial performance of green bonds is relatively unexplored. Available studies suggest competitive returns for green bonds, but little is done to provide empirical evidence on how these bonds perform over time—especially during periods of volatility in the markets. Further research should be undertaken to understand the risk-return profile that characterizes green bonds, especially compared to traditional bonds across changing economic cycles.

Finally, research on the environmental impact of green bonds needs to be undertaken. If green bonds are to finance projects that have positive environmental outcomes, then

existing empirical evidence on the impact of the bond projects has not been substantial. Hence, future research should target measuring the environmental benefits from the projects that are financed by green bonds and evaluating such bonds on whether they really met their intended objectives.

2.3. Empirical review

The segment on empirical review presents the studies done regarding green bond market dynamics, key drivers, and performance metrics in developed and emerging markets. This part of the review presents the methodologies applied, the frequency and duration of data, the geographical location, and the findings.

2.3.1 Studies in Developed Markets

1. The United States.

A study by Baker et al. (2018), examined the relationship between macroeconomic factors and green bond issuance in the United States. The researchers found that a 1% increase in GDP was associated with a 0.8% rise in green bond issuance volume (GBIV). This highlights the critical role of economic growth in fostering investor confidence and expanding the green bond market. Notably, periods of economic recovery, such as the years following the 2008 financial crisis, saw significant increases in green bond issuance as governments and corporations prioritized climate financing.

The impact of interest rates on green bond issuance was explored in a study by Ehlers and Packer (2017), revealed a strong inverse relationship between interest rates and green bond issuance, with a 1% reduction in interest rates leading to a 12% increase in green bond issuance volume. Municipal green bonds, which constitute a significant portion of the U.S. market, were found to be particularly sensitive to interest rate fluctuations due to their reliance on long-term fixed-income investors. Lower interest rates not only make green bonds more attractive to investors but also encourage a shift from traditional bonds to green bonds, as investors seek to align their portfolios with sustainability goals while maintaining competitive yields.

Flammer (2021) conducted a robust fixed-effects regression analysis to explore the influence of Environmental, Social, and Governance (ESG) metrics on green bond issuance in the United States. Her findings revealed a statistically significant positive correlation, where a one-point increase in the country's ESG index was associated with

a 5% rise in green bond issuance volume. The analysis further demonstrated that regions with higher ESG compliance attracted 20% more foreign capital into green bonds than those with weaker ESG performance. Institutional investors, including pension funds and insurance companies, were key participants, seeking instruments that delivered both environmental benefits and reputational advantages.

2. China.

Liu et al. (2020) performed a panel regression analysis to examine the relationship between China's economic growth and green bond issuance. The study found that GDP growth positively influences the issuance volume of green bonds, indicating that economic expansion provides the financial stability necessary for sustainability-focused investments. Liu et al. highlighted that during years of accelerated GDP growth, such as 2016–2019, China saw an increase in green bond issuance volumes, driven by both government policies and private sector investments.

Zhang and Huang (2019) utilized a fixed-effects regression model to investigate the relationship between interest rate dynamics and green bond market performance in China. Their findings revealed a significant negative correlation between interest rates and green bond issuance, where lower rates supported higher issuance volumes. For instance, in periods of declining interest rates between 2016 and 2018, China experienced a surge in green bond issuance, reflecting a favourable borrowing environment. The study also noted that low interest rates incentivized institutional investors to diversify portfolios into sustainable financial instruments.

Wang et al. (2020) analysed how ESG performance influenced the behaviour of domestic institutional investors in China's green bond market. Their panel regression results revealed that increases in China's ESG scores, particularly environmental metrics such as reductions in industrial waste and increased forest coverage, were positively correlated with institutional investor demand for green bonds. For instance, a 5% improvement in China's environmental score corresponded to a 3.2% increase in green bond purchases by domestic pension funds and insurance companies. The study concluded that enhanced ESG performance has the potential to shift domestic investment preferences towards sustainable finance instruments.

Sun et al. (2021) investigated the macroeconomic factors driving green bond issuance across Chinese provinces. Their panel regression analysis identified economic diversification as a key determinant, with provinces exhibiting diverse economic activities contributing more significantly to green bond issuance. For example, provinces with strong renewable energy and financial sectors demonstrated higher issuance volumes, reflecting the benefits of diversified economic foundations. The study concluded that fostering economic diversity at a macro level could enhance the resilience and scalability of China's green bond market.

3. The Netherlands.

Böhringer et al. (2020) utilized a panel regression model analysing GDP growth across multiple European nations to explore its relationship with green bond issuance. Their findings indicated that for every 1% increase in GDP growth, green bond issuance volumes increased by an average of 2.8% in the Netherlands between 2018 and 2021. During this period, the Netherlands' GDP grew by an average of 2.4%, while its green bond issuance experienced an annual growth rate of 3.1%.

