Do Green Equity issuers perform better than Green Bonds Issuers? A comparative analysis of environmental and financial performance. ?

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Année académique : 2024-2025
URI/URL : http://hdl.handle.net/2268.2/22365

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en vue de l'obtention du diplôme de

Master de spécialisation en Gestion des risques financiers.

Année académique 2024/2025

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my supervisor to whom I am most indebted, Professor Wouter Torsin for his interest in my work. This interest which was demonstrated through his availability, readings, corrections, comments, and for suggesting a way forward that led to a successful completion of this research work.

My appreciation also goes to our reader and examiner Mr. David Fassin for answering present to the task of reading and examining this work. I will equally not forget the Financial Risk Management coordination team, all Professors, Doctors, lecturers and Guest speakers for impacting me with such valuable knowledge and experience during my academic journey.

I am most grateful to my family and most especially my parents Mr. Muoshuo Francis and Mrs. Tanyifor Prudencia and siblings for the love and encouragements.

I also thank my classmates and friends especially, for their kind cooperation, friendliness and encouragements throughout this academic year.

Above all I thank the Almighty God for his grace, protection and wisdom

throughout my studies.

LIST OF ABBREVIATIONS

CBI – Climate Bond Initiative

CO_2 – Carbon Dioxide

EIB – European Investment Bank

ESG- Environmental Social and Governance

FE- Fixed Effect

GRB – Green Bonds

GRE – Green Equities

GBP – Green Bond Principle

ICMA - International Capital Market Association

IPCC – Intergovernmental Panel on Climate Change

Lev – Leverage

PRI – Principle of Responsible Investment

ROA - Return on Assets

RE- Random Effect

R&D- Research and Development

TOT RE – Total Renewable Energy

UNEP – United Nations Environmental Program

UNFCCC – United Nations Framework Convention on Climate Change

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CHAPTER ONE:

INTRODUCTION

1.1 Background of the study:

Climate change is one of the most important issues of our generation and future generations. A report from the Intergovernmental Panel on Climate change (IPCC, 2018) reveals that, the climate system has unequivocally been getting warmer since the 20th Century. As Carbon Dioxide $C0_2$ emissions from human activities constantly rise, leading to an increase in Green House Gasses (GHG) into the atmosphere, climate change will undisputedly remain one of the greatest global environmental and developmental obstacles to combat with.

The manifestations of climate change can be visible from the melting polar ice, rise in sea levels, and other extreme whether events such as floodings, droughts and extreme heat. Apart from causing serious property damages and loss of human lives, this physical climate related risk tends to interrupt business operations and further translate to operational, credit, liquidity and insurance risks (Bernstein. A, Gustav. M T, & Lewis, 2019). Closely followed by this, is the risk of transition that the economy in general will have to adjust to, emanating from tighter legal or government policies, technological innovations, market and reputational risk, aimed at reducing emissions.

According to the United Nations Framework Convention on Climate change (UNFCCC), Countries such as China and India are currently toping the chart in terms of current annual emissions. At the regional level, Asia, North America, and Europe currently account for 50%, 17% and 15% of current emissions respectively. On the other hand, the US alone accounts for a third of all cumulative emissions in the atmosphere, while European countries such as the United Kingdom, France, Germany, Italy and others, can be held responsible for a fifth of all accumulated stock of CO_2 emissions. These countries and regions are set to be operating in industries and sectors such as steel, aluminum, energy, transport, manufacturing and agriculture where the main source of energy happens to be coal fired and natural gas power plants.

Similarly, if the aforementioned carbon emission trends persist, it becomes even more challenging for investors and other stakeholders. Of pertinent interest (in terms of portfolio risk) it will be to institutional investors who hold huge values of investment funds under their management (Mercer, 2019). In the worst scenarios, these assets may become stranded due to physical or transition risk. This is consistent with Guo, Kubli, & Saner, (2021) who estimate a global loss of 10% economic value by 2050 if CO_2 emissions and temperature levels remain uncontrolled. Immediate action plans through mitigation and adaptation becomes very vital to change the status quo. In this light, policies aimed at promoting the use of green or renewable energy, and other financing instruments like green bonds are now attracting international interest.

Choosing how to respond requires both a knowledge of the science as well as an understanding of our policy options. Several efforts have so far been displayed by the international community as far a cutting down emissions and the restoration of natural resources are concerned. International Climate agreements and related climate policies are the results of global efforts to mitigate climate change. This can be trace as far back as the Earth summit in Brazil in 1992, and the UNFCCC, which also marked the first agreement on climate change (Kuramochi, et al., 2020). Following this summit, other agreements have been met, such as the Kyoto agreement in 1997 and the Paris Agreement in 2015, which were all aimed at limiting greenhouse gasses.

A significant step towards achieving this objective was the Paris Agreement at the COP 21 in 2015 where all 195 parties pledged to contribute to reach net zero target of carbon emissions by 2050. All signatories commonly agreed to the fact that, limiting temperatures below 2°C above pre-industrial levels while pursuing efforts to limit temperature rise to 1.5°C above pre-industrial levels was the only solution. As a matter of fact, it is impossible to reach Sustainable Development Goals without appropriate climate actions. To this end, countries and governments have emerged with national pledges and targets, enshrined in their individual climate policies or Nationally Determined Contributions (NDC).

After the Paris Agreement in 2015, countries started adopting national climate policies aimed at promoting sustainable investments and development. A significant policy so far has been the carbon price system, taking the form of carbon taxes and the cap & trade scheme. The carbon tax system is an imposed price per ton of CO_2 emitted, thereby forcing companies to pay for their own emissions. The objective has been to discourage coal and gas-powered plants, the use of fossil fuels, while encouraging companies to switch to green or renewable energy system. Energy generated from fossil fuels has been a major promoter of Green House Gasses, leading to Global warming and consequently, Climate change (Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022).

Therefore, in order to achieve the 2030 agenda of the United Nation Sustainable Development Goals and a smooth transition to a Net Zero economy by 2050 as stated during the Paris Agreement, the worlds' economy has to embrace renewable energy sources like the use of solar, wind, hydrogen, geothermal, nuclear and biomass. These sources can efficiently replace fossil fuels and drastically reduce carbon emissions. This is where the green finance system comes in with its key role in mobilizing and directing investments into environmentally friendly projects so as to promote low carbon technologies (Kölbel, Heeb, Paetzold, & Busch, 2022).

Reports from the United Nations Environmental Program (UNEP), and the European Commission reveal that, financial instruments such as green bonds, green equities or stocks such as clean energy stocks and other green loans could play a crucial role as they are all financial activities and investment strategies aimed at promoting environmental sustainability and transition to low carbon and climate resilient economy. Green bonds are fixed income financial assets which are issued with the proceeds directed to finance eco or environmentally friendly projects (International Capital Market Association, 2021). In most cases, green bonds are used to finance renewable projects, energy efficient buildings, and green transport projects (Flammer, 2021; Alamgir & Cheng, 2023).

As a financial tool, green bonds have gained a lot of international attention since its first issuance by the European Investment bank in 2007. Companies and investors who wish to do more good than harm to the society are becoming more concerned, especially after the Paris agreement which saw the value of green bonds issuance more than doubled. Therefore, green bonds especially those certified by independent reviewers or third parties helps in boosting companies reputation and environmental commitments. To investors more specifically, investing in green bonds is an efficient way to diversify portfolios and equally hedge against climate risk (Reboredo , 2018). Flammer, (2021) and Alamgir & Cheng, (2023) empirically documents the crucial role of green bonds as an efficient financial instrument in improving environmental performance especially when it comes to Carbon emissions reduction.

Green Equities on the other hand, are ownership shares of companies focusing on environmentally friendly technologies. In this case, they are referred to as green stocks or clean stocks that are environmentally sustainable. Buying green stocks makes one a shareholder and therefore, subjected to risk and benefits that comes with them, based on the company's performance. However, green stocks are more riskier than green bonds though both are financial instruments targeting sustainable investments. This is because, green bonds holders are entitled to fixed interest payments while green stocks holders may be entitled to profits sharing known as dividends if profits are made. Moreso, shares of these companies are proon to market risk, leading to shareprice fluctuations. Examples of green equities or green stocks issuers are mostly in renewable energy such as solar and wind, energy efficient infrastructures such as transports and buildings, sustainable agriculture, and electric vehicles companies.

Despite the diversification and risk hedging benefits that green bonds could bring to green stocks investors (Reboredo , 2018; Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022)., both instruments still remain a massive breakthrough in financing the transition to net zero economy by reducing CO_2

emissions. However, given their individual specificities, it will be vital to examine their individual contributions to sustainable investments hence environmental and even financial performance.

1.2 Problem statement

As the world mobilizes the necessary resources for the transition to net zero economy by 2050, it becomes imperative to incorporate sustainability or Environmental, Social and Governance (ESG) concerns into investments decisions. Studies have proven that, aligning investment strategies to green considerations helps to mitigate the impact of climate change on financial assets while enhancing risk-adjusted returns. Regulators and other international bodies are living no stone unturned in their efforts to accelerate the transition.

Between 2016 and 2035, an estimated sum of 2.4 trillion USD/year is needed to maintain global temperatures at 1.5 degrees. Companies that do not address environmental issues like climate change by reducing their resources away from brown intensive investments in favor of green counterparts might be faced with high cost of capital and related taxes. To this effect, the number of UN Principles of Responsible investing (UN PRI) is on the rise and as a result, global assets under management with ESG considerations grew from 22.8Trillion to 30.7 Trillion USD from 2016 to 2018 (GSIA 2019). With the current increase in climate concerns and sensibilization, these figures may reach 55Trillion USD by the end of 2025(Bloomberg 2020).

As the financial market for environmentally friendly investments grow in both scope and size, so does green equities and bonds. Green equities are part of company's shares or common stocks devoted to promote environmentally friendly projects, meanwhile green bonds are fixed interest securities whose proceeds must be used to fund projects with positive environmental and climate benefits. (Flammer C. , 2021). Prior to the Paris Agreement on Climate Change which came into force in November 2016, green equities were the most renown financial instrument with environmentally friendly or sustainable features. A recent development in sustainable finance has been the emergence of green bonds with a majority issued by corporate bodies.

By 2013, the total value of Corporate green bonds stood at about 5B USD and since then, it has increased dramatically. In 2018 alone, the corporate sector issued green bonds worth 95.7B USD and today, the total issue can be estimated at 521B with about 70% representing corporate issues (Climate Bond Initiative, 2023). A wide majority of academic documents have focused either on the comparison between green vs brown stocks or green vs brown bonds with the findings revealing that, the German green bonds for example, outperformed their high yielding non green twins as the greenium widened, while in the US, green stocks outperformed brown as climate concerns strengthened. Similar results have been documented by (Maltais & Nykvist, 2020; Pham, 2021; Pedersen, Fitzgibbons, & Pomorski, 2021; Flammer C. , 2021; Berg, Koelbel, & Rigobon, 2022; Bruno, Esakia, & Goltz, 2022; Pástor, Stambaugh, & Taylor, 2022; Ardia, Bluteau, Boudt , & Inghelbrecht, 2023; Gehricke, Ruan, & Zhang, 2024).

To be more specific or expand on the above studies, findings reveal outstanding performance of brown stocks or stocks of highly polluting companies over green stocks, (Hsu, Li, & Tsou, 2023; Bolton & Kacperczyk, 2023) meaning that in normal circumstances, brown stocks outperform green stocks. The reverse is however true during periods of extreme climate concerns as documented by (Choi, Gao, & Jiang, 2020; Pástor, Stambaugh, & Taylor, 2022; Ardia, Bluteau, Boudt , & Inghelbrecht, 2023) who studied and found that, green stocks outperform brown stocks during periods of unexpected climate change concerns or when temperature increase.

Moving over to bonds, Duan, Li, & Wen, (2021) found that, bonds of more carbon intensive firms earn less returns which is contrary to the usual carbon risk premium hypothesis. This is consistent with the study of (Pástor, Stambaugh, & Taylor, 2022) where in an attempt to investigate the existence of green premium in bond market, found that the German green bonds outperform non-green twin bonds, driven by unexpected increase in environmental concerns. These studies indeed confirms the findings of Flammer C. , (2021) on corporate green bonds, revealing that, financial markets reacts positively to the announcements of green bonds issuance and consequently leading to improved environmental performance like lower CO_2 emissions and higher environmental ratings.

Similarly, Alamgir & Cheng, (2023) demonstrate the significant impact of green bonds in achieving sustainable development as their findings reveal that, green bonds significantly reduce carbon emissions and increase renewable energy production. Further more, Zhou & Cui, (2019) using some selected chinese firms, set out to explore the impacts of green bonds issuance on stock prices, financial performance and corporate social responsibility thus revealing that, the announcement of green bonds issuance have a positive impact not only on stock prices but also on profitability and firms corporate social responsibility.

Contrary to the above finding on green bonds, (Zerbib, 2019; Baker, Bergstresser, Serafeim, & Wurgler, 2022; Seltzer, Starks, & Zhu, 2022) documents that yields on green bonds are lower than that conventional bonds. In addition to this, that firms with poor environmental profiles have higher yields spreads and lower credit ratings compared to firms with good environmental profiles. These studies also conclude that, green bonds are issued at premium (lower yields compared to conventional bonds).

The above studies on bonds and stocks turn out to be rather too conflicting and even more confusing as one goes deeper into the literature. For bonds for example, one school of taughts believe that green bonds exibit better environmental and financial performance while the opposing camp believes in conventional bonds still outperfoming green bonds. On the other end of equities or stocks, we still find one school of taughts empirically justifying that green stocks outperform brown stocks interms of environmental performance and returns, which is contrary to pro-brown stocks researchers who believe that, green stocks outperformance is just limited to the short run and may just be realised returns or when investors expectations on climate change concerns increases. Consequently making brown(carbon intensive) stocks to always outperfom especially in the long run.

Therefore, these contradictory and counter findings leaves us at cross roads and at the same time, intuitively brainstorming on what results we could find if we compare green bonds versus green stocks. Consequently, one eminent questions that could forcefully emerge and has not yet been exploited from the above conflicting strands of literature is: Do green bonds issuers realize better environmental performance than green equity or stock issuers? It is therefore from the above intuitive question that this study sets out to fill the existing literature gap by comparing green bonds vs green equities through an examination of their individual contributions to sustainble investments and consequently, environmental performance.

To the best of our knowledge, no previous study has so far been carried out to compare and contrast green financing instruments such as green bonds and green equities. Keeping aside the aforementioned studies which either compare green and brown bonds or stocks, studies directly or indirectly related to our current studies are very few as about 99% of them only examine the frequency connectedness using cross quantiligram frameworks so as to investigate the dependence and spillover effects between these markets over time and accros varying market conditions. Pham, (2021) investigated the frequency connectedness between green bonds and green equities and found that, the dependence between green bonds and green equities tend to be stronger during extreme market conditions than normal conditions. In addition to this, the spillover effect occurs with green equities transmitting more shocks to green bonds than in the opposite direction.

More recently, Zhang & Umair, (2023) investigated the interconnectedness of green finance by analysing the dynamic spillover effects among green bonds, renewable energy stocks and carbon markets. The findings reveal a significant dynamic spillover effect between green bonds and renewable energy stocks as well as between carbon markets and renewable energy stocks. More so interms of returns transmission, renewable energy stocks appears to be the primery transmitter of shocks to green bonds. These findings are strongly consistent with that of (Chatziantoniou, Abakah, Gabauer, & Tiwari, 2022; Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022) who demonstrate that, the MSCI Global environmental index and the Dow Jones sustainability index are both long term and short term shock transmitters to green bonds and the S&P Global clean energy stocks.

Mean while Tiwari et al. (2022) in a dynamic spillover effect study among green bonds, renewable energy stocks and carbon markets during the Covid-19 pandemic, evidenced that, S&P Global clean energy stocks dominates the market as it's the principal net transmitter of shocks. Once again the findings reveal green bonds and solactive global wind energy as shock recievers. Other related studies with similar findings include, (Mo, Li, & Meng, 2022; Hoque, Soo-Wah, Bilgili, & Ali, 2023). In general, these studies demonstrate the extent to which volatility and returns shocks could easily be transmitted between markets due to their interconnectedness or dependence. By implication, green bonds market could provide a hedging tool for clean energy markets and consequently, for investors who wish to diversify their green investment portfolios for longer term horizons.

Earlier studies have concluded that, market participants or sustainable investors could rely on green bonds as a portfolio diversification instruments for green equities by just examining the directional spillover effects between them. Our work extends literature by bringing nouvelty into the current discussions on green finance instruments in that it is the first to compare the effects of green bonds vs green equity stocks on environmental performance which previous studies have failed to identify. By so doing we hope to further guarantee investors of green equity stocks and if they could rely on green bonds issuers for portfolio diversification or hedging risk after comparing environmental and financial performance of both. Spefically, we look at their individual impacts on CO_2 emissions, stock price returns and ESG ratings of the issuing companies.

1.3 Objectives and Research Questions.

Drawing insights from our background and related problems stated above from pre-existing literature, our principal objective of this study is therefore, to compare and contrast environmental and financial performance of green equity stock issuers to those of green bonds issuers.

- **Specific objectives**

Specifically, this study attempts to;

1. To compare the improvement in environmental ratings of green equity issuers with those of green bond issuers.
2. To assess the effectiveness of green bonds issuer in managing CO2 emissions compared to green equity issuers.
3. To evaluate and compare the stock price returns of green equity issuers with those of green bond issuers.

- **Research Questions**

In order to attain the above objectives, our main research question will be;

Do green equity issuers realize better environmental and financial performance than their green bond counterparts?

- **Sub Research questions**

1. Do green equity issuers improve their environmental ratings as opposed to green bond issuers?
2. Are CO_2 emissions better managed through the issuance of green bonds than with green equity issuers?
3. How better are the stock price returns of green equity issuers as compared to green bond issuers.

1.4 Research Motivations

Generally, this study is motivated by the edge to know how companies issuing green instruments in the U.S are performing and if there are any disparity especially given the fact that the U.S under Trump is no longer a signatory to the Paris Agreement.

From a managerial perspective, we are also motivated by the need for business to compare their environmental performance based on the issues of particular green or environmentally friendly instrument and for further comparison with peers in the same industry. This will enable managers to formulate investment or financing strategies that are more sustainable. Within a company this study might provide a framework for comparing the proportion of revenues or profits emanating from this or that green instrument and whether it is sustainable in the future.

