

Promoting Sustainable Investment Through Designing and Pricing Green Financial Derivatives

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Abstract. As climate change and environmental degradation escalate, the financial sector faces growing pressure to adopt sustainable practices. This paper examines designing and pricing of green financial derivatives and their role in promoting sustainable investment. Through references review and case studies, the study assesses the influence of regulatory frameworks like the EU's EIA Directive on the environmental integrity of green derivatives. The findings emphasize the crucial role of EIAs in ensuring that green financial products meet sustainability goals and highlight the increasing importance of ESG derivatives. However, the effectiveness of these derivatives is hindered by challenges such as their synthetic nature, lack of direct ownership of underlying assets, and complexities in ESG reporting. The study also identifies the need for traditional pricing models to evolve by incorporating sustainability factors, with advanced data analytics and technologies. In conclusion, robust regulatory frameworks, effective market incentives, and improved investor education are essential for promoting sustainable investment. Additionally, it is significant for public-private collaboration to scale sustainable finance initiatives and the integration of ESG criteria into financial decision-making to achieve both financial and sustainability objectives.

Keywords: Sustainable Investment, Regulation, Incentives.

1. Introduction

As climate change and environmental degradation become more pressing global issues, innovative solutions that combine fiscal incentives with sustainable outcomes are increasingly needed. Traditional financial derivatives often neglect long-term environmental risks and climate change impacts due to imperfect investment standards and lack of performance disclosure. Therefore, sustainable investment and green finance have become key strategies to address these challenges in which sustainable investment involves incorporating environmental, social and governance (ESG) criteria into investment decisions, while green finance specifically targets financial instruments and strategies that support projects that are beneficial to the environment.

Integrating sustainability into financial markets is crucial to ensure that economic activities contribute to the well-being of the planet. By developing green financial derivatives and pricing them accurately, companies can attract a large amount of capital to projects that reduce environmental impacts and promote sustainable development. This strategy not only supports the transition to a low-carbon economy, but also improves market efficiency and provides investors with tools to protect against environmental risks. As the integration of ESG standards into financial decision-making becomes increasingly important in society, green financial derivatives integrate these principles into financial markets, promote corporate responsibility, contribute to global efforts to combat climate change, and gradually become an important mechanism to support climate change.

This paper introduces the design and pricing of green financial derivatives, aiming to gain a comprehensive understanding of how these instruments can be effectively used to achieve sustainable financial and environmental performance. The scope of this paper includes an overview of different types of green financial derivatives, including green bonds, green options, carbon gifts, and carbon emission credits. Besides, the paper demonstrates the main challenges associated with derivative pricing, including market inefficiencies, lack of historical data, and the need for a strong regulatory framework.

In this paper, we delve into the opportunities and barriers in the emerging field of green financial derivatives, aiming to contribute to the ongoing debate in sustainable finance and highlighting the potential of green financial derivatives in promoting meaningful environmental change. Through a comprehensive analysis of the design, pricing, and regulatory aspects of these derivatives, we seek to offer profound insights that are indispensable for policymakers, investors, and financial institutions. These insights are important for shaping strategies and policies that support the achievement of sustainability.

2. Integrated Standards for Green Financial Derivatives

2.1. Importance of Environmental Impact Assessment

Designing green financial derivatives involves comprehensive initiating criteria to guarantee environmental integrity and sustainability. Global regulatory frameworks indicate that green derivatives standards are closely linked to the Environmental Impact Assessment (EIA) process. For example, in the EU, green derivatives must adhere to rigorous environmental standards, including a comprehensive Environmental Impact Assessment to assess environmental impacts prior to financial projects being approved. The EIA Directive, codified in Directive 2011/92/EU and subsequently amended, mandates that compliant EIAs should cover key areas such as project description, environmental impacts, and mitigation measures [1]. For instance, green bonds and other derivatives are required to undergo EIA to evaluate their potential impacts on air, water quality, soil, and biodiversity, ensuring that they meet sustainability goals by mitigating adverse impacts and promoting environmental management for sustainable development. Alignment with sustainability goals is crucial to ensuring compliance with international standards, such as Goal 9 (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation), Goal 11 (Make cities and human settlements inclusive, safe, resilient and sustainable), and Goal 13 (Take urgent action to combat climate change and its impacts) from UN Sustainable Development Goals [2]. These goals emphasize the importance of environmental considerations in financial activities, and rigorous Environmental Impact Assessments will play a key role in achieving these goals by guiding their design and implementation of green financial derivatives. Additionally, the Environmental Impact Assessment process also includes public participation and decision-making records that meet the transparency and accountability standards of green derivatives. By incorporating Environmental Impact Assessments findings into the design of green financial products, these instruments go beyond simply providing a green label but genuinely contribute to environmental sustainability, thereby achieving both financial and sustainable development goals. Overall, Environmental Impact Assessments around the world establish a strong foundation for the creation of green bonds, green options, carbon futures, and carbon credits, as well as other innovative derivatives.

