Department of
Economics and Finance
and
Business and Management

Chair of
Corporate Governance

The impact of Green Bonds on Corporate Performance in the Energy & Utilities Sector

SUPERVISOR
Prof. Giovanni Fiori

CANDIDATE
Pierfrancesco Sebastiani
190901

CO-SUPERVISOR
Prof. Simone Scettri

Academic Year 2018/2019

(Page intentionally left blank)

ACKNOWLEDGEMENTS

I would like to thank my thesis supervisor Prof. Giovanni Fiori of LUISS Guido Carli University for his precious advice and his ongoing support to the writing of my final dissertation.

I would also like to thank my Chinese supervisor Prof. Shi Haina of Fudan University for her challenging perspective, her passionate participation and her overall commitment.

In addition, I would like to thank my co-supervisor Prof. Simone Scettri of LUISS Guido Carli University for his guidance and availability throughout the development of my research.

Finally, I want to express my profound gratitude to all the other people that have contributed with their valuable comments and suggestions to the improvement of this thesis.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

INTRODUCTION

This dissertation aims at investigating the existing relationship between Green Bond issuance and Corporate Performance for Energy & Utilities companies. By analysing the effectiveness of this innovative asset class in helping the Energy & Utilities sector's transition towards a low-carbon economy, this research represents an additional step in understanding the reasons behind the exponential growth of Green Bonds over years, enriching the available literature on this newly-introduced financial innovation.

This paper, after having introduced the Green Bond topic and the characteristics of this market, provides the most comprehensive and up-to-date analysis of the Green Bond phenomenon, taking into account the main parties involved in shaping the future of this market and evaluating the current governance and regulatory challenges that might prevent Green Bonds to go mainstream. However, the value added embedded in this research emerges by observing the effectiveness of Green Bonds in limiting and reducing air pollution for Energy & Utilities companies. The materiality of the environmental topic for this sector and the growing regulatory pressure pushing power and utilities industries towards a radical responsible business change represent key factors behind the overwhelming growth of Green Bonds issued by Energy & Utilities firms. Together with the expansion, a risk of "*greenwashing*" has emerged - meaning companies promoting themselves as "green" while issuing self-labelled Green Bonds that actually do not contribute to the improvement of their environmental performance. Consequently, questioning whether Energy & Utilities Green Bond issuers significantly enhance their emission and environmental scores in concomitance with their first Green Bond issuance appears to be particularly relevant.

In addition to the first research question focused on the effectiveness of the Green Bond tool, this study helps in understanding whether Energy & Utilities Green Bond issuers are more environmentally sustainable than a "control" group of Energy & Utilities companies that have not relied on Green Bonds. This query helps to investigate a possible relationship between superior environmental performance and Green Bond issuance for companies of the sector, implying the fact that this innovative financial instrument might be read as a concrete proof of Energy & Utilities firms' overall effort in dealing with environmental topics. Moreover, by analysing the total stock returns of Green Bond issuers compared to non-Green Bond ones, this paper wants to show whether Green Bond issuance is *per se* a value adding factor for Energy & Utilities companies. Investors, indeed, might read in Green Bonds a concrete proof of an Energy & Utilities firm's attention towards Environmental, Social and Governance (ESG) issues, independently of the concrete Green Bond instrument's effectiveness in generating better environmental performance. Previous research has already demonstrated the relationship between a company ESG propensity and enhanced Corporate Performance.

Data have been collected from Bloomberg, Reuters and the Climate Bond Initiative portal over a six-year timeframe, between 2013 - the year of the first Green Bond issuance by an Energy & Utilities corporation - and 2018 - the latest available fiscal year. Before running the regression models, it has been decided to implement a *matching* procedure on the overall sample of Energy & Utilities companies in order to pair the resulting 50 listed Green Bond issuers with an equal number of "control" units. To obtain a homogeneous sample of companies showing similar characteristics over the period under analysis, the 50 Green Bond firms have been matched one-to-one with Energy and Utilities non-Green Bond corporations belonging to the same sub-industry and geographic area and showing the most similar financial fundamentals in terms of size, operating performance and capital structure. The final post-matching sample counts 100 firms or - more precisely - 50 one-to-one paired couples. Obtained the matched sample, two separate regression models have been run to answer the two previously presented environmental questions regarding Green Bonds, their effectiveness for the companies of the sector and the overall environmental performance of Green Bond issuers. The effectiveness has been studied through a multiple linear regression model relating CO2 emissions - standardized for companies' size – to Green Bond issuance. The higher environmental performance has been investigated through a multiple linear regression model relating firms' environmental scores to the fact that they were Green Bond issuers. Both these two models were based on panel data, taking into account the temporal and company dimensions at the same time. Instead, the answer to the superior stock performance query has been provided through a simple linear regression model relating the monthly returns of a portfolio made of the 50 Green Bond issuers to the monthly returns of a portfolio including the 50 paired "control" corporations. Both the *matching* and the regression models have been run through the statistical software R.

Focusing on the available literature on Green Bonds, it has mainly addressed the drivers and the barriers behind the development of this market and the pricing issue. However, only a few academics have analysed the relationship between Green Bonds and Firm Performance; in addition, the analyses have been mainly in terms of change before and after the issuance. The specific focus on the Energy & Utilities sector is unprecedented and a study concerned with the overall performance characterizing Green Bond issuers has never been done, since previous academics have paid attention to the variation of performance.

Moving to the specific results of this research, it has been demonstrated the effectiveness of Green Bonds in limiting and reducing GHG emissions of Energy & Utilities companies. Differently, Energy & Utilities Green Bond issuers do not show a significantly better environmental performance compared to non-Green Bond firms over the six-year period of observations. In addition, the Energy & Utilities Green Bond portfolio has not significantly outperformed the non-Green Bond portfolio; no proof of excess stock returns has emerged, controlling for similar levels of risk. However, the findings of the last two models might be influenced by the short period of time under investigation; an analysis performed over a longer timeframe is expected to show a statistically significant environmental outperformance of Energy & Utilities Green

Bond issuers, provided the effectiveness of the instrument in fighting pollution. Also the presence of abnormal portfolio returns might emerge for the Green Bond portfolio: companies - similar from an accounting point of view but diverging from an environmental perspective due to the issuance of Green Bonds - might outline different stock returns due to the economic and financial value of better environmental performance, reduced environmental risk and regulatory friendly business transition.

The results of this research appear to be useful for several market participants. First, Energy & Utilities companies might understand the impact of Green Bond issuance on their performance, stimulating their inclination towards this innovative asset class. Second, investors might better comprehend the potentiality and the risks of investing in the equity of Energy & Utilities Green Bond issuers. Finally, regulators might figure out the importance of creating a common supranational governance and regulatory system to foster the growth of Green Bonds in the sector.

In conclusion, looking at the structure of this dissertation, the first chapter provides a definition of Green Bond and presents its characteristics; additionally, it introduces the evolution of the Green Bond market and identifies the main players and observers shaping the market itself, finally moving to an analysis of the regulatory framework and the risk of "*greenwashing*". The second chapter reports the relevant academic literature regarding the relationship between ESG and Firm Performance, the barriers and the drivers behind the Green Bond market, the Green Bond pricing issue and the "*greenium*" phenomenon. Furthermore, an overview of the available research assessing the correlation between Green Bond issuance and Corporate Performance is outlined. Then, the relevance of Green Bonds in the Energy & Utilities sector is deeply studied. The trends shaping the future of this sector and the reasons behind the choice of the power and utilities industries are presented together with the rationale supporting the exclusion of the most active Green Bond segment: Financial Institutions. The third chapter depicts a general overview of Corporate Green Bonds descriptive statistics, opportunely focusing on the Energy & Utilities sector. Then, data collection and sample construction are introduced, with a specific focus on the *matching* methodology; finally, the three regression models and the variables inserted are properly explained. The fourth chapter presents the research results and it is followed by the *Conclusions*.

1. GREEN BONDS' PILLARS AND REGULATORY FRAMEWORK

The objective of the first chapter is to introduce the reader to Green Bonds: a simple financial innovation with the potential to disrupt the bond market while accelerating the transition to a low-carbon economy. In particular, there will be a focus on the definition of this new type of security and the objectives that it tries to pursue. Additionally, the reader will be guided along the evolution of the Green Bond market over the years, providing some insights on its possible future trajectory. Consequently, an analysis of the activities carried out by the main players of the Green Bond revolution will anticipate the description of the regulatory framework shaping the boundaries of this innovative fixed income product. Finally, the reasons behind the choice of the Energy and Utilities sector and the potentialities of the instrument in driving the change of the energy generation and distribution business will follow.

However, before moving into each specific section, it is essential to introduce the possible "era-defining" event of this century, underpinning the development of Green Bonds: the Paris Agreement adopted in December 2015 by the 21st Conference of the Parties to the United Nations Framework Convention on Climate (COP21). Parties agreed to hold the increase in the global average temperature to well below 2°C and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels; this would significantly reduce the risks and impacts of climate change. Notably, more than 190 countries adopted the first-ever legally binding global climate deal, signalling their effort to protect the future of this planet. Parties also agreed to make finance flows consistent with a pathway towards low greenhouse gas (GHG) emissions and climate-resilient development[1]. According to recent estimates, more than USD 90 trillion in infrastructure investments will be needed in the next 15 years to implement a "low-carbon" scenario[2]. Furthermore, it has been highlighted the importance of debt to finance the majority of these infrastructure investments. Specifically, bond finance represents the natural fit for low-carbon and climate-resilient assets such as renewable energy infrastructures, which are characterised by high upfront capital costs and long-dated and frequent inflation-linked income stream. Green bonds may serve as the catalyst to foster the ability to adapt to the adverse impacts of climate change, strengthening climate resilience and low greenhouse gas emissions development.

1.1 The definition of Green Bond

Relying on the Green Bond Principles definition, one of the most authoritative entities in the field, Green Bonds can be described as "*any type of bond instrument where the proceeds will be exclusively applied to finance or re-finance, in part or in full, new and/or existing eligible Green Projects*"[3]. This innovative financial instrument is a regular bond; therefore, it shares many common features with

[1] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law

[2] OECD. (2017). Mobilising Bond Markets for a Low-Carbon Transition. Paris: OECD Publisher

[3] International Capital Market Association (ICMA). (2014). Green Bond Principles, 2014 - Voluntary Process Guidelines for Issuing Green Bonds. International Capital Market Association (ICMA)

government or corporate bonds, depending on the issuer. The difference lies in the purpose of the bond: provide funding to foster the transition to a low-carbon economy. Bonds that disclose the use of proceeds for environmental projects are called "labelled Green Bonds"[4]; in details, the principal collected through the issuance is exclusively *earmarked*[5] to finance "green" projects, assets or business activities[6]. However, the definition of an environmental-friendly activity is itself open to interpretation. Despite the Green Bond Principles, which mainly focus on governance, there is no globally controlled framework for labelling bonds as green and this issue represent one of the main controversies around this "new type" of security[7].

In order to streamline Green Bond issuance and provide enhanced clarity about the investable Green Bond universe, the International Capital Market Association (ICMA) established the Green Bond Principles to encourage a high level of transparency, in particular regarding four key components[8]:

- Use of proceeds;
- Process for project evaluation and selection;
- Management of proceeds;
- Reporting.

Issuances aligned to the GBP should provide an investment opportunity with transparent green credentials. The proceeds of a Green Bond can only finance climate and/ or ecological friendly projects, promoting climate mitigation and climate adaptation activities. The ICMA use the following classification for projects:

- Renewable energy;
- Energy efficiency (including efficient buildings);
- Sustainable waste management;
- Sustainable land use (including sustainable forestry and agriculture);
- Biodiversity conservation;
- Clean transportation;
- Sustainable water management (including clean and/or drinking water);
- Climate change adaptation.

[4] Weber, O., & Saravade, V. (2019). Green Bonds: Curren Development and Their Future. CIGI Papers
[5] *Earmarking* consists of funds, such as from a bond issuance, which are set aside to pay for a specific project or event. The process of *earmarking* is a fundamental component of the Green Bond market
[6] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[7] *See Section 1.4 for further explanation on the current regulative environment*
[8] International Capital Market Association (ICMA). (2018). Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bondss

It is relevant to stress that Green Bonds face some additional transaction cost because issuers must track, monitor and report on the use of proceeds. However, many issuers, especially repeat Green Bond issuers, offset this initial cost with the following benefits[9]:

- Highlight their green assets/business;
- Positive marketing story;
- Diversify their investor base (as they can now attract ESG specialist investors).

Finally, the Green Bonds market has developed around the idea of flat pricing - where the bond price is the same as ordinary bonds and the investor does not need to sustain additional costs. Prices are flat because the credit profile of Green Bonds is the same as other vanilla bonds from the same issuer; therefore, Green Bonds are *pari passu* to vanilla issuance[10] and, in financial terms, the exposure to the counterparty credit risk and the possibility to direct recourse to the issuer's assets in case of interest payments or principal reimbursement's failures do not change in the eyes of investors[11]. It is important to keep in mind that the credit rating is based on the issuer of the bond, not on the project the bond proceeds will finance. Investors, therefore, take the same risk buying a bond from a given issuer, irrespective of whether the bond is green or not[12].