This study is also worth pursuing because of its eminent relevance to regulators who might want to improve environmental performance by imposing certain thresholds on the total amount of funds that must be invested in green bonds or green stocks based on the activities of the company. For investors who always have diverse preferences, an environmentally or socially responsible investor for example might want to evaluate the greenness of the different assets before taking a decision and might therefore view this study as a starting point or a baseline from which others studies might developed to provide an extensive base for green investment decision criteria.

Academically speaking, the existing literature gap on studies involving green bonds vs green equities is another motivation to further research on this subject matter. Most past studies have focused on examining the relationship between conventional assets and emerging alternative asset classes such as green bonds and green stocks with the exception of (Pham, 2021; Chatziantoniou, Abakah, & Gabauer, 2022; Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022; Zhang & Umair, 2023) who examine the frequency connectedness or spillover between green bonds and green equity stocks. However, this study attemps to contribute to the ongoing literature on green financing instruments and sustainable investments by comaparing the environmantal and financial performamce of green bonds vs green equities.

1.5 Significance of the study

Through this study, we hope to present the following contributions or policy implications;

Managerial environmental investment decisions can be guided by an analysis of different assets classes especially among green stocks or bonds from which they can diversify their portfolios among different green instruments for a profitable environmental benefit. Apart from inspiring investors in their green portfolio making decisions, this study could also facilitate ESG fund managers classification of their holdings into either article 8 or 9 funds. More so, regulators and policy makers can gain more insights on which green instruments to promote for a more sustainable investment.

Academically, we hope to contribute to the ongoing debate and literature on the role of green bonds in sustainable investments and by extension comparing them with other green instruments in the equity market such a green energy stock. By so doing we hope to feel the gab created by existing studies who focused only on green and conventional assets or their directional spillover effects.

1.6 Research Methodology

In order to attain our study objectives and to provide answers to the research questions above, we adopt a panel research design in line with (Flammer C. , 2021). Our sample size is basically some 63 firms issuing corporate green bonds and a host of other 53 companies issuing green equities all from the U.S and covering the period from 2013 to 2014. We chose this approach because it allows us to control for unobserved variables when we combine cross sectional and time series data. With our primary objective to compare the environmental and financial performance of green issuing companies to those of green equity issuers, Data for all variables were obtained from Refinitiv Eikon Data Stream where we used the yearly observations for all variables concerned.

Our dependent variables are ESG scores, Carbon dioxide emissions, which we used to capture environmental performance and stock price returns to capture financial performance. These variables are then regress against green bonds issued amounts and the market value of green equity stocks, constituting the independent variables. In addition to this, we control for other variables such as return on assets, Beta, Leverage, capital expenditure, Research and development, oil prices, and renewable energy to total energy used.

For our estimation technique, we employ the Feasible Generalized Least Square Panel Regression (FGLS) after diagnostically testing for fixed and random effects which all turn out not supporting the basic panel data assumptions of autocorrelation, Heteroskedasticity, and cross-sectional dependence. The Feasible Generalized Least Square regression technique was also adopted after comparing with the clustered fixed effects, the Driscoll and Kraay estimator in terms of result significance, and their ability to accommodate panel data assumptions mentioned above. Through this methodological approach, we hope to share more lights on the impacts of green equity vs green bonds issuance on environmental and financial performance hence guiding socially responsible investors in their decision making.

1.7 Organization of the Study

This study is structured in three parts, in the first part we introduce and present the literature on the subject matter. Here, we present the context or background of the study, problem, the research objective and the related research questions in chapter one. In chapter two we review existing conceptual, theoretical and empirical literature on green bonds and equities. In the second part we focus on the methodology, data and presentation of results (Chapter three and four respectively. Finally, in the last part, we then discuss our findings based on the data analysis and then present our conclusions (chapter five and six).

CHAPTER TWO:

Literature Review and Hypothesis Development.

2.0 Introduction

This chapter presents relevant literature on green bonds and green equities with regards to environmental and financial performance. It brings out key concepts, theories or models and empirical evidence to support the contributions of green bonds and green equity stocks in advancing sustainable investments such as the reduction of CO_2 emissions and better environmental ratings. This is essential for this study because it presents the foundation or bases of our hypothesis which logically guides us towards attaining our study objectives.

2.1 Conceptual Literature.

Global efforts in limiting the negative effects of climate change have revealed the importance of green bonds and clean energy stocks, utilized by institutions, governments, and corporates to finance the transition to low carbon economy (Baker et al., 2022). Investing through these green instruments is a modest way through which socially responsible investors could create positive environmental impact for instance carbon dioxide reductions and investments in renewable energy. On the other hand, corporate entities might also wish to demonstrate their environmental commitments by issuing green finance instruments aimed at financing environmental and socially friendly projects. A dominant tool in recent years has been green bonds and to a lesser extent, green equity stocks. In the following sections, we look at these two markets separately, bringing out their drivers and contributions to sustainable investments.

2.1.1 Green bonds market.

A green bond is a fixed interest earning security whose proceeds are dedicated to finance projects that are environmentally friendly in nature. This is quite different from conventional bonds which do not have these environmental or green commitments. The history of green bonds can be traced far back as the year 2007 when the European investment bank (EIB) issued the first ever green bonds or climate awareness bonds worth US $1bn. Since then, this market has witnessed a sporadic growth in terms of size (amounts and number of issues). 2018 is very remarkable for the famous green bond boom as the total value of issue rose to US $143bn up from US $1bn in 2008 (Climate Bond Initiative, 2020). Today, the market is currently hosting some accumulated US $3.444tn worth of green bonds since its first issuance in 2007.

Currently, China has the highest amount of green bonds issued so far, followed by Germany, France and the United States,

Following the Paris agreement in 2015 where parties unanimously agreed to reduce global warming and temperatures below 2°C and to reach net zero by 2050, green bonds market witnessed a significant growth rate with an outstanding result in 2021 with a total amount issue of US $638.045bn. Since then, the market has been on a decline with a positive growing trend for 2024 which currently stands at US $530.4bn (Refinitiv, 2024). The above trend can partially be attributed to the 2019 Covid Pandemic and the current geopolitical crisis affecting the energy sector since green bonds are generally raised to finance alternative energy sources. Generally, bonds are issued by corporates, governments or agencies which is the same case for green bonds.

In the U.S specifically, green bonds issuance has been unstable prior to 2017. However, following the US decision under President Trump to abandon the Paris agreement in 2017, green bonds issuance was paradoxically on a rise, reaching a significant peak in 2022 where about US $50bn were issued. Just like the global trend, the figure has been dropping since then and currently stands at US $26.5bn as of November 2024. Talking of corporate green bonds which is our point of focus, the first set of corporate green bonds in the US were issued in 2013, by the Bank of American, the French Utility EDF, and a solar subsidiary of Berkshire Hathaway. Similarly, the state of Massachusetts is known for the use of green label in the issuance of Municipal bonds in 2013 (Baker, Bergstresser, Serafeim, & Wurgler, 2022).

A. Characteristics and types of green bonds

Green bonds can be classified under the category of green financial instruments related to used-of proceeds because this criteria limits where and how the proceeds are to be used. In this case, the coupon or interest rates do not depend on the outcome of specific environmental projects like the case of sustainability linked bonds or loans where the financial and structural characteristics vary depending on the achievement of predetermined sustainability or ESG objectives (Baker, Bergstresser, Serafeim, & Wurgler, 2022). Linked instruments do not restrict the use of proceeds in as much as certain targets and KPIs are met. Other categories of green financial instruments include, public listed bonds or private issued loans, and whether the bonds target specific environmental issues such as pollution or waste management. The largest of them all is the green bonds market (use of proceeds instruments), accounting for more than 50% of accumulated sustainable debt issuance (Baker, et al. 2022).

The definition, guidelines and the taxonomy of green bonds still remains a puzzle despite its rapid development in recent years. This explains why we still have two green bonds standards (Tang & Zhang, 2020). These standards are the Green Bond Principles and the Climate Bond Initiative.

1. **The Green Bond Principles:** The Green Bond Principles (GBP) emerged in 2014 after a group of banks such as the Bank of America Merrill Lynch, Citi, JPMorgan, BNP Paribas, and HSBC decided to establish a set of voluntary guidelines promoting transparency, disclosure, and integrity in the Green Bond market. According to ICMA, (2021), the primary aim is to facilitate transactions while protecting the interest of investors so as to avoid green washing. The four principles here include: the use of proceeds; project evaluation and selection process; management of proceeds; and reporting.

   With respect to the use of proceed, the green bonds principle is there to ensure that the issuing companies use the proceed for sustainable activities or green projects as defined by the ICMA and the EU Taxonomy. Here the issuing companies must list a number of green projects that are eligible for financing such as renewable energy, energy efficiency, pollution prevention, green transport and buildings (ICMA, 2021).

   Project evaluation and selection process is another principle which warrants the green bonds issuers to communicate to investors, what the objectives of the projects are, including the eligibility criteria for green projects selection (ICMA, 2021). Closely related to this is the management of proceeds principle by which issuers demonstrate that the money borrowed are indeed invested in green projects or used to finance green projects. The reporting principle ensures that green bond issuers adhere to the harmonized reporting framework of ICMA with reports produce on an annual bases, thus demonstrating progress made so far on the financed projects and how the proceeds were used (ICMA, 2021).

   It is hoped that, the aforementioned components will provide the necessary transparency in the information requested by investors, regulators and other stakeholders

2. **Climate Bond Initiative (CBI):** This is an international organization whose objective is to mobilize the necessary funds needed to finance the green transition. It therefore establishes standards that provides eligible criterion and a detailed green taxonomy by sector that third parties can adopt to assess the qualification of a green bond. Through the climate bond taxonomy, investors, governments and corporates are informed on which sectors and investments types that can foster low carbon economy. Taking the case of Europe, the EU taxonomy and the EU green bond standards are some examples of regulatory initiatives.

   The EU Taxonomy: The EU Taxonomy introduced in 2020 as part of the EU's Sustainable Finance Action Plan is a classification system that defines environmentally sustainable economic activities. It is hope that investors will sufficiently benefit from it as it provides guidelines on green bonds and other green finance instruments.

The EU Green Bond Standard: The EU is also working on the development of a Green Bond Standard, which would provide a regulatory framework for the issuance of green bonds in the EU. The standard is expected to include criteria for the use of proceeds, disclosure, reporting, and verification to guide investors and avoid green washing.

B. Rationale for issuing green bonds

Flammer (2021) richly documents the rationale for issuing green bonds and further highlights their implications to different stakeholders. According to her, companies issue green bonds to signal their environmental commitments, greenwashing, and a cheap source of capital mobilization.

1. **Demonstrate environmental commitments:** Generally, companies are more knowledgeable on their business operations and financial allocations than external stakeholders such as investors. This creates an information asymmetry (Akerlof, 1970; Williamson, 1985). Therefore, by issuing green bonds, companies provide a positive signal about their environmental engagements and consequently releasing appropriate information to guide investors in their investment decisions. Credibility is guaranteed in this case because the bonds are guided by green bonds standards and subsequently certified by independent third-party reviewers to ensure that the proceeds are actually dedicated to financing green projects.

   The above signal presents key implications for the company for instance issuing green bonds implies that the company is committed to improve its environmental performance such as carbon emission reduction and better environmental ratings (Alamgir & Cheng, 2023; Flammer C. , 2021). Secondly it also implies varying market reactions from shareholders such as stock ownership and returns. In the nutshell, green bonds issuance is a potential avenue to improve and broaden investor base as it attracts more environmentally conscious investors.

2. **Cost of Capital:** If investors with green taste or environmentally conscious investors are willing to forego returns in favor of positive impact, it simply implies that they are willing to accept even lower yields (pay high to achieve sustainable goals). If the above circumstance prevails in the market, the cost of capital for green debt issuing firms reduces leading to cheap capital mobilization.
3. **Greenwashing:** This third reason for companies to engage in green bonds issuance is actually a limitation in itself. Greenwashing is a deliberate act to misrepresent or present misleading information about a company's environmental engagement. In this case, companies may

allocate funds to projects that have very little or nothing to do with climate or social action. Greenwashing can take the form of attention deflection where companies hide unsustainable practices from stakeholders or green lighting where companies spotlight small green features of their operations or products in their communications to distract from large environmental damages being conducted elsewhere. Other forms include green labelling which are misleading claims, and green rinsing where a company may regularly change its ESG targets before they are achieved.

4. **New markets and development of innovative products to customers:** This a more business case driver of green bonds issuance as its fosters the development of new products to clients with sustainable or green taste. A typical example is the case of electric vehicles which comes with innovative and renewable energy and thus shifting from brown energy generated products to green.
5. **Risk reduction:** By issuing green bonds both investors and the issuing companies are able to prevent losses emanating from future sustainability regulations that may lead to policy and legal risk, market risk and reputation risk. Therefore, by investing in green bonds, investors are better convinced that their risk is minimal through diversification since green bonds investments provide a hedge to investment portfolios (Pham, 2021).

2.1.2 Green Equity Markets

Green equity is a generic name for clean energy stocks. In most studies, the word renewable energy, green or clean energy stocks is often used to refer to the same commodity brand in the green equity market. Therefore, a green equity are common stocks with green label, issued by companies involve in the production, used and marketing of clean energy products, mostly renewable energy such as wind, solar, geothermal, biofuels, and hydrogen. The disastrous consequences of climate change and increasing temperatures has revealed the need to transit from dark-brown energy sources to clean energy sources, hence demonstrating the importance divestments from carbon intensive firms to green firms. We shall explore the past and current trends of this markets, investment opportunities and how related they may be to green bonds as far as environmental sustainability is concerned.

A. Past and current trend in the green equity market.

Increasing Investments in alternative energy sources can be traced back in the early 1970s, marked by the oil crisis. Thes shortages prompted major oil demanding countries like the US, Canada, Western Europe and Australia to sought for alternatives (Kumar, Managi, & Matsuda, 2012). Similarly, oil price increase between 2007 and 2008 and a subsequent fall in the stock prices of alternative energy sources motivated the quest for other cheap energy sources. The 2010 New Energy Finance report documents that, global investments to new sustainable energy was estimated at 29% between 2004 and 2009. These investments reached a remarkable record of US $173bn despite the 2008 financial crisis (New Energy Finance, 2010).

Prior to 2015, total global investments in clean energy stood at US $1000bn while investments in fossil fuels could be estimated at US $1300bn. However, commitments and targets pledged by participants at the Paris Agreement aimed at reducing carbon emissions and transit to low carbon energy systems started being felt by 2016 when the World Energy Investment reported energy investments dominating fossil fuel investment which has been the case till date. In 2023 alone, a total of US $1800bn was invested into clean energy while dark brown energy stood at US $950bn (IEA, 2023). Similarly, within the clean energy sector, renewable power and energy efficiency have the highest accumulated total annual investments with an average of US $300bn annually. This seems good but more still needs to be done if we want to be carbon neutral by 2050.

B. Factors that have led to the growth of sustainable energy

It will be too quick to attribute the rapid growth and expansion of the green equity market and sustainable energy investments to the Paris Agreement. Of course, the United Nations Framework Convention on Climate Change and other international treaties on climate change must have stimulated and foster growth but the orchestrating factors to this growth include;

1. **High fuel prices:** Increasing fuel prices driven by excess demand from emerging economies such as China and India coupled with shortages created by the conflicts in the Middle East and the Russian cuts to Europe have so far aggravated the situation leading to high exorbitant prices of oil and gas. This alone has motivated the quest for alternative sources of energy such as renewable energy and thus spark up multiple investments in clean energy (Henriques & Sadorsky, 2008).
2. **The US mid-Term Elections:** According to Henriques & Sadorsky, (2008) the November 2006 mid-term elections in the US confirmed clean energy as a mainstream issue. A review on the economics of climate change highly promoted the need to embrace investments in low carbon technologies since economic growth was very compatible with technology driven energy consumption.
3. **International commitments and initiatives to tackle climate change:** The Paris Agreement of 2015 was the major eye opener for increased investments in clean energy markets. This is because, this agreement laid down targets and commitments which participants had to pledge, with the goals of maintaining temperatures to 2°C with more efforts to reduce it to

1.5°C. By so doing, Net Zero by 2050 can easily be met. This was very important because oil and gas production and coal are set to be a major contributor to Green House Gasses. Striving to reach these targets was the only way to switch from dark to green energy such as renewables.

4. **Regulations and transition risk of stranded assets:** Transition risk, which is part of climate risk comes in when the economy undergoes certain transformation and dislocation with the primary goal of eventually eliminating Net Green House Gasses so as to reach net zero by 2050. This is considered to be a major driving force pushing companies to abandon non-renewable energy generation sources. The operational mechanisms here involve;
    - government policies and legal actions such as the carbon tax or the cap-and-trade scheme which simply impose a tax per carbon or a carbon price for each ton of CO_2 emitted. This help to set a limit on the quantity of emissions. The government may also mandate closures of certain entities by revoking previously agreed fossil fuels infrastructural projects, while enforcing mandatory shut down dates for intensive carbon facilities like coal-fired power plants. Through this weapon several companies have switched to energy efficiency productions or clean energy (Caldecott, Kruitwagen, Dericks, & Tulloch, 2016).
    - Technological risk has pushed carbon intensive companies to embrace new technologies that limits emissions. As documented by Ahmad (2017), technology companies are major suppliers of inputs to clean energy companies, demonstrating the positive relationship between clean energy companies and technology providers in the face of increased oil prices. Therefore, with the development of renewable energy technologies, companies still relying on outdated technology will suffer from technology risk considering the fact that new energy sources from wind farms, solar photovoltaic panels have become economically competitive than fossil fuels such as coal-fired plants and natural gas power plants. Other technologies include the wide use of lithium-ion battery which implies that electric vehicles will be more affordable than combustible engine vehicles which may end up being stranded. The transport sector is therefore not safe for those still relying on obsolete technologies.
    - Reputation risk, which comes with pressure from stakeholders such as consumers, suppliers, employees and even investors and banks who all have a green taste might also be a driving force behind a company's push for sustainable actions. The fear of a dilapidating image or brand name will surely encourage companies to shift from brown activities to green or clean activities since the share prices may be affected and investors withholding supply of capital.

- At the market level, the demand and supply mechanism come into play as demand for high polluting products may fall leading to loss of market share and even higher cost of production for firms with high carbon intensity productions.

C. Green Bonds Versus Green Equity stocks.

This study is an attempt to compare green bonds to green equities such as clean energy stocks with the aim of investigating how and to what extent green bond firms may perform better than green equity firms in terms of C02 emissions, ESG scores, and financial returns. Given the undeveloped nature of existing literature on this type of comparative study, we have so far made some clarifications on key concepts surrounding these two asset classes.