3. Role of ESG Factors in Sustainable Investment

In recent years, the financial industry has witnessed a significant shift towards sustainable development and responsible investment. These changes are reflected in companies adopting sustainability frameworks that include key performance indicators (KPIs) related to environmental, social and governance (ESG) factors [3]. These KPIs are the basis for structuring financial products that are explicitly linked to sustainability goals and giving rise to ESG derivatives.

3.1. Adoption of ESG Criteria in Financial Products

The first trading of sustainability-related derivatives began in 2019, signaling a growing demand for financial products that incentivize ESG performance. Since then, market participants have engaged in a variety of ESG-related derivatives and products. This reflects the growing importance of integrating sustainability considerations into financial markets [3]. For instance, UBS Global

Wealth Management has made a significant case for integrating sustainability and ESG criteria into investment products, particularly using equity index futures in multi-asset portfolios [4]. The motivation for harmonizing these criteria is to optimize portfolios for sustainable outcomes while maintaining comparable risk-adjusted financial returns, rather than viewing sustainable investing as a distinct asset class. The strategy offers the efficiency and flexibility of using derivatives such as equity index futures to adjust exposure to the underlying asset without having to convert the securities directly into cash, allowing a more sustainability-focused strategy to be effectively implemented.

3.2. Challenges and Opportunities in ESG-Integration

However, problems arise due to the synthetic nature of derivatives, the lack of direct ownership of the underlying assets, and the potential complexity that private investors perceive as missed opportunities to directly impact environmental and social issues [4]. To address these challenges, it is necessary to consider criteria such as the underlying assets and structure, issuer profile, the use of proceeds, the intention to identify sustainable development goals, and the potential to generate financial returns when using derivatives in a portfolio assessment. Derivatives are included in ESG reports, with a focus on indicators such as ESG scores and transparency in reporting controversial activities, although they are not directly related to the reported sustainable development goals. Despite derivatives having limited direct impacts, they can support finance sustainable development-related projects, increase confidence in sustainable portfolios, and contribute to broader capital flows into sustainable investments, especially when combined with inflows from structured debt instruments. Overall, derivatives play a pivotal role in diversifying and enhancing the investment toolkit of sustainable portfolios.

4. Market Inefficiencies and Pricing Challenges

4.1. Market Anomalies and Behavioral Finance

There are various challenges to pricing green financial derivatives, one of which is market inefficiency. According to the Efficient Market Hypothesis (EMH), security prices should reflect all available information, theoretically eliminating any yield differential between Green Bonds (GBs) and Conventional Bonds (CBs) [5]. However, the existence of a negative GB premium, where GBs trade at lower yields, casts doubt on this assumption and suggests that there are anomalies in the market. These discrepancies are often driven by investors' sustainability preferences or other non-financial motivations that may influence price trends, such as environmental awareness. Behavioral finance theory reveals that investors are not always rational and may be swayed by emotions and social goals, leading to market irregularities. External economic developments, such as the European Central Bank's (ECB) response to COVID-19 through the Pandemic Emergency Purchase Programme (PEPP), will further underscore the impact of policy interventions on market efficiency and financial instrument prices. These interventions had a positive effect on bond liquidity and lower yields, reflecting the impact of regulatory actions on market trends. However, the volatility of the pandemic also highlighted certain risk factors associated with green projects and their impact on the stability and accuracy of green financial derivative prices.

4.2. Data Limitations and Transparency Issues

Another major challenge in the pricing of green financial derivatives is the scarcity of historical data and benchmarks. The availability of detailed and reliable data plays a crucial role in certifying the environmental impact of financial products. However, the current situation is challenging due to limited data quality and accessibility. Companies often have incentives to disclose information selectively, which can potentially result in incomplete or biased data that obscures the true greenness of investments [6]. This situation underscores the need for greater transparency and standardization in sustainability reporting. However, technological advances offer promising solutions by improving data collection methods and enabling real-time monitoring, thereby increasing market efficiency and

investor confidence in green financial products. Ongoing efforts by regulators and industry stakeholders to improve data availability and reliability are important steps to ensure the integrity and accuracy of pricing for green financial derivatives.