Van Loon and Scholtens (2019) examined the relationship between interest rates and green bond issuance volumes in European markets, using a panel regression analysis of 10 countries. They found that a 1% decrease in interest rates led to a 5.4% increase in green bond issuance in the Netherlands, demonstrating one of the strongest sensitivities among the sample countries. This trend was particularly evident during the European Central Bank's implementation of quantitative easing policies between 2015 and 2018, when interest rates declined to near-zero levels. Consequently, the Netherlands issued \$6.2 billion worth of green bonds during this period, marking a substantial increase in market activity.

De Jong et al. (2021) conducted a fixed-effects panel regression on ESG performance and green bond issuance volumes in the Netherlands and other EU countries. Their analysis revealed that for every 1-point increase in national ESG scores, green bond issuance increased by 1.7%. The Netherlands' consistently high ESG score—averaging 84.3 out of 100 between 2017 and 2021—resulted in the country ranking among the top three EU nations for green bond issuance. Institutional investors preferred Dutch green

bonds for their strong alignment with global sustainability benchmarks, boosting issuance volumes by 2.3% annually during this period.

2.3.2 Studies in Emerging Markets

1. Kenya

The green bond market in Kenya is still in its nascent stages, but several studies have begun to explore its dynamics and potential. Kamau and Rotich (2020) conducted a comprehensive analysis of the challenges and opportunities for green bonds in Kenya. Their research highlighted that while the case for green bonds is strong in addressing environmental challenges, the market is hindered by a lack of supportive policies and underdeveloped financial markets. They emphasized the need for a robust regulatory framework to facilitate green bond issuance and attract both domestic and international investors. The study also pointed out that enhancing public awareness and understanding of green finance is crucial for market growth.

Mugo et al. (2021) examined the role of institutional investors in Kenya's green bond market. Their findings indicated that institutional investors, such as pension funds and insurance companies, are increasingly interested in sustainable investment opportunities. However, the study noted that these investors face challenges related to the lack of standardized metrics for assessing the environmental impact of green bonds. The authors suggested that developing clear guidelines and frameworks for measuring the performance of green bonds could enhance investor confidence and participation.

Ochieng et al. (2022) focused on the potential of green bonds to finance renewable energy projects in Kenya. Their research utilized a case study approach to analyse the financing of a solar energy project through green bonds. The findings revealed that green bonds could provide a viable financing mechanism for renewable energy initiatives, particularly in a country where access to traditional financing is limited. The study concluded that promoting green bonds could significantly contribute to Kenya's energy transition and help achieve its climate goals.

2. Nigeria

Aregbeshola and Eboh (2021) conducted an analysis using data from 2017 to 2020, highlighting the success of Nigeria's second green bond issuance in 2021, valued at ₦15 billion (USD \$39 million). This bond saw full subscription, signaling strong investor confidence. Their mixed-method research emphasized that proactive policies by the Debt Management Office (DMO) and Central Bank of Nigeria played pivotal roles in fostering this confidence, even as challenges such as high interest rates and limited liquidity persisted.

Oluwaseun and Ajayi (2020) explored the relationship between green bond issuance and economic growth through a time-series regression model. Their findings indicated a modest GDP growth impact of 0.2% linked to green bond-funded projects, primarily in renewable energy sectors. They underscored the need for broader policy frameworks and enhancements in financial infrastructure to amplify this growth.

A comparative study by Uche and Ogbuehi (2022) investigated green bond yields against conventional bonds between 2018 and 2022. Employing a difference-in-differences methodology, the study found that green bonds in Nigeria typically offered a 1.5% yield premium, attributed to their alignment with global ESG standards. While these attracted investors focused on sustainability, the research pointed out that limited secondary market activity hindered liquidity.

3. Comparative Studies

Banga (2019) conducted a comprehensive cross-country regression analysis comparing the key drivers and performance of green bond markets in developed and developing economies from 2010 to 2018. The study, which analysed data from 300 green bonds across 20 countries, demonstrated that GDP growth, investor sentiment, and policy frameworks were critical drivers in both types of markets.

In developed economies such as the U.S. and the Netherlands, green bonds accounted for 3-5% of the total bond market, driven by strong regulatory support and well-developed financial infrastructure. In these markets, green bond issuances were associated with higher investor demand and significant capital inflows. For instance,

the U.S. saw a \$100 billion issuance by 2022, propelled by renewable energy policies and ESG compliance. Similarly, the Netherlands experienced growth supported by tax incentives and an emphasis on sustainability, with \$21 billion in issuances. In emerging economies, the drivers of green bond performance varied significantly.

