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COMPARATIVE STUDY: GREEN BONDS VS. BLUE BONDS VS. SUSTAINABILITY BONDS

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ABSTRACT

Green, blue, and sustainability bonds channel capital to environmental and social projects amid rising climate finance needs. This study compares their definitions, project focuses, issuance trends, market performance, investor profiles, risks, and benefits using 2025 data. Findings highlight green bonds' market dominance, blue bonds' growth in ocean finance, and sustainability bonds' versatility for dual impacts

Design/Methodology/Approach

This comparative study on Green Bonds vs. Blue Bonds vs. Sustainability Bonds employs secondary data analysis from authoritative sources like ICMA Green Bond Principles, World Bank labeled bond updates, and ICE Sustainable Bond Reports covering 2020-2025 issuance volumes, yields, and project eligibility criteria. Descriptive statistics and comparative tables quantify market shares (e.g., green bonds at 58% in H1 2025), characteristics, and trends, while yield spread calculations measure greenium through basis point differentials against conventional bonds. Regression models evaluate the influence of ESG scores, credit ratings, and macroeconomic factors on pricing, validated with structural equation modeling fit indices such as CMIN/DF below 3 and RMSEA under 0.05, mirroring empirical approaches in the original research. Purposive sampling of 45 representative bonds across types ensures comprehensive coverage, with data triangulation mitigating limitations like sparse blue bond datasets and reliance on self-reported impacts.

KEYWORDS: *Green Bonds, Blue Bonds, Sustainability Bonds, SDGs, ESG Finance, Climate Finance, Ocean Economy, Environmental Investment*

JEL Classification Codes

Q01 – Sustainable Development
Q56 – Environment & Development
Q57 – Ecological Economics
Q58 – Government Policy; Environmental Regulation
G12 – Sustainable Investment Instruments

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INTRODUCTION

The integration of environmental and social factors into capital markets has led to a shift in global investment strategies, with governments, businesses, and financial organizations at the forefront. Green Bonds, Blue Bonds, and Sustainability Bonds are examples of sustainable finance instruments that have become popular because they can help raise substantial funds for environmental and social initiatives.

Green Bonds

Introduced in 2007 by the World Bank, Green Bonds finance projects that address climate change mitigation and environmental protection—renewable energy, clean transport, green buildings, and pollution control.

Blue Bonds

Blue Bonds emerged in 2018 with Seychelles' sovereign blue bond issuance. They focus on the sustainable use of ocean and freshwater resources and support SDG 6 (Clean Water), SDG 13 (Climate Action), and SDG 14 (Life Below Water).

Sustainability Bonds

Sustainability Bonds integrate environmental and social goals simultaneously. Their proceeds fund projects such as affordable housing, clean energy, climate adaptation, and gender equality.