5. Advanced Pricing Models and Risk Management

5.1. Incorporating ESG Factors into Pricing Models

In today's investment environment, it is imperative to modify existing pricing models to incorporate sustainability factors. As ESG considerations become increasingly important, investors are seeking comprehensive assessments that reflect the true value of companies, including their impact on sustainability. By integrating ESG criteria into their pricing models, investors can make more informed decisions that are more aligned with their values and can address risks and opportunities in an evolving market that is increasingly impacted by regulatory changes and ESG reporting standards. These modifications are essential to making accurate strategic and valuation investment decisions for a sustainable future. For example, the Black-Scholes model revolutionized the way options are priced and risk managed. Combining the principles of geometric Brownian motion and risk-neutral probability, the formula provides a solid groundwork for option valuation and the comprehensive evaluation of price dynamics of a wide range of financial derivatives and insurance products. As the financial environment continues to evolve to embrace sustainable practices, there is growing interest in incorporating ESG factors into financial models [7]. This integration represents a modern approach to risk management that enhances traditional risk measures by considering sustainability and ethical governance. In this case, ESG scores that assess companies based on their environmental impact, social responsibility, and governance practices can be incorporated into the Black-Scholes model to provide a more comprehensive view of risk. For instance, companies with high ESG scores may be considered lower risk profiles due to their proactive approach to environmental sustainability, strong social commitments, and robust governance structures. By incorporating ESG indicators into pricing frameworks, investors and financial institutions can make more informed decisions that are aligned with the sustainability goals and responsible investment principles. Such integration not only improves risk assessment, but also contributes to driving positive environmental and social outcomes for the financial ecosystem.

5.2. Environmental Risks in Pricing and Risk Management

Furthermore, pricing green financial derivatives is intricately linked to risk management as it involves assessing and incorporating environmental risks into pricing models, ensuring that the pricing accurately reflects the associated risks and promoting informed decision-making to mitigate potential financial and sustainability risks. These risks encompass physical risks from climate change, transitional risks related to shifts in policies or technologies, and financial stability risks stemming from inadequate management of sustainability issues [8]. Neglecting these risks could lead to misallocation of capital, market inefficiencies, and threats to financial stability. To mitigate these risks effectively, robust risk management practices are essential [8]. This involves thorough assessment and monitoring of environmental risks, integration of sustainability factors into risk models, stress testing for climate-related scenarios, and diversification of portfolios to reduce exposure. Additionally, collaboration with industry experts, leveraging advanced analytics and data, and ensuring transparency in reporting and disclosures are critical components of a comprehensive risk management strategy in the context of green derivatives. By adopting such strategies, financial institutions can enhance resilience, protect against ESG risks, and contribute to sustainable growth and a greener transition in the financial sector [8].

The future of pricing of green financial derivatives holds both great promise and challenges. As ESG considerations become increasingly important, pricing models are likely to become more sophisticated through the integration of emerging technologies such as advanced data analytics, blockchain, and artificial intelligence. However, issues such as scarcity of data, non-financial biases,

and the need for a standardized reporting framework remain and require further research. Key areas for improvement encompass developing widely accepted sustainability indicators, incorporating new technologies into traditional pricing models, and understanding investor behavior on ESG factors. Collaboration between academia, industry, and regulators is essential to driving innovation in green finance and strengthening risk management practices.

