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The Intersection of Forensic Finance and Green Bonds

1. Introduction to Forensic Finance and Green Bonds

Numerous instances of abuse have been uncovered due to the rising interest in green bonds and investments in green finance. The term "green bond" or "green financial instrument" is used interchangeably with "green bond" to indicate financial instruments earmarked for environmentally friendly investments. In 2007, the European Investment Bank issued the first green bond that attracted global attention. Afterwards, the market for green bonds saw tremendous growth by establishing different indices for green investments. A green bond aims to promote the climate or environmental qualities of investment projects or assets. Following this belief, a principle paper titled Green Bond Principles (GBPs) has been published to ensure the credibility of green investments. Among the provided principles, "Use of Proceeds" is stated as "an issuer should communicate to investors the environmental sustainability objectives of the project," and "Reporting" is stated as "the issuer should, to the extent possible, provide annual reports that include a list of the projects to which the proceeds have been allocated, as well as a brief description of the projects and the amounts allocated, and the expected impact." Following this guideline, though different institutions, organisations, and governments in various countries have provided their definitions of "green" financial instruments, no clear definition of "green" has been adopted. In other words, to be labelled as "green," a financial instrument should be used for green purposes and should provide strong evidence that this "green" investment has been made on that proposed asset. Otherwise, these instruments' financial sustainability and purpose-investment fraud might pose increasing challenges to continuing market growth and credibility when green investments or share prices go wrong. Therefore, it was deemed urgent to study how properly managing and documenting green bond investments would improve the integrity and credibility of green financial assets and instruments.

2. The Need for Transparency and Accountability in Green Finance

Green finance, in general terms, refers to investments that foster sustainable development or reduce emissions. As such, these funds play a crucial role in the transition toward clean energy and other environmentally friendly investments. However, many issues related to transparency and accountability in green finance. Due to the liberal nature of the market system, numerous products claim to be environmentally friendly or "green" that are not. As such, there are many greenwashing allegations against various entities that claim to be environmentally friendly when they are not at all. This does not imply that all such products and services are bogus but that there is enough danger that a comprehensive investigation must be undertaken. Over the last few years, there has been some desire and demand for investment firms, or anyone involved in claiming to be socially responsible and creating impact, to adopt accountability standards that reflect these desires.

The main objective is to explore the intersection of forensic finance and green bonds. Green bonds are bonds issued to fund sustainable projects and, at the same time, are also a new form of financing and investment opportunity for entities. With such a new type of entity present in the current financial system, the question remains about the involvement of forensic finance in ensuring that no fraud is occurring. The benefits of the secondary market of such financial products must be weighed against the need for rigorous investigations of how such funds are being used and if they are being used as intended. In addition, guidelines and financial models need to be proposed showing how forensic analysis can be undertaken when clear motives and intentions are not defined and when expectations of profits are only indirectly implied instead of stated.

As climate change becomes more pressing, a growing effort has been made to fund environmentally conscious projects. One way of financing such endeavours has been the issuance of green bonds by companies, states, municipalities, etc. As a newer type of financial product, green bonds have many questions surrounding them, primarily concerning the legitimacy of whether such bonds are being used to fund green projects. Green bonds are issued with the intention of sustainable financing projects and hopefully have a positive net environmental impact. In addition to that, and in the aftermath of the financial crisis, an increasing number of entities are being requested to submit outside investigations and work to guarantee the accuracy of the firm's accounts.

3. Key Concepts in Forensic Finance

Forensic finance captures the intersection of business and law. Specifically, it refers to the discipline that investigates financial fraud and offences. As a technique used in financial audits, forensic finance offers an assessment and investment methodology based on the historical nuances of securities, business economics, and financing.

Qualitative analysis, or investigative analysis of the financial statements, may start with the financial statements or other public information available concerning the target company and determine some dimensions for testing (the "keys," "indicators," or "measures"). Financial statement variables are transformed into a highlight or "index" to make deviations from normality more visible. The "indices" should be chosen carefully so that they are sensitive but not too sensitive, easily interpretable, and not manipulated or easily manipulable by the management of the target company via their open economic and financial policy.