Despite being green assets, they both still hold some of their original conventional characteristics which we intent to explore in comparing them. To this end, we present this comparison in the following tabular format;

Differences between Green Bonds and Green Equities

Table 1: Differences between green bonds and green equities.

Green bonds	**Green Equities**
Debt Securities or instrument	Capital or Common stocks
Not entitled to ownership	Gives right to ownership
Fixed returns from coupon payments	Variable rewards based on firms' performance
Have a maturity date with the principal repaid	Shareholders may loss original capital due to market conditions
less risky in the face of market movements	Riskier than bonds during unstable market conditions
Green bonds market is a net receiver of shocks	Clean energy stocks are net transmitter of shocks to green bonds
Green bonds can provide hedging benefits to green equity portfolios	Cannot hedge green bonds because of the risk and since carbon allowance can serve as a safe haven for energy shocks
Highly regulated by standards such as the green bond standards and principles	Some sort of laissez faire in the form of individual green labelling

Proceeds from green bonds are mostly raised to finance clean or green energy	Raises capital to finance their green investments

Source: Author's Computation

Irrespective of the differences presented above, we can however strike out the following similarities of both instruments:

1. Both are very connected during extreme market conditions where they boom and bust together.
2. Both green instruments have strong short-term spillovers which disappears in the medium- and long-term investments horizons.
3. Strong diversification benefits of holding both instruments especially during extreme market movements in the medium and long term.
4. In both cases investors are more environmentally and socially responsible with green taste and ready to sacrifice returns for environmentally friendly projects.

2.1.3 **Green Instruments and Environmental performance.**

The most common green instruments that literature presents as green financing tools are green bonds and green equities which have seen remarkable growth in recent years following the Paris agreement. Rising temperatures fueled by accumulated emissions is a call for concern (Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022). It is hoped that carbon dioxide is better controlled and managed through the issuance of green bonds and other green stocks. In this study, we use carbon dioxide emissions and ESG scores to measure environmental performance. In this section, we present the relationship between green bonds, green equities or clean energy stocks and environmental performance management with regards to CO_2 emissions and corporates environmental ratings.

A. Carbon emissions and green bonds vs green equity issuing firms.

Firms that make use of green financing instruments do so with specific obligation to use the proceeds for environmentally friendly projects such as reducing CO_2 emissions and pollution control, renewable energy efficiency, green transports, sustainable agriculture and forestry, biodiversity conservation. The aforementioned projects are all aimed at cutting down emissions which make CO_2 a priority. For effectiveness to prevail, the bonds must be certified by an independent third party as well as respect certain standards and guidelines or principles such as used of proceeds and reporting (ICMA, 2021).

Therefore, by issuing green bonds firms can reduce Green House Emissions (GHE). This is actually being implemented by corporate and government institutions that can invest the proceeds in renewable sources rather than financing oil and gas companies or coal-fired plants. In the U.S, Flammer C. , (2021) conducted a study on some 1189 corporates entities issuing green bonds and find that the environmental performance of those companies significantly improved especially when it comes to CO_2 emissons after the green bonds were issued. This also corroborates that of Alamgir & Cheng, (2023) who use green bonds data of some 68 countries (Supranational bonds) between 2007 and 2021, revealing that green bond issuance in those countries helps to reduce CO_2 emissions by 0.8tons. This was the same case with some chinese listed companies documented by Zhou & Cui, (2019).

The above evidence demonstrate the realationship between green bonds issuance and CO2 emissions. With regards to green equities or clean energy stocks, which is another type of green financing tool to limit CO_2 emissions. In this case the firms simply issue stocks to raise finance or capital which is then invested in clean energy production or renewable energy. By so doing, the companies simply switch from carbon intensive productions to renewable technologies and in this case we evaluate the total amount of renewable energy that is used or produce which automatically limits total amounts of CO_2 emissions. In this study, the 53 clean energy firms are opearting in industries such as energy and utilities, automobile and parts, technology, chemicals and materials, which are normally intensive or heavilly carbon intensive in oprations and therefore issuing green equity stocks is a clear demonstration of its commitments to limit CO_2 emissions.

However, studies demonstrating green equities and CO_2 emissions are still very far fetched in literature and not to talk of comparing these equities with green bonds. There is no doubt that by issuing such green stocks, these companies tend to reduce CO_2 emissions. However, comparing them to green bonds, which could be more performant in terms of CO_2 management and ESG score? This is then the purpose of this study.

B. Financial Performance and ESG scores

Corporate entities issuing green bonds or green stocks are not only interested in environmental performance which is their main goal but might in one way or the other be interested in the overall performance of the company or the green instrument in this case bonds price returns or yield and stock price returns for green stocks. Flammer C. ,(2021) and Zhou & Cui, (2019) found that stock market reacts potively following the issuance of green bonds due to the positive abnormal returns that may be generated post issuance. With respect to clean energy stocks, the use of advanced renewable technologies which are cheaper and competitive makes them more attractive. According to Kumar, Managi, & Matsuda, (2012) as energy demands spike up, carbon intensive companies such as steel, oil and gas, in turn increase their demands for carbon allowance and consequently augmenting carbon prices.

The above scenario pushes companies to opt for cheaper production technologies or greener production channels so as to minimize the negative effects on their stock prices or returns. On the other hand, investors concerntrate their portfolios on green stocks which are less exposed to stock price returns risk. At this point, issuing green bonds becomes profitable for companies and at the same time, a better investment opportunity to investors since the green bonds are used to finance less carbon intensive business operations and thus positive returns. Similarly, green companies or clean energy stocks can capitalize on the carbon being saved and consequently earn additional revenues or incomes from the sales to carbon allowance seeking companies and thus positive clean energy stock prices and returns.

Therefore, investing in green energy stocks or equity may turn to reduce CO_2 emissions and consequently lead to higher financial returns meanwhile green bonds, considered as shock receivers from clean energy stocks because of the large directional spillovers (returns and volatility) from clean energy markets to green bonds markets hence green bonds issuing firms may realize less returns and slightly lower emissions (Pham, 2021; Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022). Another relevant study include that of Pastor, Stambaugh, & Taylor,(2022) who revealed that green stocks outperform non green stocks especially in periods of unexpected climate change concerns. This is similar to the German green bonds outperforming non green bonds in terms of returns.

With regards to ESG scores, which is a typical framework on which to evaluate a company's environmental, social and governance performance, it allows us to assess the sustainability approach of a company. The environmental pillar consist of components such as climate, GHG emissions, pollution, waste and water management, land use, biodiversity while the social pilar includes labour rights, gender diversity, equality, customer satisfaction, employees, human rights. Meanwhile the governance pillar encompases board composition and independence, shareholders, business ethics and compliance. Determining the ESG rates or score entails allocating and measuring certain attributes while aggregating the weights allocated to each element (Gehricke, Ruan, & Zhang, 2024).

For the sake of this study, we use an aggregated ESG score obtained from Refinitiv a key data provider. Other related data providers are MSCI, Sustainalytics, S&P Global, Bloomberg. A study by Berg, Koelbel, & Rigobon,(2022) demonstrates how ESG raters tend to disagree mostly becauqe different rating agencies measure the same attribute using different indicators hence acconting for more than 50% of overall variation in ESG scores from different rating agencies. Despite this differences, a numbers of studies have resulted to using data from a combination of several rating agencies to minimise these effects. Flammer C. , (2021) for example find that firms that do issue corporate bonds improve their E S and G scores. Mean whiles Zhou & Cui, (2019) document significant improvements in the corporate Social responsibilities of some chinese listed firms issuing green bonds.

Unfortunatly, exploring the relationship between green equity stocks and ESG performance is still very scanty in existing literature which is partly the raison d'etre of this study which we intend investigating by camparing with green bonds.

2.2 Theories and Assumptions

According to **(Van Ryn & Heaney, (1992)** a theory is a "set of interrelated concepts, definitions, and propositions that present a systematic view of events or situations by specifying relations among variables, in order to explain and predict the events or situations". In a broader perspective, the theoretical literature explores the interconnectivity of study variables, developed in a story that leads to a hypothesis. It might begin with a conceptual framework or model explaining this relationship through a theory.

Given the novelty of green finance instruments in the domain of sustainable development, academic literature is still very slow in developing appropriate theories to explain the relationship between green finance markets and environmental performance. However, we adopt one or two related conventional or traditional finance and management theories which we think can play a key role in demonstrating these variables of interest. In this section of our literature, we explore and draw insights from signaling theory and the theory of information asymmetry in linking our study variables.

2.2.1. Signaling Theory

The Signaling theory developed by Micheal Spence (Spence, 1973) can be used to explain the role of green finance instruments such as green bonds and green equities in promoting sustainable development practices such as climate action (GHG mitigation). Signaling simply means conveying information through actions or decisions to a less informed party. The theory was further developed by Stephane A. Ross who gave more impetus to the theory by applying it to corporate finance. In finance, the theory is applied in a firm's capital or finance structure to explain how companies engage in certain financial instruments such as debt or equities to transmits pertinent information to market participants.

Green bonds and green equities which are being compared in this study are instruments used by their issuers to convey information about their environmental commitments. Flammer C. , (2021) documents that by issuing green bonds, corporate entities transmit credible information about their environmental commitments to various stakeholders such as investors who can through the signals, differentiate green firms or environmentally friendly firms from non-green firms and thus guiding them in their portfolio selection and decision making. This same study by Flammer further reveals that firms that issue green bonds reduce a considerable amounts of CO_2 emissions from their operations and further improve their environmental, social and governance ratings.

Using green bonds as a signal to demonstrate environmentally friendly projects, Zhou & Cui, (2019) find that the market reacts positively following the issuance of green bonds and the stock price returns and financial performance get better. As a response to this signal investors increase their holdings on the firms' assets especially for long-term and green investors. The implication of this theory to our study are simple and clear in that, the signals created by issuing green bonds or clean energy stocks is an indication of the firm's motivations in raising capital dedicated solely for creating positive environmental impacts such as CO_2 reductions or financing renewable energy through clean energy stocks thus revealing the company's investments in advanced technology through research and development expenses which might even double.

2.2.2. Information Asymmetry Theory

Closely related to the signaling theory is Information Asymmetry theory propounded by (Stiglitz J. 1961; Akerlof, 1970; Spence, 1973). This is a finance theory that explains the variability of information between parties for instance a company and a potential investor or lender. According to this theory, one party is more knowledgeable or has more information than the other. In a firm-lender relationship, the firm is said to have more information than the lender or potential investor leading to moral hazards and adverse selection, hence market failure (Williamson, 1985).

In the case of green bonds or green equity issues, this information asymmetry is totally reduced or eliminated as the information environment between both parties becomes narrow. Similarly, the transaction cost which could be borne by green investors is entirely eliminated due to the fact that, the bonds being issued are guided by norms requiring transparency in the disclosure of how proceeds are used and projects selection procedure, coupled with regular reporting. With these characteristics, green investors are guaranteed on the types of projects being financed before any investments. Therefore, by eliminating information asymmetry through green finance instruments, companies significantly change investor's perception in a positive way.

This is relevant to our study in that, by reducing information asymmetry, investors are now armed with the necessary tools to evaluate corporate environmental commitments and performance. However, given that the information asymmetry and agency cost may be much higher in equity stock issues than bonds, recent development within the green bonds market such as standards and principles leave us with the assumption that green bonds are better tools to manage environmental issues like carbon emissions and thus better environmental ratings than clean energy stock issuers who are still not guided by stringent guidelines or standards

2.3. Empirical Evidence and Hypothesis Development

Following global or international commitments to reduce global temperatures to 2°C and to transition to Net Zero Economy by 2050, multiple studies have emerged to provide scientific or evidence-based insights on how these targets could be met. To this end, research on green financial instruments have become very popular in providing evidenced based policy implications specifically through comparative studies on green versus brown stocks or bonds and further demonstrating the relationship and connectedness amongst these green instruments. However, this has not been the case for green bonds versus green equities.

In this section, we explore the above related studies by presenting three strands of literature as follows; First, we present empirical evidence on green versus brown bonds and stocks, then review literature on green bonds and environmental/financial performance, and finally we dive into evidenced based literature on green equity or clean energy stocks and their connections not only with environmental/financial performance but also with other green asset class such as green bonds or commodities. It should be noted that none of these studies compare green bonds versus green equities which is the focus of this study and thus our contribution to existing literature.

2.3.1. Green Versus Brown Stocks and Bonds

In order to promote sustainable investments and further guide investors in ESG, several studies have been done by comparing green versus brown stocks and bonds (In, Park, & Monk, 2017; Choi, Gao, & Jiang, 2020; Bolton & Kacperczyk, 2021; Duan, Li, & Wen, 2021; Pástor, Stambaugh, & Taylor, 2022; Ardia, Bluteau, Boudt , & Inghelbrecht, 2023; Faccini, Matin, & Skiadopoulos, 2023; Hsu, Li, & Tsou, 2023). In the equity market for instance, Choi, Gao, & Jiang, (2020) in a study period from 2001 to 2017 found that, stocks of highly polluting companies underperformed those of less carbon intensive firms during periods of extreme climate concerns thus forcing carbon intensive stock holders to sell their stocks. Similarly, while investigating green premium in the equity markets, Pastor, Stambaugh, & Taylor, (2022) resulted that, green stocks outperfom brown stocks in the US equity market when environmental concerns double. Ardia, Bluteau, Boudt , & Inghelbrecht, (2023) went futher to test the predictions of (Pastor, Stambaugh, & Taylor, 2022) and found identical results of green minus brown stocks underperformance.

Conversely, Bolton & Kacperczyk, (2021) in a similar study in the US documents that, firms with high carbondioxide emissions earn higher returns which means that brown stocks have higher expected returns than green counterparts. This findings are not in anyway different from those of Hsu, Li, &

Tsou, (2023) whose study also reveals a positive significant relationship between stock returns and toxic emitting companies, implying that brown stocks tend to exhibit higher expected returns and thus surporting the findings of Faccini, Matin, & Skiadopoulos, (2023) in that same perspective.

In the bonds market, while investigating the existence of carbon risk pricing in the corporate bonds market Duan, Li, & Wen, (2021) confirmed that bonds of more carbon intensive firms earn lower returns which is contrary to the usual carbon premium hypothesis. This findings actually corroborates that of Pastor, Stambaugh, & Taylor, (2022) where in an attempt to examine green premium in bonds markt found that German green bonds outperform non-green twin bonds driven by unexpected increase in climate change concerns from investors (Kräussl, Oladiran, & Stefanova, 2024).

Contrary to these studies Zerbib, (2019) applied the matching and the two-step regression methods to determine the yields of green versus conventional bonds between 2013 and 2017 with findings revealing that green bonds outperformed brown bonds in terms yields. Similarly, in "pricing and ownership of US green bonds" between 2010 to 2016 Baker, Bergstresser, Serafeim, & Wurgler, (2022) found that green bonds were issued at a premium meaning lower yields than traditional bonds. Supporting these arguments, Seltzer, Starks, & Zhu, (2022) confirmed that firms with poor ESG profiles tend to realize higher yield spreads but then lower credt ratings for their bonds than firms with good environmental profiles. However, Hyun, Park, & Tian, (2020) still reamain neutral to this ongoing debate on green versus brown bonds performance.

The aforementione studies seem to put potential investors at cross roads with one school of thoughts revealing that green bonds outperform non green bonds which is not the case for pro-brown bond researchers who found higher yields despite intensive carbon activities. On the other end of stocks, a couple of findings still support green stocks outperforming brown stocks though this outperformance exist only in the short run which are only realized and not expected returns, driven by high climate change concerns as documented by pro-brown stocks researchers. However, a firm's or investor's decision will depend on its ESG preference or green taste. Our current study differ and extends literature on green finance instruments by comparing green bonds versus green equities or green energy stocks in terms of envirommental and financial performance.

2.3.2 Green bonds and Evironmental/financial performance

Another strand of literature petinent to our study is the relationship between green bonds and environmental/financial performance, specifically, carbon emissions, ESG ratings coupled with the financial returns of those firms issuing green bonds. Studies such (Zhou & Cui, 2019; Fatica & Panzica, 2021; Flammer C. , 2021; Meo & Abd Karim, 2022; Alamgir & Cheng, 2023; Gehricke, Ruan, & Zhang, 2024) have so far been very instrumental in highlighting these correlations. Zhou & Cui, (2019) used the Propensity Score Matching and the Difference in Difference methodology in a study of 144 green bonds issued by some 70 firms listed on the Chinese stock exchange between 2016 and 2019. The study revealed that the issuance of green bonds by these firms did not only affect their stock prices but also led to a significant positive impact on their financial performance and corporate Social Responsibility. Therefore, by issueing green bonds firms contribute significantly to environmental improvements and financial performance which could attract investors.

Similarly, Fatica & Panzica, (2021) examined whether green bonds issuing firms are more associated to carbon emissions reduction than conventional bond issuing firms and found that, green bonds issuers were more associated to scope 1 GHG emissions intensity reduction than their traditional counterparts with similar financial and ESG ratings characteristics. This study is in line with Alamgir & Cheng, (2023) who employ a one step Generalized Method of Moments (GMM) to investigated the role of green bonds in promoting sustainability and document that green bonds played a vital role in reducing CO_2 emissions while increasing renewable energy production. In fact the study revealed that before 2015 green bonds had no significant effects on emissions and renewable energy production but after the Paris Agreement, global emissions could be seen decreasing while renewable energy production more than doubled.

The most influential of all these studies is that of Flammer C. , (2021) who employed an event study methodology on some 1189 corporate green bond issuers globally and found that stock market reacts positive after the issuance of green bonds leading to cummulative abnormal returns. The findings also revealed that, following the issuance of green bonds, those firms noticed significant improvements in their environmental performance, measured by CO_2 emissions which reduced and ESG ratings which also increased. This significant effect was very pronounced especially with first time issuers and independent third party certified bonds. Despite the studies of (Zerbib, 2019; Seltzer, Starks, & Zhu, 2022; Baker, Bergstresser, Serafeim, & Wurgler, 2022) demonstrating that green bonds were assocoated with lower yiels, the above studies clearly demonstrate the role of green bonds in reducing CO_2 emissions and creating a positive environmental ratings for the issuing companies.