Assuming a cynical perspective, the characteristics of a Green Bond can be summarized in the following way: a debt instrument – like any other bond – with additional reporting requirements but no upside in terms of credit enhancements[13]; bearing this idea in mind, the market participants' attention to this innovative instrument and the ongoing success that it is experiencing[14] seem unmotivated. On the other side, a supportive approach to Green Bond issuance treats this instrument as a better and clean measure of a firm's purpose to devote itself to green investment and sustainable development without sacrificing any element of an ordinary bond[15].

All the above-mentioned topics and characteristics of Green Bonds will be subject to a specific focus along the dissertation; however, a general overview of this instrument was necessary before moving into the critical analysis of each of these aspects.

1.1.1 Use of Proceeds

In line with the guidance provided by the Green Bond Principles, the key element of a Green Bond consists of the utilisation of the bond proceeds for Green Projects; indeed, the "use of proceeds" should be

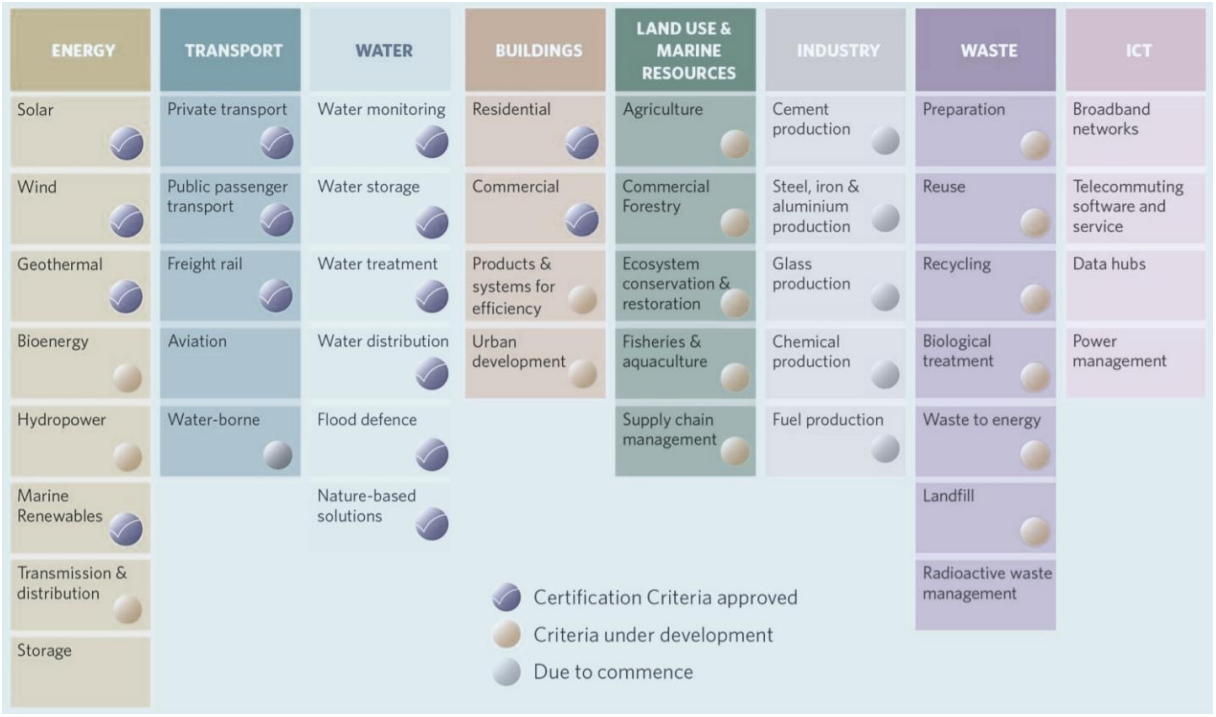
[9] Climate Bonds Initiative (CBI). (2019, May 13). Explaining green bonds. Retrieved from https://www.climatebonds.net/market/explaining-green-bonds
[10] Climate Bonds Initiative (CBI). (2019, May 13). Explaining green bonds. Retrieved from https://www.climatebonds.net/market/explaining-green-bonds
[11] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[12] Archer, O., & Tournaire, M. (2018). Green Bonds: Is the grass always greener? AON Investment Research and Insights
[13] Counihan, G. (2019). Is the green bond market running out of steam? Franklin Templeton Investments
[14] *See Section 1.2 for further explanation on the Green Bonds' success*
[15] Tang, D. Y., & Zhang, Y. (2018). Do Shareholders Benefit from Green Bonds? Journal of Corporate Finance

appropriately described in the legal documentation for the security[16]. All designated Green Projects should provide clear environmental benefits, which will be assessed and, where feasible, quantified by the issuer. Issuers should also provide an estimate of the share of proceeds raised for financing vs. re-financing purposes, clarifying which investments or project portfolios might be refinanced.

In addition, even if the GBP do not take a position on which green technologies, declarations, standards and claims are the most appropriate for environmental-friendly objectives, recently the Climate Bonds Initiative (CBI) – another "pillar" of the Green Bonds' world – has elaborated a taxonomy to assess whether a project can be considered "green", trying to harmonize the various international and national initiatives in order to ensure comparability[17]. A taxonomy provides a list of eligible assets with thresholds and metrics as necessary and the aim of the CBI's one is to provide a scientifically robust but also practical guide - usable by issuers and reliable for investors – limiting the exposure of the market to the risk of "*greenwashing*", namely promoting the bond as "green" to attract investors even if the funds raised from the security issuance are not used to finance low-carbon projects[18]. In particular, the CBI identifies the assets and the projects needed to deliver a sustainable economy, outlining specific criteria for each sector and sub-sector (*see* Figure 1) and showing a peculiar attention to the level of greenhouse gas (GHG) emissions generated by the "green" project compared to a "brown" one. Furthermore, it is relevant to highlight that currently the International Standards Organisation has convened a working group to develop the *ISO 14030, Green bonds – Environmental performance of nominated projects and asset*, a global taxonomy supported by various international organisations and the CBI itself that is expected to be published by 2020.

[16] International Capital Market Association (ICMA). (2014). Green Bond Principles, 2014 - Voluntary Process Guidelines for Issuing Green Bonds. International Capital Market Association (ICMA)
[17] Climate Bonds Initiative (CBI). (2019). Growing green bond markets: The development of taxonomies to identify green assets . Climate Bonds Initiative (CBI)
[18] *See Section 1.4 for further explanation on the* "*greenwashing*" topic

Figure 1. Climate Bonds Taxonomy



Source: Climate Bonds *Initiative – CBI*

Finally, it should be pointed out that, as of today, there are four types of Green Bonds according to the Green Bond Principles - even if other types may emerge as the market develops - with peculiar characteristics regarding the use of proceeds, the risk profile and the debt-reimbursement system[19]:

- *Standard Green Use of Proceeds Bond*: a standard unsecured recourse-to-the-issuer debt obligation characterized by the fact that no pre-determined specific cash flows are destined to the reimbursement of investors except for the standard business capability to generate financial resources from the company activity.
- *Green Revenue Bond*: an unsecured non-recourse-to-the-issuer debt obligation in which the credit exposure in the bond is specifically linked to the company pledged cash flows (revenue streams, fees, taxes, etc.) and whose "use of proceeds" might go either to related Green project or to unrelated ones.
- *Green Project Bond*: a project bond for a single Green Project for which the investor has direct exposure to the risk of the project itself, with or without potential recourse to the issuer.
- *Green Securitised Bond*: a bond collateralised by one or more specific Green Project(s), including but not limited to covered bonds, ABS, MBS, and other structures. The first source of repayment is generally the cash flows of the assets.

[19] International Capital Market Association (ICMA). (2018). Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bondss

1.1.2 Process for Project Selection and Management of Proceeds

The GBP outline some specifics that the issuers need to communicate to the market regarding the procedure adopted to assess the "greenness" of the project, in particular[20]:

- the environmental sustainability objectives;
- the process by which the issuer determines how the projects fit within the eligible Green Projects categories identified by the ICMA and previously described;
- the related eligibility criteria, including, if applicable, exclusion criteria or any other process applied to identify and manage potentially material environmental and social risks associated with the projects.

In addition, it is stressed the importance of a high level of transparency to facilitate the involvement of interested parties, while it is recommended that the issuer's process for project evaluation and selection is supplemented by an external review, as explained in the next sub-section.

Regarding the management of proceeds, the best practice suggests that the funds raised through a Green bond should be allocated to a specific sub-account or otherwise tracked by the issuer in an appropriate manner. During the time the Green Bond is outstanding, the balance of the tracked net proceeds should be periodically adjusted to match allocations to eligible Green Projects made in the period[21]. As mentioned previously, also in this case the use of an auditor, or another third party, to verify the internal tracking method and the allocation of funds is highly endorsed.

1.1.3 Reporting and External Review

According to the ICMA guidance, the information on the use of proceeds should be made and keep readily available and up-to-date, underlining the need of a revision at least on an annual basis until the full allocation of the resources and pointing out the necessity of a review each time material developments take place[22]. Specifically, it should be disclosed to the public a list of the projects to which Green Bond proceeds have been allocated, as well as a brief description of the projects and the amounts allocated, and their expected impact. In the event of a large number of projects or confidentiality/competitive considerations, the best practice allows presenting the information in generic terms or on an aggregated portfolio basis, differentiating on a percentage rationale. Finally, it is required the use of both qualitative indicators and quantitative performance measures - such as the Greenhouse Gases emissions reduced/avoided or the decrease in water use – together with disclosure of the key assumptions underlying the quantitative determination.

[20] International Capital Market Association (ICMA). (2014). Green Bond Principles, 2014 - Voluntary Process Guidelines for Issuing Green Bonds. International Capital Market Association (ICMA)
[21] International Capital Market Association (ICMA). (2018). Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bondss
[22] International Capital Market Association (ICMA). (2018). Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bondss

Additionally, the reliance on an external review provider is strongly supported to confirm the alignment of the single Green Bond or whole Green Bond programme to the international guidelines described in the previous paragraphs. Investors require assurance that proceeds from Green Bonds are going towards genuine 'green' projects; consequently, external independent reviewers provide additional due diligence on Green Bond issues. It is critical to evaluate the Environmental, Social and Governance (ESG) aspects to understand whether the bond is deserving of a green label[23]. However, independent external reviews vary in scope and purpose; following the OECD scheme on Green Bonds' assurance, it is possible to identify three main types of external review[24]:

- *Second party reviews and consultation*. It refers to a case where an issuer seeks advice from consultants and/or institutions with recognised expertise in environmental sustainability to establish and review its process for project selection. It normally entails an assessment of the alignment with the Green Bond Principles. Interestingly, the reviews and reports of the second party are private due to the absence of mandatory disclosure requirements; however, issuers often make them public to raise the standing of the bond issue. Second opinions focus on internal frameworks, not outcomes - they do not attempt to analyse or forecast the actual environmental impacts of Green Bond financed projects[25]. However, prescriptiveness is limited by the fact that the review process is performed only in the period prior to the issuance of a given Green Bond, due to the fact that second opinions do not provide ongoing or *ex-post* assurance.
- *Audits*. The best practice supports issuers to independently verify and audit certain aspects of their Green Bond process - for instance, the allocation process of the raised funds or the internal monitoring systems on the use of proceeds. The assurance should be provided by qualified third parties or external auditors, even if the simple internal review is often accepted.
- *Third-party certifications*. It is becoming increasingly common to rely on qualified third parties to assess the compliance of the single issue or the whole process to second-party standards, such as the CBI ones. It is provided with an internationally recognized certification that gives credibility to the issue, otherwise simply "self-labelled" as green. In addition to the certification, the external reviewer might provide a score to the Green Bond or its related framework explicitly distinguished from the credit rating, benchmarked against some specific environmental performance data or sustainable procedure guidelines[26].

[23] Archer, O., & Tournaire, M. (2018). Green Bonds: Is the grass always greener? AON Investment Research and Insights
[24] OECD. (2017). Mobilising Bond Markets for a Low-Carbon Transition. Paris: OECD Publisher
[25] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[26] Filkova, M., Frandon-Martinez, C., & Giorgi, A. (2019). Green bonds: The state of the market 2018. Climate Bonds Initiative (CBI)

1.2 The Evolution of the Green Bond Market

In slightly more than ten years, Green Bonds have moved from a niche experiment of financial innovation to a consolidated reality. According to the 2018 CBI Report on the state of the market, the cumulative numbers testify this success path:

- Since 2007, there have been more than USD 521 billion of cumulative Green Bonds' issuances at a global level.
- The USA represent the current leading country with an amount issued equal to USD 118.6 billion, followed by China with USD 77,5 billion and France with USD 56,7 billion.