6. Regulatory Frameworks and Market Incentives

6.1. EU Green Deal and Sustainable Growth

Promoting sustainable investment requires a comprehensive approach, including a strong regulatory framework, effective market incentives, and investor education and awareness. Currently, existing regulations and policies play an important role in promoting green finance. For example, the European Union has made significant progress in promoting sustainable development through initiatives such as the European Green Deal. This ambitious plan aims to transform the EU into a fair and prosperous society with a modern and resource-efficient economy where there are no net emission of greenhouse gas by 2050 [9]. The Green Deal emphasizes decoupling economic growth from resource use and promoting transition to new and renewable energy, secondary raw materials, and clean energy. It also includes a comprehensive strategy, including a new circular economy action plan, the smart integration of renewables, and a sustainable products policy, all of which are designed to foster a cleaner, more circular bioeconomy. These efforts reflect the EU's commitment to sustainable and inclusive growth, supporting sectoral transformation, and setting global standards for environmental and climate goals. However, despite these efforts, important gaps persist that need to be addressed in order to achieve true sustainability. Critics such as Kambites and Kopnina argue that the concept of sustainable development often adapts to dominant political rhetoric and avoids the drastic measures needed to truly protect the environment. In the context of the global economic system, the idea that economic growth can be decoupled from natural resource consumption is highly questionable. The inherent contradiction between economic expansion and ecological sustainability is often obscured by the frequent use of terms such as “sustainable growth” and “inclusive growth” in the Green New Deal. The EU strategy also emphasizes the importance of the financial system supporting sustainable growth, while calling for substantial upfront investments and carefully designed tax reforms to build resilience to climate change shocks. Filling this gap requires stronger regulatory frameworks and greater international cooperation to ensure that global green finance initiatives fully and effectively address their underlying structural problems. In addition, the implementation of various strategies focused on financial incentives can profoundly influence market dynamics, encouraging sustainable practices and even facilitating sustainable investing. To be specific, a key approach is through the utilization of green bonds and loans, which are financial instruments specifically designed to finance projects that have a positive impact on the environment. By expanding and improving access to green bonds and green loans, investors will be incentivized to allocate their capital to environmentally beneficial initiatives, thereby driving sustainable investing [10].

6.2. Government Incentives and Public-Private Partnerships

More significantly, governments also play a vital role in incentivizing sustainable investment by directly supporting green projects through subsidies. These subsidies, which may come in the form of grants, low-interest loans or tax credits linked to sustainable initiatives, help ease the financial burden on investors and make environmentally friendly projects more viable and economically attractive. Additionally, governments can extend support by offering tax breaks or exemptions to companies that substantially contribute to environmental sustainability. This not only encourages businesses to prioritize green practices, but also creates a culture of corporate environmental responsibility.

Furthermore, collaboration between the public and private sectors is essential for the success and scalability of sustainable investment initiatives. Public-private partnerships can facilitate the creation of innovative financing mechanisms such as green investment funds and sustainability-focused venture capital initiatives. These partnerships not only bring together diverse expertise and resources but also enable crucial activities like knowledge sharing, capacity building, and technology transfer, which are fundamental for advancing sustainable investment on a larger scale.

An integrated approach to closing the gap and promoting sustainable investments requires enhancing regulatory frameworks and leveraging fiscal incentives. Through stronger regulation, governments can encourage sustainable practices across industries and compensate for environmentally responsible behavior, while setting clear standards and penalties for non-compliance. These combinations of economic incentives and environmental goals are key to driving market action toward sustainable development and fostering a thriving and resilient economy that prioritizes environmental awareness. Ultimately, by working collaboratively across sectors and aligning policies with sustainable development objectives, policymakers can drive market behavior towards sustainability and create a more resilient and environmentally conscious economy.

7. Conclusion

In summary, incorporating environmental impact assessment (EIA) into the design of green financial derivatives can ensure that these products truly contribute to environmental sustainability. Green financial derivatives (including green bonds, options and carbon credits) are required to undergo a thorough environmental assessment in accordance with the rigorous regulatory framework and sustainable development standards set out in the EU EIA Directive 2011/92/EU. This process guarantees the integrity of sustainable development goals and adherence to international standards, such as the UN Sustainable Development Goals (SDGs). Furthermore, incorporating ESG criteria into traditional pricing models can enhance risk assessment, promote informed investment decisions, and address market inefficiencies and lack of reliable data.

The importance of this study lies in its potential to advance the transformation of the financial industry towards sustainable development and responsible investment. The survey provides a comprehensive framework for integrating sustainability considerations into financial products, providing companies and investors with valuable insights to align their portfolios with environmental, social and governance (ESG) goals. The adoption of green financial derivatives and the incorporation of ESG criteria into pricing models not only supports sustainable investment, but also enhances environmental and social performance. Moreover, the research highlights the importance of regulatory frameworks, market incentives, and investor education in promoting sustainable finance, ultimately contributing to the growth and resilience of the industry.

However, one of the limitations of this study is that it relies on secondary data and may not fully capture the nuances and real-time dynamics of the market. Future research could address these limitations by incorporating primary data through surveys, interviews, and case studies in order to provide a more comprehensive and reliable understanding of market behavior and investor preferences. In addition, further research could explore incorporating emerging technologies such as advanced data analytics, blockchain, and artificial intelligence into green financial derivative pricing models. These technologies would improve the quality and accessibility of data, enhance market efficiency and investor confidence, drive innovation, and strengthen risk management practices in sustainable finance.

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