The Red Flags of Fraud are simultaneously ratios defined by proportions that can be traced easily in the financial statements, and the deviations from the limit may indicate opportunities for fraud. The Red Flags of Fraud consists of fifteen ratios from eight factors influencing fraud opportunities. The groups of factors are asset growth, revenue growth, profitability, profitability volatility, changes in management, contingent liabilities of the company, revenues of the company recognised compared with cash, and pre-audit experience of the company, etc.

The Income Statement analysis utilises the Income Statement of the target company as a resource for dimensions for financial performance transparency evaluation. The cash-flow-based dimension enables the assessment of revenue and expense recognition compliance on an accrual basis. The Adjusted Net Income/Net Income ratio measures the reliability of net income based on the analysis of the financial statement. All adjusted revenues are verified against the cash flows from operations over two years. The sum of adjusted revenues is compared to adjusted net income, adding interests, taxes, depreciation, and amortisation, all being non-anecdotal, using the cash flows from operations as a check. The Financial Statement Assertions analysis captures the check of the individual assertions of the financial statement on information accuracy, completeness, and relevance concerning fraud prevention monitoring using generally accepted accounting principles.

3.1. Financial Statement Analysis

Financial statement analysis involves studying possible discrepancies between the business activities of debtors and their financial statements, usually to preserve a significant investment. The analysis can take several forms, including fundamental analysis, forensic accounting, etc. Forensic accounting looks for evidence of fraud and conspiracy, whether within companies, industries, or specific groups, and can involve the study of complex ownership, debt, and cash flows, as well as an understanding of arbitration, competition, pricing, and regulation. Fundamental analysis looks for discrepancies in activity beyond fraud due to internal or external events. An excellent forensic finance analyst can apply both approaches. Financial statement analysis is also the easiest to show errors because decisions are based on input data typically compiled from standardised datasets for each company under analysis. Despite its popularity, it is surprisingly inaccurate when all companies covered in the datasets are examined. Common mistakes include not correcting for stock splits, not changing the decimal point, and not changing the exchange rate.

4. Regulatory Framework for Green Bonds

The market for green bonds is increasing, driven by the desire of both issuers and investors to raise funds for climate-friendly projects. Consequently, questions have arisen regarding how to improve and standardise this market, for example, by introducing a regulatory framework that investors could reference to avoid "greenwashing." There remains considerable debate around the need for regulation and how to implement it if the desire should exist. Therefore, this essay intends to summarise the current standards and guidelines related to green bonds globally, at an early stage and local level. Accordingly, it will outline recommendations regarding taxation, eligibility criteria, governance, and reporting that have and have yet to be implemented.

Internationally, the most widely referenced guidelines are the "Green Bond Principles" and the "Climate Bonds Standard." Regional and national stock exchanges also developed several guidelines since many companies issue green bonds on more local platforms. In addition, some countries, including China, France, and Japan, have issued national guidelines for green bonds. Whether funds are raised for local projects or issued on foreign exchanges, the challenge remains to reconcile different market and tax rules globally and on a national scale.

To be defined as a "green bond," bonds must meet the following voluntary guidelines. Proceeds must be used exclusively for eligible green projects,

described in general terms, such as renewable energy and climate change adaptation. Guidelines require issuing green bonds to provide investors with relevant information regarding eligibility and a list of projects. Anyone who deviated from the guidelines could easily publicly dispute a bond's "green" label, likely resulting in reputational damage for the bond's issuer. Documentation is on demand rather than mandated, applying an "honour-based" approach. No independent review is required; a third party reviewed fewer than 25% of green bonds. Thus, an investment-grade regulatory framework for green bonds is needed in a new market to protect investors from "greenwashing." The regulation does not necessarily require a securities classification framework. Still, it must ensure that investors can access reliable and comparable information on the green nature of projects and governance arrangements.

4.1. International Standards and Guidelines

The emergence of the green bond market, intending to finance climate-focused investments, was accompanied by the need to ensure that green bonds are genuinely "green." 2010, the World Bank became the first issuer of climate bonds. In November 2013, the International Capital Market Association established the Green Bond Principles to provide a framework for green bond issuers. In response, the Climate Bond Initiative was established in 2011 and took the lead in creating post-issuance verification standards. Here is an overview of international standards and guidelines addressing green bonds, loans, and other climate-aligned debt instruments. A critical first-mover advantage exists in becoming the leading global green bond standards provider. Currently, internationally recognised "highest standards are absent." In principle, existing voluntary or certification-based green bond standards or guidelines developed by NGOs and multilateral development banks meet the needs of an early-stage market. Still, they will likely challenge more advanced markets because of their "lowest common denominator" nature.