These data highlight the worldwide success of the "Green Bond Program", initially in the developed nations and with the next wave it is expected in the emerging economies, dragged by the Chinese initiative.

More and more stock exchanges are creating dedicated Green Bond lists, following the "hype" around this new type of security but – at the same time – further determining the market uptrend. Indeed, stock exchanges play a vital role in providing market access, showcasing Green Bonds[27]. As can be seen in Table 1, Oslo Stock Exchange has been the first to adopt this decision and currently it is possible to count 14 supporters among the financial trading venues, including London Stock Exchange, Shanghai Stock Exchange, Luxembourg Stock Exchange, Japan Exchange Group and Frankfurt Stock Exchange.

Table 1. Stock Exchanges with a Dedicated Green Bond List

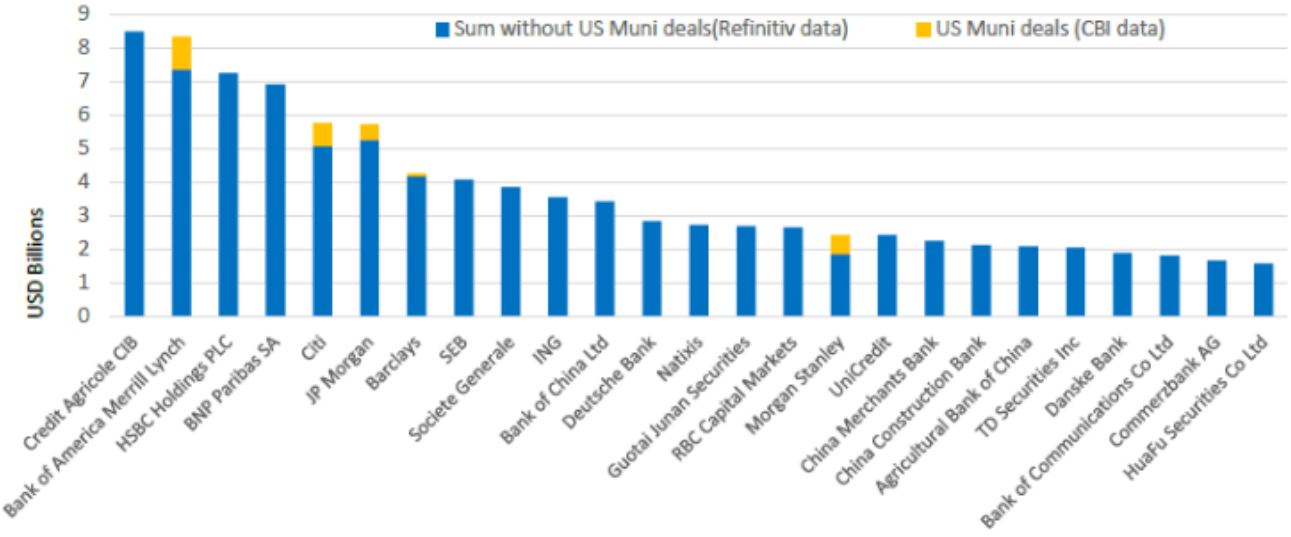
Name of Stock Exchange	Type of Dedicated Section	Launch Date
Oslo Stock Exchange	Green bonds	January 2015
Stockholm Stock Exchange	Sustainable Bonds	June 2015
London Stock Exchange	Green bonds	July 2015
Shanghai Stock Exchange	Green bonds	March 2016
Mexico Stock Exchange	Green bonds	August 2016
Luxembourg Stock Exchange	Luxembourg Green Exchange	September 2016
Borsa Italiana	Green and Social Bonds	March 2017
Taipei Stock Exchange	Green bonds	May 2017
Johannesburg Stock Exchange	Green bonds	October 2017
Japan Exchange Group	Green and Social Bonds	January 2018
Vienna Exchange	Green and Social Bonds	March 2018
Nasdaq Helsinki	Sustainable Bonds	May 2018
The International Stock Exchange	Green bonds	November 2018
Frankfurt Stock Exchange	Green bonds	November 2018

Source: CBI

[27] Climate Bonds Initiative (CBI). (2019, May 13). Green Bond Segments on Stock Exchanges. Retrieved from https://www.climatebonds.net/green-bond-segments-stock-exchanges

In the meanwhile, investment and commercial banks are increasingly battling to get the leadership in this burgeoning asset class[28]; Green Bonds not only represent a profitable growing market segment for underwriters but may also stress to the vast array of Financial Institutions' stakeholders a proof of the effort to promote the shift to a low-carbon economy, improving the banks' overall standing. In Figure 2 it is represented the fierce competition described above, with Credit Agricole, Bank of America Merrill Lynch and HSBC topping the 2018 Underwriters League Table.

Figure 2. 2018 Green Bonds Underwriters League Table



Source: CBI and Refinitiv

1.2.1 Origins and First Steps

The first appearance of investment products designed to raise awareness on climate change adaptation and mitigation can be traced back to 2007 in the form of "cool bonds" and "eco notes"[29]; investors showed great interest in products that offered both appropriate risk-adjusted returns and contribute to an environmentally sustainable development. Specifically, in 2007 the European Investment Bank (EIB) issued what can be considered the first Green Bond, denominated "Climate Awareness Bond"; the success of this first issuance was mainly due to the fact that it represented the first attractive solutions for institutional investors' fixed-income allocations towards climate-related products. In 2008, the appeal of this innovative financial instrument was confirmed by the World Bank Green Bond, which generated significant interest worldwide and reached investors that normally did not deal with World Bank securities, leveraging on the additional information provided by due diligence process linked to the bond. The wider bond market started to react after the first USD 1 billion Green Bond sold within an hour of the issue by IFC in 2013. Since this issuance, the Green Bond market has seen strong growth, starting to take off in 2014 when USD 37 billion were placed to the public.

[28] Morgan Stanley. (2017). Behind the Green Bond Boom. Morgan Stanley Research
[29] Reichelt, H. (2010). Green bonds: a model to mobilise private capital to fund climate change mitigation and adaptation projects. World Bank

The entrance of corporate Green Bonds has dramatically altered the dynamics of this market. The first corporate-issued Green Bond was by Vasakronan, a Swedish real estate company, in November 2013. Later on, utilities such as GDF Suez (now Engie) and Électricité de France (EDF) and transportation companies such as Toyota have issued record-breaking Green Bond issuances, financing the development of renewables and low-carbon production as part of the companies' core business models[30]. In February 2016, Apple issued its first USD 1,5 billion Green Bond, showing the wide potential of this instrument across different sectors. The first Green "Muni-Bond" was issued by Massachusetts in June 2013. Gothenburg issued the first Green City Bond in October 2013. As of today, US states are major Green Bond issuers, but issuers also include Province of Ontario, City of Johannesburg, and Province of la Rioja (Argentina); also local government Green Bonds continue to grow[31]. SolarCity (now Tesla Energy) issued the first solar ABS in November 2013, while currently the biggest ABS issuer is Fannie Mae.

1.2.2 A Well-established Reality

According to the latest available data on the "state-of-the-art" of the Green Bond market, collected in the 2018 CBI Annual Report[32], it results that an amount equal to USD 167,6 billion of eco-labelled bonds have been purchased by investors worldwide in 2018. It represents a year-on-year growth of nearly 5% compared to the total 2017 issuances, signalling the ongoing market uptrend. To be more specific, USD 167,6 billion simply stood for Green Bonds which met the CBI Green Bond database criteria[33]: at least 95% "use of proceeds" financing or refinancing green/environmental projects and only bonds which are broadly aligned with the Climate Bonds Taxonomy[34]. In addition to Green Bonds, the market has seen the issuance of USD 21 billion of Sustainability/SDG/ESG Bonds financing sustainable initiatives and circa USD 14,2 billion of Social Bonds supporting social projects. These two categories respond to United Nations Sustainable Development Goals and, more in general, to broad purpose of promoting the importance of sustainability and social impact; however, SDG and Social Bonds are not subject to the strict requirements governing Green Bonds, due to their novelty. Finally, around USD 23,7 billion of "non-CBI aligned" Green Bonds reached the public in 2018; in this category, it is possible to include those bonds that did not satisfy CBI screening criteria due to inconsistency among different regulatory regimes[35]. Figure 3 summarizes this evidence.

[30] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law

[31] Climate Bonds Initiative (CBI). (2019, May 13). Explaining green bonds. Retrieved from https://www.climatebonds.net/market/explaining-green-bonds

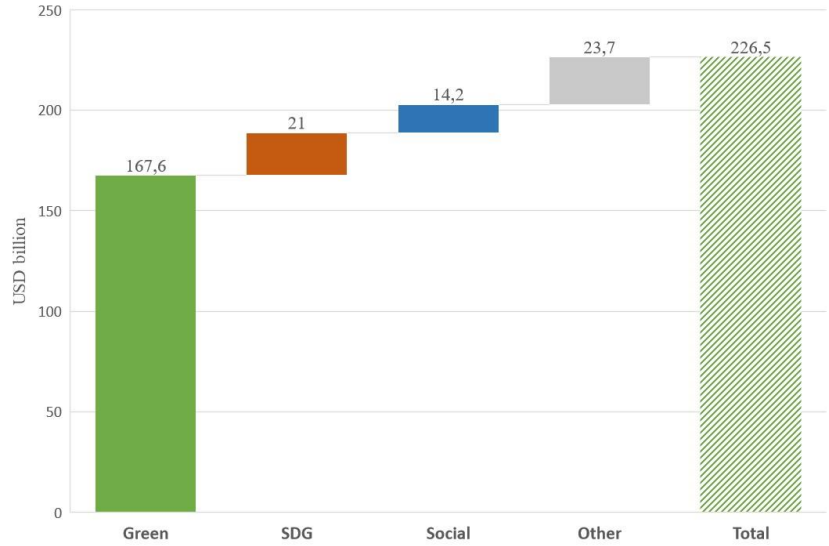
[32] Filkova, M., Frandon-Martinez, C., & Giorgi, A. (2019). Green bonds: The state of the market 2018. Climate Bonds Initiative (CBI)

[33] Climate Bonds Initiative (CBI). (2019, March 22). Labelled green bonds data. Retrieved from https://www.climatebonds.net/cbi/pub/data/bonds

[34] *See Sections 1.3 and 1.4 for further explanation on CBI criteria*

[35] *See Sections 1.4 for further explanation on regulatory inconsistency*

Figure 3. 2018 Issuance of Green, SDG, Social and Other Excluded Bonds

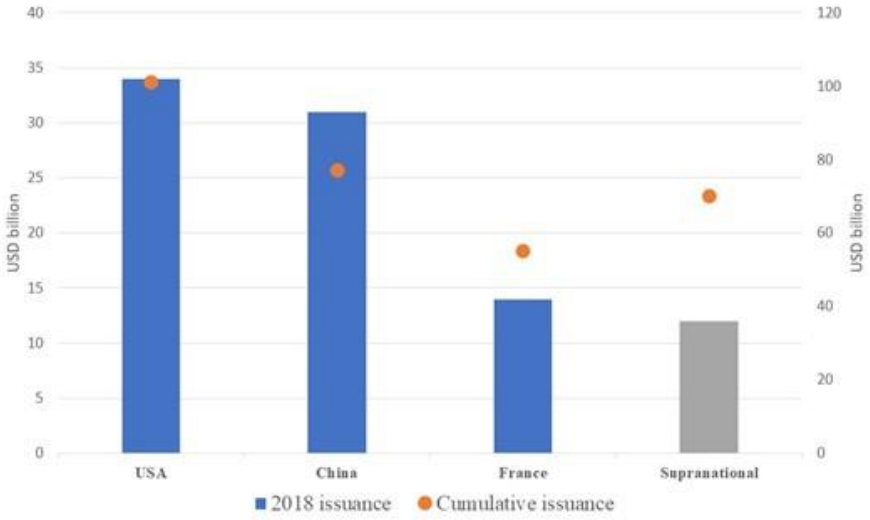


Source: Personal Elaboration from CBI

During 2018, the Top 3 countries for amount issued - accounting for 47% of global issuance - have been the USA with USD 34,2 billion, followed by China with USD 31 billion and France with 14,2 billion; not surprisingly, the fourth major "country" with nearly USD 12 billion was Supranational, due to the heavy reliance on Green Bonds by international entities to finance environmental-friendly projects worldwide. In these figures, only CBI-aligned bonds have been considered (*see* Figure 4)[36]. It is worth noting that China contribution to the market has been continuously expanding over the years, a strong signal of Green Bonds' potential in emerging economies, as highlighted in the following paragraphs. Almost 6% of the issuances have been benchmark-sized deals with more than USD 500 million of placement per issue; however, this number grows to 23% if Fannie Mae's small-size and repetitive issuances are excluded. This proportion results to be similar to 2017 performance. The median deal size of about USD 20 million grows to USD 128 million excluding Fannie Mae, in line with 2017 data. Moving to the average Green Bond issue size, in 2018 it was USD 320 million without considering Fannie Mae, as 2017. These figures stress the fact that most of the companies still cannot afford "giant-size" deals. However, both the median and the average deal size have grown over the years; this is positive as larger deals can provide more liquidity and depth to the market, and thus attract additional investors. The growth in the median size indicates that more issuers are issuing larger deals, whereas the growth in average size is driven more significantly by the volume of large-bond deals. Additionally, 95% of the issuances received at least one of the previous-mentioned types of external reviews (83% excluding Fannie Mae) - with second-party opinions topping the rankings - showing the increasing need of external verification to attract investors and reduce information asymmetries.