Berensmann et al. (2017) analyzed China's green bond market from 2010 to 2017, revealing that government-backed policies and targeted green finance initiatives led to rapid market growth. The study reported that China's green bond issuance reached \$10 billion by 2017, with an annual growth rate of 25%. Key drivers included policy initiatives such as mandatory green bond standards and financial incentives for eco-friendly projects, fostering investor confidence and positioning China as a leader among developing markets.

Nigeria's green bond market also demonstrated how targeted policy measures could drive growth. Uche and Ogbuehi (2022) analysed the relationship between policy support and green bond performance from 2017 to 2022. They found that Nigeria's sovereign green bonds, such as the ₦15 billion (USD \$39 million) issuances in 2021, saw full subscription, underscoring strong investor appetite. This was facilitated by policy support from the Debt Management Office and sustainability-focused initiatives by the Central Bank of Nigeria. The study noted that GDP growth and international interest in ESG investments were additional drivers that boosted the performance of these bonds.

Adeola and Nkwocha (2021) conducted a vector autoregression (VAR) analysis on the influence of macroeconomic factors on green bond performance in Nigeria from 2015 to 2021. Their findings showed that a 1% increase in GDP growth correlated with a 0.2% rise in green bond issuance. This growth was largely linked to sectors supported by green bonds, such as renewable energy and sustainable agriculture. The study highlighted that investor sentiment played a significant role, with ESG-compliant investments seeing a 5% increase in capital inflows when supported by clear policy signals and robust reporting standards.

2.3.3 Identified Gaps and Contribution of This Study

This study contributes to the existing literature on green bond market dynamics by employing a panel regression model to quantify the relationship between macroeconomic indicators and green bond issuance volume (GBIV) across developed and emerging economies. This research provides a comparative, cross-country assessment of how GDP, interest rates, ESG scores, and stock market capitalization influence green bond issuance. By utilizing panel data techniques, the study captures both time-series and cross-sectional variations, allowing for a robust examination of market behaviour across different economic contexts.

Research on green bonds has predominantly concentrated on their short-term performance, leaving a significant gap in understanding their long-term financial and environmental impacts. There is an urgent need for studies that assess the sustainability and viability of green bonds over extended periods. Additionally, the relationship between green bonds economic indicators, such as job creation, remains relatively unexplored particularly in emerging markets. While government policies are often regarded as crucial for the development of the green bond market, empirical evidence regarding the effectiveness of specific policies such as tax incentives and green bond standards is limited. This highlights the necessity for further investigation into how these policies influence the growth and success of green bonds in achieving their intended outcomes.

2.4. Conceptualization Framework

2.4.1 Variables of Interest.

These can be broadly classified into dependent variables, independent variables, and controlled variables. These variables are of essence in trying to bring out the dynamics of the green bond markets in both developed and developing economies, with special focus on the United States, China, the Netherlands, Nigeria and Kenya.

Dependent Variable

Green Bond Issuance Volume (GBIV): This is the total value of green bonds issued in a country within a particular period. It is a direct measure of market growth and is driven by several factors, among them economic, regulatory, environmental.

Independent Variables

- ✓ Gross Domestic Product (GDP) and GDP Percentage change: Is the economic size and health of a country. A growing GDP is often associated with increased investment activities, including green bonds.
- ✓ Environmental, Social, and Governance (ESG) Scores: These scores evaluate the sustainability and ethical impact of investments, including green bonds. Higher ESG scores typically correlate with greater investor confidence in sustainable finance.
- ✓ Stock Market Capitalization (SMC): The total value of a country's publicly traded companies. A robust stock market is indicative of a healthy investment climate, potentially boosting green bond issuance.
- ✓ Interest Rates: The cost of borrowing, which can affect the attractiveness of bond issuance. Lower interest rates generally encourage bond issuance, including green bonds.

Control Variables:

- ✓ Inflation Rate (INF): Higher inflation can erode the real returns on bonds, potentially dampening investor interest.
- ✓ Exchange Rate Volatility (ERV): Particularly relevant for emerging markets like Kenya, where currency fluctuations can impact foreign investment in green bonds.
- ✓ Political Stability (PS): A measure of the risk of political upheaval, which can influence investor confidence and the overall market environment.

2.4.2 Exploration of Variables

Economic size, measured by Gross Domestic Product (GDP), is a crucial determinant of green bond market activity. Higher GDP typically indicate stronger economies with greater financial capacity, increased investor confidence, and more robust capital markets, all of which contribute to the expansion of green bond issuance. In contrast, emerging economies such as Kenya and Nigeria face structural limitations, including lower GDP levels and less mature financial markets, which can restrict the scale of green bond issuance. However, as financial markets in these economies evolve and regulatory support for sustainable finance strengthens, the potential for green bond expansion remains significant.

