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Green bonds and impact investing as financing mechanisms for the circular economy

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Abstract

The transition to a circular economy is increasingly recognized as a strategic pathway for addressing environmental degradation, resource scarcity, and climate change. However, the financing of circular economy projects remains a major constraint due to high capital requirements and perceived investment risks. This study examines green bonds and impact investing as alternative financing mechanisms for supporting circular economy initiatives. Using a qualitative review of secondary data from international institutions, market reports, and selected case studies, the paper analyzes market trends, investment scope, and key challenges associated with these instruments. The findings indicate that green bonds and impact investing play a growing role in mobilizing capital for circular economy projects, particularly in waste management, renewable energy, and sustainable infrastructure. Nonetheless, issues such as greenwashing, lack of standardized reporting frameworks, and transaction costs continue to limit their effectiveness. The study contributes to the literature on sustainable finance by highlighting policy and market measures needed to scale green financing for circular economic transformation.

Keywords: Circular economy; Green bonds; Impact investing; Sustainable finance; ESG

1. Introduction

The global economy faces significant environmental and resource-related challenges due to increasing waste generation, climate change, and unsustainable production and consumption patterns [1]. Global material use has more than tripled since 1970 and is projected to double by 2060 if current trends persist [2]. Similarly, global municipal solid waste generation exceeds two billion tons annually and is expected to rise substantially by mid-century [5, 1].

In response, the circular economy has emerged as an alternative economic model emphasizing resource efficiency, waste reduction, recycling, and regenerative production systems [6]. While its environmental and social benefits are well documented, financing remains a critical barrier to implementation, as many circular economy projects require high upfront capital investment and involve longer payback periods [6, 1].

Sustainable finance instruments, particularly green bonds and impact investing, have gained prominence in mobilizing capital toward environmentally beneficial projects. Global green bond issuance exceeded USD 500 billion in recent years, while impact investing assets under management have surpassed USD 1.5 trillion worldwide [3, 4]. This study explores the role of these financing mechanisms in supporting circular economy initiatives and identifies key challenges and policy implications.

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2. Literature Review

2.1. Circular Economy and Financing Challenges

The circular economy aims to decouple economic growth from resource consumption by promoting reuse, recycling, and sustainable product design [5]. Adoption of circular practices is linked to improved resource efficiency, reduced environmental impact, and long-term economic resilience [6].

Despite its promise, the transition to circular practices faces significant financing challenges, including limited access to affordable capital for innovative technologies, uncertainty regarding financial returns, inadequate policy support, and risk perception by mainstream investors due to project complexity and longer payback periods [6, 1, 7]. Policy incentives and blended finance models can mobilize private capital, particularly in developing economies where traditional financing is often unavailable [1, 2, 7].

2.2. Green Bonds

Green bonds are fixed-income instruments whose proceeds are earmarked for environmentally sustainable projects, including renewable energy, energy efficiency, waste management, and sustainable infrastructure [7, 8, 3].

Empirical studies suggest that green bonds lower the cost of capital for issuers by attracting ESG-focused investors, enhance corporate reputation, promote transparency, and influence corporate decision-making toward long-term sustainability goals [7, 8, 3].

However, challenges include greenwashing risks, inconsistent impact reporting, and high issuance costs, which may limit investor confidence and market scalability (Wikipedia, n.d.; Financial Times, 2024). Standardized frameworks and international taxonomies are recommended to improve market integrity and ensure green bonds contribute effectively to sustainable development [13, 33].

2.3. Impact Investing

Impact investing refers to investments intended to generate positive social and environmental impacts alongside financial returns [9, 4]. Unlike traditional investments, impact investing integrates sustainability metrics into portfolio management and decision-making.

Studies indicate that impact investing can influence corporate and governmental behavior toward sustainable practices, promote long-term value creation, catalyze innovation in circular technologies and business models, and engage private and institutional investors in funding transformative projects [9, 4, 5].

Challenges include heterogeneous measurement approaches, limited standardized reporting, and longer investment horizons, which can complicate performance evaluation and investor participation (Global Impact Investing Network, 2023; Wikipedia, n.d.).

2.4. Research Gap

While green bonds and impact investing have been studied extensively independently, there is limited research on their combined role in financing circular economy initiatives. Existing literature rarely explores how these mechanisms can complement each other, leverage different risk-return profiles, and collectively scale capital toward circular projects.