[36] Filkova, M., Frandon-Martinez, C., & Giorgi, A. (2019). Green bonds: The state of the market 2018. Climate Bonds Initiative (CBI)

Figure 4. 2018 Top Countries per Amount Issued

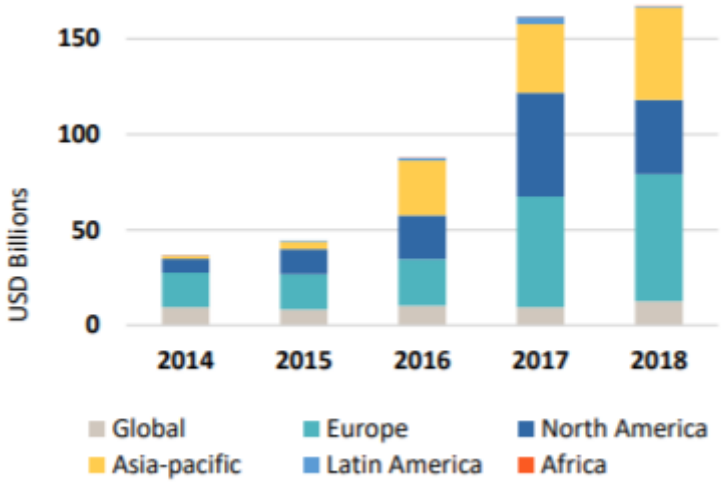


Source: Personal Elaboration from CBI

Last year, there have been 130 repeat issuers out of a total of 320, accounting for the 63% of 2018 volume: USD106bn. Most came back to the market once; however, a third of repeat issuer volume came from 9 entities that issued 5 or more deals in the course of the year. Companies reliance on Green Bonds according to recurring intervals suggests that some corporations are truly capable to exploit the positive effects provided by this new instrument; on the other side, issuers that have placed Green Bonds only once either consider costs greater than benefits or are not capable to extract value as effectively as repeat issuers. From a regional perspective, Europe secured the top spot as the largest Green Bond market overall; it showed the third-largest year-on-year growth rate at 15%, reaching USD 190 billion of issuance since 2017. In 2018, Europe's new Green Bonds amounted to USD 66,6 billion, equal to nearly 40% of the new issue; however, Asia-Pacific region recorded the highest level of increase, with 35% over 2017 to reach USD 48,5 billion in 2018 and around 29% of the new issue. On the other side, US issuance stood at 30%, showing a 10% drop in share compared to 2017 mainly due to a slowdown in the US Muni[37]. In Figure 5 is highlighted the geographical evolution of Green Bonds over the years, stressing the growth of emerging countries and the change in leadership from the USA to Europe. Finally, 8 new countries placed Green Bonds to investors for the first time, reaching a total of 44 issuing nations in 2018.

[37] Climate Bonds Initiative (CBI). (2019). Green Bonds Policy: Highlights from 2018. Climate Bonds Initiative (CBI)

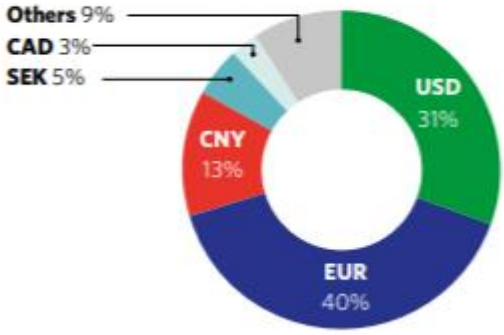
Figure 5. Regional Evolution of the Green Bond Market



Source: CBI

From a sector perspective, Financial Institutions' Green Bond boom is unprecedented; indeed, issuances more than double in the sector[38]. Furthermore, EUR surpassed USD as the denomination of choice, underlining Europe's leadership. While in 2017 US dollar was the first currency of issuance with 46% of annual volume, Euro reached the top of the ranking in 2018 with 40% of annual market volume. This change is partly due to the drop in US municipal issuance as well as large-scale issuance from Eurozone sovereigns. Chinese RMB places third, signalling the continued robust Green Bond market growth of Mainland China (*see* Figure 6).

Figure 6. Currency Ranking by Volume



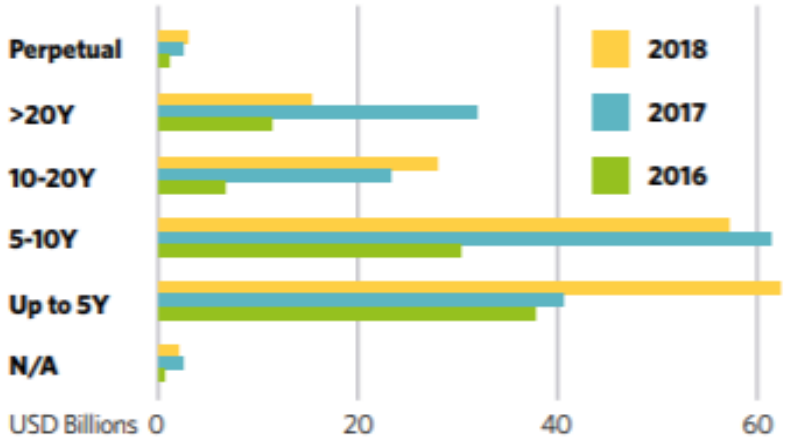
Source: CBI

Regarding data on bond maturity, 2018 showed that Green Bonds were shorter-dated compared to the previous year. Specifically, bonds within the "Up to 5 years" range made up the largest tenor category with more than USD 60 billion of issuances (circa 37% of 2018 new Green Bonds), while the "5-10 years" bracket was the largest in 2017 (see Figure 7). This preference towards short-dated bonds is partly associated with the increased issuance from commercial banks, which tend to issue bonds with a short tenor.

[38] Filkova, M., Frandon-Martinez, C., & Giorgi, A. (2019). Green bonds: The state of the market 2018. Climate Bonds Initiative (CBI)

Part of the shift may also arise from higher market volatility and rising interest rates in 2018; in fact, short-duration strategy is a way of reducing exposure to interest rate risk[39].

Figure 7. Green Bond Maturity



Source: CBI

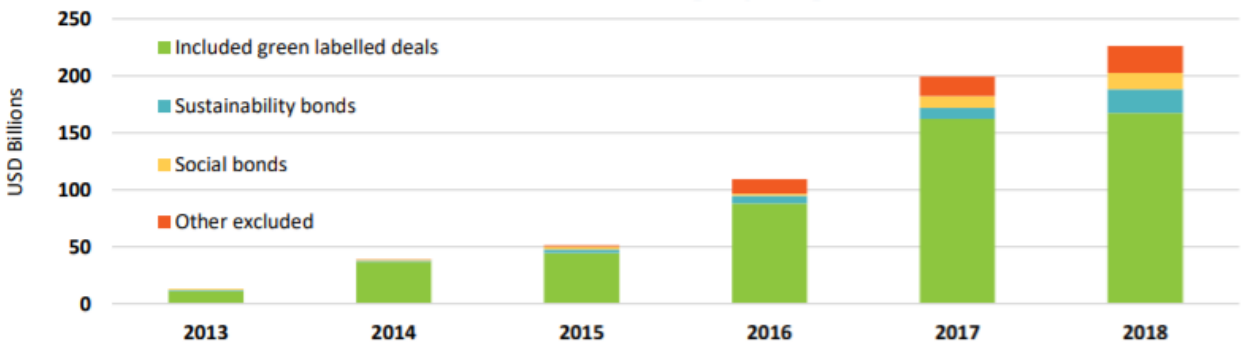
Moving to the "fresh" insights provided by the results of the first quarter of 2019, Green Bond issuance reached USD 47,9 billion, surpassing Q1 2018 volume of USD33.8bn by 42%, on a clear upward trend[40]. Contrary to 2018 data, volumes were driven by Non-Financial corporates, which accounted for a third of issuance. Europe remained the largest source of Green Bonds at 49%. An astonishing outcome comes from the issue size, since two-thirds of Q1 2019 Green Bonds by amount were benchmark-sized deals (USD 500 million and above).

Currently, scholars, investors and industry experts have contrasting opinions regarding the future of the Green Bond Market due to 2018 performance[41]. Adjectives such as "robust", "stunning" and "exponential" have been used to describe the expansion of the market from USD 1,48 billion in 2007 to USD 173,61 billion in 2017. Some experts say that this growth is impressive because Green bonds are no more legally secure than regular bonds. However, the volume of Green Bonds might appear insignificant when compared with the $6 trillion that should be invested each year over a 15-year period just to climate-proof our infrastructures and meet sustainable development goal, according to OECD studies[42]. The volume of green issuance in 2018 might suggest that growth is waning since the market grew barely 5% in 2018. Yet, while Green Bond expansion did not reach the performance of the previous years, the issuance of sustainable debt has significantly increased, paving the way for an alternative evolutionary path for the "Sustainability" market. Green loans, sustainability-linked loans, green mortgages are all market responses to investors demanding something slightly different, especially when the Green Bond framework is not a perfect fit for the project, the issuer or the investor.

[39] Filkova, M., Frandon-Martinez, C., & Giorgi, A. (2019). Green bonds: The state of the market 2018. Climate Bonds Initiative (CBI)
[40] Climate Bonds Initiative (CBI). (2019). Green Bonds Market Summary - Q1 2019. Climate Bonds Initiative (CBI)
[41] Counihan, G. (2019). Is the green bond market running out of steam? Franklin Templeton Investments
[42] OECD. (2017). Mobilising Bond Markets for a Low-Carbon Transition. Paris: OECD Publisher

Coming back to the specifics of the Green Bond market, Rahul Ghosh - senior vice-president for environmental, social and governance at Moody's – has noted that the growth in other forms of sustainable and socially labelled debt had contributed to Green Bonds' levelling off, by offering alternative labelling options for issuers to choose[43]. Indeed, taking all labelled issuance into account, it is possible to stress that the market has moved from USD 199,3 billion to USD 226,1 billion, up 13% in 2018 (see Figure 8). Furthermore, even though some may consider the market fell short from the beginning of the year's expectations, it is worth noting it showed encouraging signs of resilience to more testing market conditions and was even able to keep the ongoing growth trend in a more challenging and volatile environment[44].

Figure 8. Labelling Differentiation over Years



Source: CBI

1.2.3 Future Outlook

In the short-term, Green Bond market is expected to continue its growth path, leveraging on 2018 consolidation; the good progress in the development of taxonomies and the harmonisation effort have created solid bases for the Green Bond's future evolution[45]. In particular, there is a high probability that the next wave of deals will be aligned to Climate Bonds Taxonomy, leading to fewer exclusions in CBI's screening process. A clearer definition of what is "green" and improved disclosure on the projects being financed and their environmental impact can help investors' assessment. Additionally, the growing number of dedicated Green Bond funds and the increased ESG relevance across the investment community are beneficial to the further development of the market[46]. According to a new report from Moody's Investors Service[47], Green Bond issuance is set to reach USD 200 billion in 2019, growing by 20% year-on-year. Continued issuers' diversification and greater clarity around standards and definitions will help expand the Green Bond market. Although 2018 experienced slower growth, a number of supporting factors suggest an expansion in 2019 and beyond. A broader focus on sustainability will also drive growth in social, sustainability and other labelled bonds, strengthening long-term market growth. Specifically, Moody's

[43] Allen, K. (2018). Green bonds start conversation in the market. Financial Times

[44] International Capital Market Association (ICMA). (2019, January 31). Green, Social & Sustainability Bonds - Quarterly Newsletter from the Green and Social Bond Principles. Retrieved from https://www.icmagroup.org/Emails/ICMA-events/quarterly-newsletter-20

[45] *See Section 1.4 for further explanation on regulatory consolidation*

[46] Filkova, M., Frandon-Martinez, C., & Giorgi, A. (2019). Green bonds: The state of the market 2018. Climate Bonds Initiative (CBI)

[47] Moody's Investor Service. (2019, January 31). Moody's: Green bond market poised to hit $200 billion in 2019. Retrieved from https://www.moodys.com/research/Moodys-Green-bond-market-poised-to-hit-200-billion-in--PBC_1159526

experts foresee the importance of Non-financial corporates to sustain Green bond issuance. Differently, CBI's target for Green Bond issuance in 2019 is USD 250 billion; it seems an ambitious target, but it is the threshold level that it is necessary to reach to slow down the impacts of climate change – according to the organisation. Issuers, investors and governments are increasingly aware of the need to scale up climate finance and CBI expects more issuers, more repeat issuance and a further rise in Green Bond issuance from Financial Institutions, acting as aggregators for the loan market. Furthermore, the Climate Bond Initiative stresses that the Green Bond market should reach USD 1 trillion by 2020 in order to produce a concrete impact on climate targets[48].