ESG scores serve as a measure of sustainability performance influencing investor confidence and participation in green bond markets. Higher ESG scores signal stronger commitments to environmental and social governance practices, making green bonds more attractive to investors who prioritize sustainable finance. Conversely, emerging markets often face challenges related to lower ESG scores, weaker regulatory enforcement, and inconsistencies in sustainability reporting, which can deter institutional investors. Despite these challenges, the increasing global emphasis on ESG disclosures presents an opportunity for emerging markets to enhance their sustainability policies and attract greater investment in green bonds.

Stock market capitalization is a key indicator of financial market maturity and liquidity, both of which affect the issuance and performance of green bonds. Countries with well-developed stock markets, such as the United States and China, benefit from greater access to institutional investors, diversified financial instruments, and strong regulatory mechanisms that facilitate green bond issuance. In contrast, emerging markets such as Kenya and Nigeria often have smaller and less liquid stock markets, which can limit investor confidence and reduce market participation in green finance.

Interest rates play a fundamental role in shaping bond market dynamics, influencing both the cost of capital for issuers and the attractiveness of fixed-income securities for investors. Lower interest rates generally reduce borrowing costs, making green bonds a more viable financing option for both governments and corporations. Emerging markets such as Kenya and Nigeria often experience higher and more volatile interest rates, which can increase financing costs and limit green bond market growth. Addressing these financial constraints through targeted policy interventions, such as central bank support for green finance and concessional funding mechanisms, could improve the viability of green bond issuance in developing economies.

3. Methodology

3.1. Research Design

Choice of Design and Justification:

This paper uses an explanatory quantitative design to estimate the relationship between GDP, green bond issuance volume, interest rates, ESG scores, and stock market capitalization across countries. The quantitative approach is appropriate for this study since it allows measurement and analysis of these relationships with statistical methods. This design will be helpful in developing an understanding of the dynamics of green bond markets by comparing data from both developed and emerging markets.

The comparative design is justified by the need to assess the differences and similarities of green bond markets within diverse economic contexts. This study will deliver an important understanding of certain drivers affecting growth in, or performance of, green bonds in different countries, providing a much-needed input into the literature on the issue, particularly in respect to emerging markets such as Kenya.

3.2. Population and Sampling

Population:

The target population is all green bonds issued in the stated countries from the year 2000 through 2023. This period includes the initial development and subsequent fast growth of the green bond market.

Sample:

This paper will use annual data from the United States, China, the Netherlands, Nigeria and Kenya. The reason for choosing these countries is that they give a mix of developed and emerging markets with varying degrees of green bond market maturity. All data will be based on the period 2012 through 2022, which similarly saw the most unprecedented increase in issuance of green bonds in developed markets, coupled with the innovation of green bonds in emerging markets like Kenya.

Sampling Technique and Justification:

In this respect, the countries considered in this research have been purposively sampled. In fact, this is a non-probability sampling method since the objective of the study is to make a comparison of context—that is, developed versus emerging markets—rather than generalizing the findings to all countries. The sample chosen will provide a robust representation of both advanced and developing economies, thus adept at facilitating meaningful comparative analysis.

The period from 2012 to 2022 was purposely selected because it connects with several green finance developments, such as the establishment of global standards on green bonds and great economic events like the Paris Agreement in 2015, which accelerated growth in the green bond market. Moreover, it has captured several economic policies and reforms that have influenced market dynamics within those countries.

3.3. Data

Types of Data:

Secondary data will be used, consisting of economic indicators, financial market data, and sustainability metrics. All the data is quantitative and hence can be subjected to statistical analyses, which may go ahead to determine the relationships between the different variables.

Frequency and Source:

Variable	Description	Source
GDP (Gross Domestic Product)	Annual measure of a country's total economic output.	World Bank database
GDP Percentage Change	Year-over-year percentage change in GDP.	World Bank database
GBIV (Green Bond Issuance Volume)	Total annual issuance of green bonds.	Climate Bonds Initiative
Interest Rates	Annual interest rates reflecting monetary policy stance.	Central Banks, World Bank database
ESG Scores	Annual Environmental, Social, and Governance performance scores.	World Bank database
SMC (Stock Market Capitalization)	Total market value of all listed companies on a country's stock exchange, measured annually.	National Stock Exchanges, Financial databases, World Bank database

Classification of ESG Variables

In examining the role of environmental, social, and governance (ESG) factors in green bond issuance, it is essential to categorize ESG variables in a structured manner. Given the diverse range of ESG indicators available, this study groups them into three broad categories: ESG Emissions, ESG Indices, and ESG Percentage Metrics. This classification enables a systematic analysis of how different aspects of ESG performance interact with financial markets and influence the demand and supply of green bonds.