This paper addresses this gap by:

- Integrating analysis of green bonds and impact investing within a circular economy context
- Highlighting synergies, limitations, and best practices for mobilizing sustainable finance
- Providing case-based evidence of practical applications and policy implications

The study thus contributes to the literature by offering a holistic perspective on sustainable finance instruments, bridging the gap between theory and practice, and informing both policymakers and investors seeking to accelerate circular economy adoption.

3. Research Methodology

3.1. Research Design

This study adopts a qualitative research design. The approach focuses on systematic review and analysis of secondary data to understand the role of green bonds and impact investing in financing circular economy projects. A descriptive and exploratory framework is applied to integrate existing market data, institutional reports, and case studies, providing insights into trends, challenges, and policy implications in sustainable finance.

3.2. Population and Sampling

Given the secondary nature of the research, the population comprises documents, reports, and market data related to green finance and circular economy initiatives. This includes:

- Publications from international organizations such as the World Bank, OECD, and UN
- Market data from the Climate Bonds Initiative
- Reports and publications from financial institutions, regulators, and investment funds
- Media reports and case studies on specific green bond issuances and impact investment funds

Sampling was purposive and criterion-based, selecting documents and reports that:

- Focus on green bonds or impact investing
- Include quantitative data or market trends relevant to circular economy projects
- Provide recent or landmark case studies demonstrating practical application

3.3. Data Collection

Data collection was conducted entirely from secondary sources, using publicly available documents, databases, and reports. The researcher systematically reviewed and extracted relevant information on:

- Volume and growth of green bond markets
- Trends and scale of impact investing in sustainability initiatives
- Case studies illustrating circular economy projects funded through green finance
- Regulatory frameworks and reporting standards influencing green finance

3.4. Data Analysis

Data analysis was conducted using qualitative content analysis, focusing on identifying patterns, trends, and thematic insights across multiple sources. The process included:

- Synthesizing market data to highlight growth, issuance volumes, and sectoral allocation of green bonds and impact investing
- Thematic categorization of challenges and policy implications (e.g., greenwashing, standardization, transaction costs)
- Integrating case studies to provide real-world examples of financing circular economy initiatives

Findings were presented descriptively and narratively, supported by quantitative figures where available, to demonstrate the practical significance and policy relevance of green bonds and impact investing for circular economy projects.

4. Green Bonds and the Circular Economy

Green bonds have emerged as a critical financing instrument for promoting environmentally sustainable projects. By earmarking proceeds specifically for green initiatives, issuers gain access to investors focused on ESG-aligned opportunities, while signaling organizational commitment to sustainability objectives. Green bonds bridge the gap between financial returns and environmental impact, providing long-term capital for projects that might otherwise struggle to secure traditional funding.

4.1. Key Applications in the Circular Economy

- Waste Management and Recycling Facilities – Financing for state-of-the-art recycling plants, waste-to-energy projects, and municipal waste reduction programs.
- Renewable Energy Systems – Solar, wind, and biomass energy projects that replace fossil-fuel-based production.
- Sustainable Buildings and Infrastructure – Funding green construction projects that maximize energy efficiency, water conservation, and circular resource flows.
- Water and Wastewater Management – Infrastructure projects promoting water reuse, efficient water treatment, and resource recovery.
- Circular Supply Chains – Investments in technologies that extend product lifecycles, reduce raw material consumption, and enable closed-loop manufacturing.

4.2. Market Trends

The global green bond market has experienced exponential growth over the past decade. According to the Climate Bonds Initiative, issuance reached USD 522 billion in 2021, a 75% increase from the previous year, with 839 new issuers entering the market. The average bond size also grew to approximately USD 250 million, reflecting the increasing scale of sustainable finance projects. Notably, governments, multilateral development banks, and private corporations have all utilized green bonds, signaling a shift in capital allocation toward sustainability-focused investments.