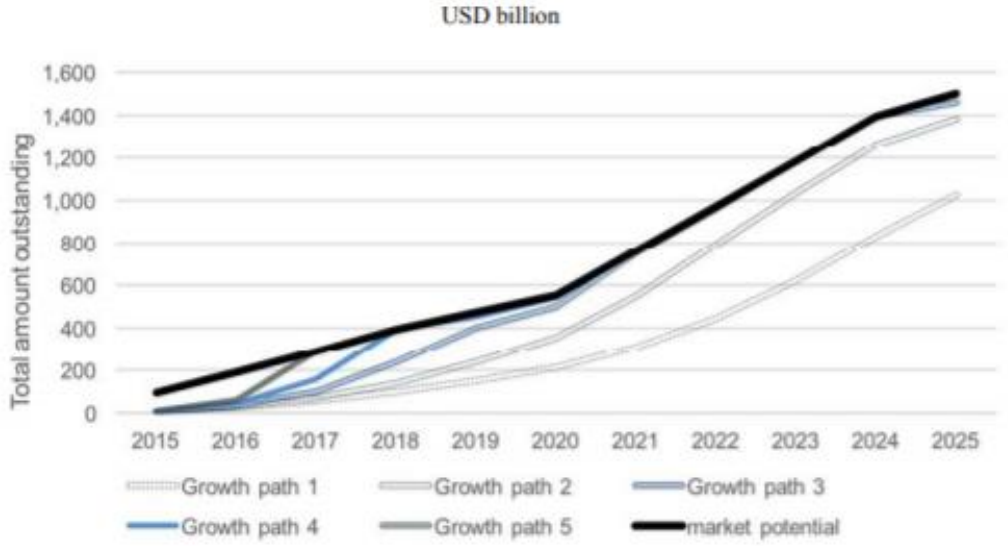
Shifting to a long-term perspective, the OECD proposes two main scenarios for the Green Bond market to keep pace with the "2°C pathway (2DS)" agreed in Paris[49]:

- a baseline scenario that relies on conservative asset securitisation assumption;
- a scenario with a 10% increase in asset securitisation rate across all sectors.

Both scenarios assume that policymakers adopt supportive policies to overcome various challenges. The results of the analysis suggest that by 2035 in a 2DS, bonds financing and refinancing have the potential to scale to USD 4.7-5.6 trillion in outstanding securities globally and USD 620-720 billion in annual issuance. While these figures may seem large on an absolute basis, they as small as approximately 4% of the scale of debt securities markets – counting more than USD 19 trillion of gross issuance on an annual basis. Interestingly, OECD believes that the 2020s have the potential to be the start of the "*Golden Years*" for bond issuance in the low-carbon sectors: due to the progress of environmental-friendly technologies and the stabilization of policies worldwide, the risks of assets will fall and the role played by bonds could expand rapidly. In Figure 9 it has been described a wider range of possible scenarios together with the previous two; the top solid line illustrating the market growth potential represents the enhanced securitisation scenario with a 10% increase in asset securitisation. It shows a theoretical upper limit for Green Bonds outstanding modelled in a 2DS world, given capital structures and investment needs. The other lower lines illustrate, over a ten-year period, the speed at which the theoretical potential might be reached, depending on how the bond market develops. If both emerging and major markets move together strongly supporting Green Bond market expansion, the growth could be on the scale of 100-200%. On the other hand, if the policy and regulatory environment does not hold up rapid market growth, Green Bond issuance will fall behind its potential and may never reach it, as growth path 1 illustrates[50].

[48] Weber, O., & Saravade, V. (2019). Green Bonds: Curren Development and Their Future. CIGI Papers
[49] OECD. (2017). Mobilising Bond Markets for a Low-Carbon Transition. Paris: OECD Publisher
[50] OECD. (2017). Mobilising Bond Markets for a Low-Carbon Transition. Paris: OECD Publisher

Figure 9. Alternative Scenarios for Green Bond Market Evolution



Source: OECD

1.2.4 Emerging Markets' Potential

Emerging markets are the most exposed area to climate change risks; indeed, they need to reduce the reliance of their economies on fossil fuels while following a solid sustainable growth path. This scenario highlights the issue of funds and financing shortage to build up new environmental-friendly infrastructures. According to recent estimates, untapped investment opportunities in "*greenification*" projects amount to a total of USD 29.000 billion in emerging markets up to 2030[51]. The current situation suggests that Green Bonds may represent the right instrument to finance sustainable growth in developing countries. The Amundi-IFC Emerging Market Green Bond Report 2018[52] points out that USD 140 billion have been issued in 28 emerging markets between 2012 and 2018, forecasting a growth up to USD 250 billion by 2021. In addition, it shows that Green Bonds equal to 3% of developing countries bonds' issuances, a proportion significantly higher respect to developed markets. At USD 52,6 billion, emerging economies accounted for 31% of 2018 issuance, showing an uptrend compared to the 29% of 2017.

Asia-Pacific has been the core of emerging markets expansion, achieving the highest regional year-on-year growth rate at 35% and having the second largest 2018 volume after Europe. The bulk of the regional growth can be attributed to the increasing weight of financial corporate issuers in the market, representing more than half of Asia-Pacific issuance volumes in 2018[53].

[51] Caparello, A. (2019, May 13). Mercati emergenti, green bond destinati a raddoppiare entro 2021. Retrieved from https://www.finanzaonline.com/notizie/mercati-emergenti-green-bond-destinati-a-raddoppiare-entro-2021
[52] Amundi Asset Management; International Finance Corporation (IFC). (2019). Emerging Market Green Bonds Report 2018. Amundi Asset Management; International Finance Corporation (IFC)
[53] Climate Bonds Initiative (CBI). (2019). Green Bonds Market Summary - Q1 2019. Climate Bonds Initiative (CBI)

Focusing on China, the country retained a leading role with 78% of 2018 emerging markets' issuance volumes and 18% of global volumes, up from 14% in 2017[54].

The rapid growth of China's Green Bond market depends on both the strong policy support and the enormous potential of China's green finance system. Although the Green Bond market was launched in China only in December 2015 - when the People's Bank of China first introduced Green Financial Bonds in the country's interbank bond market and the Green Finance Committee of the China Society for Finance and Banking published its Green Bond Endorsed Project Catalogue - it became one of the world's largest within a single year, making up 40 percent of total "self-labelled" Green Bond issuance in 2017[55]. It is necessary to clarify that the 40% data refer to a "wide concept" of green projects - including coal and nuclear energy production – outlined by the People Bank of China (PBOC)[56]. Summing up, China's Green Bond market is a relative latecomer, but it has grown rapidly since its inception. The market is particularly keen on certain innovative products such as Green Covered Bonds and Green ABS. Currently, in China around 2 percent of China's bonds are considered "green"; however, experts in the field expect the size of the Green Bond market to grow to around 20 percent of total bond issuance in China to meet the market's need for green investments. Specifically, to reach this ambitious objective, there are several things to watch for in the development of the Chinese Green Bond market:

- China's further harmonization of its domestic Green Bond taxonomies; without a clear Green Bond taxonomy, indeed, it is difficult for investors to distinguish between green and brown projects.
- China is expected to play a leading role in scaling up green investment in the Belt and Road countries; China's Belt and Road Initiative is providing huge investment opportunities for green infrastructure projects, especially since the first official mention of a "green coalition" along the Belt and Road in 2017. Going forward, Green Bonds are expected to be an indispensable financing instrument for the development of infrastructure projects along the Belt and Road Initiative[57].

1.3 Players and Observers Shaping the Market

The major actors driving the development of green finance include banks, institutional investors and international financial institutions as well as central banks and financial regulators. However, public budgets fall far short of the required funding. For this reason, a large amount of private capital is needed[58]. Starting from this assumption and from the necessity to joker at least tens of billions of dollars each year to finance the cost of adaptation caused by an inevitable amount of global warming that the world will experience, it appears clear that the task is too great for governments resources alone. Private investment is urgently needed to supplement scarce government funds and credit. On a large scale, this can only be

[54] Climate Bonds Initiative (CBI). (2019). Green Bonds Policy: Highlights from 2018. Climate Bonds Initiative (CBI)
[55] Schipke, A., Rodlauer, M., & Zhang, L. (2019). The Future of China's Bond Market. International Monetary Fund (IMF)
[56] *See Section 1.4 for further explanation on the PBOC Green Bond regulation*
[57] Schipke, A., Rodlauer, M., & Zhang, L. (2019). The Future of China's Bond Market. International Monetary Fund (IMF)
[58] Berensmann, K., & Lindenberg, N. (2016). Green Finance: Actors, Challenges And Policy Recommendations. German Development Institute (DIE)

generated through the global financial markets, with innovative solutions across asset classes; among the feasible alternatives, Green Bonds seem to be the most solid one since new products must have the right financial incentives to attract private investment and use public credit efficiently[59].

The international community of nation-states cannot act alone also from a regulatory perspective; ascertained that the traditional paradigm of a single comprehensive treaty-based regime - constituted and funded by governments - is surpassed nowadays, greater collaboration between market's players is needed to sustain Green Bonds' success. Even for countries that are indisputably committed to meeting nationally determined contributions under the Paris Agreement, their governments are frustrated by tight budgets, lack of political will, and competing policy priorities. Climate mitigation and adaptation will be enormously expensive in the short-term, requiring trillions of dollars of investment in low-carbon and climate-resilient infrastructure. To bridge this gap in financial resources, the Paris Agreement expressly calls for mobilizing private sector financing and involving all the participants to the market to support the large number of investments in green technologies and infrastructure that will be needed to realize carbon emissions' goals. Indeed, aware of the existential threat posed by climate change, the persistence of public gridlock requires private solutions[60].

1.3.1 Issuers

Currently, the Green Bond market unlocks a number of benefits by increasing the transparency of information available to investors on underlying assets and companies[61]. Green Bonds can help bond issuers communicate their sustainability strategies, create internal synergies between financial and sustainability departments, expanding and enhancing the relationships between borrowers and debt providers.

In light of recent market developments, it seems critical to make a distinction between a Corporate Green Bond and a Government-related issue since the reasons and the objectives guiding the action of profit-seeking institution differs from the ones of an entity guided by a social purpose. Trying to remain as general as possible, a corporation seeks to improve its reputation and to convey the idea of an environmental-friendly organization through Green Bonds, while attracting a larger number of investors to potentially reduce its cost of financing and, eventually, improve its performance. On the other side, the action of governments and supranational institutions is not moved by profit rationales; they try to embrace a broader objective balancing equality and equity rationales, recurring to Green Bonds to promote their own regional or national policies. In the future, differentiation between Government-related and Corporate Green Bonds will be needed not only to ensure clarity to investors but also to attract more diversified investors with

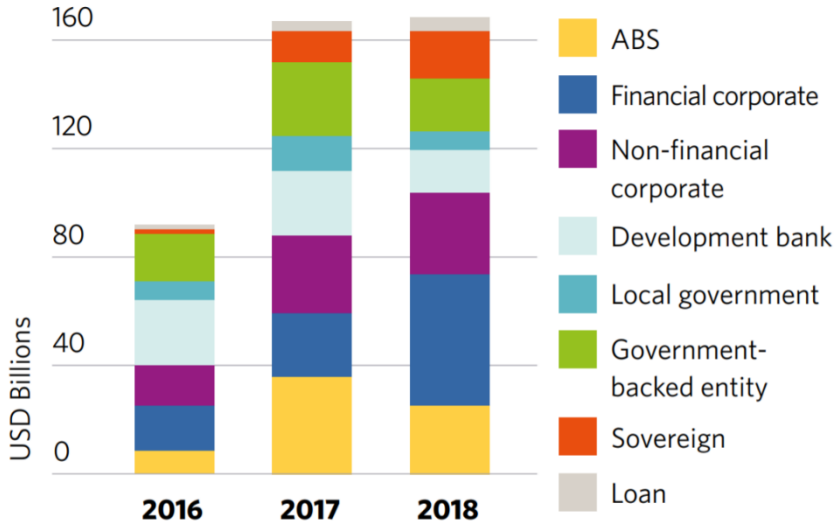
[59] Reichelt, H. (2010). Green bonds: a model to mobilise private capital to fund climate change mitigation and adaptation projects. World Bank

[60] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law

[61] Shishlov, I., Morel, R., & Cochran, I. (2016). Beyond transparency: unlocking the full potential of green bonds. Institute for Climate Economics (I4CE)

different risk constraints[62]. In Figure 10 it can be tracked the evolution of Corporate Green Bonds - with a clear distinction between Financials and Non-Financials - relative to the overall market, showing that in 2018 Green Bonds issued by corporations amounted to nearly 50% of annual issuances: a significant proof of the exponential success of the instrument in the Corporate world[63].