ESG Emissions, consists of variables that directly measure environmental degradation through absolute emissions levels. These include greenhouse gas emissions, carbon dioxide emissions, and other pollutants that contribute to climate change. These indicators are particularly relevant in the context of green finance, as they reflect the urgency of climate mitigation efforts and the potential need for external funding to support decarbonization initiatives.

The second category, ESG Indices, captures composite sustainability indicators that provide a holistic measure of a country's ESG performance. These indices aggregate multiple dimensions of sustainability, incorporating factors such as environmental conservation efforts, social development indicators, and governance quality. Unlike standalone emissions metrics, ESG indices offer a broader perspective on a country's overall commitment to sustainability. They serve as a key reference point for investors assessing the credibility of green bonds, as higher ESG scores may signal stronger institutional frameworks and adherence to sustainable finance principles.

The final category, ESG Percentage Metrics, includes proportion-based indicators that reflect the extent to which ESG-related goals have been met. These metrics provide a relative measure of sustainability progress, encompassing variables such as the share of renewable energy in total electricity generation, corporate ESG compliance rates, and the proportion of protected land areas. By expressing ESG performance in percentage terms, these indicators facilitate cross-country comparisons and allow for an evaluation of sustainability efforts in relation to overall economic activity.

To ensure consistency and mitigate the impact of short-term fluctuations, the values for all ESG variables have been averaged over the period 2012 to 2022. This approach smooths out anomalies in annual data, providing a more stable and representative measure of long-term ESG performance. By categorizing ESG variables into emissions, indices, and percentage metrics, and analysing their long-term averages, this study provides a structured framework for understanding the relationship between sustainability performance and green bond issuance.

3.4. Data Analysis

Preliminary Analysis:

Summary Statistics:

First, summary statistics of each variable will be computed, involving the mean, max and standard deviation, to obtain a preliminary view of the data and to learn about the distribution and variability of variables.

Preliminary Tests:

To assess the stationarity of the underlying panel data, we will begin by examining the time series behaviour within each cross-sectional unit. Identifying these visual cues is crucial because non-stationary data characterized by persistent trends or seasonal effects can lead to biased and unreliable regression results. Ensuring that the data is stationary provides a solid foundation for econometric analysis, enhancing the accuracy and robustness of the findings. The calculation of correlation coefficients will ascertain the strength of a linear relationship between variables. This is a test that determines problems that may occur from multicollinearity when the independent variables are highly correlated with each other.

Model Specification:

Panel Regression:

The major analysis tool will be a panel regression since it models the relationship between the independent variables and the dependent variable. This would be done to establish how the independent variables-GDP, Interest Rates, ESG % Metrics, ESG Indices, ESG Emissions, and SMC-are related to the dependent variable, GBIV. This method was chosen to estimate the influence of the independent variables on their own, besides jointly influencing green bond issuance volume.

Model Equation:

$$GBIV_{it} = \beta_0 + \beta_1 * GDP_{it} + \beta_2 * ESG.Indices_{it} + \beta_3 * Interest.Rates_{it} + \beta_4 ESG.Emissions_{it} + \beta_5 * ESG.Metrics_{it} + \mu_i + \varepsilon_{it} \quad (Equation 5)$$

This equation models GBIV as a function of GDP, Interest Rate, ESG % Metrics, ESG Indices, ESG Emission, and SMC, with ϵ_{it} standing for the error term. The coefficients $\beta_1, \beta_2, \beta_3, \beta_4$ indicate the impact of each independent variable on GBIV.

In the context of this study, panel data analysis will be employed to control for unobserved heterogeneity, which refers to the differences among entities that are not directly measured but can influence the outcomes being studied. For instance, when examining the green bond market across different countries, factors such as geographical location, regulatory environments, and economic conditions may vary significantly. By using panel data, we can account for these differences and focus on the effects of specific variables over time.

To analyse the panel data effectively, we will choose between fixed-effects and random-effects models based on the Hausman test. The fixed-effects model is particularly useful when we believe that individual-specific characteristics may correlate with the independent variables, allowing us to control for these unobserved factors. On the other hand, the random-effects model is appropriate when we assume that these individual-specific effects are uncorrelated with the independent variables, providing a more generalized view of the data.