Our study is similar to the aforementioned studies in that, we also investigate the role of green bonds in environmental management specifically CO_2 emissions and subsequent improvement in ESG ratings of the study companies in the US. We however differ by providing an extension or contributing to current literature in that we compare green bonds issuing firms to green equity issuing firms interms of CO2 emissions, improvement in ESG ratings and financial performance, which to the best of our knowledge has not been exploited by existing literature. Secondly we adopt a panel data research design with fixed and random effects estimation techniques instead of the event study methodology of matching and Diff in Diff which is very common amongst the studies listed above.

2.3.3. Green Equity markets and Environmental/Financial performance

Apart from the studies examine previouly on green versus brown stocks, literature on green equities or clean energy stocks and environmental performance such as CO2 emissions seems to be scanty and at the same time very contradictory. Most studies before the 2015 Paris Agreement revealed that clean energy consumption such as renewable energy reduce environmental quality by increasing carbon emissons (Apergis, Payne, Menyah, & Wolde-Rufael, 2010; Farhani & Shahbaz, 2014; Bölük & Mert, 2014). On the other hand, studies on green energy with negative impacts on carbon dioxide emissions(reducing CO_2 emissions through the production and consumption or clean energy) began emerging after the paris agreement of 2015 (Shafiei & Salim, 2014; Bölük & Mert, 2015; Al-Mulali & Ozturk, 2016; Bilgili, Koçak, & Bulut, 2016; Sinha & Shahbaz , 2018; Zafar, Zaidi .S, Sinha, Gedikli, & Hou, 2019).

Zafar et al. (2019) used the Langrange Multiplier Boostrap Panel Cointegration model and found that renewable energy increased environmental quality captured by carbon emissions reduction in G-7 and G-11 countries. Consistent with this results is Bilgili, Koçak, & Bulut, (2016) and Sinha & Shahbaz , (2018) who revisited the Environmental Kuznets Curve Hypothesis and equally applying the Panel Fully Modified/Dynamic Ordinary Least Squares estimations (FMOLS/DOLS) and Autoregressive distributed Lag (ARDL) approach to cointegration for 17 OECD countries and India respectively and found an inverted-U shape relationship between renewable energy and CO_2 emissions. This implies that investments in clean or renewable energy reduces carbon emissions.

Closely related and corroborating the above results is Al-Mulali & Ozturk, (2016) who applied similar panel methodology of FMOLS and the VEC Granger causality for some selected 27 advanced economies with findinga revealing renewable energy negatively impacting CO_2 emissions. Similar results were found in Turkey by Bölük & Mert, (2015) and Shafiei & Salim, (2014) who used the Augmented Mean Group (AMG) approach in verifying the significance of renewable energy on environmental quality. These empirical evidence demonstrate how environmental quality through CO_2 emission reduction can be fostered by investing in clean or green energy such as renewable energy.

Another important and prevalent orientation or on-going research on this particular strand of literature is the dynamic spillover or connectedness amongts green equity (renewable energy stocks), green bonds, crude oil and carbon markets (Henriques & Sadorsky, 2008; Ahmad, 2017; Ferrer, Shahzad .S, López, & Jareño, 2018; Pham, 2021; Nguyen .T, Naeem, Balli, Balli, & Vo, 2021; Liu, Liu, Da, Zhang, & Guan, 2021; Mo, Li, & Meng, 2022; Chatziantoniou, Abakah, Gabauer, & Tiwari, 2022; Tiwari

A. K., Abakah, Gabauer, & Dwumfour, 2022; Hoque, Soo-Wah, Bilgili, & Ali, 2023; Zhang & Umair, 2023).

Pham, (2021) utilized the Generalized Forecast Error Variance Decomposition (GFEVD) of the VAR Model to check the frequency connectedness and the cross quantile dependency between green bonds and green equities and noticed the dependencies between both markets to be high during extreme market conditions, mean while green energy was a net transmitter of shocks to green bonds markets and thus concluding that green bonds can serve as a hedge to green energy stocks. Closely related to this study is Chatziantoniou, Abakah, Gabauer, & Tiwari, (2022) who also evidenced that the S&P Green Bonds Index was the main receiver of short term and long term shocks from the MSCI Global Environmental and the Dow Jones Sustainability world Indices followed by S&P Global Clean Energy index after applying the GFEVD and the (Baruník & Křehlík, 2018; Diebold & Yilmaz, 2012) Models. This again indicates that the green bond market is very sensitive to market movements originating from clean energy markets

Tiwari A. K., Abakah, Gabauer, & Dwumfour, (2022) also made the same conclusions after applying the the Time Varying Parameter VAR-Approach in a investigative study of dynamic spillover effect among green bonds, renewable energy stocks and carbon markets during Covid-19 Pandemic with Clean energy market dominating all other markets in terms of net transmitter of shocks as green bonds and Wind energy Index could be seen receiving these shocks. These findings are consistent with Mo, Li, & Meng, (2022) and Zhang & Umair, (2023) who also applied the Time Varying Parameter VAR-model and the Quantile regression approach.

Given the role played by crude oil prices and technology advancement on renewable energy stocks, we probe further into literature to uncover the degree of spillovers and connectedness which could affect the financial performance green equity stocks. According to Henriques & Sadorsky, (2008), rising oil prices affects the financial performance of alternative companies. Using the VAR Model, his findings revealed that, alternative energy stock prices are more sensitive to movements in the technology markets than crude oil markets. Ahmad, (2017) also document the significant role played by technology and clean energy stocks in crude oil stock prices stating that technology and clean energy indices are the dominant transmitters of shocks (volatility and return spillovers) to crude oil markets. Contrary to this, Ferrer, Shahzad .S, López, & Jareño, (2018) found that crude oil prices are not the main drivers of renewable or clean equity stock prices performance as the market is becoming very efficient in analysing any new informantion. It should however be noted that the technology and renewable energy market move together because switching to less carbon intensive activities will require tecnological inovations.

Secondly any upward movements in oil prices which causes consumers and companies to switch to renewable souces may affect stock market prices of green equity stocks and tecnology companies leading to higher returns for clean energy stocks as their market volatilty increases (Henriques & Sadorsky, 2008; Ahmad, 2017; Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022).

Our study differs from these studies in that we compare green bonds to green equity stocks by investigating whether green bonds issuers better perform environmentally or fiancially than green equity issuers which to the best of our knowledge has not yet been presented in previous literature. By so doing, we intent to better guide investors in their green investment preferences or choices. This is relevant because most studies just compare green versus brown bonds and stocks or examine the frequency connectedness and spillovers amongst these markets which is not our case. Against this background, we find stocks of green equity issuers more performant as they are able to save more carbon allowance than green.

2.4 Hypothesis Development

Given that the negative effects of climate change is now been felt more than ever, studies have revealed the potentials of green finance instruments in financing the transition to green economy and to eventually boost sustainable investments (Pham, 2021; Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022). It is hoped that the switch to renewable energy systems could easily be achieved through the issuance of green bonds or green equities (Clean energy stocks) and by so doing, CO_2 emissions would have been reduced significantly (Alamgir & Cheng, 2023). According to Flammer C. , (2021), issuing green bonds for example is a way of transmiting a message to stock market participants about the firm's commitment to environmental sustainability as it helps to reduce CO_2 emissions and equally promotes the firms ESG scores in a positive way.

The Signaling theory by Spence, (1973) can be used to demonstrates the firms willingness to employ the proceeds raised from these green instruments for environmental projects thus creating a positive impression or signal about the companies'commitment and dedication to Corporate Social Responsibility or environmental wellbeing (Zhou & Cui, 2019; Flammer C. , 2021). This is consistent with the information asymmetry theory of Stiglitz J. , (1961) Akerlof, (1970) and Spence (1973) in that green instruments guided by regulations and standards helps in conveying clear information to investors who are then able to evaluate the performance of the issuing company and thus deciding whether it suits their green or environmental taste. By so doing, information assymmetry between the issuers and the lenders or investors are eliminated. It is therefore no doubt that green bonds issuing firms tend to improve environmental performance as documented by Flammer C. , (2021) and Alamgir & Cheng, (2023).

On the otherhand, the story is not the same for green equities as the instrument is characterized by extreme market conditions, high risk, and volatility especially clean energy stocks (Henriques & Sadorsky, 2008). This market is not highly regulated like the green bonds market, meaning that information asymmetry may prevail, coupled with high agency and transaction cost in trading. The signal generated in this clean energy market may not be as homogeneous as in the green bonds market as a result of the above mentioned factors and specifically because green energy prices are highly sensitive to oil prices and tend to correlate with stock prices of technological companies (Henriques & Sadorsky, 2008; Ahmad, 2017; Ferrer, Shahzad .S, López, & Jareño, 2018).

An increase in oil prices for example will create more market reactions or signals within the clean energy market affecting its stock prices as consumers switch to such alternative energy sources such as renewable energy that co-moves with technological development leading to high stock price returns for clean energy stocks given an increase in their market volatility and demand (Nguyen .T, Naeem, Balli, Balli, & Vo, 2021; Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022). Moreso, given that stock markets reacts quickly and posively to the issuance of green bonds (Flammer C. , 2021), it might just be an indicatio that the market might even react more and positively at the issuance of clean energy stocks coupled with the fact that green bonds are used to finance clean energy stocks.

Against this backgound of empirical evidence and theories, we hypothesise that:

Ha: Green Equity issuers realize better financial returns than green bond issuers.

CHAPTER THREE

DATA AND METHODOLOGY

3.0 Introduction.

This chapter marks the beginning of the second part of our study dedicated to empirical or quantitative analysis. A research methodology presents the roadmap of the steps and procedures applied in transforming an intuition, observation and hypothesis into results or findings using qualitative or quantitative analysis (Thiétart, 2014). In this chapter, we present the research design, data, and variables used in our study, the econometric model, the analytical techniques and estimations thereof.

3.1. Research design, Data and variables.

This study adopts a panel research design where several entities or companies are being observed or studied over a specific time span. This design was carefully chosen because it allows us to control for unobserved variables when we combine cross sectional and time series data, coupled with the fact that the quality and volume of data is guaranteed (Wooldridge, 2015). The panel data also allows us to exploit short and long-term patterns. With this design, we make use of secondary data which is sourced mainly from Refinitiv Eikon DataStream.

The scope of this study spans from the period 2013 to 2024, specifically covering the United States green finance market. This is because the first green finance instrument (green bonds) in the U.S was issued in 2013 by the Bank of America. Secondly, we focus on the U.S market because the U.S is amongst the top green finance mobilizers when it comes to green bonds, after China and Germany (Climate Bond Initiative, 2020). Therefore, in order to provide appropriate answers to our research question which is built on investigating whether green bonds issuers perform better than green equity issuers, we compare the environmental and financial performance of some selected corporate green bond issuers against a couple of corporate green equities or clean energy stock issuers.

Our population under study consist of some 255 corporate green bond issuers in the U.S bond market and some 53 green equity stock issuers from the Nasdaq Clean Edge Green Energy stocks (NASCEUL), for the period 2013 to 2024. For this study, we use the yearly issued amounts and stock prices of both asset classes, which we obtained from Refinitiv Eikon DataStream. We use the Refinitiv data base because of its diversity and concise methodology in presenting ESG data which is quite different from other ESG data providers. In addition to this, other studies such as (Gehricke, Ruan, & Zhang, 2024; Gibson Brandon, Krueger, & Schmidt, 2021) have also exploited this database in their respective studies with appealing results. Our study entities cut across several sectors of the economy such as the clean or renewable energy sector, utilities, chemicals, technolog, industries and the retail sector.

A. Green Bonds Data

The increasing use of green bonds as an instrumental variable to empirically test the growth and advancement in climate finance cannot be overemphasized. Studies such as (Flammer C. , 2021; Alamgir & Cheng, 2023; Zhou & Cui, 2019; Zhang & Umair, 2023) have enormously exploited green bonds data in different perspective. To this end, we adopt green bonds as our principal regressor or independent variable. This data variable is obtained from Refinitiv Eikon DataStream where we use the yearly issued amounts of some 255 corporate green bonds issuers in the U.S green bond market from January 2013 to 31 October 2024. The bonds International Security Identification Numbers (ISIN codes) was very instrumental in the process. With this ISINs we were then able to track their respective linkage IDs or Bond Ultimate Parent Company Data Stream Equity Code (BUPCECD) which we used in obtaining the bonds related equity data or firm fundamentals as related study variables.

In the course of using the bonds BUPCECD codes to get their related firm data such as ESG and financial data, we notice that, a single BUPCECD code was being attributed to one or more ISINs or companies. This is because a single BUPCECD is not unique to a single company and may be sometimes shared across multiple securities or instruments which is not entirely our case. However, after cross examination, we notice that some companies in our green bond data set were subsidiaries or parent companies to others. Similarly, a company like Tesla with over 80 green bond issues had a unique BUPCECD allocated to all 80 Tesla companies with different ISINs.

This repetition across our data was eliminated by researching and matching a unique ISIN to a corresponding BUPCECD through the S&P Capital IQ platform which enabled us to identify the main issuing parent or subsidiary company and thus reducing our total green bond variable data to 62 companies. This is important because other related green bond variables such as ESG and financial data showed only 62 entities using the BUPCECD. Since the objective of this study is to examine the extent to which green bond issuers environmentally and financially perform as compared to green equity issuers, the study makes use of three dependent variables, thus capturing the effects of green bonds on companies; Carbon dioxide emissions, ESG ratings, and stock price returns. These variables are explained below.

In line with (Flammer C. , 2021; Bolton P. &. Kacperczyk, 2021; Alamgir & Cheng, 2023; Ardia, D., Bluteau, K., Boudt, K., & Inghelbrecht, K. (2023). we capture environmental performance by adopting the yearly CO_2 emissions of the 63 green bonds issuing companies as our first dependent variable. For this variable we use the estimated CO_2 emissions total, which includes the total scope 1, 2, and 3 CO_2 and CO_2 equivalent emissions measured in tonnes. We used the total estimated CO_2 equivalent emissions instead of total CO_2 emissions or as a percentage of total revenues firstly because, the estimated values were not only similar to the original values but also because of its rich availability over the study periods. Moreso, the total CO_2 equivalent emissions to revenues data points were very scanty or not available over the entire study period. Therefore, by using the estimated CO_2 emissions total we hope to track and measure the environmental commitments of the 62 green bonds issuing companies in the U.S.

The next dependent variable used in tracking environmental performance of our study entities was their ESG ratings (Flammer C. , 2021; Gibson Brandon, Krueger, & Schmidt, 2021; Gehricke, Ruan, & Zhang, 2024). Using the Environmental, Social and Governance score of these companies we hope to capture the company's progress towards sustainable investments and development. This aggregated yearly data was obtained from Refinitiv which is a renowned ESG data provider with a very clear and concise methodology ranging from 630 + data points to ESG overall score rated between 0 - 8 (D-) to 90 - 100 (A+). An A score indicates that the company is improving and making progress in its environmental, social and governance targets meanwhile a D score reflects very poor performance.

To measure the financial performance of green bond issuers, we used an aggregated stock price returns of the green bonds issuing companies (Gehricke, Ruan, & Zhang, 2024) which we got as a percentage change in the stock prices over the study period. As a third dependent variable of this study, we hope to examine whether by issuing green bonds, firms also realize some capital gains especially to investors who are engaged in doing more good than harm and thus verifying whether and to what extent green bond markets offer a premium to its holders.

Other control variables were worth examining in this study since a company's environmental and financial performance could not only be driven by issuing green bonds. In this light we employ other control variables which could randomly affect our three outcome variables. The following control variables are used in our panel regression as documented by (Bolton & Kacperczyk, 2023): $BETA_{i,t,}$ which is a measure of the market risk; ROA which measures the efficiency of the company in generating profits using its assets; LOG TOT RE TO ENERGY USED IN MILLIONS which reflects and measures the total primary renewable energy purchased and produced in gigajoules divided by energy used total; INVEST/A which is measured and expressed as the firm's capital expenditure divided by total asset book value; ESG CONTROVERSIES which measures the company's exposure to ESG controversies and negative events in the global media; LEVERAGE, which is the ratio of debt to book value of assets; Oil P which captures oil price movements un the U.S; and LOG R&D which measures the companies' total research and development expenses for the period. Given the aforementioned controls, it is important to note that, existing literature still remains very vague on factors that may affect carbon emissions of a company. Data for the above-mentioned variables with the exception of green bonds issued amounts were all obtained from Refinitiv Eikon DataStream using the BUPCECD codes.

The table below presents the 62 green bond issuing companies in the US employed in this study. The table demonstrates that the energy and utility sector is leading in terms of number of companies issuing green bonds (17). This is closely followed by the renewable sector with 9 companies, then the technology and chemicals sector with 7 companies each.

Table 2: Number of green bonds issuing companies per sector

SECTORS	NUMBER OF COMPANIES
Energy and Utilities	17
Renewable Energy	9
Automative	5
Technology/Electronics	7
Material/Chemicals	7
Real Estate	3
Conglomerate	4
Metals/Mining	2
Food&Beverage	1
Retail	1
Transport/Shiping	1
Telecomunications	1
TOTAL	**63**

Source: From Refinitiv Eikon DataStream

B. Green Equity Data

Given the comparative nature of this study, another set of data for green equities stock or variable was necessary for an effective comparison with green bonds. Previous studies on green equities have documented the use of renewable energy, clean energy, green energy stocks, or indices such as S&P Global Clean Energy Index, the NASDAQ OMX Green Economy family, MSCI Global Environmental Index, Solactive Global Wind and Solar Energy, and the Dow Jones Sustainability World Index all referring to green stocks or green equities as documented by (Mo, Li, & Meng, 2022; Pham, 2021; Mo, Li, & Meng, 2022; Chatziantoniou, Abakah, Gabauer, & Tiwari, 2022; Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022; Zhang & Umair, 2023). In corroboration with these studies, we adopt and make use of the NASDAQ Clean Edge Green Energy index (NASCEUL) with 53 constituents for our green equity variable.

We use the 53 U.S companies listed on the NASDAQ Clean Edge Green Energy index (NASCEUL). These companies cover key sectors such as industrial materials, Chemicals, Automobiles and parts, Retails, Electronics, Energy and utilities, Real estate investment trust, and Alternative energy all in the U.S. By using their ISIN codes, the market values of green energy stocks issued by these companies was obtained. The market value of green stocks issued is measured by the stock prices times the number of shares outstanding for the period 2013 to 2014. This constituted our second independent variable for this study.