Figure 10. Corporate vs Government-Related Green Bonds



Source: CBI

An additional topic that must be considered refers to the concept of "Green Pure-Play" issuers. This term wants to describe all those bond issuers that do not label their issuance as "Green Bond" even if the company business and the issuances themselves have all the characteristics to be included in the category. Assuming an investor's perspective, this situation might create an opportunity to invest in financial instruments that are supportive of a low-carbon future, but which are not labelling themselves as "green". Indeed, this would allow investors to earn a higher return on their unlabelled green debt instruments while providing liquidity to a portion of the market that would seemingly benefit from it. To reduce this "arbitrage gap", "Green Pure Plays" should absolutely be recognised as compliant with the Green Bond Principles, according to major experts and scholar, such as Suzanne Buchta, one of the original authors of the principles[64]. The idea that labels and ratings create convenience – and opportunity - is hardly novel in debt markets. For instance, in 2016 bonds aligned with the global climate agenda were estimated to USD 895 billion out of approximately USD 221 billion of labelled Green Bonds[65].

1.3.2 Institutional Investors

In the last two decades, institutional investors' appetite for sustainable investment product has constantly grown due to the escalating pressure towards ESG topics coming from beneficiaries. Recent data shows that over 70 percent of mainstream institutional investors consider sustainability as central to their

[62] Archer, O., & Tournaire, M. (2018). Green Bonds: Is the grass always greener? AON Investment Research and Insights
[63] Filkova, M., Frandon-Martinez, C., & Giorgi, A. (2019). Green bonds: The state of the market 2018. Climate Bonds Initiative (CBI)
[64] Counihan, G. (2019). Is the green bond market running out of steam? Franklin Templeton Investments
[65] Weber, O., & Saravade, V. (2019). Green Bonds: Curren Development and Their Future. CIGI Papers

investment decisions[66]. Considering US alone, Audrey Choi - Chief Sustainability and Marketing Officer at Morgan Stanley[67] - reports that the US SIF (The Forum for Sustainable and Responsible Investment) figures demonstrate that more than USD 8,7 trillion in US assets under management now consider environmentally and socially responsible factors, which is more than 1 in 5 dollars under professional management. Thus, investor demand across various asset class has stimulated the emergence of climate-related investment opportunities; so far, however, such opportunities have been more concentrated in equity – both private and public – rather than in fixed income. To succeed in channelling larger sums of capital into green initiatives, securities must appeal to institutional investors with large volumes of assets under management. Nowadays, these are with pension funds, insurance firms, asset managers and sovereign wealth funds. Specifically, although many players have been increasing allocations to alternative assets classes, fixed income still makes up about 25% to 40% of their assets. Regardless of whether these investors pursue ESG strategies or not, the numbers show that there is a large untapped potential in the fixed income space to access capital for low-carbon initiatives, alluring investors that appreciate both liquid high-grade investments and climate-resilient solutions[68]. Additionally, a recent survey conducted by Morgan Stanley Institute for Sustainable Investing has highlighted that more than 84% of institutional investors already pursue or is strongly considering the integration of ESG strategies in their investment process[69]. Rui de Figueiredo – co-Head of Solutions and MultiAsset at Morgan Stanley Investment Management – stresses that the interest for sustainable investments is constantly increasing, in line with the wider diversification followed by institutional investors.

In light of this market forces, bond finance has the potential to play a significant role in mobilising additional institutional investors to support the low-carbon investment necessary to meet a 2DS by mid-century. Institutional investors in the OECD have the potential to absorb the increased supply of such bonds, shifting their asset allocations in response to the increased percentage of Green Bonds as a share of the broader bond markets. This reasoning is based on two assumptions: firstly, institutional investors' appetite for Green Bonds is expected to grow in light of the increasing attention to climate risks and opportunities in investment portfolios; secondly, institutional investors will shift allocations to align their portfolios with the increasing share of Green Bonds in the market as a whole[70]. The surge in interest in Green Bonds reflects an incipient revolution in socially responsible approaches to finance; quite surprisingly, this revolution is led by the most unlikely of revolutionaries: mutual funds, pension funds, and insurers that collectively hold the largest pool of capital[71]. Green Bonds could be a solution to address financing shortage for the shift

[66] Unruh, G., & al., e. (2016). Investing for a Sustainable Future. M.I.T. SLOAN Management Review
[67] Nixon, T. (2017). Values and impact are increasingly relevant to investors. Reuters
[68] Reichelt, H. (2010). Green bonds: a model to mobilise private capital to fund climate change mitigation and adaptation projects. World Bank
[69] D'Angerio, V. (2018). Finanza sostenibile tra consulenti e green bond. Il Sole 24 Ore
[70] OECD. (2017). Mobilising Bond Markets for a Low-Carbon Transition. Paris: OECD Publisher
[71] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law

towards an environmentally sustainable reality, given their mandate of channelling debt capital specifically toward green or low-carbon projects and assets. Nowadays, bonds are the single largest pool of capital - an estimated US$80 trillion versus US$53 trillion in equities as of 2014[72] - and they can be directly linked to low-carbon infrastructure projects. The Green Bond market aims to enable and develop the key role that debt markets can play in funding projects that contribute to environmental sustainability[73].

Importantly, Green Bonds give investors an option for socially responsible investment outside of equities, which have historically dominated this space[74]. Furthermore, the Green Bond universe provides investors with a large choice of different maturities, which can help to match a range of different institutional investor liabilities[75]. The Green Bond market has seen exponential growth over the past 5 years as an increasing number of investors have sought environmentally sustainable investments without having to sacrifice financial returns[76]; however, the developments in Green Bond taxonomy may skyrocket the attraction for this innovative asset class. Because of second-party review, audit, and certification, the Green Bond can be treated as a qualified investment opportunity. Together with issuers of Green Bonds, bondholders can also be classified as socially responsible investors[77]. Another relevant topic is the opportunity that Green Bonds provide to move from the traditional shareholder activism to bondholder activism[78]. The extra disclosure required to sell a Green Bond creates more dialogue between borrowers and lenders than the ordinary process of issuing debt has traditionally done. Green bonds boomed during an era of unprecedentedly loose monetary policy that pushed investors to hunt for returns. Considering policy tightening and volatility rising, environmental finance is likely to face more headwinds that might be tempered trough activist strategies[79]. Regardless, it is important not to forget that bonds' "voice" in an "exit-or-voice" rationale will always be harder to implement compared to the relatively cheap solution represented by "exit"; additionally, the investment downside of a given Green Bond is capped and investors are not exposed to the risks of a given project beyond their investment[80].

Finally, many private investors have already spotted an opportunity to earn rewards leveraging on green bonds' opportunity to directly invest in green energy. Vikram Widge - Global Head of Climate Finance and Policy at the International Finance Corporation (the World Bank's private sector arm) – depicts an increasingly larger share of investors who care about climate change not because they think they want to

[72] Weber, O., & Saravade, V. (2019). Green Bonds: Curren Development and Their Future. CIGI Papers
[73] International Capital Market Association (ICMA). (2018). Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bondss
[74] Archer, O., & Tournaire, M. (2018). Green Bonds: Is the grass always greener? AON Investment Research and Insights
[75] Archer, O., & Tournaire, M. (2018). Green Bonds: Is the grass always greener? AON Investment Research and Insights
[76] Climate Bonds Initiative (CBI). (2019). Growing green bond markets: The development of taxonomies to identify green assets . Climate Bonds Initiative (CBI)
[77] Tang, D. Y., & Zhang, Y. (2018). Do Shareholders Benefit from Green Bonds? Journal of Corporate Finance
[78] Allen, K. (2017). Sellers of green bond face a buyer' s test of their credentials. Financial Times
[79] Allen, K. (2019). Disclosure is a lure for green bond investors. Financial Times
[80] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law

make the world a better place but because they see it as a risk[81]. Green bonds are particularly attractive since they are simple and easy to understand. The governance structure is simple, representing a form of synthesized *ex-ante* monitoring: the investor selects the specific projects associated with a Green Bond prior to purchasing the bond, relying on the issuers' disclosures regarding the "use of proceeds" and the criteria that they will apply once funds are allocated to support specific projects. Green Bonds have a structurally embedded advantage compared to traditional fixed income products: they are similar to bonds in all aspects but give more intelligence; consequently, Green Bonds are potentially a better investment solution. They have a sort of *free option* that is worth money[82].

1.3.3 Self-Regulatory Organizations (SROs)

Currently, Self-Regulatory Organizations (SROs) play a leading role in shaping the dimension and the boundaries of the Green Bond market, supporting contrasting interest and sometimes creating inconsistencies among the Green Bond framework[83].

One of the most influential players is the *International Capital Market Association (ICMA)* through the Green Bonds Principles (GBP): an example of process standards representing a pillar of the Green Bond market. The ICMA - relying on these process standards - define methods and processes that companies can use to develop their own operational frameworks[84]. This entity promotes integrity in the Green Bond market through high-level guidelines that recommend transparency, disclosure and reporting. The reports produce by the ICMA are intended for use by market participants and are designed to drive the provision of information needed to increase capital allocation to green projects. Through the GBP, the ICMA is trying to enhance the transparency of green credentials, fostering Green Bonds as an investment opportunity[85]; however, the voluntary-based approach might dampen market uniformity regarding the key components required to launch a credible Green Bond. The ICMA plays a pivotal role, supporting investors by promoting the availability of information necessary to evaluate the environmental impact of a Green Bond investments; at the same time, it assists underwriters by moving the market towards expected disclosures that will facilitate transactions[86]. Finally, this entity is not involved in vetting individual Green Bond issues but simply promotes guidance.

Another key entity of the Green Bond world is the *Climate Bonds Initiative (CBI)*, a UK-government-backed non-profit that offers accreditation and certification. It represents the quintessential example of

[81] Espinoza, J. (2018). Private players plug in to the green energy revolution. Financial Times
[82] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[83] *See Section 1.4 for further explanation in regulatory inconsistency*
[84] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[85] International Capital Market Association (ICMA). (2018). Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bondss
[86] International Capital Market Association (ICMA). (2018). Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bondss

certification as a mode of governance[87]. In particular, the CBI has set forth the strict requirements and eligibility criteria for Climate Bonds Certification, the most recognized certification standard globally. In order to be certified by CBI, a Green Bond must satisfy pre-issuance requirements as well as post-issuance requirements that must be met within the first two years. Once certified by CBI, an issuer is entitled to use a certification logo for a specific Green Bond issuance under terms agreed upon by the issuer and CBI. As a condition to certification, CBI requires an independent third-party assurance provider or auditor to assure that an issuer is complying with the Climate Bonds Standards.

The third spot among the SROs is occupied by external reviewers and second-opinion providers. Considering that second opinions are the predominant form of external review, a growing number of entities is starting to provide specialized services to satisfy the demand. As highlighted at the beginning of the chapter, a second opinion is an independent review of the framework of rules, regulations, and guidelines used by a Green Bond issuer. It focuses on the process by which an issuer selects projects and investments to determine whether the selection criteria contribute to reductions in GHG emissions. In addition, second opinions assess the issuer's broader ESG policies. According to a recent report for the European Investment Bank (EIB)[88], it is possible to identify 4 main providers of external opinions:

- *CICERO (Center for International Climate and Environmental Research - Oslo)* - the most active second opinion provider – is an independent not-for-profit research institute that has been active on the market since its inception in 2008. It ranks the issuer's Green Bond framework, project types and the terms of the Green Bond on a three-point "*Shades of Green*" scale (dark-medium-light green scale). It provides over two-thirds of second opinions to date[89].
- *Sustainalytics* is a global ESG and corporate governance research and analysis firm, helping clients turn ESG information into insightful, value-added analysis to enable more informed investment decisions.
- *Oekom Research AG* is a leading external reviewer in the segment of sustainable investment.
- *Vigeo Eiris* is a global independent provider of ESG research and services for investors, public and private organisations and NGOs.

Additionally, rating agencies are also getting involved; for instance, *Moody's* runs a Green Bond assessment and *Standard & Poor's* recently launched a green evaluation service[90].