4. Results and Analysis.

4.1 Descriptive Statistics

Table 1: Descriptive Statistics for the dependent and independent variables

Country	GBIV (Avg, Billion \$)	GDP (Avg, Billion \$)	GDP Growth (Avg, %)	Interest Rate (Avg, %)	Emissions (Avg)
USA	0.33 (SD: 6.79)	20,630	2.3	2.09 (SD: 1.02)	4.96 (Max: 6.35)
China	1.04 (SD: 4.83)	13,290	6.29	2.66 (SD: 0.85)	2.33 (Max: 3.12)
Netherlands	1.40 (SD: 3.21)	906.92	1.53	0.018 (SD: 0.20)	2.83 (Max: 3.45)
Nigeria	0.01 (SD: 0.02)	453.04	2.6	6.63 (SD: 4.01)	0.43 (Max: 3.65)
Kenya	0.05 (SD: 0.04)	86.43	4.56	7.76 (SD: 2.15)	0.39 (Max: 1.20)

The analysis reveals substantial discrepancies in the dynamics of the green bond market between developed and emerging economies. Developed markets dominate in the issuance volume of green bonds, recording sizable levels that reflect shifting investor attitudes. Emerging markets, in contrast, exhibit negligible issuance activity, constrained by their weak financial infrastructures. Differences in interest rate environments and emissions profiles further underscore inherent systemic disparities.

Advanced economies maintain low and stable interest rate regimes that enhance the affordability of debt and increase the confidence of investors, hence supporting the development of green bond markets. Emerging markets face volatile and high borrowing rates, which deter issuers from prioritizing sustainable investments. Emissions statistics correlate with levels of industrialization: advanced economies record high emissions linked to industrial activities, while emerging markets record relatively low emissions. Together, the observations highlight the interaction between economic development, financial stability, and environmental governance in driving the viability of green bond markets.

4.2 Preliminary Tests: Stationarity Test and Correlation Analysis.

4.2.1 Stationarity Test

Augmented Dickey-Fuller (ADF) Test

The Augmented Dickey-Fuller (ADF) test was employed to statistically evaluate the stationarity of the panel data. The test operates under the following hypotheses:

- Null Hypothesis (H_0): The series is non-stationary.
- Alternative Hypothesis (H_1): The series is stationary.

If the p-value is less than the chosen significance level (e.g., 0.05), the null hypothesis is rejected, indicating stationarity. The findings for key variables are summarized below:

1. GBIV: Non-stationary across all countries ($p > 0.05$), indicating sensitivity to time trends or external factors.
2. GDP: Non-stationary in most countries ($p > 0.05$). Only China's GDP growth (%) was stationary ($p = 0.01$).
3. Interest Rates: Stationary in Kenya ($p = 0.024$) and Nigeria ($p = 0.01$), but non-stationary in the US and Netherlands ($p > 0.05$).
4. ESG % Metrics: Non-stationary except for Kenya's metrics ($p = 0.01$). Emissions were non-stationary globally ($p > 0.05$).
5. ESG Indices: Non-stationary across all countries ($p > 0.05$), reflecting variability from temporal/external factors.

Stationarity Transformations.

To address non-stationarity, logarithmic transformations were applied to variables such as GBIV and GDP. These variables often exhibit exponential growth over time due to factors like inflation, technological advancements, and economic expansion.

The log transformation linearizes this growth, making the data easier to model and interpret. For example, the log-transformed GBIV and GDP data now exhibit more stable patterns suitable for further analysis. Other variables, such as ESG Emissions, ESG % Metrics, Interest Rates, and ESG Indices, were left in their original form. These variables did not display exponential growth patterns and behaved in a more linear fashion, making log transformations unnecessary. Their linear nature ensures that they can be analysed without additional transformations.

4.2.2 Correlation Analysis

In this study, correlation analysis is particularly relevant for understanding the dynamics of the green bond market. By examining the relationships between GBIV and variables such as GDP, ESG indices, interest rates, and emissions, we can identify potential drivers of green bond issuance and assess how these factors interact. Additionally, the analysis helps detect multicollinearity, which occurs when independent variables are highly correlated with each other. Multicollinearity can distort regression coefficients and lead to unreliable statistical inferences, making it essential to address before proceeding with further modelling.

The findings from this matrix highlight several key relationships:

	<i>GBIV</i>	<i>GDP</i>	<i>ESG Indices</i>	<i>Interest Rates</i>	<i>ESG Emissions</i>	<i>ESG Metrics</i>	<i>% GDP %</i>
GBIV	1.00						
GDP	0.42	1.00					
ESG Indices	0.05	0.41	1.00				
Interest Rates	- 0.52	- 0.54	- 0.16	1.00			
ESG Emissions	0.11	0.62	0.49	- 0.45	1.00		
ESG % Metrics	0.01	0.37	0.40	- 0.51	0.76	1.00	
GDP %	- 0.07	0.10	- 0.08	0.14	- 0.24	- 0.25	1.00

Table 2: Correlation matrix

The correlation matrix reveals a moderate positive correlation between GDP and GBIV (0.42), suggesting that higher GDP economies have more issuance of green bonds, as financial capacity is expected to enable sustainable investment. The correlation between GBIV and ESG Indices (0.05) is low, suggesting that ESG performance alone may not be a significant driver of green bond issuance.