In line with the dataset on green bonds, we employ similar dependent variables so as to ease comparison between green bonds and green equities. In this case, we use the yearly estimated CO_2 equivalent emissions total and yearly ESG score to capture environmental performance and for financial performance, we also use the yearly stock price returns of the 53 entities constituting the NASDAQ Clean Edge Green Energy index (NASCEUL) for the period between 2013 to 2024. We sourced this data from Refinitiv Eikon DataStream using the unique ISIN codes of each NASCEUL constituent.

Similarly, our control variables for clean edge green energy stocks include; $BETA_{i,t,}$ which is a measure of the market risk; ROA which measures the efficiency of the companies in generating profits using its assets; TOT RE TO ENERGY USED IN MILLIONS which reflects and measures the total primary renewable energy purchased and produced in gigajoules divided by energy used total; INVEST/A which is measured and expressed as the firm's capital expenditure divided by total asset book value; ESG CONTROVERSIES which measures the company's exposure to ESG controversies and negative events in the global media; LEVERAGE, which is the ratio of debt to book value of assets: ; Oil P which captures oil price movements in the U.S; and LOG R&D which measures the companies' total research and development expenses for the period. Though this research is a comparative study and requiring some common characteristics in terms of variables, it is worth noting that the control and dependent variables of each asset class is strictly associated to that specific asset class and group of company, in this case green bonds or green energy stocks, thus affecting our model specification.

The table below presents the total number of green equity stocks issuers per sector used in this study. From the table, we notice that the alternative energy sector has the highest number of companies issuing green stocks under the NASCEUL, followed by the technology sector, and then energy and utilities.

Table 3: Number of green equity (Clean energy stocks) issuing companies per sector

SECTORS	NUMBER OF COMPANIES
Automobile and parts	5
Industrial Materials	2
Alternative Energy	16
Technology	11
Chemicals	3
Construction and Real Estate	4
Energy and Utilities	9
Leisure and consumer goods	1
Investment Trust	1
Retail	1
TOTAL	**53**

Source: From Refinitiv Eikon Datastream

3.2 Econometric Model Specification.

To address the study research question of whether green bond issuers realize better environmental and financial performance than green equity issuers, we adopt a panel regression model which is similar to Bolton & Kacperczyk,(2023) whose cross sectional and time series model covers some 14,468 firms across 77 countries between 2005 to 2018 all in an attempt to price carbon transition risk among carbon intensive firms. Contrary to these, previous related studies such as Flammer C. , (2021) used an event study methodology to assess the impact of corporate green bonds on environmental performance, Similarly, Alamgir & Cheng, (2023) employ the Generalized Method of Moments to investigate the role of green bonds in achieving sustainable development goals.

On the otherhand, previous studies on green equities all aimed at investigating the directional spillover and frequency connectedness between green equity markets, carbon markets and green bonds iether use quantile to quantile regressions, the generalized forecast error variance decomposition of the vector autoregression model, or the time varying parameter VAR – approach (Pham, 2021; Chatziantoniou, Abakah, Gabauer, & Tiwari, 2022; Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022; Hoque, Soo-Wah, Bilgili, & Ali, 2023), all sourced from Diebold & Yilmaz, (2012).

Our regression model is carefully chosen which differs from those stated above because we are not looking at any spillovers between green bonds and green equity markets but rather, we compare both instruments to capture their short- and long-term effects on firms financial and environmental performance. However, studies such as (Farhani & Shahbaz, 2014; Al-Mulali & Ozturk, 2016; Bölük & Mert, 2015) also use panel data models with estimation techniques such as the ARDL, Co-integration, and the FMOLS in documenting the relationship between CO_2 emissions and renewable energy stocks.

Our model below is however based on key variable notes:

1. **Dependent Variables** :

    - **CO2 emissions** (Estimated CO_2 equivalent emissions total measured in tonnes attributed to green investments).
    - **ESG ratings** (Environment, Social, and Governance score).
    - **Financial returns** (Stock price returns of green equity and green bonds issuing companies).

2. **Independent Variables** :

    - **Green Bonds** (issued amounts of green bonds issued).
    - **Green Equities** (the market value of green equity stocks issued).
    - **Control Variables** (we control for Beta, ROA, leverage, capital expenditure, and renewable energy production, oil prices, Research and development).

3. **Time Dimension and cross-sectional units**: We use yearly time periods for the different asset class issuing companies.

4. **Cross-sectional Units (i)**: This would represent different companies, or issuers.

Based on the aforementioned variables specification we use a panel data regression model that considers both fixed and random effects to account for firm level and time differences. To this end, we adopt two main models:

Model 1: Capturing the impact of green bonds issuers on CO2 emissions, ESG score, and returns.

a. Green Bonds CO2 Emissions Reduction Model:

With this model will assess the contributions of green bonds issuers in CO2 emissions reduction while controlling for other factors that might affect emissions:

$$\mathbf{CO2^{GB}_{\mathit{it}} = \beta_0 + \beta_1 Greenbonds(value)_{\mathit{it}} + \beta_2 X_{\mathit{it}} + \mu i + \lambda t + \epsilon_{it}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{(1a)}$$

Where:

- $CO2^{GB}_{it}$ is the estimated CO2 equivalent emissions total by green bonds issuers measured in tonnes per year for entity i at time t.

- Green $Bonds_{it}$ is the yearly issued amount of green bond for entity i at time t.

- X_{it} represents a vector of control variables (like renewable energy produced, Invest/A , or leverage ratio).
- μ_i refers to firm-specific fixed effects (to capture unobserved individual heterogeneity).
- λ_t is the time fixed effects (to account for time-specific shocks that affect all entities).
- ϵ_{it} is the error term.

b. Model for Green Bonds ESG score:

We then use this model to examine and compare how green bonds issuers are improving their ESG ratings:

$$\mathbf{ESG^{GB}_{\mathit{it}} = \alpha_0 + \alpha_1 Greenbonds(value)_{\mathit{it}} + \alpha_2 x_{\mathit{it}} + \mu i + \lambda t + \epsilon_{it}} \quad \textbf{(1b)}$$

Where:

- ESG^{GB}_{it} is the yearly ESG ratings of green bonds issuing firms or for entity i at time t.
- Green $Bonds_{it}$ is the yearly issued amount of green bond for entity i at time t.
- X_{it} represents a vector of control variables (like renewable energy produced, Invest/A , or leverage ratio).
- μ_i refers to firm-specific fixed effects (to capture unobserved individual heterogeneity).
- λ_t is the time fixed effects (to account for time-specific shocks that affect all entities).
- ϵ_{it} is the error term.

c. Model for Green Bonds Financial Returns:

With this model we hope to capture the financial returns associated with green bonds issuing firms

$$\mathbf{RET^{GB}_{\mathit{it}} = \gamma_0 + \gamma_1 Greenbonds(value)_{\mathit{it}} + \gamma_2 x_{\mathit{it}} + \mu i + \lambda t + \epsilon_{it}} \quad \textbf{(1c)}$$

Where:

- RET^{GB}_{it} is the yearly returns of green bonds issuing firms or for entity i at time t.
- Green $Bonds_{it}$ is the yearly issued amount of green bond for entity i at time t.
- X_{it} represents a vector of control variables (like renewable energy produced, Invest/A , or leverage ratio).

- μ_i refers to firm-specific fixed effects (to capture unobserved individual heterogeneity).
- λ_t is the time fixed effects (to account for time-specific shocks that affect all entities).
- ϵ_{it} is the error term.

MODEL 2: Capturing the effects of green equity stock issuers on CO2 emissions, ESG ratings, and returns.

a. Green equities and CO2 Emissions Reduction Model:

With this model, we evaluate the attempts made by green equity issuers in reducing CO2 emissions while controlling for other factors that might affect emissions:

$$\mathbf{CO2^{GE}_{it} = \beta_0 + \beta_1 Green\ Equities(Mkt\ Cap)_{it} + \beta_2 x_{it} + \mu i + \lambda t + \epsilon_{it}} \quad \text{...}\mathbf{(2a)}$$

Where:

- $CO2^{GE}_{it}$ is the estimated CO2 equivalent emissions total by green equity issuers measured in tonnes per year for entity i at time t.
- Green $Equities_{it}$ is the yearly market value of all green stocks issued for entity i at time t.
- X_{it} represents a vector of control variables (like renewable energy produced, Invest/A, or leverage ratio, e.t.c..).
- μ_i refers to firm-specific fixed effects (to capture unobserved individual heterogeneity).
- λ_t is the time fixed effects (to account for time-specific shocks that affect all entities).
- ϵ_{it} is the error term.

b. Model for Green Equity firms ESG score:

We then use this model to examine how green equity issuers are improving their ESG ratings:

$$\mathbf{ESG^{GE}_{it} = \alpha_0 + \alpha_1 GreenEquities(Mkt\ Cap)_{it} + \alpha_2 x_{it} + \mu i + \lambda t + \epsilon_{it}} \quad \text{...}\mathbf{(2b)}$$

Where:

- ESG^{GE}_{it}: is the yearly ESG ratings of green equity issuing firms or for entity i at time t.
- Green $Equities_{it}$ is the yearly market capitalization value of green equity stocks issues for entity i at time t.
- X_{it} represents a vector of control variables.

- μ_i refers to firm-specific fixed effects.
- λ_t is the time fixed effects.
- ϵ_{it} is the error term.

c. Model for Green Equities Financial Returns:

With this model we attempt to capture the financial returns associated with green equity issuing firms

$$\mathbf{RET^{GE}_{\mathit{it}} = \gamma_0 + \gamma_1 Greenbonds(value)_{\mathit{it}} + \gamma_2 x_{\mathit{it}} + \mu i + \lambda t + \epsilon_{it}} \text{……………………………………………………………….} \textbf{(2c)}$$

Where:

- RET^{GE}_{it} is the yearly returns of green equity issuing firms for entity i at time t.
- Green Equities $_{it}$ is the yearly market capitalization value of green equity stocks issues for entity i at time t.
- X_{it} represents a vector of control variables.
- μ_i refers to firm-specific fixed effects.
- λ_t is the time fixed effects.
- ϵ_{it} is the error term.

For our comparative analysis, model 1 results will be compared with those of model 2. In this case, 1a Vs 2a, 1b Vs 2b, and 1c Vs 2c so as to derive the most performing green instrument.

3.3 Analytical methods and estimation techniques.

In order to test the above specifications and provide answers to our research questions, we engaged several methods of analysis with respect to the models. However, our analysis is driven by the following hypothesis:

Ha: Green Equity issuers realize better financial returns than green bond issuers.

We follow strict econometric procedures for our estimations where we run both random and fixed effects regressions for both green bonds and green equities. Then we proceed to the Hausman test results based on the Prob > chi2 values to supports the use of fixed effects or random effect for either green bonds or green equities. From the results we also verify whether the model supports key panel data assumptions such as heteroskedasticity and autocorrelation. Despite the Hausman test being in support of Fixed effects or Random effects, we could observe some basic violations of panel assumptions. To curb this issue and ensure validity and reliability of our results, it was pertinent for us once again to conduct an estimation technique that could handle this issue. To this end, we employed the clustered fixed effects, the Driscoll and Kraay estimator, and the feasible generalized least squares (FGLS). Among these, the FGLS results revealed more outstanding and reliable estimates which we finally adopt for our analysis from STATA.

CHAPTER FOUR:

DATA ANALYSIS AND PRESENTATION OF RESULTS.

4.0 Introduction

In this chapter, we develop and present our results based on quantitative analysis conducted. The chapter however unfolds with a brief statistical description of our data using the mean, standard deviation and correlation. We then proceed to verify the results in line with our research objectives, question and hypothesis. Following our preestablish models, analytical techniques and estimations, we are able to either accept or discard our hypothesis which is also in line with our study objectives.

4.1 Descriptive Statistics and Correlation Matrix.

The following table represents the summery statistics and the correlation Metrix from our analysis in their raw forms.

Table 4: Descriptive statistics

Green Bonds

Variable	Obs	Mean	Std.dev.	Min	Max
CO_2	732	1.46e+07	2.35e+07	394	1.80e+08
ESG	732	58.94112	17.22616	5.35	92.12
Returns	744	1.231934	3.428413	-11.0005	26.6442
GRB issue	744	570437.1	238764.1	5000	1300000
Beta	744	1.011401	.7793688	-1.2711	13.025
ESG Controv	732	82.94756	27.65507	.75	100
Invest/A	732	7.107366	7.274239	0	68.325
Lev	732	237.461	426.4322	-2529.42	3595.44
ROA	732	4.371861	4.942285	-15.73	43.62
Tot RE	540	4.16e+07	1.73e+08	0	1.50e+09
Oil P	744	64.96582	20.25002	36.3683	96.3727
R&D	324	3.74e+08	8.25e+08	0	4.90e+09

Source: Author’s computation from STATA

Green Equity

Variable	Obs	Mean	Std. dev.	Min	Max
CO_2	468	296491	752131.4	61	8500000
ESG	480	36.8417	20.03356	.24	85.09
Returns	504	.8967553	5.321867	-12.7339	38.285
GRE issue	504	4415.327	8530.573	18.7283	102201
Beta	504	1.513002	1.65782	-15.0079	26.3258
ESG Controv	480	89.99949	19.43025	3.85	100
Invest/A	504	2142865	1.95e+07	0	3.60e+08
Lev	504	98.63183	539.4414	-2270.39	9676.97
ROA	504	-18.5333	146.232	-3186.81	61.85
Tot RE	216	1.89e+08	7.14e+08	0	3.80e+09
Oil Price	504	64.96552	20.25632	36.3683	95.9958
R&D	396	126483.3	266239.5	0	1900000

Source: Author's computation from STATA

From the table above, we noticed that due to missing values in our data sets the total number of observations vary across different variables after cleansing. However, looking at the statistics of green bonds issuers against that of green equity issuers, we noticed that CO_2 emissions of green bonds issuers is way too higher than that of green equity issuers with a maximum of 180,000,000tons and a minimum of 394 tons, contrary to a maximum of 850,000tons for green equity issuers and a minimum of 61tons. The same tendency holds for the means and standard deviations meaning that green bond issuing firms are emitting more CO_2 emissions that green equity issuers.

The next dependent variable of this study is the ESG scores. The statistics above equally reveals green bonds issuers realizing or improving their environmental ratings than green equity issuers with a maximum of 92% and a minimum of 35%, with an average score of 58% for all green bonds' issuers. On the other hand, green equity issuers on an average only have an ESG score of 36% which is poor according to Refinitiv ratings. In addition to this, the highest ESG score for green equity firms is 85%. Looking at the returns, green equity issuing firms turn to realize higher percentage change in their stock price with a maximum positive percentage change of 38.2 while that of green bonds issuers is at 26.6 percentage change. This shows that green bonds issuing firm turn to improve their ESG ratings more than that of green equity firms though green bonds issuers may be emitting more than green equity issuers simply because of the capital expenditure or asset investment types of green bonds issuers that might not entirely promote environmental sustainability.

Comparing our main dependent variables of interest, green bonds issued amount and the market value of green equity stocks issued, we find green bonds dominating with a maximum of USD 1.3billion and a minimum of USD 5,000,000. Averagely a green bond issuing firm could issue bonds worth USD 570,437,000. In the case of green equities, these values are much lower with just a maximum of USD 102,000,000 and a minimum of USD 18,700. Averagely, green equity issuers mobilized the sum of USD 4,415,000 as green equity. Looking at the figures, we clearly see that green bond issuers mobilized more green funds than green equity issuers.

Looking at the beta, which we use to capture market risk, we notice this risk to be much higher within the equity market with a maximum of 26.3 and an average of 1.51. Green bonds issuing firms on the other hand exhibit less market risk with a maximum of 13.02 and a mean value of 1.01. This implies that equity market could be riskier than green bonds market and therefore we expect high returns in such risky markets. For capital expenditure, denoted by invest/A, both group of firms show significantly high proportion of capital expenditures investments in assets with green equity issuers dominating on average. The mean value for green equity capital expenditure is 2142865, and 7.107366 for green bonds issuers. This shows that green equity issuers really use the funds generated to invest in new renewable technologies which require huge capital expenditures.

Green bonds issuing firms also tend to be highly leverage with an average leverage ratio of 236% and 98% for green equity firms. This is because green bonds is a cheap source of capital for such firms whose investors are ready to give up financial returns. With respect to return on assets, green equity issuers have a maximum return on assets of 61.85 and an average of – 18.53. which obviously reflect their capital expenditure as indicated above. Green bonds however show a more realistic average returns on assets 4.371% with a maximum of 43.62%. Therefore, averagely speaking, green bonds with less capital expenditure on assets are able to generate high returns on assets than green equity issuers with huge assets capital expenditure. Oil prices remain the same for both group of companies since they are all sample companies selected from the US. Similarly, green bonds issuing companies exhibit very high research and development expenses, with a mean value of USD 374,000,000, which is much higher than the mean value for green equity issuers of USD 126,483. This shows that green bonds issuers invest more funds into developing new technologies and innovations that accommodate high environmental sustainability.

From the descriptive statistics above we also run a regression to estimate the correlation between variables. This enabled us to ascertain the degree of association between our explanatory variables and the dependent variable. Table 5 and 6 below presents the summary of the correlation results.

In table 5 below, representing green bonds, we notice an overall week correlation between the variables with the highest value at 0.28 representing a positive relationship between beta and returns which is normal because high risk is always associated with high returns. Looking at our key variables of interest, Log of green bonds issued and our dependent variables: ESG, Log of CO_2 emissions, and their stock price returns, we notice a very weak, though positive association between green bonds issued and ESG scores, CO_2 emissions and a negative correlation with returns.

These results are however significant, meaning that an increase in green bonds issued amount is positively associated with an increase in ESG scores, CO_2 emissions and negatively associated with the stock price returns of those companies. We also observe a negative relationship between total renewable energy as a proportion of energy used with variables such as ESG scores, returns, ROA, ESG controversy, and R&D while maintaining a positive relationship with other variables. The ESG scores actually reduces because the amount of renewable energy used is not enough to influence the environmental sustainability of the companies which explains why CO_2 emissions may increase and thus justifying the fact that more non-renewable sources are used by green bonds issuing companies. The returns also decrease, meaning that a significant proportion of the RE used is purchased than produced which deteriorates market returns.

Furthermore, green bonds also display a negatively weak relationship with the Beta risk factor and ESG controversy while the other variables such as Invest/A, R&D, Oil Prices, and RE used are positively associated to it. The negative relationship is normal as green bonds are almost risk-free financial instruments hence less risk and by issuing them, a positive image is created which reduces any possible controversy about the companies. The former also explains why Beta and Lev have a negative relationship. The positive relationship with invest/A, R&D, RE used, and Oil prices basically reflects the high capital expenditure and increased research and development that the green bond issuing companies are involved with such as renewable energy and other technologies that required high research and investments in the assets concerned thus justifying the positive relationship between R&D and Invest/A with a value of 0.18.