[87] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law

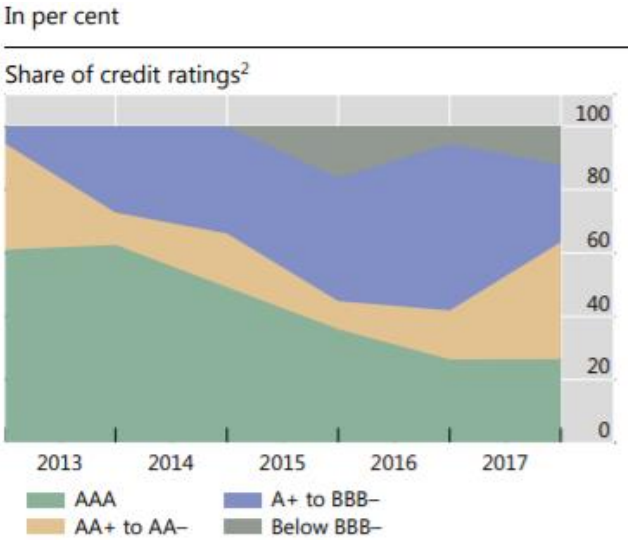
[88] European Investment Bank (EIB). (2018, September 14). Scaling Finance for Subnational and Corporate Climate Action through Green Bonds. Retrieved from https://www.eib.org/en/press/all/2018-229-launch-of-the-global-green-bond-partnership?media=rss&language

[89] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law

[90] Allen, K. (2017). Sellers of green bond face a buyer' s test of their credentials. Financial Times

Finally, *Market Indices* are significantly contributing to the development of the Green bond market; they represent a form of informational regulation that might influence market decisions by consumers and producers. Sustainability indices - such as the Dow Jones Sustainability Indexes and the FTSE4Good Index Series - have become a widely recognized governance tool. As the Green Bond market grows, *Market Indices* are expected to play an increasingly significant role since institutional investors are often required to invest exclusively in "benchmark-eligible" securities[91]. Furthermore, the rapid growth in issuance is altering the nature of Green Bond indices; in particular, the number of new Corporate Green Bond issues is changing the average credit rating of indices. The average credit rating has deteriorated over the years with more BBB Green Bonds being issued (*see* Figure 11). In 2014, the first Green High Yield Bonds were issued: one rated 'B' by S&P and one rated 'Bb1' by Moody's[92].

Figure 11. Evolution of Green Bond Credit Ratings



Source: Ehlers & Packer from Bloomberg and CBI data

The 5 main *Market Indices* for Green Bonds[93] are the following:

- *Bloomberg MSCI Barclays Green Bond Index*. A multi-currency benchmark that includes local currency debt markets tracked by the Barclays Global Aggregate Index. Launched in November 2014, it is a multi-currency benchmark that tracks Corporate, government-related, treasury and securitized Green Bonds according to specific green criteria established by the MSCI. It is in line with the GBP but not explicitly aligned with the CBI guidelines and includes only investment-grade bonds with a fixed minimum issue size of EUR/USD 300 million.
- *BAML Green Bond Index* - the most appropriate for monitoring Corporate Green Bond results. Designed to track the performance of debt issued by quasi-governments and corporations where the proceeds of the issue are to be used solely for projects and activities that promote climate or other

[91] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[92] Archer, O., & Tournaire, M. (2018). Green Bonds: Is the grass always greener? AON Investment Research and Insights
[93] Green Bond Principles (GBP). (2018). Summary of Green – Social - Sustainable Fixed Income Indices Providers. Green Bond Principles (GBP)

environmental sustainability purposes. Launched in October 2014, it is a multi-currency benchmark that tracks corporate and quasi-government issuers but excludes securitized and collateralized securities. It is not explicitly aligned with the GBP/CBI guidelines and includes only investment-grade bonds with a fixed minimum issue size of EUR/USD 250 million. Qualifying bonds must have a clearly designated use of proceeds.

- S*&P Green Bond Index* and *S&P Green Bond Select Index*. Multi-currency benchmarks that include bonds issued by multilateral, government and corporate issuers. They include only those bonds whose proceeds are used to finance environmentally friendly projects. Launched in July 2014 and February 2017 respectively, they are multi-currency benchmarks that track Corporate, government and multilateral Green Bonds according to CBI criteria. They have no fixed minimum issue size requirements; the S&P Green Bond Index has no credit requirements, while the S&P Green Bond Select Index includes only rated issues by S&P, Moody's or Fitch with minimums for Investment Grade and maximums for High Yield.
- *Solactive Green Bond Index*. A rules-based, market value weighted index engineered to mirror the Green Bond market. Launched in March 2014, it is in line with the CBI criteria and mandates a fixed minimum issue size of USD 100 million.
- *ChinaBond China Green Bond Index* and *ChinaBond China Green Bond Select Index*. The first indices to capture the development of China's fast-growing Green Bond market launched in April 2016. They include publicly issued debt instruments, excluding ABS, and only RMB-denominated securities. The ChinaBond China Green Bond Index considers only bonds aligned either with Chinese Regulation or with GBP/CBI guidelines; the ChinaBond China Green Bond Select Index mandates the compliance with both Chinese Regulation and GBP/CBI criteria.

1.3.4 Public Authorities

Green bonds can support the implementation of national climate policies - exploiting more efficient capital allocation and increased awareness - especially in redirecting capital towards low-carbon and climate resilient projects. Policymakers can support the implementation of a climate-friendly transition by better matching green issuers and investors[94]. In addition, Green Bonds might also represent a driver for economic growth, financing governments' heightened commitment to address climate change[95].

While private governance predominates in the Green Bond market, public regulation is becoming increasingly relevant. For instance, China's Green Bond market is subject to public regulation enacted in 2015 by the People's Bank of China (PBOC) - China's central bank. The PBOC regulates the Chinese

[94] Shishlov, I., Morel, R., & Cochran, I. (2016). Beyond transparency: unlocking the full potential of green bonds. Institute for Climate Economics (I4CE)

[95] Moody's Investor Service. (2019, January 31). Moody's: Green bond market poised to hit $200 billion in 2019. Retrieved from https://www.moodys.com/research/Moodys-Green-bond-market-poised-to-hit-200-billion-in--PBC_1159526

interbank bond market, which accounts for 93 percent of outstanding bonds in China[96]. Additionally, in March 2017 the China Securities Regulatory Commission (CSRC) issued the Guidelines to Support the Development of Green Bonds, defining the principles regulating the issuing entity, the purpose of capital spending, information disclosure, management requirements and related policy measures. The guidelines force the issuer to disclose the environmental benefits of the project and encourage third-party certification agencies to assess and certify the Green Bond before and after the issuance. It is noteworthy that the Chinese national government has promoted third-party green verification as an important means for information disclosure, as it provides guarantees of both the authenticity and reliability of Green Bonds[97]. Another example of public regulation can be found in India, where the Securities and Exchange Board of India (SEBI) - the government's securities regulator –approved Green Bonds guidelines in January 2016. Green Bonds sold in India are subject to SEBI regulations on the issuance and listing of debt securities and the SEBI expressly reserves the right to define the criteria for Green Bonds[98].

1.4 The Regulatory Framework

Taking as a reference point the analysis on the Green Bond regulatory environment conducted by Stephen Park[99], clear evidence is the absence of government regulators from the still-nascent Green Bond market. Indeed, the market's governance system is decentralized and primarily shaped by private governance regimes - such as standards, ratings, third-party certification schemes and second-party opinions - which compete and collaborate with each other at the same time. In comparison to public regulation, private governance is often faster to implement and more responsive to the needs of market participants but may suffer from a lack of legitimacy, accountability, and consistency and be prone to *greenwashing*. Public choice economists and administrative law scholars have long discussed and criticized the extra-legal influence of firms on the regulatory process, maximized in a private governance framework. The second type of governance challenge is represented by the existence of multiple private governance regimes - with non-exclusive jurisdiction between them - that allow a firm to select the regulatory framework that is most in line with its interests. In fact, firms that face multiple schemes of different degrees of stringency can "shop" for the most business-friendly among them, incentivizing regulatory competition and fostering the vicious cycle of standards' relaxation[100].

It is still uncertain or unclear whether Green Bonds effectively contribute to environmental sustainability; nevertheless, the current regulatory fabric of the Green Bond market is suffering from systemic legitimacy

[96] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[97] Schipke, A., Rodlauer, M., & Zhang, L. (2019). The Future of China's Bond Market. International Monetary Fund (IMF)
[98] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[99] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[100] Abbott, K. W., & Snidal, D. (1998). Why States Act through Formal International Organizations. The Journal of Conflict Resolution

deficits in the eyes of investors, stakeholders and regulators, significantly damaging the Green Bonds' take-off. If left unaddressed, a lack of legitimacy will permanently inhibit the growth of the Green Bond market, leading to a situation of stall instead of fostering the sustainable finance revolution[101]. The worst consequence of regulatory pluralism is represented by fragmentation, which leads to incoherent or conflicting regulatory mandates, uncertainty among market participants, and decreasing levels of compliance.

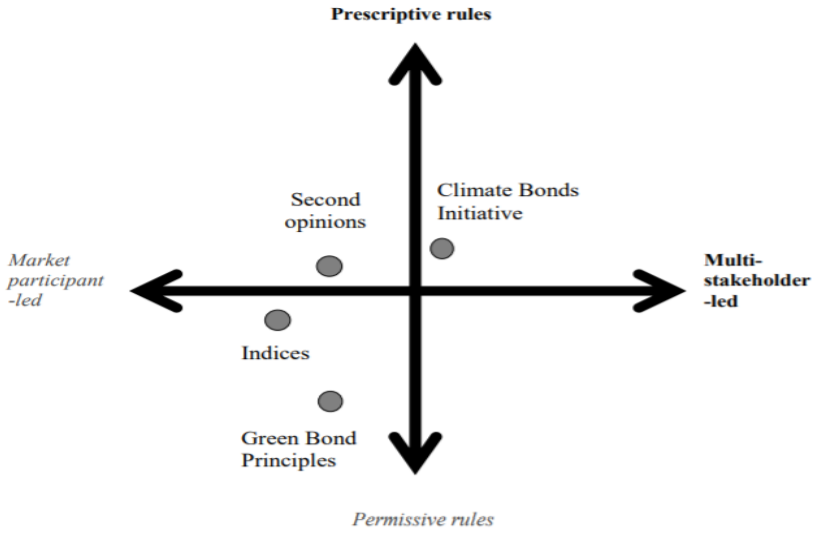
1.4.1 Inconsistency and Fragmentation

An interesting representation of the current regulatory inconsistency characterizing the Green Bond market come from Stephen Park. The scholar measure pluralism relying on two different dimensions and classifying some of the existing governance regimes along the resulting matrix (*see* Figure 12)[102]. The first dimension taken into account is *inclusiveness*; it measures the diversity of the governance regime and the extent to which stakeholders are involved in creating and enforcing its rules. The two extremes are represented by either private governance regimes whose members are exclusively selected among investors, issuers, assurance providers and financial intermediaries or private governance regimes that take into account the interests of all stakeholders – i.e. government agencies, social and environmental advocacy groups, local community organizations and other members of civil society. The second dimension, instead, assess the degree to which private governance regimes' enforcement resembles traditional command-and-control public regulation. It is a measure of *prescriptiveness* of these standards according to the relative "hardness" of the rules that they create and enforce. Many private governance regimes adopt "softer" processes that lack the formality of public regulation. Diverging from traditional "hard" law, soft law consists of standards, principles, and norms that lack obligation but still have legal authority; it is often created through multi-stakeholder dialogue and enforced by investigation and disclosure. The two extremes are represented by either private governance regimes that rely on soft law and flexible standards or private governance regimes that are more prescriptive. Violations of such prescriptive rules determine mandatory sanctions, such as exclusion from certain membership benefits or withdrawal from the private governance regime. Finally, inconsistency may also depend on the contrasting objectives prompted by the various regulatory regimes due to the different supporters backing up those entities that promulgate private governance systems.

[101] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law

[102] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law

Figure 12. Inclusiveness and Prescriptiveness of Green Bonds' Private Governance Regimes



Source: S. Park

Another relevant data, that should be the object of a specific reflection, is the 89% of Green Bond deals (by amount) which have external reviews. The issue, this time, emerges from the fact that some of these reviews are overlapping – at least in some of their parts – mining the efficiency of the system; in addition, some of the parameters considered to perform the assessment are not uniform. Issuers need to balance second-party opinions, certifications such as the Climate Bonds Standard, the gaining ground of ratings provided by global agencies like Moody's and S&P and other available options[103]. In Table 2 it is further represented the manifold regulatory framework influencing Green Bond issuance. A number of competing standards for what constitutes a Green Bond populates the market, with investors increasingly relying on independent certification to differentiate between financing for projects that will make an environmental difference and those whose claims are merely "greenwash"[104].

Table 2. The Manifold Regulatory Framework

Characteristics of different green bond identification and certification schemes — Table 1

	CBI Climate Bonds Certification	Green bond indices[1]	CICERO Second Opinions	Moody's Green Bond Assessments	Standard & Poor's Green Evaluations
Use of funds must be tied to green investment	Yes	Yes	Yes	Yes	Yes
Eligibility criteria differ by sector	Yes	Yes			Yes
Ex post monitoring/assessment				Yes	
Granular assessments of greenness			Yes	Yes	Yes
Quantitative weights for specific factors				Yes	Yes

[1] Bank of America Merrill Lynch, Barclays MSCI, Standard & Poor's and Solactive.