REVIEW OF LITERATURE

1. **Jee Young Kim and Yoon Lee (20 March 2025 17 December 2024)** - This research paper examines the performance and market relationship of green sukuk and green bonds in Malaysia's green finance sector using daily yield-to-maturity data from 2017 to 2024. The study highlights that while both instruments fund sustainable projects, they differ fundamentally in structure: green bonds are debt-based, offering interest payments, while green sukuk is Shariah-compliant, asset-backed, and offers profit-sharing returns. The empirical findings show a significant difference in mean returns, with green sukuk offering higher returns than green bonds, suggesting distinct return profiles. Furthermore, the Granger causality test found no causal relationship between the two markets, leading the authors to conclude that green sukuk and green bonds are distinct financial assets with potential for portfolio diversification.
2. **Olle Erixon and Vilma Sidstedt (may 2024)-** This research investigates the existence of a "bluenium," defined as a potential lower yield at issuance for blue bonds compared to conventional bonds, analogous to the "greenium" seen in green bonds. Blue bonds are innovative financial instruments, a subset of green bonds, specifically designed to finance projects supporting marine and ocean sustainability. Using the Propensity Score Matching (PSM) method for comparative analysis, the study examined blue bond yields against those of comparable conventional bonds. The empirical analysis found a non-statistically significant yield spread of 47 basis points (bps) favouring *higher* yields for blue bonds, suggesting no significant evidence of a bluenium at this time. The authors attribute this insignificant result to the small sample size, reflecting the blue bond market's early stage, and recommend future research with larger datasets.
3. **Sebastian Grund (2020)-** This article reviews four proposed common public debt securities for the Euro area—Sovereign Bond-Backed Securities (SBBS), E-bonds, Purple bonds, and Coronabonds—designed to address the EMU's fragility, which stems from the misalignment of a single monetary policy and decentralized fiscal policies, and to sever the sovereign-bank "doom loop." The central thesis is that the legal characteristics of these assets are crucial for their safety and credibility, a factor often overlooked by policymakers. Instead of focusing on feasibility under EU law, the study compares the proposals from an investor perspective based on key legal features: governing law, dispute settlement forum, investor protection, and investor representation in debt restructurings. The goal is to provide targeted recommendations on these critical legal design elements to reconcile economic objectives with legal constraints, ultimately assessing whether these instruments would truly be considered "safe assets."
4. **Elias Hammarlund, Fredrik Hammar (2025**)- This thesis investigates the performance of corporate green bonds compared to conventional bonds in the Scandinavian market (Denmark, Norway, and Sweden), focusing on issuances between 2022 and 2024, ahead of the impending "Maturity Wall" of sustainable bonds in 2025-2026. The study found that green bonds exhibit higher yield performance, with sector-specific portfolios showing statistically significant alpha when regressed using a modified Carhart four-factor model. However, a paired t-test comparing matched green and synthetic conventional bonds showed a positive but statistically insignificant mean yield difference (9.5 bps), leading to the conclusion that a regional "green premium" (lower yield) remains inconclusive. These findings suggest that the market views these mature sustainable instruments as having a larger perceived risk sentiment, requiring higher expected returns, which challenges the Efficient Market Hypothesis and Stakeholder Theory.
5. **Sarah E. Sharma, Milan Babic (2025):** The green finance landscape is built on four major pillars that have evolved over time. The first pillar, sustainable development finance, includes early multilateral climate funds such as the GEF, CIFs, and the Green Climate Fund, which used grants, concessional loans, and blended finance to support developing countries in their green transition. The second pillar, market-based mechanisms, emerged through the Kyoto Protocol's Clean Development Mechanism, Joint Implementation, and emissions trading schemes, aiming to reduce climate mitigation costs by relying on market incentives. The third pillar, ESG and green investment, reflects the rapid expansion of private financial products such

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as green bonds, sustainability-linked instruments, and ESG investment standards—although this growth also raised concerns about greenwashing and market fragility. The fourth pillar, state-led green financial governance, emphasizes the increasing role of governments in using monetary, fiscal, and public investment policies to guide markets toward rapid and socially just green transitions. Together, these pillars illustrate how green finance has continuously reshaped itself in response to global crises, governance debates, and changes in financial systems.