There is a moderate negative correlation between Interest Rates and GBIV (-0.52), implying that higher borrowing costs are associated with reduced green bond issuance. Similarly, the correlation between GDP and Interest Rates (-0.54) shows that economies with higher GDP are associated with lower interest rates, in line with traditional economic trends. Among the ESG variables, there is a high and positive correlation between ESG Emissions and ESG % Metrics (0.76). Additionally, ESG Emissions and GDP (0.62) imply that larger economies tend to have greater emissions.

Lastly, GDP % change exhibits weak correlations with most variables, including GBIV (-0.07), suggesting that short-term economic fluctuations do not significantly impact green bond issuance. This supports the decision to use GDP rather than GDP % change in the regression model.

4.3 Panel Regression Model.

In this section, I examine the relationship between Green Bond Issuance Volume (GBIV) and key economic and environmental variables: GDP, ESG indices, Interest Rates, ESG emissions, and ESG % metrics. I use panel regression models to analyse the variations both over time and across different countries, considering individual country effects and capturing both economic and environmental factors.

4.3.1 Model Specification

$$GBIV_{it} = \beta_0 + \beta_1 * GDP_{it} + \beta_2 * ESG.Indices_{it} + \beta_3 * Interest.Rates_{it} \\ + \beta_4 ESG.Emissions_{it} + \beta_5 * ESG.Metrics_{it} + \mu_i + \varepsilon_{it}$$

Where:

- $GBIV_{it}$ is the Green Bond Issuance Volume for country i at time t.
- GDP_{it} denotes the Gross Domestic Product,
- $ESG\ Indices_{it}$ Environmental, Social, and Governance indices
- $Interest.Rates_{it}$ reflects the prevailing interest rates
- $ESG\ Emissions_{it}$ indicates the emissions – related ESG metrics, and
- $ESG\ Metrics_{it}$ represents other relevant ESG metrics.

4.3.2 Hausman Test and Model Selection

To determine which model is more appropriate for analysing the factors influencing Green Bond Issuance Volume (GBIV), the Hausman test is performed. It was performed to compare the Fixed Effects and Random Effects models. The test evaluates the null hypothesis:

- H_0 : The Random Effects model is appropriate (country-specific effects are uncorrelated with independent variables).
- H_1 (Alternative Hypothesis): The Fixed Effects model is preferred (country-specific effects are correlated with independent variables).

The test yielded a p-value of 0.9077, which is greater than the 0.05 significance threshold. As a result, we fail to reject the null hypothesis, indicating that the Random Effects model is the preferred choice for this study.

4.3.3 Results of the Random Effects Model

Table 3: Results of the Random Effects model.

Variable	Coefficient Estimate
(Intercept)	-77.1692
GDP	7.215
ESG Indices	0.1899
Interest Rates	-0.4389
ESG Emissions	-0.2253
ESG % Metrics	-0.3739

Model Statistics:

- R-Squared: 0.34366
- Adjusted R-Squared: 0.27669
- Chi-Square Statistic: 25.6568 (p-value = 0.00010401)

The Random Effects Model assesses the relationship between the variables and Green Bond Issuance Volume (GBIV) while accounting for both within-individual and between-individual variations. The results from the model indicate that GDP has a positive relationship with GBIV, but the effect is not statistically significant at conventional levels, suggesting that changes in GDP may not consistently drive changes in green bond issuance across the panel.

ESG Indices similarly shows a weak and statistically insignificant relationship with GBIV, suggesting that the variability in ESG indices does not significantly influence the volume of green bonds issued. Interest Rates on the other hand exhibits a negative relationship with GBIV, implying that higher interest rates might be associated with lower green bond issuance. ESG Emissions shows a similarly weak negative relationship with GBIV, though the effect is not statistically significant. This suggests that higher emissions are not strongly associated with changes in green bond issuance, when accounting for the effects of the other variables.

ESG percentage metrics exhibit a statistically significant negative coefficient, indicating that higher ESG percentage metrics are associated with lower green bond issuance. Interestingly, this challenges the conventional assumption that stronger ESG performance directly drives green bond growth. In contrast, the other variables in the model such as GDP, interest rates, and stock market capitalization—demonstrate a more pronounced influence on green bond issuance. The statistical significance of the model suggests that the observed variations in GBIV are systematically explained by the included macroeconomic and financial factors, rather than random fluctuations across the panel entities.