In general, we observe a very weak relationship between all variables whether positive or negative with a majority of them displaying a significant value with the highest correlation at 0.28. However, this indicates that multicollinearity may not be an issue in the model and variables selection.

Table 5: Correlation Table Green Bonds

	1	2	3	4	5	6	7	8	9	10	11	12
ESG	1.0000											
Log CO_2	0.2226*	1.0000										
Returns	-0.0457	-0.1411*	1.0000									
Log GRB	0.0951*	0.1564*	-0.1153*	1.0000								
Beta	-0.0942*	-0.1221*	0.2820*	-0.0374	1.0000							
ROA	0.0732*	0.0527	-0.0281	0.0943*	-0.0495	1.0000						
Lev	-0.1359*	-0.0111	-0.0420	-0.0355	-0.0895*	-0.1062*	1.0000					
ESG Controv	-0.1612*	-0.1486*	-0.0105	-0.1390*	-0.1112*	-0.0100	0.0777*	1.0000				
Invest/A	-0.1513*	-0.2257*	0.1499*	0.0753*	0.1987*	0.0179	0.1180*	-0.1263*	1.0000			
Log R&D	-0.0660	0.1319*	-0.0805	0.0429	-0.0965	0.1345*	-0.2016*	-0.0988	0.1831*	1.0000		
Oil P	-0.0162	0.0075	-0.0524	0.0000	0.0385	0.1167*	-0.0641	-0.0690	0.0343	-0.0170	1.0000	
Log RE	-0.1015*	0.0607	-0.0566	0.1322*	0.0781	-0.0136	0.1818*	-0.0359	0.0478	-0.1711*	0.0332	1.0000

Source: Authors computation from STATA

With respect to green equities, presented in table 6 below, we observe a relatively weak relationship between variables with the exception of 0.58 denoting the relationship between R&D and Green equity stocks (Log GRE). Apart from this, all other associations are below 0.35 demonstrating an averagely weak correlation between our variable.

Looking at our variables of interest, we observe that GRE has a positive relationship with ESG scores, CO_2 emissions and a negative relationship with returns which is the same as observed under green bonds issuers even though the relationship here are pretty much stronger than those of green bonds. This relationship however implies that, the issuance of green equity stocks leads to an increase in ESG scores, CO_2 emissions, and decreases the issuers stock price returns. With respect to other control variables, GRE shows a negatively weak relationship with Beta, ESG Controversy score, and Invest/A, with a positively weak association to ROA, Lev, R&D, Oil Prices, and RE. The only exceptional coefficient here is 0.58, denoting the relationship between R&D and GRE, meaning that as research and development expenses increase, the company is more comfortable issuing green equity stocks since the company already possesses a good mastery of recent innovations or technological developments in renewable energy which eases investments in such domains.

The table also shows a negative relationship between ROA, Beta, Lev, Oil Prices, R&D, RE and the stock price returns which could be explained by the nature of investments (Invest/A) which does not favors growth and that the proportion of renewable energy used is purchased or produced at a higher cost leading to negative returns. Note that Invest/A and ESG controversy are the only variable with a positive association with returns. The Beta and Lev variables also display a positive relationship indicating that as these groups of companies borrow, their market risk gets higher which negatively affects their returns. This is because green equity stocks are normally riskier than green bonds thus negative expected returns.

Despite the positive relationship between R&D and GRE, we notice a similar relationship between R&D, Invest/A and CO_2 emission. This again implies that green equity companies' capital expenditure and R&D expenses are associated with high emissions as they do not entirely favor green energy operations which might still mean that, despite involve in clean energy stock, these companies still invest in carbon intensive operations. Next, we observe the relationship between renewable energy purchased and produced as a fraction all energy used and other variables where we realize a negative relationship with CO_2 emissions, Returns, Beta, ESG Controversy, Invest/A, R&D, and Oil Prices. This is normal and indicates that as the companies makes used of more renewable energy sources in their operations, emissions falls, reducing any controversies on ESG, which forces the companies to moderates their capital expenditures, and R&D expenses. Since products reflects renewable energy innovations, consumers easily switch to such products leaving oil producing companies unattractive thus a decrease in oil Prices. However, the returns of these companies drops because increased consumers demand cause prices to rise affecting the stock prices which leads to low expected returns.

With this, the results of green equities correlation still show an exceptionally weak-strong relationship on an average than those of green bonds as shown below.

Table 6: Correlation Table Green equities (GRE)

	1	2	3	4	5	6	7	8	9	10	11	12
ESG	1.0000											
Log CO_2	0.2552*	1.0000										
Returns	-0.0470	0.0897	1.0000									
Log GRE	0.2300*	0.1676*	-0.1186*	1.0000								
Beta	0.0234	0.0777	-0.0287	-0.0025	1.0000							
ROA	0.0431	-0.1190*	-0.0315	0.2149*	-0.0177	1.0000						
Lev	0.0733	0.0571	-0.0471	0.0371	0.0145	0.0301	1.0000					
ESG Controv	0.0770	0.0870	0.0841	-0.1573*	0.0490	-0.0026	0.0737	1.0000				
Invest/A	-0.1000*	0.0148	0.1005*	-0.1216*	0.0432	-0.0583	-0.0195	0.0580	1.0000			
Log R&D	0.2002*	0.3441*	-0.1065*	0.5845*	-0.0508	-0.0908	-0.0129	-0.0293	-0.0608	1.0000		
Oil P	0.0496	-0.0049	-0.1799*	0.0696	-0.0108	0.0360	0.0033	-0.1297*	-0.0573	0.0503	1.0000	
Log RE	0.1108	-0.0308	-0.2557*	0.0805	-0.2034*	0.0355	0.0628	-0.1033	-0.0049	-0.3240*	-0.0049	1.0000

Source: Author’s Computation from SATA

4.2. Model 1: Improvement of Environmental ratings between green between green equity issuers and green bonds issuers.

Our objective here was to investigate whether green equity issuing companies do improve their ESG ratings or scores than green bonds issuing companies. Our initial estimation technique was the fixed and random effects panel regressions which we employed on the yearly observations of these two groups of companies from 2013 to 2024. Green bonds issuers represented by 25 companies from a total of 63 originally selected companies after data cleansing, thus leaving us with a total of 299 yearly observations. Similarly, for green equities, our data cleansing resulted to 32 companies from 53 originally available companies, leading to a total of 382 yearly observations.

We then ran the fixed and Random effects on these two groups of companies so as to account for any unobserved or individual heterogeneity within and across companies over time. However, following the results of our Hausmann test with a p-value or $p>chi2 = 0.0209$ for green bonds issuing firms and a $p>chi2 = -100.59$ for green equity issuing firms, we rejected the null hypothesis of the error term not correlating with the model regressors. These tests was therefore in favour of fixed effect results adoption. Unfortunately for us, these results were not free from cross sectional dependence, autocorrelation and heteroskedasticity problems that need not be violated as key panel data assumptions, demonstrated by the Breusch-Pagan and the Wooldridge test of heteroskedasticity and autocorrelation respectively (see appendices, page 66 – 74).

To address these problems, and ensure the robustness of the results, we applied techniques specifically designed to accommodate such issues. This includes, clustered fixed effects, the Driscoll and Kraay estimator, and the feasible generalized least squares (FGLS) (see appendices, page 66 – 74). Among these, the FGLS results provided more reliable estimates as displayed below.

Table 7: Green bonds and ESG scores

ESG Score	Coefficient	Std. err.	z	P>|z|
LOG GRB ISSUE	3.06617	1.698764	1.80	0.071*
BETA	-.5556528	1.56194	-0.36	0.722
ROA	.2400422	.1674507	1.43	0.152
LEVERAGE	-.0033866	.0024113	-1.40	0.160
ESG CONTROV	-.0459246	.018883	-2.43	0.015**
INVEST/A	.0055494	.1796165	0.03	0.975
LOG R&D	-1.395044	.2629363	-5.31	0.000***
OIL PRICE	.0020043	.020147	0.10	0.921
LOG TOT RE	-.2661464	.2376451	-1.12	0.263
Constant	51.31865	24.28063	2.11	0.035***

Number of observations: 227
Number of groups: 19
P-value: *** Sig at 1%; ** Sig at 5%; *Sig at 10%

Source: Author’s computation from STATA

Table 8: Green Equity issuers and ESG score

ESG Score	Coefficient	Std. err.	z	P-value
LOG GRE ISSUE	2.08009	.8302883	2.51	0.012**
BETA	-2.385445	1.352182	-1.76	0.078*
ROA	-.080255	.0416066	-1.93	0.054*
LEVERAGE	.0014858	.0011436	1.30	0.194
ESG CONTROV	-.0157445	.0253439	-0.62	0.534
INVEST/A	-.0185621	.0636963	-0.29	0.771
LOG R&D	4.272667	.9413873	4.54	0.000***
OIL PRICE	.062407	.0313298	1.99	0.046**
LOG TOT RE	-.4004809	.3289778	-1.22	0.223
Constant	-11.66442	10.41766	-1.12	0.263

Number of observations: 143
Number of groups: 12
P-value: *** Sig at 1%; ** Sig at 5%; *Sig at 10%

Source: Author's computation from STATA

The results from the two tables above reveals that green bond issuers improve their ESG scores following the issuance of green bonds as the GRB issued displays a positive coefficient of 3.066. On the other hand green equity firms also realize a GRE positive coefficient of 2.080 which is however lower than that of green bonds issuing firms. These results are however statistically significant at 10% and 5 % respctively. Looking at our control variables we also find that, the firms leverage ratio, research and development and oil prices all have positive coefficients, while the other control variables such as Beta, Invest/A, ROA, and total renewable energy used to energy usage display a negative effect on the ESG scores of green equity issuing firms though only research and development portrays a significant value. This implies that, when the firm is highly leverage through green bonds, it tends to improve its research and development expenses on environmentally sustainable projects so as to meet the changing and increased demands from environmentally friendly consumers and investors especially as oil prices tend to rise.

For green bonds, ROA, Invest/A, and Oil prices tend to positively impact their ESG scores while the other remaining control variables like research and development, leverage, renewable energy used to total energy all have a negative effect on green bonds issuers ESG scores.

4.3. Model 2: Management of CO_2 emissions by green bonds issuers versus green equity issuers.

In order to answer the question of whether green bonds issuing firms are better in managing their CO_2 emissions than green equity stock issuers, we employ the total estimated CO_2 emissions of these two groups of companies as our dependent variables while maintaining the issued amount and the market value for green bonds and green equities respectively as independent variables. Again, due to the amount of missing data, we proceeded to data cleansing, eliminating companies with no data thus leaving us with just 19 companies from a total of 62 green bond issuing companies and thus 227 observations. A similar process was affected on green equity data base, leaving us with just 12 companies and 143 observations from an initial number of 53 green equity issuing companies.

Our statistical analysis follows the same econometric procedures like in model 1 above where we first run a random and fixed effects regression estimations for both green bonds and green equities. Although the Hausman test results (Prob > chi2 = 0.0488) supported the use of fixed effects estimation for green bonds and the random effect for green equities (Prob > chi2 = 0.9558), both results were problematic as they both still exhibit some violations of panel data assumptions such as heteroskedasticity and autocorrelation. To curb this issue and ensure validity and reliability of our results, it was pertinent for us once again to conduct an estimation technique that could handle this issue. To this end, we employed the clustered fixed effects, the Driscoll and Kraay estimator, and the feasible generalized least squares (FGLS) (see appendices, page 66 – 74). Among these, the FGLS results revealed more outstanding and reliable estimates as seen on the following tables:

Table 9: Green bonds and CO_2 management

LOG CO_2	Coefficient	Std. err.	z	P-value
LOG GRB ISSUE	.6657565	.1131142	5.89	0.000***
BETA	.3883671	.1398255	2.78	0.005***
ROA	.0024624	.0135048	0.18	0.855
LEVERAGE	-.0002049	.0002721	-0.75	0.451
ESG CONTROV	-.00033	.0011533	-0.29	0.775
INVEST/A	.0377767	.0159161	2.37	0.018**
LOG R&D	.0010578	.0305891	0.03	0.972
OIL PRICES	.0010756	.0016395	0.66	0.512
LOG TOT RE	.0251591	.0207524	1.21	0.225
Constant	5.301414	1.61993	3.27	0.001***

Number of observations: 227
Number of groups: 19
P-value: *** Sig at 1%; ** Sig at 5%; *Sig at 10%

Source: Author's computation from STATA

Table 10: Green equity issuers and $C0_2$ management

LOG CO_2	Coefficient	Std. err.	z	P-value
LOG GRE ISSUE	.2245685	.0794029	2.83	0.005***
BETA	-.2001779	.0956516	-2.09	0.036**
ROA	-.0056689	.0034949	-1.62	0.105
LEVERAGE	-.0000559	.0001234	-0.45	0.651
ESG CONTROV	-.0018609	.0019719	-0.94	0.345
INVEST/A	-.0043675	.0064161	-0.68	0.496
LOG R&D	.2847964	.088056	3.23	0.001***
OIL PRICE	-.0035349	.0024205	-1.46	0.144
LOG TOT RE	-.0148624	.0187413	-0.79	0.428
Constant	7.15752	1.0807	6.62	0.000***

Number of observations: 143
Number of groups: 12
P-value: *** Sig at 1%; ** Sig at 5%; *Sig at 10%

Source: Author's computation from STATA

The above results demonstrate that green finance instruments in the US (green bonds and green equities do not reduce carbon emissions. Both green instruments display a positive and significant effect on CO_2 emissions with green bonds issuers increasing their CO_2 emissions by 0.66tons and green equity issuers by 0.22 tons. However, green equity issuers tend to be more efficient in managing their emissions than green bonds issuers as revealed by their coefficients though more significant for green bonds issuers. Interestingly and to better explain the above results, we controlled for total renewable energy to energy used which measures the total primary renewable energy purchased and produced in gigajoules divided by energy used total.

We find that, this variable reduced CO_2 emissions for green equity firms (with a coefficient of - 0.014) meanwhile it increases CO_2 emissions for green bond issuing firms (coefficient of 0.025). This implies that green equity firms used and produce more renewable energy in their business operations which does not seem to be the same case for green bond issuers who use and produce more traditional energy in their business operations leading to more CO_2 emissions. Closely related to this are variables such as invest/A, R&D, and oil prices which also increase CO_2 emissions meaning that green bonds issuing firms capital expenditure on assets (invest/A), research and development expenses are not directed to enhance environmental sustainability. For green equity issuing companies, all control variables except research and development tend to reduce CO_2 emissions especially when the R&D expenses might still be at the pilot identification stage of potential renewable sources.

4.4. Model 3: Comparing stock price returns of green equity issuers to that of green bonds issuers.

Our main objective here was to determine how better the stock price returns of green equity issuers were, as compared to green bonds issuers (bonds returns). In order to attain this objective, we make use of a formulated hypothesis, constituting our main hypothesis for this study. We assumed that green equity issuers realize better financial returns than green bond issuers. To capture these returns, we used the changes in stock prices of green equity stocks and the changes in bond prices for green bonds returns. Our data cleansing and elimination of irrelevant variables resulted to 227 observations for 19 green bonds issuing firms and 143 observations for 12 green equity issuing firms for the study period interval.

Our statistical analysis follows the same econometric procedures like in model 2 above where we first run a random and fixed effects regression estimations for both green bonds and green equities. Although the Hausman test results (Prob > chi2 = 0.5430) supported the use of random effects estimation for green bonds and the fixed effect for green equities (Prob > chi2 = 0.0003), both results however appear to be problematic as they both still exhibit some violations of panel data assumptions such as heteroskedasticity and autocorrelation. To adjust this issue and ensure validity and reliability of our results, it was pertinent for us once again to conduct an estimation technique that could handle these issues. To this end, we employed the clustered fixed effects, the Driscoll and Kraay estimator, and the feasible generalized least squares (FGLS) (see appendices, page 66 – 74). Among these, the FGLS results revealed more outstanding and reliable estimates as seen on the following tables:

Table 11: Green bonds and stock price returns

GRB Returns	Coefficient	Std. err.	z	P-value
LOG GRB ISSUE	-.3641197	.2939616	-1.24	0.215
BETA	.3003327	.2868093	1.05	0.295
ROA	-.0150492	.0449601	-0.33	0.738
LEVERAGE	.0004138	.0003632	1.14	0.255
ESG CONTROV	.0026992	.005026	0.54	0.591
INVEST/A	.0202253	.0444107	0.46	0.649
LOG R&D	-.0488681	.0327247	-1.49	0.135
OIL PRICE	.0122459	.0061626	1.99	0.047**
LOG TOT RE	-.0387649	.0363272	-1.07	0.286
constant	5.358461	4.216113	1.27	0.204

Number of observations: 227
Number of groups: 19
P-value: *** Sig at 1%; ** Sig at 5%; *Sig at 10%

Source: Author's computation from STATA

Table 12: Green equity issuers and stock price returns

GRE Returns	Coefficient	Std. err.	z	P-value
LOG GRE ISSUE	-.0274768	.4822323	-0.06	0.955
BETA	-.2467022	.6263913	-0.39	0.694
ROA	.0019957	.024753	0.08	0.936
LEVERAGE	.0023964	.0012098	1.98	0.048**
ESG CONTROV	.010475	.0144761	0.72	0.469
INVEST/A	-.1403698	.050366	-2.79	0.005***
LOG R&D	-.2913697	.3933066	-0.74	0.459
OIL PRICE	-.0458546	.0167987	-2.73	0.006***
LOG TOT RE	-.4510392	.1223536	-3.69	0.000***
Constant	13.64087	5.117897	2.67	0.008***

Number of observations: 143
Number of groups: 12
P-value: *** Sig at 1%; ** Sig at 5%; *Sig at 10%

Source: Author's computation from STATA

The results above reveal that, the issuance of green bonds or green equities has a negative impact on the stock price returns of these two groups of companies even though this negative impact is highly felt by green bonds issuers than green equity issuers. Specifically, green bond issue has a negative coefficient of -0.36 indicating that the issuance of green bonds reduces bonds price returns by 0.36. On the other hand, green equity issuing firms realize a much better stock price returns as the log of green equity issuance displays a negative coefficient of just - 0.02 which means that by issuing green equities or clean energy stock, the stock market reacts negatively by just 0.02. This demonstrates that, green equity issuing firms have better performing stock price returns that green bond issuing firms.