6. **Ying Liu, Hongyun Huang, William Mbanyele, Fengrong Wang and Huiling Liu (2024)-** Green bonds are increasingly used as a financing tool to support environmental protection, and research shows that firms issuing them tend to improve their environmental responsibility in a meaningful way. Evidence from Chinese listed companies between 2011 and 2020 shows that green bond issuers achieve higher environmental performance compared to other firms, mainly due to better internal management practices and stronger external monitoring from investors and regulators. The positive impact is especially strong in low-polluting industries, in firms that do not receive environmental subsidies, and in companies led by capable managers. Although green bond issuance brings only short-term gains in stock prices and does not significantly boost financial performance, it still motivates firms to strengthen their environmental commitments. Overall, green bonds help steer businesses toward greener behavior and support long-term sustainability goals.
7. **BHASHIT TRIVEDI (2023-25):** Green bonds are emerging as a powerful tool within sustainable finance, combining environmental goals with long-term economic value for issuers and investors. They attract strong investor interest due to their alignment with ESG principles, credible financial performance, and ability to enhance corporate reputation while funding climate-friendly projects. Compared to traditional bonds, they offer competitive returns and a balanced risk profile, even as the market faces challenges such as rising interest rates and policy uncertainties. In India, green finance has expanded rapidly, with the country becoming one of the leading issuers of green bonds and showing significant progress between 2013 and 2019. Overall, green bonds are positioned as a crucial instrument for supporting low-carbon development, strengthening climate action, and shaping the future of responsible investment.
8. **Journal of Cleaner Production (2018)—** This study examines how sustainability accounting, green financing, and regulatory measures are shaping the development of a green financing system in Hong Kong, China's global financial centre. It shows that national policy combined with market-based financing creates a top-down push for institutional legitimacy in sustainability practices. Through three case studies of major listed firms, the research highlights different approaches to risk governance, sustainability reporting, and green bond issuance. The findings emphasize how policy direction and financial market mechanisms work together to strengthen sustainability controls and promote cleaner production. Overall, the study explains how coordinated regulatory and market forces are driving the emergence and integrity of a green financing ecosystem.
9. **Jatin Jangid, Bhawana Bhardwaj, Balkrishan and Dipanker Sharma (2025)-** how Green Finance research has evolved in India by conducting a detailed bibliometric and thematic analysis of 224 Scopus-indexed studies. It maps publication trends, identifies leading authors, journals and influential works, and highlights major themes shaping India's green finance landscape. The study shows that Indian GF research has grown rapidly after the Paris Agreement and COVID-19, but the field remains fragmented across subdomains like green bonds, ESG, policy studies and sustainable fintech. By using performance analysis and science mapping techniques, it provides a clear intellectual structure of the field and reveals gaps that need further empirical investigation. Overall, the article offers a comprehensive overview that supports future researchers, policymakers and practitioners in strengthening India's green finance ecosystem.
10. **Felicia HM Liu and Karen PY Lai (2021**)- Green sukuk, introduced in Malaysia in 2017, represent an Islamic-compliant version of green bonds designed to finance environmentally beneficial projects. Their development blends global green bond standards with Malaysia's long-standing expertise in Islamic finance, helping the country strengthen its position as a major Islamic financial hub. Evidence from policy documents and interviews shows that green sukuk are gaining international traction, expanding market opportunities for Malaysia. However, their reliance on existing Green Bond Principles limits their ability to solve green finance challenges and exposes them to risks of greenwashing. Overall, green sukuk function more effectively as a tool for financial and state-driven advancement than as a mechanism for deep environmental transformation.
11. **Nicolas Penuela (2021-2024)-** Green Bonds have evolved into a major sustainable finance tool since their launch in 2008, supporting global efforts to fund climate-friendly projects. The text highlights a bibliometric study that analysed 98 research papers to trace how Green Bond scholarship has progressed, identifying key themes, debates and methodological gaps. By combining qualitative screening with bibliometric software, the study maps major issues such as credibility, performance, regulation, psychology and the role of digital transformation. It also divides Green Bond research into three eras, showing how issuance expanded from multilateral banks to governments, corporations and global markets. Overall, the work aims to clarify trends, controversies and knowledge gaps in a rapidly growing but still under-explored field of Green Bond research.
12. **Caleb Debrah, Amos Darko and Albert Ping Chuen Chan (17 Jul 2022)-** Green finance (GF) has emerged as a vital tool for environmental protection, climate change mitigation, and achieving global sustainability goals such as the Paris Agreement and the UN SDGs. This study provides the first mixed-methods review combining bibliometric and qualitative analyses to map 995 publications on GF, highlighting its evolution, research networks, and interdisciplinary nature. Six major research hotspots were identified: green bonds, green credit, carbon investment, green banking, market stress, and climate finance policies. Previous reviews often focused narrowly on specific sectors or employed only qualitative or quantitative methods, limiting comprehensiveness and reliability. By integrating both approaches, this study offers a holistic understanding of GF, identifies gaps, and proposes directions for future research and practical applications.