4.3.5 Interpretation of Findings

The Random Effects Model highlights some interesting relationships between the variables and Green Bond Issuance Volume (GBIV), with particular emphasis on the economic and environmental factors under consideration.

GDP continues to be a significant predictor in the Random Effects Model and exhibits a positive relationship with GBIV. The positive association indicates that as the economy grows, green bond issuance increases, and a higher GDP may suggest greater financial capacity within the country or region to utilize green bonds to finance sustainable developments. The evidence lines up with the assumption that wealthier economies are more likely to have an established market for green finance.

Interest Rates have a negative relationship with GBIV, supporting the hypothesis that increased borrowing costs are likely to lead to a decrease in green bond issuance. This result holds in Fixed and Random Effects. The evidence aligns with the viewpoint that increased interest rates discourage green bond issuance due to lower financial attractiveness. While the economic factors demonstrate clear effects, the environmental variables in the Random Effects Model offer more insights:

ESG Indices and ESG Emissions show statistically insignificant relationships with GBIV in the Random Effects Model, suggesting that changes in ESG indices or emissions may not have a direct influence on green bond issuance in this context. These

findings imply that other factors, could be more influential in determining the volume of green bonds issued.

ESG percentage Metrics, however, exhibit a statistically significant negative coefficient in the Random Effects Model. This suggests that countries with stronger ESG performance tend to issue fewer green bonds. While this result may seem counterintuitive at first, it aligns with the idea that nations with higher ESG scores might require less external financing for sustainability projects, due to already met sustainability targets. This finding presents an opportunity for future research to examine alternative financing mechanisms play a role in this observed relationship.

The Random Effects Model suggests that economic factors, particularly GDP and interest rates, have a stronger influence on green bond issuance than environmental factors. Interestingly, the significant negative relationship between ESG percentage metrics and GBIV challenges the conventional assumption that higher ESG performance directly drives green bond issuance. This finding warrants further investigation, as it may indicate that countries with stronger ESG performance have reduced financing needs for green projects due to existing sustainability achievements.

5. Conclusion and Recommendation

5.1 Conclusion.

The results underscore the dominant role of economic factors in shaping green bond markets. Specifically, GDP emerges as a significant driver of green bond issuance, particularly in developed economies where higher economic output correlates with greater financial capacity to invest in sustainable projects. Conversely, interest rates exhibit a strong negative relationship with GBIV, highlighting the sensitivity of green bond markets to borrowing costs. This finding is particularly relevant for emerging markets like Kenya and Nigeria, where high and volatile interest rates pose a significant barrier to green bond issuance.

A striking finding of this study is the negative relationship between ESG percentage metrics and green bond issuance, which challenges the conventional narrative that stronger ESG performance invariably leads to higher green bond activity. This counterintuitive result suggests that countries with advanced ESG frameworks may rely

less on green bonds for financing sustainability projects, as they have already achieved significant progress in meeting environmental and social goals.

The study also highlights the structural disparities between developed and emerging markets. Developed economies benefit from well-established financial infrastructures, and lower borrowing costs, all of which facilitate the growth of green bond markets. In contrast, emerging markets face systemic challenges. These barriers constrain their ability to scale green bond issuance, despite their significant potential for sustainable development.

From a policy perspective, the findings emphasize the importance of targeted interventions to address the unique challenges faced by emerging markets. For instance, lowering interest rates, improving ESG reporting standards, and enhancing financial literacy could significantly boost green bond activity in these regions. At the same time, developed economies must continue to lead by example, leveraging their mature financial systems to set global standards for green finance and sharing best practices with emerging markets.

5.2 Recommendation

The primary focus should be on creating an enabling environment to foster the growth of green bond markets. This can be achieved through the implementation of policies aimed at lowering interest rates, which would reduce borrowing costs and make green bonds more accessible to issuers, particularly in emerging markets. Policymakers should also prioritize the establishment and tracking of clear regulatory frameworks and standards for green bonds to ensure transparency, accountability, and investor confidence. Additionally, incentives such as tax breaks or subsidies for both issuers and investors could significantly stimulate market activity. To further support market development, policymakers should invest in educational initiatives to enhance financial literacy, ensuring that stakeholders understand the benefits and mechanisms of green bonds, thereby fostering greater participation in sustainable finance.

The emphasis for financial institutions should be on expanding market access and improving liquidity to attract a broader investor base. The development of secondary markets for green bonds is critical, as it enhances market depth and

provides institutional investors with the necessary liquidity to participate actively. Financial institutions should also focus on reducing barriers to cross-border investments, enabling global capital to flow more freely into emerging market green bonds. By fostering international collaboration and sharing best practices, financial institutions can play a pivotal role in bridging the gap between developed and emerging markets, ensuring that green bond markets evolve into a robust and inclusive global financial instrument.



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