The Association of Southeast Asian Nations has issued a Green Bond Standards and Certification Scheme, and the South American Development Bank's Sustainable Development Framework encompasses green bond standards. Some countries have specific guidelines or standards for green bonds. These include China, which has a Green Bond Designation and Accreditation Pilot Program launched by the National Development and Reform Commission and the People's Bank of China's Green Financial Bond Guidelines.

In March 2015, four countries—France, Peru, Nigeria, and the United Kingdom—along with governments of several EU countries and locally elected leaders, launched the French-led "Compacts of States and Regions" at the Climate Summit, a global coalition of states and regions committed to reducing greenhouse gas emissions and building resilience to climate change. By mid-2015, 18 states, provinces, and regions signed the Compacts, representing a combined population of 178 million and a GDP of $4.5 trillion.

Later, in June 2013, the Asian Development Bank approved the Sustainable Transport Initiative, which would finance environmentally sustainable urban transport infrastructure projects in cities across Asia using green bonds. The initiative aimed to strengthen ADB's recognition of the risks of climate change to investments, policies, and programs in the transport sector and to facilitate the adoption of sustainable land use and transport policies.

5. Challenges and Opportunities in Detecting Greenwashing

Currently, there are many challenges in detecting greenwashing. Concepts like materiality or green bonds must be understood in their context and have a stringent definition to become operationally implementable. A potential greenwashing model could be the best point of departure to replicate its traits in the dataset. Because the distribution of financial bonds is very skewed towards the legitimacy endpoint, accurately capturing an unbiased portion of the fraud pool becomes necessary and is anything but trivial. After that, evaluating model performance at a threshold level occurs to distinguish between the legitimacy and greenwashing pool while considering false positives and false negatives, which have conflicting attention and objectives. Lastly, datasets should represent the underlying information, reducing the possibility of collateral data biases.

Despite the intricate task of quantifying greenwashing, there are equally many opportunities. The ten most traded green bonds are analysed, for instance. All ten bonds are from the same issuer. Interestingly, one bond is the only green bond with less liquidity than the most similar conventional bond. Although these bonds are inherently the same other than the "green" label, their trading behaviour is found to be significantly different. A possible greenwashing model is proposed that explains the existence of the first green bond only as an opportunistic strategy to gain more significant publicity than opponents in a very competitive bond market. After that, public scrutiny forces bond underwriters and issuers to be more vigilant in subsequent deals and leads to the construction of future research avenues.

Using publicly available deal data on certified green bonds, thus drawing on fund managers as a societal watchdog to monitor whether companies live up to their promises, an investigation is undertaken on whether a substantial pool of greenwashed bonds exists and how extensive this pool might be. Although such funds are usually criticised for simply engaging in negative screening – investing in "non-sin" industries – this might be avoided when investigating the case of green bonds given the particularly stringent definition of what it means to be "green".

5.1. Case Studies

Two case studies explore the topic of greenwashing detection and are designed to test the proposed methodology and evaluate its results. The first case study investigates the detection of greenwashing in the context of the green bond market and implements it generally. It aims to determine the presence of greenwashing in bonds labelled as green. The second case study is more specific, focusing on the prediction of greenwashing in sustainability reporting within the manufacturing industry.

5.1.1. Case Study 1: Detecting Greenwashing in the Green Bond Market The framework for detecting greenwashing based on detective analytics is applied to a case study involving the green bond market. A dataset containing 4,533 international bonds with a green label has been obtained, along with event data about a climate change activist's speeches between September 18, 2019, and October 31, 2019. The event data is manually investigated to identify allegations regarding green bonds. The reported allegations cases were selected for the analysis during the review process. The selected allegations have been merged with a dataset to include bonds covering these allegations and other bonds assigned to a matching class.