More interestingly under green bonds, when we control for other variables, we realize that the return on assets for green bonds issuing firms, research and development and the proportion of renewable energy to energy used all negatively affects their bonds price returns which is not the case for the leverage ratio, ESG controversy score, capital expenditure on assets and oil prices as they tend to improve bonds price returns. Oil prices display a significant and positive relationship with bonds prices because as oil prices increase, the bonds proceeds are indeed directed to sustainability linked investments as captured by their huge capital investments since consumers tend to technologically driven-cheaper energy sources thus positively impacting its prices in the bond market.

In the green equity market with minor negative impacts on stock price returns, the leverage ratio, return on assets, and ESG score display a positive effect on clean stock returns while capital expenditure (Invest/A), R&D, oil prices, and total renewable proportion to energy used all have a negative impact on stock returns with significant values for capital expenditure on assets, oil prices and renewable energy usage. In general, the results validate our hypothesis that green equity issuers realize better financial returns than green bonds issuers as their stock price returns are less impacted by investments in renewable energy as compared to those of green bonds issuers whose stock price returns falls by 0.36 contrary to 0.02 for green equity issuers.

The above results therefore reveal that despite emitting more CO_2 emissions, green bonds issuers are gaining more ESG credits than green equity issuers with low CO_2 emissions which we attribute to the capital expenditure relative to assets (Invest/A) which improves green bond issuers ESG ratings while negatively affecting green equity issuers ESG ratings. This also implies that the capital expenditures of green bond issuers accommodate more sustainable development activities or investments. On the other hand, green equity issuers emit less CO_2 emissions than green bonds issuers because of the high proportion of renewable energy purchased and produced. This is contrary to green bond issuers with very low amount of renewable energy produced and purchased as a proportion of its total energy used. Even though both groups of companies realize negative returns, those of green bonds issuers are worser than those or green equity issuers implying that green equity issuers have better financial performance in terms of stock price returns than green bond issuers.

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CHAPTER 5:

DISCUSION OF RESULTS.

5.0 Introduction.

In the previous chapter, we have presented the results based on our analysis and interpretation. This chapter will take us through a critical and an in-depth understanding of the results obtained with emphasis on their significance and comparing the results obtained with existing theoretical and empirical literature. We shall also be assessing to what extend our research questions/objectives are answered or attained and if in line with our hypothesis. By so doing we hope to emerge with possible justifications for any divergence from existing literature.

5.1 ESG Scores and Green finance instruments (Green bonds vs green equities)

Our objective here was to compare the ESG ratings of green bonds issuing firms versus those of green equity firms. This implies that it was pertinent to know whether green equity firms achieve better environmental scores than green bonds issuers. The results obtained reveals that green bonds issuers have better ESG scores than green equity issuers who also display a positive relationship with ESG scores. Our research objective is indeed attain here in that we find some differences in the ESG scores of both group of companies though we find a response to our research question in the opposite direction with green bonds issuers dominating green equity issuers in ESG scores.

Controlling for other variables, we notice that capital expenditure on asset book value, denoted by (Invest/A) was high and displayed a positive relationship with green bonds issuer's ESG ratings which was not the case for green equity issuers with a negative coefficient which simply implies that green bonds issuing companies invest on assets and initiatives that accommodates environmental, social and governance criteria such as green infrastructures, green technological equipment's and social initiatives than green equity issuers.

One abnormality with this result is that research and development which should have complemented the huge and significant investments of green bonds issuers tend to portray a negative relationship with their ESG scores which is not the case for green equity issuers with a positive research and development coefficient. This implies that green bond issuers research and development expenses are not adequately directed towards green innovation as may be the case for green equity issuers who may just be at the early stages of their research and development, reason why we do not feel its impact on their ESG scores.

The findings are however consistent with those of Flammer C. , (2021) and Zhou & Cui,(2019) who also find that companies that issue green bonds tend to improve their environmental ratings and corporate social responsibility, thereby ceating a positive image for themselves. By extension, this means that a signal is also created to all stakeholders and particularlly investors because the companies in doing so reiterates its commitments to environmental sustainability as a positive message is been sent to all stakeholders. To this end, our signalling theory developed earlier is also validated since the issuing firms end up displaying their strong will to advance environmental sustainability. On such basis, market participants are now armed with the relevant information to evaluate the firms before any investment decisions thus unblocking any information asymmetry in the market.

Apart from research and development and capital expenditure on assets with controversial positive and negative impacts on ESG ratings with opposite directions, the results are however consistent with existing literature that have persistently reveal the positive impacts of issuing green finance instruments on their environmental, social and governance scores with green bonds dorminance.

5.2. Carbondioxide emissions management (Green bonds versus Green equities)

Most studies on green financial instruments have been conducted to verify their impacts on CO_2 emissions which does not make ours an exception as one of our primary objectives was to establish how far and better green bonds were in managing their CO_2 emissions than green equity issuers. This was relevant to better approach the research question of whether CO_2 emissions were better managed by green bonds issuers than by green equity issuers. The results at first sight reveals that both green bonds and green equity issuers are not efficient in managing their CO_2 emissions which tend to increase despite mobilizing capital from the green market which is meant for environmentally friendly investments or projects.

Comparing these results, we realize that green bonds issuers have more greenhouse gas emissions than green equity issuers indicating CO_2 are better managed by issuing green equity stocks than green bonds in the U.S. These results are exceptionally contrary to most existing or recent studies such as (Al-Mulali & Ozturk, 2016; Bilgili, Koçak, & Bulut, 2016; Sinha & Shahbaz , 2018; Fatica & Panzica, 2021; Flammer C. , 2021; Meo & Abd Karim, 2022; Alamgir & Cheng, 2023) who find a negative and significant relationship between green finance instruments (green energy stocks/green bonds) and CO_2 emissions under different methodologies and settings. Our results which show a positive and significant relationship with CO_2 emissions are however consistent with the findings of (Apergis, Payne, Menyah, & Wolde-Rufael, 2010; Bölük & Mert, 2014; Farhani & Shahbaz, 2014; Bulut, 2017) who all document the positive relationship between green energy stocks and CO_2 emissions.

Our findings here does not really seem to move in the same direction with existing literature or theories. With respect to the signaling and information asymmetry theory where firms are supposed to display their environmental commitments by investing in environmentally friendly activities thus creating a positive signal to all stakeholders, our results tend out to be different as a negative signal is generated when CO_2 emissions instead rise following the issuance of green bonds or green stocks. This also indicates that information between the borrowers and lenders in such markets are asymmetric as the issuing companies do not fully invest the funds raised on green projects or on renewable enery projects which are meant to reduce CO_2 emissions for example.

Based on this findings abnormality with respect to current studies, we further controled for total amount of renewable energy to energy used for each group of companies and interestingly, we find that this variable tend to reduce CO_2 emissions for green equity issuers meanwhile it instead increase CO_2 emissions for green bonds issuers. This implies that of all energy total used, green equity firms use more of renewable energy souces than traditional energy which explains why they have a low amount of CO_2 emissions than green bonds issuers whose proportion of non renewable energy produced and and purchased constitute a significant portion of their total energy used. Just like research and development which had a negative relationship with the ESG scores of green bonds issuers as seen above, it also displays a positive relationship with CO_2 emissions thus justifying the fact research and development expenses of green bonds issuing companies in the U.S do no sufficiently accommodate or favour investments in green technologies or renewables as capital expenditures on assets also reveals a positive and even significant relationship with CO_2 emissions.

Another point of reflection from these findings is that, the U.S under Donald Trump departed from the Paris Agreement in 2017. Our study period spans from 2013 to 2024 and may just be another reason why despite issueing green bonds or green equities these firms still experience high CO_2 emissions, meaning that the departure from the paris agreement must have played a significant role in companies neglect on environmental sustainability especially as companies were no longer answerable to any regulations like the EU taxonomy that favors Sustainable Development Goals. In this case, investment decisions is set to not have incorporated critical environmental, social and governance aspects such as pollution management.

The results therefore signify some sort of green washing in the form of decoupling where organizations claim to fulfill stakeholders' expectations for actions on sustainability without making any actual changes in what they do in practice and thus making false claims and statements without action. These companies by issuing green bonds or green equities do not walk their talk as far as pollution or CO_2 emissions management is concern.

5.3. Comparing the stock returns of green equities and green bonds.

Haven looked at the ESG scores and CO_2 emissions of our sample companies, it was pertinent for us to compare the stock price returns of both groups of companies and to see if their price returns reflect their environmental performance discussed above. Therefore, in order to evaluate and compare the stock price returns of green equity issuers with those of green bond issuers, we establish a hypothesis which constitute the main hypothesis of this study, stating that green equity issuers realize better financial returns than green bonds issuers.

We find negative coefficients for both green bonds issuers and green equity issuers. This implies that the issuance of green bonds or green equities has a negative impact on the stock price returns of green equities and green bonds issuing companies. However, looking at the results, we realize that the negative impact was greater for green bonds issuers than green equity issuers, meaning that green equities tend to realize better stock price returns than green bonds and thus validating our initial hypothesis. An important question now should be if these results are normal and if they are equally consistent with existing literature.

Our findings deviate from the findings of (In, Park, & Monk, 2017; Zhou & Cui, 2019; Choi, Gao, & Jiang, 2020; Duan, Li, & Wen, 2021; Pastor, Stambaugh, & Taylor, 2022; Ardia, Bluteau, Boudt , & Inghelbrecht, 2023) who document green stocks or green bonds outperformance in terms of stock returns especially when compared with their brown counterparts in exceptionally extreme periods of climate change concerns. Unfortunately, this might not be our case as most U.S companies might have reduced their climate concerns following the U.S exit from the Paris Agreement which may justify their low stock price returns. Also, looking at the increasing CO_2 emissions produced by these companies as noticed above, one might have expected them to generate high stock returns as established by (Bolton & Kacperczyk, 2021; Hsu, Li, & Tsou, 2023; Bolton & Kacperczyk, 2023) who document high stock returns or carbon premium for firms with high carbon emissions which is not our case.

Our results are also inconsistent with those of Flammer C. , (2021) and the sigaling theory. According to her findings, the stock market reacts positively to the issuance of green bonds as the stock prices of the issuing companies rise leading to cumulative abnormal returns thus highlighting the positive signal generated in the stock market by the issuance of green bonds. Given that these companies have high emissions as seen above may also generate a negative signal in the market, especially for ESG sensitive investors who may tend to shy away from such stocks leading to a decline in their stock prices. On the other hand, a possible argument to justify our results may be the preference – based theoretical model whereby investors who like to hold green stocks or green bonds are always willing to pay more to hold these assets, pushing their prices up and thereby leading to lower expected returns (Pástor, Stambaugh, & Taylor, 2022).

Making use of oil prices, our findings in the equity market appear to be consistent with those of (Henriques & Sadorsky, 2008; Ferrer, Shahzad .S, López, & Jareño, 2018) who document a negative relationship between oil prices and renewable energy stocks, stating that oil prices do not drive the stock price returns of clean energy stocks. Our results corroborates this findings as we notice a negative coefficien when we control for oil prices in the U.S, thus demonstrating a negative impact of oil prices on the stock price returns of green equity issuers. Contrary to this, Ahmad, (2017) found that there is a positive relationship between oil prices and clean energy stocks given that the rise in oil prices force comsumers to switch to clean energy which makes investments in such systems attractive to investors thus leading to postive stock returns.

Our results in the green bonds market might just be a response to the hapenings in the green equity market since there is some directional spillover effect between these two markets (Pham, 2021; Chatziantoniou, Abakah, Gabauer, & Tiwari, 2022; Tiwari A. K., Abakah, Gabauer, & Dwumfour, 2022). According to pham, (2021) both markets boom and bust together as a good(bad) news in one market tend to spillover to the other as positive (negative) shock to the other market which then encourage (discourage) investors. This is particularly true especially when we look at the impacts of green bonds/green equities on our dependent variables. We notice that they both have a positive effect on their ESG ratings, a positive effect on CO_2 emissions and a negative effect on their returns though at varying degrees of impact with green equities having the least impact on each dependent variable. This shows that green equity firms environmentally and financially perform better than green bonds isuing firms.

CHAPTER 6:

CONCLUSIONS AND POLICY IMPLICATIONS

6.0 Summary of Findings

Previous studies have laid emphasis on promoting green finance instruments as a way of enhancing global decarbonization especially after comparing them to brown assets. In this study, we investigate whether green equity stock issuers perform better than green bonds issuers, based on a comparative analysis of their environmental and financial performance in the U.S. Employing a Feasible Generalized Least Squares Panel Regression estimation technique on our two group of companies sampled between 2013 to 2024 in the U.S, our first objective was to compare the ESG scores of these two groups of companies. We find that, both groups of companies improve their ESG scores as our analysis reveals a positive relationship between green bonds amount issued/green equity stock market value and ESG scores.

However, in comparing the ESG scores between both green instruments, we notice that green bonds issuers improve their environmental social and governance scores than green equity issuers. These results are said to be influenced by varying proportions of research and development and capital expenditure on assets where green bonds issuing firms invest more on assets that promote environmental sustainability though their research and development expenses do not seem to accommodate such initiatives as shown by green equity companies.

Then we look at the CO_2 emissions of these groups of companies to better ascertain their environmental performance. Our objective here was to determine if green bonds issuers better manage and reduce their CO_2 emissions then green equity issuers. Unexpectedly, our findings show that, the issuance of green bonds or green equity stocks increase the CO_2 emissions of both group of companies with those of green bonds issuers dominating those of green equity issuers. However, after controlling for the amount of renewable energy purchased and produced as a proportion of total energy used, we realize that CO_2 emissions of green equity issuers is quite lower than those of green bonds issuers because of the considerable amount of renewable energy mobilized from their operations as opposed to green bonds issuing companies who make more use of dark-brown energy sources.

Again, research and development expenses of green bonds issuers stood outstanding with a positive effect on their CO_2 emissions and thus implying that research and development expenses of green bonds issuing companies do not foster climate action or accommodate sustainability considerations like green innovations leading high levels of CO_2 emissions.

We then compare the financial performance of both companies by looking at their stock price returns with findings revealing a negative relationship between the issuance of both instruments and their stock price returns though with a more severe negative impacts on the stock price returns of green bonds issuing firms. This implies green equity or clean energy stock issuing firms have better financial performance than those of green bonds issuers. Moreover, the return on assets of green equity firms tend to portray a positive relationship with their stock price returns which is not the case for green equity firms.

Therefore, despite having a high ESG score, green bonds issuing companies in the U.S are high level carbon emitters and do generate lower returns than green equity issuing firms with lower CO_2 emissions and better stock price returns. However, the fact that both group of companies reveal a positive relationship with ESG scores, CO_2 emissions, and a negative relationship with stock price returns is an indication that they move together and may boom and bust together especially when we consider the fact that green bonds proceeds are mostly used to finance clean energy or renewable energy stocks which may lead to a spillover effect between both markets.

6.1 Managerial and theoretical implications

Our managerial implications of this study are two-fold, first to policy makers and then to investors.

The study highlights the need for policy makers to promote policies that can foster the growth of green finance instruments in the U.S such as green bonds and clean energy stocks given the role they play in global sustainability. This is very important as policy makers need to draft standardized frame works and standards to guide the effective used of green bonds proceeds and for the evaluation of environmental impacts of such projects.

Our results also suggest increase in CO_2 emissions despite issuing green instruments which are meant to reduce such negative externalities. There is therefore a need for stringent regulations for all corporate green bonds and green energy stock issuing firms making sure that their bonds are thoroughly review by external independent auditors and subsequent follow-up to ensure that the use of proceeds do not deviate from environmentally friendly projects initially presented to investors. In addition to this, a carbon tax or a carbon credit system needs to be stimulated so that companies can be motivated to reduce carbon emissions while earning additional revenues.

Due to the spillover tendencies between green bonds and green equities in the U.S, more policies are needed to accommodate and reduce any extreme market shocks that may affect both markets. By so doing, investors will be more attracted and encouraged to invest in both green bonds and green equity markets simultaneously.

To investors;

The results suggest that investors need to watch closely and need not be carried away by any green labelling on financial assets. This goes most especially to environmental and socially responsible investors. By so doing, investors will be conscious and orientate their investments decisions towards genuine green projects.

To better guide investors in making informed decisions on green investments, there is a need for collaborative initiatives for trainings, seminars and information sharing through workshops among investors for more education on the risk and opportunities that may be inherent in green bonds and green energy investments.

Given the negative stock price returns of both instruments as revealed by our study, institutional investors can draw insights to improve on their risk returns estimations or forecast of the green market in general, given the extent to which policy changes can influence or affect investments outcomes in such markets such as changes in U.S climate policies. Therefore, investors in the U.S can clamor for the U.S reintegration into global climate policy initiatives such as the Paris Agreement.

The results also highlight the need for investors to diversify their investment portfolios by holding both green bonds and green equity stocks which comes with immense diversification benefits especially during normal periods, this will also help investors assess which instruments to channel more investors into based on environmental and financial criteria.

Theoretically speaking, this study contributes to the ongoing academic debate on green finance instruments by comparing two green instrument, namely green bonds and green equity stocks by bringing out their environmental and financial performance. The study therefore provides fresh empirical evidence on the extent to which green equity stocks could better contribute to environmental sustainability as compared to green bonds.

Our study also justifies the raison d’etre of most recent studies that are oriented towards investigating the connectedness and spillovers between green bonds market and green equities or clean energy market. Therefore, this study will foster or promote more studies designed to better understand the nature or other market properties responsible for the co-movement of these two markets as highlighted by our results.

6.2 Limits and Suggestions for future research

Our study is limited to the U.S market, with data explored only from one data provider, covering the period barely before the Paris Agreement till 2024 and equally covering just fewlly selected companies from a single data provider (Refinitiv) with specific interest on corporate bonds. Based on this study delimitations, future studies can incorporate the following aspects.

Future studies can extend the sample size, to touch more U.S companies (incorporating both government and corporate bonds) while exploring data from several data providers.

Future studies can do a more extensive study, comparing between U.S and EU companies so as to see which of the two groups of companies or states with different climate policies have better environmental and financial performance.

In terms of methodology, future studies can employ an event study methodology, that is, before the Paris Agreement and after the Paris agreement with particular interest on post 2017 when the U.S under President Trump signed out of the Paris agreement.