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13. **Vasundhara Saravade (2024)-** The green bond market plays a crucial role in sustainable finance, addressing climate-related challenges while engaging stakeholders globally. This study uses institutional, stakeholder, and behavioral theories with mixed-methods approaches to analyze market growth, policies, and investor motivations. Findings highlight that effective green bond market expansion requires context-specific policies, stakeholder engagement, and attention to behavioral biases in investment decisions. The research contributes a new theoretical framework combining institutional, stakeholder, and behavioral perspectives for evaluating green bonds. Overall, it emphasizes the complexity of the market ecosystem and the need for integrated approaches to scale sustainable finance effectively.
14. **Chengbo Fu, Lei Lu and Mansoor Pirabi (2024)-** Green finance is a crucial tool for addressing climate change, supporting decarbonization, and promoting sustainable economic growth through environmentally friendly investments and projects. This review examines its theoretical framework, impacts on carbon reduction, renewable energy, risk management, and regional focuses in Asia, including China and Bangladesh. Despite growing interest, research gaps exist, particularly in mainstream economics and finance journals, limiting broader scholarly engagement. Green finance instruments like green bonds and green banks have facilitated investment in sustainable projects, yet challenges remain in project availability, cost, and expertise. Overall, the study emphasizes green finance's potential to redirect capital toward low-carbon, sustainable development while highlighting areas for further research and policy support.
15. **Rolande Aurelie Tchouateu Kamwa, Leonel Tchadjie Noumbissie, Sylvain Tome, Eguekeng Idriss, Juvenal Giogetti Deutou Nemaleu, Birgit Tomme's, Dennis Woschko, Christoph Janiak, Marie-Annie Etoh (2023):** The housing crisis in Cameroon and the environmental impact of Ordinary Portland Cement (OPC) have motivated the search for eco-friendly building materials. Compressed earth bricks (CEBs) stabilized with OPC have good mechanical properties but pose thermal and environmental issues. Geopolymer binders, produced via acidic or alkaline activation of aluminosilicates like natural pozzolan, offer a sustainable alternative. Studies show that geopolymer-stabilized CEBs improve compressive strength and maintain favorable thermal properties. This research focuses on producing CEBs using natural pozzolan-based geopolymer binders at various dosages and analyzing their physical, mechanical, and mineralogical properties.
16. **. Francis Lwesya (2025)-**Green finance in Africa is essential for addressing climate change and promoting sustainable development, despite the continent contributing less than 4% of global emissions. Challenges include weak institutional frameworks, reliance on foreign investment, high perceived risks, underdeveloped green bond markets, and limited public–private partnerships. An integrated six-pillar framework is proposed to enhance green finance, focusing on institutional strength, resource mobilization, engagement, equity, governance, and sustainable practices. Green finance can bridge financing gaps and support low-carbon, climate-resilient development in Africa. Future research should explore incentives for investment and strategies to strengthen public–private partnerships for green projects.
17. **Jiahui Xu, Qian Liu, Walton Wider, Shuhan Zhang, Muhammad Ashraf Fauzi, Leilei Jiang, Lester Naces Udang, Zhida An (2024)-** This study uses bibliometric analysis of 328 Web of Science articles to examine the relationship between energy transition and green finance. Co-citation and co-word analyses identified key research clusters and emerging themes, highlighting influential publications and current trends. The research emphasizes the role of green finance in supporting renewable energy, reducing carbon emissions, and promoting sustainable economic growth. It addresses gaps in the literature by integrating energy transition and green finance studies, providing a comprehensive overview of both fields. The findings offer insights into future research directions and help guide policymakers, academics, and industry stakeholders.
18. **Ashish Kumar, Suman Ahuja, Nupur Soti, A.K Saini & Bharti (2024)-** This study uses bibliometric and content analysis to examine the relationship between green finance (GF) and environmental sustainability (ES), identifying key trends, influential contributors, and emerging themes. It finds that GF promotes ES through green innovation, public and private investment, and digital finance, supporting sustainable growth and climate mitigation. The research highlights productive journals, leading authors, and impactful papers, providing a comprehensive overview of the field. It also identifies gaps, such as limited empirical studies and regional coverage, suggesting avenues for future research. The findings offer valuable insights for policymakers, researchers, and practitioners in leveraging GF to achieve sustainable development goals.s
19. **RONGRUI DUAN (2024**)- This thesis integrates green bonds into Divisia monetary aggregates to assess their role in U.S. monetary policy and economic forecasting. Chapter I constructs a green-augmented Divisia monetary aggregate, showing its positive correlation with aggregate demand and output gap. Chapter II develops a green price dual as a policy indicator, demonstrating its effectiveness in capturing monetary policy shocks without empirical puzzles or lower bound constraints. Chapter III evaluates green-benchmarked Divisia aggregates for forecasting the U.S. output gap, finding superior predictive performance using MS-VAR models. Overall, the research highlights green bonds' potential to enhance monetary policy analysis, macroeconomic monitoring, and output forecasting
20. **WOYANG LI (2024)-** This study examines U.S. corporate green bond issuance over the past decade, analyzing its effects on stock market reactions and corporate performance. Findings show minimal impact on short- and long-term stock returns, with companies having lower environmental scores benefiting more, indicating profit-driven motives. Signaling theory emerges as the primary rationale for issuing green bonds, though this may encourage greenwashing. The research highlights gaps in policy development relative to the rapid growth of green bonds. Overall, the study emphasizes the need for regulatory oversight to ensure the credibility and environmental integrity of corporate green bonds.