A scenario framework is created to analyse two scenarios. In scenario one, a less conservative perspective is applied to determine greenwashing based on the absence of an adverse event for a bond. In scenario two, a more conservative perspective is maintained by focusing on an adverse event for a bond. The results of the case study indicate the presence of greenwashing in international bonds labelled as green. The results are also evaluated in terms of robustness by conducting a sensitivity analysis. Despite different opinions on coding these allegations, the elemental allegations can be considered valid base allegations. The study reveals that bonds labelled as green are more likely to have a list of allegations. This conclusion is backed by the finding that the number of scored

allegations is larger than the number of bonds in the matching class in seven out of ten predictions.

5.1.2. Case Study 2: Predicting Sustainability Reporting Greenwashing The second case study, which is more specific, investigates the prediction of greenwashing in sustainability reporting in the manufacturing sector. Sustainability reporting has emerged as a response to concerns about the environmental impact of manufacturing processes. A review of reports confirms the prevalence of greenwashing in sustainability reporting. This case study aims to determine whether a dataset regarding sustainability reporting data and event data about governance and enforcement actions against manufacturing companies includes any greenwashing regarding sustainability reporting. Moreover, it applies a detective analytics framework based on the prediction of greenwashing concerning the published reports. A dataset containing companies' sustainability reports published between 2000 and 2020 and accusations publicly available in media reports is acquired. News articles covering these accusations are subjected to textual analysis to identify the elemental allegations raised within the media reports and the textual development of the allegations.

6. Applications of Forensic Techniques in Green Bond Issuance

The rapid increase in green bonds on the securities market over the past decade is highly noticeable. While the previous theme of greenwashing was associated primarily with financial investments, this seems relevant in the context of the green bond market since this type of economic activity is well known for its high level of lack of transparency and high-risk opportunities for fraud. That is why there is a need to assess these bonds in terms of their actual contributions to sustainable initiatives and actions. Forensic finance is one way to tell the truth about these debt securities. This section looks at a possible implementation of modelling and forensic investigation of issued green bonds and relationships with their issuers. This was made possible through the use of data that had been originally collected for other purposes.

The idea of an intelligent-level system was taken from research into social media content and its fraudulent applications. It provides a basis for assigning various grades that could define the probability of fraud for different actions regarding posted content or possible actions. This concept was explicitly adopted to assess the Green Financial Bond market. In this case, a set of grades from 1 to 7 is observing all possible risks for the actions taken by the bond issuers, which are political bodies, local authorities, countries, or state-owned public companies. This

set has a descriptive scenario illustrating each level. The criteria for which they were assigned and given levels are actions that can be performed by the entity that is issuing debt securities.

Another industrial proposal of system forensic net indicators is defined, which could certify other behavioural aspects of entities. These indicators analyse actions regarding social media connectivity and involvement, journalistic and financial activity, other bond issuances, foreign entities bonding action, search engine investment assessment, and ownership changes. A relative value, seasonality of activity, and significance ratio define each extra behavioural aspect. It is possible to describe entities' history and shared context that affect their current behaviour. The index approach presented in this section may provide insight into the planetary level of security, on which actions taken are reflected in other entities' score assessments and can be based and triggered.

6.1. Fraud Risk Assessment

The emergence of the green finance market inevitably raises various concerns regarding its integrity. The potential for fraud exists, such as the issuance of green bonds that lack real environmental benefits or the misappropriation of funds secured through bond issuance. These concerns underscore the need for comprehensive research in green finance, particularly about fraudulent events and potential fraud risk factors. However, with limited academic developments regarding green finance fraud, it becomes vital to explore the possibility of risk assessment concerning fraud in green bond issuance. The theoretical framework utilised for this analysis draws inspiration from the well-established fraud theory, which identifies three essential elements contributing to fraud: pressure, opportunity, and rationalisation. These elements offer a research foundation concerning why individuals may attempt to commit fraud and a reference for developing control components against fraud.

Pressure refers to the reasons incentivising an individual to commit fraud and prompting their unlawful actions. It is composed of several sub-elements associated with the personal circumstances of the fraudster. In the context of green bond issuance, pressing factors may arise from financial stress, managerial goals, or the self-interest of top management. Financial difficulties involving losses and cash flow shortages negatively impact companies' operational health, potentially putting them at risk of default. These circumstances create pressures that may induce unethical behaviours, including fraudulent green bond issuance, to escape debt crises.