4.3. Benefits and Challenges

Benefits:

- Lower cost of capital for issuers in some markets
- Attracts a broader pool of investors committed to ESG goals
- Enhances corporate reputation and transparency

Challenges:

- Potential for greenwashing if projects are not independently verified
- Complex reporting and certification requirements increase transaction costs
- Market fragmentation and lack of global standardisation limit comparability and investor confidence

4.4. Case Study: Climate Investment Funds (CIF)

The Climate Investment Funds' Capital Markets Mechanism (CCMM) issued a USD 500 million green bond, specifically aimed at climate-related infrastructure in developing economies. Investor demand exceeded USD 3 billion, highlighting the market appetite for large-scale, sustainable finance initiatives. The projects financed include renewable energy installations, water treatment plants, and municipal recycling programs, demonstrating the practical impact of green bonds on circular economy outcomes [10].

5. Impact Investing and Circular Economy Development

Impact investing complements green bond financing by channeling capital toward projects with measurable social and environmental outcomes alongside financial returns. While green bonds primarily finance specific projects, impact investing allows for more flexible capital deployment across a portfolio of initiatives, targeting long-term circular economy transformations.

5.1. Key Applications in the Circular Economy

- Waste Reduction Technologies – Funding innovative recycling processes, biodegradable materials, and circular packaging solutions
- Sustainable Supply Chains – Supporting companies that implement closed-loop logistics, reduce material waste, and integrate remanufacturing
- Regenerative Agriculture – Promoting soil health, sustainable land use, and organic farming systems
- Clean Energy and Transport – Investment in electric mobility, microgrid development, and renewable energy distribution networks

5.2. Market Trends

Global impact investing assets have grown rapidly, reaching over USD 1.5 trillion, driven by institutional investors, sovereign wealth funds, and private equity firms incorporating ESG metrics into investment decisions [4]. Annual growth rates of approximately 21% since 2019 highlight the expanding scale and investor appetite for sustainable projects. Millennials and Gen Z are driving demand for impact-aligned financial products, influencing corporate and governmental adoption of circular economy practices.

5.3. Benefits and Challenges

Benefits:

- Encourages businesses to integrate sustainability into core strategy
- Provides flexible capital for early-stage or innovative circular economy projects
- Generates measurable social and environmental impact alongside financial return

Challenges:

- High variability in measurement of outcomes across sectors
- Risk of overstated impact claims due to lack of standardized verification
- Investment horizon may be longer than conventional financing, potentially limiting investor participation

5.4. Case Study: Australia's Circular Future Fund

The Circular Future Fund in Australia, backed by Boston Global, plans to mobilize USD 1 billion by 2030 to finance projects that reduce waste, lower carbon emissions, and promote circular economy principles. Investments include recycling infrastructure, sustainable manufacturing, and waste-to-energy projects. This fund demonstrates how impact investing can accelerate national adoption of circular economy practices, mobilizing private and institutional capital toward measurable environmental outcomes [11].

Table 1 Comparison of Green Bonds and Impact Investing in Financing the Circular Economy

Feature	Green Bonds	Impact Investing
Definition	Debt instruments where proceeds are earmarked for environmentally sustainable projects	Investments intended to generate positive social/environmental impact alongside financial returns
Investment Structure	Fixed-income; repayment and interest guaranteed	Equity, debt, or hybrid; returns vary by performance
Typical Projects	Renewable energy, energy-efficient infrastructure, waste management, sustainable buildings	Waste reduction technologies, regenerative agriculture, sustainable supply chains, clean energy & transport
Target Investors	Institutional investors, development banks, sovereign/municipal issuers	Institutional investors, impact funds, private equity, HNWI's
Capital Scale	Large-scale, often hundreds of millions USD per issuance	Flexible—from seed to multi-million funds
Risk Profile	Issuer credit risk; generally lower variability	Higher variability; outcome and execution dependent
Impact Measurement	Project-level allocation & reporting (ICMA/TCFD aligned) [17, 20]	Portfolio/enterprise metrics (ESG/SDG aligned) [4, 34]
Advantages	Predictable returns; strong ESG demand; transparency	Catalyzes innovation; aligns finance with outcomes; flexibility
Challenges	Greenwashing risk; certification/reporting costs; fragmentation	Consistent impact measurement; longer horizons

Role in Circular Economy	Funds enabling infrastructure (recycling, water reuse, buildings)	Funds innovation and scaling across sectors
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5.5. Challenges in Green Finance for the Circular Economy

Despite their growth, green bonds and impact investing face several challenges:

- **Greenwashing:** Inconsistent definitions and verification standards allow some issuers to label financial instruments as green without delivering substantial environmental benefits
- **Lack of Standardization:** Divergent taxonomies and disclosure frameworks hinder comparability and cross-border investment [13].
- **High Transaction Costs:** Reporting and certification requirements increase issuance costs relative to traditional debt instruments.
- **Financial Risk:** Green-labeled issuers remain subject to conventional credit and market risks, which may affect investor confidence [14].