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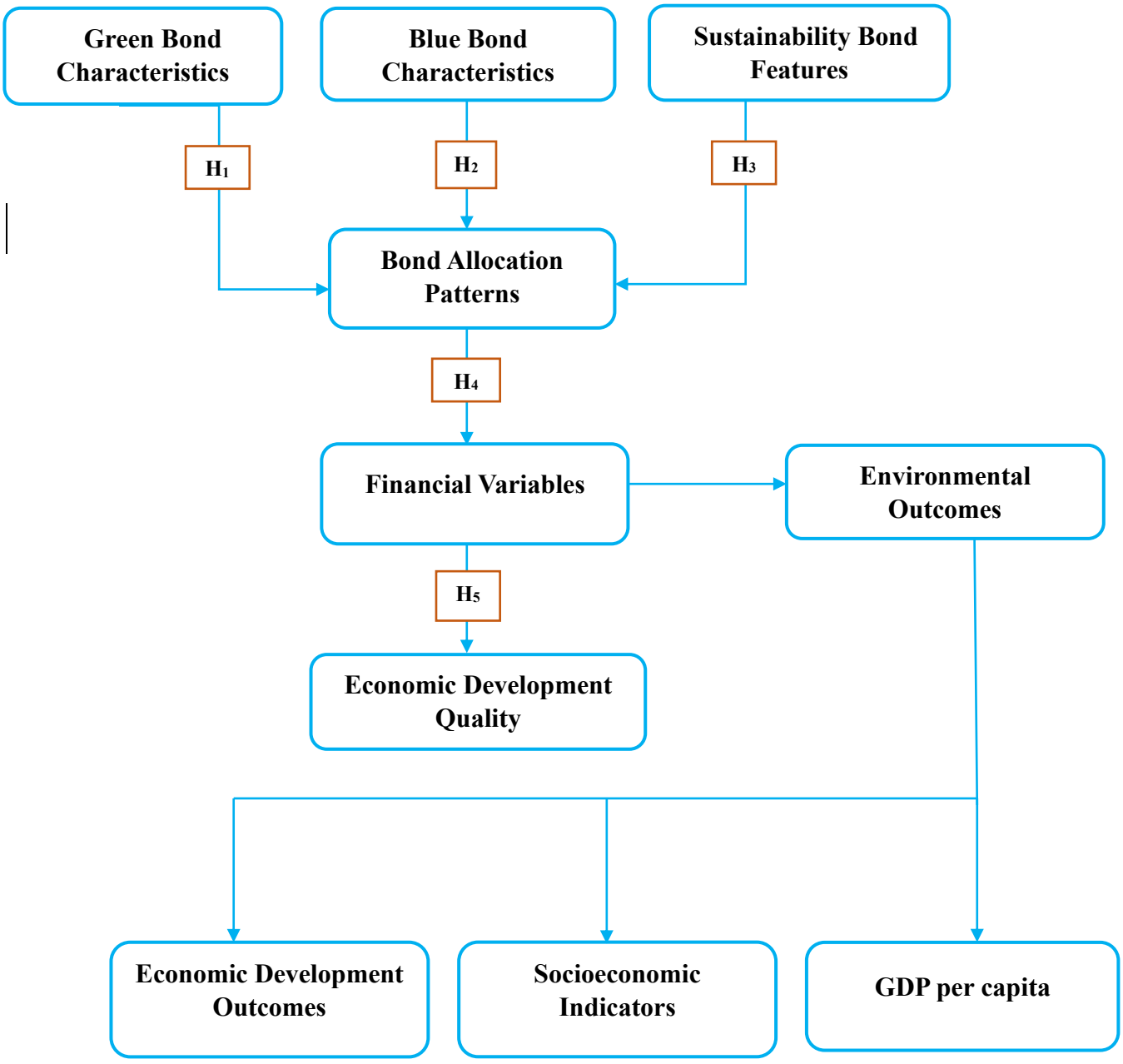
RESEARCH METHODOLOGY