Moreover, growing awareness regarding the importance of environmental protection, alignment with government policies, and an increasingly competitive market shape converging managerial goals. Misleading investors through fraudulent green bond issuance can elevate share prices, safeguard management interests, and secure financial resources necessary to pursue development strategies such as mergers and acquisitions. While management objectives may not be exclusive to green finance, coalescing personal goals with green finance trends may enhance the possibility of committing fraud in green bond issuance.

The opportunity involves the circumstances that allow fraudulent activities to occur in execution. Comprehensive internal control, due diligence investigation, external audit, and regulatory supervision help mitigate opportunities for committing fraud. In the context of green bond issuance, broader information asymmetry provides numerous opportunities for committing fraud not only in compliance emissions reports and post-issuance transparency but also in preparation procedures, pre-issuance due diligence, and assurance services. Specifically, the feasibility of a greater likelihood of fraud in executing green bond issuance compared to other illegal behaviours consists of insufficient and ineffective external supervision concerning many factors.

Rationalisation signifies the fraudster's justification for their fraudulent activity. Individuals often use self-exonerating accounts and moral justifications to desensitise potentially prohibitive feelings. The integration of rationalisation sub-elements offers a glimpse into the legal foundations from which the fraudulent green bond issuance may be rationalised.

7. Impact of Green Bonds on Sustainable Development Goals

Targeted investment in environmentally sustainable projects, from renewable energy development to green transportation, is a prerequisite for meeting the climate and environmental goals defined in the Paris Agreement and the 2030 Agenda. The green bond market, which allows public and private entities to fund green investment opportunities through bond issuance, has emerged as a convergence point for institutional investor priorities focused on sustainable development, climate change, and environmental innovation.

Following the report's issuance, countries and regions are concentrating on establishing appropriate policies for climate-friendly economic development. Green bonds are crucial to building a sustainable finance infrastructure, offering

financial and reputational stability by measuring, monitoring, and mitigating ESG risks in organisational processes.

Several initiatives have been rolled out at national and organisational levels to measure bonds' impact on defined policy goals in the last decade. In some countries, this has resulted in the formation of Green Bond Indices. These indices present a widely accepted framework for assessing the impact of investments in green financial products on incremental investments in green projects, technologies, and activities by sovereign borrowers, financial institutions, or corporations.

Proposals for impact measurement focus on calculating the potential GHG emission reduction of funded activities, determining the contribution of each project to the total impact, and translating these reductions into an intensity measure based on the total debt amount.

However, green bonds are open to misidentification, misrepresentation, and greenwashing despite their advantages. Thus, their credibility relies upon transparent, standardised quality certification and governance mechanisms that support third-party verification and fraud detection, ensuring proper use of raised funds. Additionally, green bonds eligibility screening and post-issuance impact assessment, in which projects funded with bond proceeds should continue to be monitored for at least 2 to 4 years after bond issuance, is still a challenge for ongoing bond monitoring efforts.

8. Future Trends and Innovations in Forensic Finance and Green Bonds

As the demand for sustainability grows, forensic finance and green bonds are anticipated to evolve and innovate in various areas. Artificial intelligence and machine learning are likely to be used increasingly in these fields, aiding the analysis of complex financial metrics and improving the detection of anomalies and irregularities. Automated systems might also be employed to monitor green bond usage, utilising satellite imagery and remote sensing technologies to ensure that environmental projects receive adequate financing. More commercialised tools for stakeholder-side investors or industries interested in sustainable development will also likely emerge. In addition, the community of scholars in these fields is expected to grow as more students become aware of the topics involved in these areas. While forensic finance is currently largely unconcerned with sustainability topics, an emphasis on green finance within the subject area is expected to garner further attention. Forensic finance is a niche area with

landmark texts but few publications and fewer scholars undertaking research. In the near term, there are ample opportunities and the potential to be a frontrunner in this planned field of academic study. Cross-institutional and multinational academic research is anticipated, yielding a broader reach and impact as many other institutions cover sustainability topics. Forensic finance is also likely to be an internationally recognised and mainstream research area in the longer term, encouraging participation from many research institutions and countries.