6. Policy Implications and Future Research

6.1. Policy Implications

The growth of green bonds and impact investing as financing mechanisms for the circular economy highlights the need for robust policy frameworks to ensure transparency, credibility, and scalability. Policymakers and regulators can take several key actions:

- **Strengthening Sustainability Disclosure Requirements** - Transparent reporting is critical to prevent greenwashing and enhance investor confidence. Governments and regulatory authorities should mandate standardized ESG reporting. Frameworks such as the EU Sustainable Finance Taxonomy, the Task Force on Climate-related Financial Disclosures (TCFD), and the International Capital Market Association (ICMA) Green Bond Principles serve as models for consistent and verifiable disclosure standards (ICMA; TCFD).
- **Harmonizing Green Finance Taxonomies** - Divergent definitions of “green” create confusion and limit cross-border investment; harmonization reduces costs and improves comparability.
- **Promoting Blended Finance Structures** - Public, private, and philanthropic capital can be combined to de-risk circular projects and crowd-in mainstream investors.
- **Incentivizing Innovation** - Policies that encourage R&D in circular technologies (tax credits, subsidies, concessional loans) can complement green finance instruments.
- **Capacity Building and Investor Education** - Improve literacy around ESG and impact measurement so investors can evaluate opportunities and demand accountability.

6.2. Future Research Directions

While qualitative reviews provide valuable insights, there is a need for quantitative and empirical research to strengthen the evidence base around green finance and impact investing in the circular economy:

- **Financial Performance Analysis** - Compare risk-adjusted returns of green bonds and impact investments to conventional instruments (yields, default, liquidity).
- **Environmental and Social Impact Measurement** - Develop standardized metrics and conduct longitudinal studies on carbon reduction, resource efficiency, and waste diversion.
- **Sectoral and Regional Comparisons** - Identify contexts where specific mechanisms are most effective (e.g., waste management vs. renewable energy; developed vs. developing).
- **Technology and Data** - Leverage digital platforms, blockchain, and AI for tracking, verification, and portfolio optimization.
- **Behavioral and Institutional Studies** - Understand investor behavior, corporate decision-making, and regulatory compliance to scale green finance.

6.3. Summary

Strengthened policy frameworks, harmonized taxonomies, blended finance structures, and investor education are essential to unlocking the full potential of green bonds and impact investing. Rigorous empirical research is required to

evaluate financial performance and real-world impact, ensuring sustainable finance becomes a reliable, scalable driver of circular economy adoption globally.

7. Conclusion

Green bonds and impact investing have emerged as critical drivers of sustainable finance, offering innovative solutions to financing circular economy initiatives. By channeling capital toward projects that reduce waste, promote renewable energy, and encourage resource efficiency, these instruments support environmental objectives and create economic opportunities and resilience.

Both mechanisms complement each other: green bonds provide large-scale, predictable funding for infrastructure and technology projects, while impact investing enables flexible, outcome-focused financing for innovative initiatives. Together, they offer a holistic approach to mobilizing capital in support of circular economy principles.

Significant challenges remain, including greenwashing, inconsistent reporting standards, high transaction costs, and varying financial risks. Addressing these requires coordinated efforts by regulators, investors, and issuers - enhancing transparency, harmonizing taxonomies, and advancing risk management frameworks. Technology (data analytics, blockchain, digital reporting) can improve monitoring, verification, and accountability to ensure financial flows deliver genuine outcomes.

Policy alignment and investor engagement are crucial. Supportive regulations, blended finance structures, and capacity building can scale sustainable finance. Institutional and impact-oriented investors play a pivotal role in fostering corporate adoption of circular practices and scaling transformative projects globally.

Further empirical research should evaluate financial performance, measure environmental and social impacts, and identify sectoral/ regional conditions where instruments are most effective - evidence essential to accelerate the circular transition.

In sum, green bonds and impact investing are indispensable catalysts for sustainability. With coordinated action, these instruments can reshape industries and drive systemic transformation toward a resilient, resource-efficient global economy.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflicts of interest related to this manuscript.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study

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