APPENDICES

Objective one: Do green equity issuers improve environmental ratings more than green bond issuers?

In this appendix, we present our methodological and estimation approach which begins with fixed and random effect estimation, then we run the Hausman text to compare which best fits our model. Noticing the presence of Heteroskedasticity and Autocorrelation, we run some diagnostic test of Breusch-Pegan an Wooldridge test respectively to confirm the above violations. We then run robust estimation test of clustered fixed effects, Driscol Kraay regression and the feasible generalized least square regression. We finally adopt the Feasible Generalized Least Square Regression technique with more efficient and reliable estimates for our analysis.

We follow the same methodology for the rest of our objectives.

A. By Group-Green Bonds: fixed effect regression

```
note: log_issue omitted because of collinearity.

Fixed-effects (within) regression               Number of obs     =        227
Group variable: panel                           Number of groups  =         19

R-squared:                                      Obs per group:
     Within  = 0.1003                                         min =         11
     Between = 0.0436                                         avg =       11.9
     Overall = 0.0238                                         max =         12

                                                F(8, 200)         =       2.79
corr(u_i, Xb) = -0.7518                         Prob > F          =     0.0060
```

esg	Coefficient	Std. err.	t	P-value
LOG_GRB ISSUE	0 (OMITTED)			
BETA	.8956432	2.026273	0.44	0.659
ROA_CLEAN	.6323999	.2553871	2.48	0.014
LEV	-.0019683	.0026613	-0.74	0.460
CONTROV	-.0243814	.0307926	-0.79	0.429
INVESTA	.4718393	.2630877	1.79	0.074
LOG_RD	3.332641	1.257907	2.65	0.009
OILP	-.0196692	.027444	-0.72	0.474
LOG_TOTRE	-.7272274	.3533949	-2.06	0.041
_CONS	17.1578	20.66287	0.83	0.407

F test that all u_i=0: F(18, 200) = 38.10 Prob > F = 0.0000

F test probability significant at 1% indicating a problem of autoregression

Random-effects regression

```
Group variable: panel                          Number of obs      =        227
                                                Number of groups  =         19

R-squared:                                      Obs per group:
     Within  = 0.0780                                         min =         11
     Between = 0.0155                                         avg =       11.9
     Overall = 0.0216                                         max =         12

                                                Wald chi2(9)      =      15.78
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.0716
```

Esg	Coefficient	Std. err.	z	P-value
LOG_GRB ISSUE	3.913925	3.532846	1.11	0.268
BETA	1.031843	1.988821	0.52	0.604
ROA	.5107619	.253464	2.02	0.044
LEV	-.0020628	.0026685	-0.77	0.440
ESG CONTROV	-.0239465	.0305678	-0.78	0.433
INVEST/A	.4310644	.2596718	1.66	0.097
LOG_R&D	.5129961	.7756123	0.66	0.508
OILP	-.0248244	.027679	-0.90	0.370
LOG_TOTRE	-.7919374	.3393819	-2.33	0.020
_CONS	11.21724	47.76236	0.23	0.814

From the wald ch2 Prob value of 0.0716 which is insignificant at 5% thus no problem of Heteroskedasticity

Hausman Test For Fixed Or Random Effect Adoption

	---- Coefficients ----			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fe	re	Difference	Std. err.
BETA	.8956432	1.031843	-.1362002	.3877812
ROA	.6323999	.5107619	.121638	.0312823
LEV	-.0019683	-.0020628	.0000945	.
ESG CONTROV	-.0243814	-.0239465	- .0004349	.0037138
INVEST/A	.4718393	.4310644	.0407749	.0422576
LOG_R&D	3.332641	.5129961	2.819645	.9903306
OILP	-.0196692	-.0248244	.0051552	.
LOG_TOTRE	-.7272274	-.7919374	.06471	.0985284

b = Consistent under H0 and Ha; obtained from xtreg.
B = Inconsistent under Ha, efficient under H0; obtained from xtreg.
Test of H0: Difference in coefficients not systematic

chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 29.75 Prob > chi2 = 0.0002 We adopt the fixed effect estimation with a probality value of less than 0.05 thus rejecting the null hypothesis

Diagnostic Tests: Test of Autocorrelation within the fixed effect model adopted

```
note: log_issue omitted because of collinearity.

Fixed-effects (within) regression               Number of obs     =        227
Group variable: panel                           Number of groups  =         19

R-squared:                                      Obs per group:
     Within  = 0.1003                                         min =         11
     Between = 0.0436                                         avg =       11.9
     Overall = 0.0238                                         max =         12

                                                F(8, 200)         =       2.79
corr(u_i, Xb) = -0.7518                         Prob > F          =     0.0060
```

Esg	Coefficient	Std. err.	t	P-value
LOG_GRB ISSUE	0 (OMITTED)			
BETA	.8956432	2.026273	0.44	0.659
ROA	.6323999	.2553871	2.48	0.014
LEV	-.0019683	.0026613	-0.74	0.460
ESG CONTROV	-.0243814	.0307926	-0.79	0.429
INVEST/A	.4718393	.2630877	1.79	0.074
LOG_R&D	3.332641	1.257907	2.65	0.009
OILP	-.0196692	.027444	-0.72	0.474
LOG_TOTRE	-.7272274	.3533949	-2.06	0.041
_CONS	17.1578	20.66287	0.83	0.407

F test that all u_i=0: F(18, 200) = 38.10 Prob > F = 0.0000

Just like indicated above there is a problem of autocorrelation with the Prob > F = 0.0000 too significant at 1%

```
Breusch-Pagan test for heteroscedasticity

Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (19)  =    4724.29
Prob>chi2 =      0.0000


Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      24) =     65.587
           Prob > F =      0.0000
```

Robustness Estimation

1. Fixed effects with clustered standard errors

```
note: log_issue omitted because of collinearity

Fixed-effects (within) regression               Number of obs     =        227
Group variable: panel                           Number of groups  =         19

R-squared:                                      Obs per group:
     Within  = 0.1003                                         min =         11
     Between = 0.0436                                         avg =       11.9
     Overall = 0.0238                                         max =         12

                                                F(8, 18)          =       4.36
corr(u_i, Xb) = -0.7518                         Prob > F          =     0.0045

                              (Std. err. adjusted for 19 clusters in panel_id)
```

ESG	Robust Coefficient	std. err.	t	P-value
LOG_GRB ISSUE	0 (OMITTED)			
BETA	.8956432	4.526151	0.20	0.845
ROA	.6323999	.3005826	2.10	0.050
LEV	-.0019683	.0018103	-1.09	0.291
ESG CONTROV	-.0243814	.021711	-1.12	0.276
INVEST/A	.4718393	.4153938	1.14	0.271
LOG_R&D	3.332641	2.396963	1.39	0.181
OIL P	-.0196692	.0412396	-0.48	0.639
LOG_TOTRE	-.7272274	.6434241	-1.13	0.273
_CONS	17.1578	37.05784	0.46	0.649

Std. err. adjusted for 19 clusters in panel_id)

2. Driscoll and Kraay Standard Errors (Robust to Autocorrelation and Heteroskedasticity in Panel Data):

```
Regression with Driscoll-Kraay standard errors   Number of obs     =        227
Method: Fixed-effects regression                 Number of groups  =         19
Group variable (i): panel                        F(  8,     11)    =   88806.70
maximum lag: 2                                   Prob > F          =     0.0000
                                                 within R-squared  =     0.1003
```

esg	Drisc/Kraay Coefficient	std. err.	t	P-value
LOG GRB ISSUE	1.318674	1.091892	1.21	0.252
BETA	.8956432	1.404312	0.64	0.537
ROA	.6323999	.2384578	2.65	0.023
LEV	-.0019683	.0015085	-1.30	0.219
ESG CONTROV	-.0243814	.0131665	-1.85	0.091
INVEST/A	.4718393	.1585127	2.98	0.013
LOG_R&D	3.332641	.9386611	3.55	0.005
OIL P	-.0196692	.0560818	-0.35	0.732

LOG TOT RE	-.7272274	.1711217	-4.25	0.001
_CONS	0 (omitted)			

4. .Cross-sectional time-series FGLS regression

```
Coefficients:  generalized least squares
Panels:        heteroskedastic
Correlation:   common AR(1) coefficient for all panels  (0.7211)

Estimated covariances      =        19         Number of obs     =        227
Estimated autocorrelations =         1         Number of groups  =         19
Estimated coefficients     =        10         Obs per group:
                                                             min =         11
                                                             avg =   11.94737
                                                             max =         12
                                               Wald chi2(9)      =      48.53

                                           Prob > chi2       =     0.0000
```

Esg	Coefficient	Std. err.	z	P-value
LOG_GRB ISSUE	3.06617	1.698764	1.80	0.071
BETA	-.5556528	1.56194	-0.36	0.722
ROA	.2400422	.1674507	1.43	0.152
LEV	-.0033866	.0024113	-1.40	0.160
ESG CONTROV	-.0459246	.018883	-2.43	0.015
INVEST/A	.0055494	1796165	0.03	0.975
LOG_R&D	-1.395044	.2629363	-5.31	0.000
OILP	.0020043	.020147	0.10	0.921
LOG TOTRE	-.2661464	.2376451	-1.12	0.263
_CONS	51.31865	24.28063	2.11	0.035

We adopt the FGLS regresion with better estimates and efficiency in accounting for Heteroskedasticity and Autocoreation

B. **By Group-Green Equity**

.

Fixed Effects Regreesion

```
Fixed-effects (within) regression               Number of obs     =        143
Group variable: panel                           Number of groups  =         12

R-squared:                                      Obs per group:
     Within  = 0.2761                                         min =         11
     Between = 0.1204                                         avg =       11.9
     Overall = 0.1397                                         max =         12

                                                F(9, 122)         =       5.17
corr(u_i, Xb) = -0.4710                         Prob > F          =     0.0000
```

Esg	Coefficient	Std. err.	t	P-value
LOG_GRE ISSUE	1.081207	.8217378	1.32	0.191
BETA	-1.597154	1.434168	-1.11	0.268
ROA	-.0595302	.0562049	-1.06	0.292
LEV	.0008913	.0018467	0.48	0.630
ESG CONTROV	-.0433076	.0327263	-1.32	0.188
INVEST/A	-.0971384	.0786739	-1.23	0.219
LOG_R&D	7.765475	1.693482	4.59	0.000
OILP	.0441714	.030449	1.45	0.149
LOG_TOTRE	-.8323376	.5890607	-1.41	0.160
_CONS |	-31.3408	18.96564	-1.65	0.101

F test that all u_i=0: F(11, 122) = 38.98 Prob > F = 0.0000

Good estimate for fixed effects but presence of autocorrelation as indicated by th prob of F test results of 0.0000 (very significant at 1%.

Random-effects GLS regression Number of obs = 143

```
Group variable: panel                           Number of groups  =         12

R-squared:                                      Obs per group:
     Within  = 0.2513                                         min =         11
     Between = 0.2244                                         avg =       11.9
     Overall = 0.2340                                         max =         12

                                                Wald chi2(9)      =      42.02
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.0000
```

esg	Coefficient	Std. err.	z	P-value
LOG_GRE ISSUE	1.428178	.8662199	1.65	0.099
BETA	-3.067771	1.4207	-2.16	0.031
ROA	-.055084	.0568148	-0.97	0.332
LEV	.0011438	.0019756	0.58	0.563
ESG CONTROV	-.0301045	.0348179	-0.86	0.387
INVEST/A	-.0834363	.0816164	-1.02	0.307
LOG_R&D	5.650325	1.394912	4.05	0.000
OIL P	.0549037	.0324476	1.69	0.091

LOG_TOTRE	-.1318887	.4762782	-0.28	0.782
_CONS	-20.21979	16.3014	-1.24	0.215
Presents of autocorrelation as indicated by the Prob > chi2 of 0.0000				

. Hausman test to compare fixed vs random effects

	(b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
Coefficients				
LOG_GRE ISSUE	1.081207	1.42817	-.3469704	.1837067
BETA	-1.597154	-3.067771	1.470617	.6082384
ROA	-.0595302	-.055084	-.0044462	.0209812
LEV	.0008913	.0011438	-.0002525	.0002386
ESG CONTROV	-.0433076	-.0301045	-.0132031	.0055986
INVEST/A	-.0971384	-.0834363	-.0137021	.0229332
LOG_R&D	7.765475	5.650325	2.11515	1.176574
OILP	.0441714	.0549037	-.0107323	.004871
LOG_TOTRE	-.8323376	-.1318887	-.7004489	.4196155

b = Consistent under H0 and Ha; obtained from xtreg.
B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic
chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 18.94 with a Prob > chi2 of 0.0152 Hauseman test validates fixed effect

Breusch-Pagan test for heteroscedasticity

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (12)  =     103.27
Prob>chi2 =      0.0000
```

Wooldridge test for autocorrelation in panel data

```
H0: no first order autocorrelation
    F(  1,      11) =      9.209
           Prob > F =      0.0114
```

Robustness Estimation

1. Clustered fixed effects with standard errors

```
Fixed-effects (within) regression               Number of obs     =        143
Group variable: panel                           Number of groups  =         12

R-squared:                                      Obs per group:
     Within  = 0.2761                                         min =         11
     Between = 0.1204                                         avg =       11.9
     Overall = 0.1397                                         max =         12

                                                F(9, 11)          =       6.67
corr(u_i, Xb) = -0.4710                         Prob > F          =     0.0023
```

ESG	Robust Coefficient	std. err.	t	P-value
LOG_GRE ISSUE	1.081207	1.052225	1.03	0.326
BETA	-1.597154	2.328805	-0.69	0.507
ROA	-.0595302	.0593142	-1.00	0.337
LEV	.0008913	.0006704	1.33	0.211
ESG CONTROV	-.0433076	.0319266	-1.36	0.202
INVEST/A	-.0971384	.0480218	-2.02	0.068
LOG_R&D	7.765475	3.701887	2.10	0.060
OILP	.0441714	.0424936	1.04	0.321
LOG_TOTRE	-.8323376	.2686267	-3.10	0.010
_CONS	-31.3408	34.31314	-0.91	0.381

(Std. err. adjusted for 12 clusters in panel_id)

2. Driscoll and Kraay Standard Errors (Robust to Autocorrelation and Heteroskedasticity in Panel Data):

```
Regression with Driscoll-Kraay standard errors   Number of obs     =       143
Method: Fixed-effects regression                 Number of groups  =        12
Group variable (i): panel                        F(  9,     11)    =     85.18
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.2761
```

ESG	Drisc/Kraay Coefficient	std. err.	t	P-value
LOG_GRE ISSUE	1.081207	.4784503	2.26	0.045
BETA	-1.597154	1.452771	-1.10	0.295
ROA	-.0595302	.0359099	-1.66	0.126
LEV	.0008913	.0003498	2.55	0.027
ESG CONTROV	-.0433076	.0299747	-1.44	0.176
INVEST/A	-.0971384	.0178076	-5.45	0.000

LOG_R&D	7.765475	2.337765	3.32	0.007
OILP	.0441714	.0473802	0.93	0.371
LOG_TOTRE	-.8323376	.2602288	3.20	0.008
CONS	-31.3408	20.79111	-1.51	0.160

3. Generalized Least Squares (GLS) with Panel Data:

Cross-sectional time-series FGLS regression

```
Coefficients:  generalized least squares
Panels:        heteroskedastic
Correlation:   common AR(1) coefficient for all panels  (0.6148)

Estimated covariances      =        12          Number of obs      =        143
Estimated autocorrelations =         1          Number of groups   =         12
Estimated coefficients     =        10          Obs per group:
                                                               min =         11
                                                               avg =   11.91667
                                                               max =         12
                                                Wald chi2(9)       =      63.98
                                                Prob > chi2        =     0.0000
```

Esg	Coefficient	Std. err.	z	P-value
LOG_GRE ISSUE	2.08009	.8302883	2.51	0.012
BETA	-2.385445	1.352182	-1.76	0.078
ROA_CLEAN	-.080255	.0416066	-1.93	0.054
LEV	.0014858	.0011436	1.30	0.194
CONTROV	-.0157445	.0253439	-0.62	0.534
INVESTA	-.0185621	.0636963	-0.29	0.771
LOG_RD	4.272667	.9413873	4.54	0.000
OILP	.062407	.0313298	1.99	0.046
LOG_TOTRE	-.4004809	.3289778	-1.22	0.223
CONS	-11.66442	10.41766	-1.12	0.263

We adopt the FGLS regresion with better estimates and efficiency in accounting for Heteroskedasticity and Autocoreation

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Executive Summary

Investigative studies on the performance of green versus brown bonds and equity stocks and to a lesser extent, their connectedness and directional spillover effects has become a popular area of research. This has not been the case for green bonds versus green equities as global efforts are aimed at mobilizing the necessary finance through green instruments to fight climate change. In this study, we attempt to provide a response as to whether green equity stock issuers perform better than green bonds issuers through a comparative analysis of their environmental and financial performance within the U.S green finance market.

Employing a Feasible Generalized Least Square Regression (FGLS) on a yearly Panel data of 62 green bonds issuing companies and 53 green equity stock issuing companies in the U.S from 2013 to 2024, our analysis revealed that, environmentally, green bonds issuers have better or improve on their environmental scores (ESG scores) than green equity issuing companies which is due to their heavy investments or capital expenditure on assets that enhance environmental sustainability. We further examine and compare their CO_2 emissions, with our analysis documenting evidence of green bonds issuing companies emitting more CO_2 emissions than green equity issuing firms. Though both group of companies show a positive relationship with CO_2 emissions, green equity issuers are better in managing their CO_2 emissions than green bonds issuers. However, after controlling for renewable energy produced and purchased as a proportion of total energy used, we find that green bonds issuing companies use more non-renewable energy sources and their research and development expenses did not accommodate sustainable practices leading high emissions.

With regards to financial performance which we measure by stock price returns, we observe a negative relationship between both instruments and their stock price returns. Most especially, green bonds issuing companies show lower returns than green equity stock issuers. This is unexpected as we however justify this scenario by the preference-based theoretical model where green investors are willing to pay more to hold green firms, pushing the prices of the green assets up and consequently leading to lower expected returns. Furthermore, the high CO_2 must have generated negative signals in the market leading low stock price returns.

Our findings however suggest that green bonds and green equities boom and bust together and therefore policy makers should improve regulations to protect investors interest in green investments.

Key words: Green bonds, Green equities, CO_2 emissions, ESG scores, Stock price returns.

Word count:29,726