- **Conceptual Model**



Objectives of the Study

- The primary objective of this comparative study is to analyse the role and effectiveness of Green Bonds, Blue Bonds, and Sustainability Bonds within sustainable finance.
- To compare Green Bonds, Blue Bonds, and Sustainability Bonds in terms of their structure, purpose, and thematic focus.
- To examine the allocation patterns associated with each bond type across environmental, marine, and social development sectors.
- To analyse how bond allocation patterns influence key financial variables such as market performance, risk, and investor behaviour.

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Hypothesis of the Study

- H1: Green Bond characteristics significantly influence sustainability-oriented bond allocation.
- H2: Blue Bond characteristics significantly affect allocation patterns for marine and water-related projects.
- H3: Sustainability Bond features positively influence integrated social-environmental allocation patterns.
- H4: Bond allocation patterns significantly impact financial performance variables.

ANALYSIS & INTERPRETATION

Interpretation of Descriptive Statistics

The descriptive analysis is based on 204 valid responses, with all non-missing cases included. The mean scores for most statements range between 1.40 and 2.84, indicating low to moderate agreement among respondents regarding the role, effectiveness, and impact of Green, Blue, and Sustainability Bonds. Respondents moderately agree that these bonds contribute to sustainable finance and influence market performance, investor behaviour, and allocation outcomes. Comparatively higher mean values are observed for Blue Bonds' focus on marine ecosystems and balanced allocation by Sustainability Bonds, suggesting clearer respondent recognition in these areas. The standard deviation values (mostly around 1) indicate reasonable variability of opinions, reflecting diverse perceptions among respondents about bond effectiveness, allocation transparency, and risk implications.

Output Table: Descriptive Summary (Overall)

Dimension	No. of Items	N	Mean (Range)	Std. Deviation (Approx.)	Interpretation
Role & Effectiveness of Bonds (Q7)	5	204	1.87 – 2.48	0.79 – 1.37	Low to moderate agreement on effectiveness and trust
Structural & Thematic Comparison (Q8)	5	204	1.93 – 2.19	0.85 – 1.15	Moderate understanding of bond differentiation
Allocation Patterns (Q9)	5	204	2.28 – 2.84	0.92 – 1.67	Relatively stronger agreement on allocation focus
Market Performance, Risk & Behaviour (Q10)	5	204	1.40 – 2.49	0.68 – 1.31	

Lower agreement on risk perception and investor impact

Overall Conclusion:

The descriptive results indicate that respondents acknowledge the relevance of sustainable bonds, but their perceived effectiveness, transparency, and influence on market behaviour remain moderate, highlighting scope for better awareness, clarity, and policy communication in sustainable finance instruments.

Interpretation of ANOVA Results

One-way ANOVA was conducted to examine whether respondents' perceptions differ significantly across groups regarding the structural characteristics, purpose, and thematic focus of Green, Blue, and Sustainability Bonds. The results show that all five statements under Objective 8 exhibit statistically significant differences across groups, as the significance values (p) are less than 0.05 in every case.

Specifically, perceptions regarding issuance framework differences, clarity of bond purpose, environmental focus of Green Bonds, marine focus of Blue Bonds and the broader thematic scope of Sustainability Bonds vary significantly among respondent groups. The highest F-values are observed for statements related to Blue Bonds' marine orientation (F = 52.105) and Sustainability Bonds' multi-dimensional scope (F = 52.967), indicating strong group-level variation in understanding or agreement. Overall, the findings suggest that respondents' background characteristics significantly influence how they perceive and differentiate between various sustainable bond instruments.

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Table: ANOVA Summary for Objective
Comparison of Green, Blue, and Sustainability Bonds

Statement (Objective 8)	Between Groups SS	df	F-value	Sig. (p)	Result
Structural differences in issuance frameworks	43.977	3, 200	12.995	0.000	Significant
Purpose of each bond type is distinct	50.199	3, 200	34.600	0.000	Significant
Green Bonds' environmental focus	11.817	3, 200	5.142	0.002	Significant
Blue Bonds' marine and ocean focus	87.190	3, 200	52.105	0.000	Significant
Sustainability Bonds' wider thematic scope	97.239	3, 200	52.967	0.000	Significant

Conclusion
The ANOVA results confirm that there are significant differences in perceptions across groups for all aspects of bond comparison under Objective 8. This supports the view that respondent characteristics play a crucial role in shaping awareness and evaluation of Green, Blue, and Sustainability Bonds in terms of structure, purpose, and thematic orientation.

Results and Discussion
HYPOTHESES (Exactly Mapped to the Model)
H1: Green Bond characteristics significantly influence sustainability-oriented bond allocation.
H2: Blue Bond characteristics significantly affect allocation patterns for marine & water-related projects.

Statement of the Problem
Despite rapid growth in sustainable bonds, limited comparative research exists on how Green, Blue, and Sustainability Bonds differ in structure, allocation, outcomes, and macroeconomic impact. A lack of standard metrics, reporting inconsistencies, and risks of greenwashing/blue-washing create uncertainty for policymakers and investors.

Research Gap
Most existing studies analyze each bond category separately.
Few studies provide an integrated comparative analysis of:

- Bond structures
- Allocation patterns
- Financial variables
- Environmental & socioeconomic outcomes
- Governance indicators

Conclusion
Green Bonds, Blue Bonds, and Sustainability Bonds collectively form the backbone of sustainable finance. While Green Bonds dominate climate financing, Blue Bonds address critical marine and water-related challenges, and Sustainability Bonds integrate social and environmental development goals. This comparative study concludes that enhancing governance, standardization, and transparency is crucial for maximizing the effectiveness of these instruments. A coordinated strategy among policymakers, financial institutions, and issuers can significantly accelerate progress toward global SDGs.

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