Source: Ehlers & Packer

[103] Filkova, M., Frandon-Martinez, C., & Giorgi, A. (2019). Green bonds: The state of the market 2018. Climate Bonds Initiative (CBI)

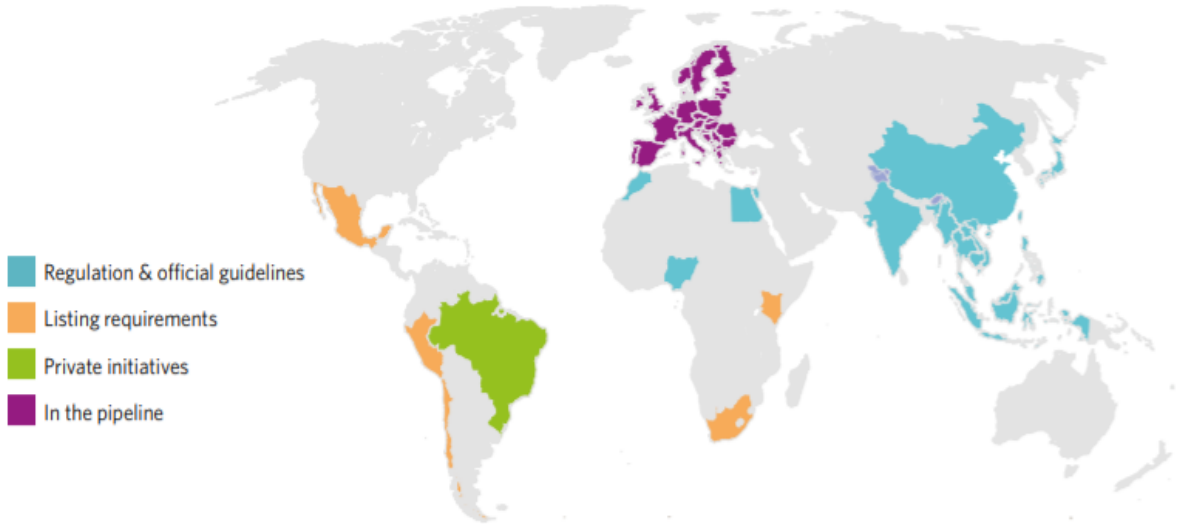
[104] Allen, K. (2017). Green bond issues hit record high on 'sustained global momentum'. Financial Times

The monitoring mechanisms themselves need to be taken into account; Green Bonds can be issued currently under a variety of voluntary standards, but no monitoring mechanism exists to ensure compliance with either the Green Bonds Principles or Climate Bonds Standards, the two main frameworks. Critics say this fragmentation creates uncertainty for investors and will slow the growth of the market in future. Recently, the WWF itself stressed that only a bond for which the issuer can demonstrate measurable environmental benefits - properly certified by an independent party - should qualify as a Green Bond[105].

From a geographical perspective, Figure 13 below sums up the availability and variety of national and regional Green Bond guidance, in the form of regulation, guidelines and listing requirements. However, some common trends do emerge[106]:

- All regimes developed so far recognise the international good practice provided by the Green Bond Principles (GBP) and the Climate Bonds Standard (CBS), building from this international guidance.
- Eligibility of assets and projects is indicated through broad categories, evidencing a lack of taxonomies or robust and consistent definitions for "green" projects.
- External reviews are becoming mandatory across jurisdictions, especially for sustainability segments on exchanges.
- Reporting is compulsory on an annual basis until proceeds are fully allocated.

Figure 13. Regulatory Differences among Countries regarding Green Bonds



Source: CBI

According to Standard & Poor's studies, the absence of a universal certification system is holding back the Green Bond market, preventing this asset class to qualify as a mainstream investment vehicle[107]. This issue particularly applies in more opaque markets – especially the Chinese one, which represents nearly a third

[105] Flood, C. (2017). Green bonds need global standards. Financial Times
[106] Climate Bonds Initiative (CBI). (2019). Green Bonds Policy: Highlights from 2018. Climate Bonds Initiative (CBI)
[107] Allen, K. (2017). Sellers of green bond face a buyer's test of their credentials. Financial Times

of 2018 Green Bond issuance. To make some examples, Chinese entities issuing Green Bonds on the onshore interbank market are less likely to get an external review. This represents a challenge for the market in terms of pre- and post-issuance transparency, especially if the information is only available in the Chinese and there is almost no information in English[108]. Furthermore, in China the guidelines for Green Bonds' "use of proceeds" are more liberal compared to GBP and CBI criteria: issuers can use up to half of the proceeds to repay bank loans and invest in general working capital[109] or it is allowed to finance fossil fuel-based energy and transportation projects - such as clean coal and nuclear power plants - which are prohibited or restricted under the GBP and CBI[110]. Consequently, out of more than USD 40 billion of Green Bond issuance from Chinese companies in 2018, only about USD 30 billion can be considered in line with international standards.

The urgency of harmonization is evident; however, when different countries are involved, it becomes particularly complex[111]. The initiative to improve the consistency of definitions and methodologies for determining the eligibility of green projects across Chinese and European Union jurisdictions - two of the main markets for Green Bonds - represents the most significant effort to date to address this issue[112]. Nevertheless, to promote uniformity it is necessary to better understand the peculiarities of the Chinese system. Firstly, the majority of Green Bonds issued in China follow the People's Bank of China (PBOC) Catalogue, even if four globally recognized principles and standards are currently used. In addition to the People's Bank of China's Catalogue, there are the Green Bond Principles (GBP) by ICMA, the Climate Bonds Taxonomy by CBI, and the Common Principles for Climate Mitigation Finance Tracking developed by the joint climate finance group of multilateral development banks and the International Development Finance Club[113]. Since 2015, China has been continuously refining policy and regulations to promote Green Bonds as a tool to finance environmental solutions. This effort has led to the rapid growth of China's Green Bond market since 2016, as well as further regulation of bond issuance. The key initiatives to scale up Green Bonds in China include the Green Bond Endorsed Project Catalogue (2015) and the Guidelines for Establishing the Green Financial System, as well as a wide array of policy documents, pilot programs, and supporting mechanisms, which have been used to set standards for information disclosure, evaluation and certification, use of proceeds, and supervision. China's local governments are also playing a critical role in promoting Green Bond issuance through a combination of policy and regulatory supports and fiscal and financial measures. Additionally, the Green Bond market in China is continuously moving forward through product innovation and regulatory changes. However, according to the current Chinese regulation, Green

[108] Filkova, M., Frandon-Martinez, C., & Giorgi, A. (2019). Green bonds: The state of the market 2018. Climate Bonds Initiative (CBI)
[109] Morgan Stanley. (2017). Behind the Green Bond Boom. Morgan Stanley Research
[110] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[111] Weber, O., & Saravade, V. (2019). Green Bonds: Curren Development and Their Future. CIGI Papers
[112] Ehlers, T., & Packer, F. (2018). Green bond finance and certification. The European Money and Finance Forum (SUERF)
[113] Schipke, A., Rodlauer, M., & Zhang, L. (2019). The Future of China's Bond Market. International Monetary Fund (IMF)

Bonds can still pursue a wider range of green initiatives compared to international standard; this depends on the fact that China is facing other issues such as severe environmental pollution, aggravated resource constraints and deteriorated ecological degradation[114]. Consequently, the Catalogue must take multi-dimensional environmental benefits as the defining standard, addressing a broader scope. The Catalogue takes on projects with marked environmental benefits, classified into the following 6 categories (Level-1 Category): energy saving, pollution prevention and control, resource conservation and recycling, clean transportation, clean energy, ecological protection and climate change adaption. It is interesting to stress the peculiarity of one category: *pollution prevention and control*; it distinctly allows the inclusion of coal or other hydrocarbon-related projects.

1.4.2 Greenwashing

Together with the expansion of the Green Bond market, greater accountability and transparency is required to mitigate fears of "greenwashing." Greenwashing in the Green Bond market means bond proceeds get allocated to assets that have little or no environmental value, shaking market confidence[115]. One of the best examples to show "greenwashing" risk refers to the Spanish oil and gas company Repsol, which issued a EUR 500 million self-labelled Green Bond in May 2017 to finance and refinance energy efficiency in its chemical and refinery facilities in Spain and Portugal; however, the green tag sparked controversy since major Green Bond indices excluded the bond. This exclusion depends on the fact that market participants do not consider improving the efficiency of fossil fuel plants a primary reason behind a Green Bond; on the contrary, Climate Bonds should help issuers similar to Repsol to move towards a low-carbon business strategy by investing more into renewables. This "*brown-to-green*" model is well represented by the case of India's biggest power utility, NTPC Ltd, when it issued the INR 20 billion (USD 369 million) Green "Masala" Bond in August 2016. The bond got certified by the CBI since the company exploited the existing strength of its "brown" balance sheet to fund the expansion of clean energy generation.

A key characteristic that needs to be strengthened and strongly monitored is disclosure; it represents a powerful reason why Green Bonds have become popular. Indeed, if a corporate or sovereign borrower wants to sell a bond with the green label, it has to publish its environmental strategy and how it will use the proceeds. Involving independent third parties delivering a report that assesses green credentials is another powerful requirement; fund managers can rely upon this document when deciding whether to buy. It would represent a warranty for investors that want to ensure that the company isn't simply selling greenwash[116].

[114] Green Finance Committee of China Society of Finance and Banking (GFC). (2015). China Green Bond Endorsed Project Catalogue (2015 Edition). Green Finance Committee of China Society of Finance and Banking (GFC)
[115] Weber, O., & Saravade, V. (2019). Green Bonds: Curren Development and Their Future. CIGI Papers
[116] Allen, K. (2019). Disclosure is a lure for green bond investors. Financial Times

To further enhance transparency regarding the use of proceeds, the World Bank suggests reporting the sustainability impact of Green Bonds on a project-by-project basis[117], limiting greenwashing risk.

Regulatory capture – i.e. regulatory agencies' submission to the industries or interests they are charged with regulating[118] - and *regulatory arbitrage* - i.e. selecting the regulatory framework that better satisfy a company's interest - enable greenwashing by making it easier for firms to elude their private governance obligations. Such companies seek to free ride on the reputational benefits coming from the adherence to a regime without having to pay the costs of actually complying with the regime's standards. Greenwashing, therefore, poses a threat to the stability of the Green Bond market by placing into doubt mutual commitments made by market participants. Left unchecked, an unvirtuous cycle of rule breaking will bring a lack of faith in the regulatory framework, generating additional rule breaking[119]. The future of the Green Bond market depends on the ability to sell more Green Bonds and the confidence of investors and civil society in their economic value and environmental impact.

1.4.3 Moving towards Harmonization

The absence of a universally accepted global framework implies that there is a lack of standardisation and regulation in the Green Bond market, which poses risks to investors. However, this issue shows signs of diminishing as Green Bond issuance increases[120]. Regarding the potential next steps to safeguard the future of Green Bonds, it is necessary to discuss two critical topics: *expectation gap* and *transparency risk*[121]. Currently, it does exist a gap between the ambitious objectives behind this innovative financial instrument and the actual results shown by the market. Leading players and government need to clearly lay out the objective of different standards in order to define "greenness"; additionally, it is required a public regulatory intervention to define the investment areas compatible with long-term national sustainable pathways and the relative publicly endorsed standards. On the other side, the lack of transparency regarding evaluation and monitoring processes poses a threat to the success of Green Bonds. Market players and governments must promote further convergence around enhanced transparency frameworks, seeking standardisation while keeping transaction costs in check; furthermore, it is required an increased support by public institutions to expand the Green Bond market. Finally, the role of Green Bond certifiers needs to change to satisfy ongoing monitoring procedures instead of "issuance-only" certification[122].

[117] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[118] Stigler, G. J. (1971). The Theory of Economic Regulation. The Bell Journal of Economics and Management Science
[119] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[120] Archer, O., & Tournaire, M. (2018). Green Bonds: Is the grass always greener? AON Investment Research and Insights
[121] Shishlov, I., Morel, R., & Cochran, I. (2016). Beyond transparency: unlocking the full potential of green bonds. Institute for Climate Economics (I4CE)
[122] Ehlers, T., & Packer, F. (2018). Green bond finance and certification. The European Money and Finance Forum (SUERF)

Stephen Park recently published a theoretical framework proposing a solution for regulatory inconsistency[123]; it is a stakeholder-oriented conceptual framework based on the theory of *hybridity*. According to international law and global governance academics, hybridity is both descriptive and aspirational. It is based on the coexistence of legal and quasi-legal structures that govern any given legal phenomenon. In their idealized forms, public regulation and private governance regimes engage in a mutually interdependent and sustaining relationship. The scholar underlines that private governance regimes will continue to grow in number and expand in scope as the Green Bond market expands, further requiring the need for a conceptual framework defining the optimal relationship between private governance and public regulation. In light of the current state of the Green Bond market, the author suggests three alternatives in which *hybridization* can be implemented:

- The first hybridization strategy improves the use of certification as external assurance. Differently from other areas of CSR-based external assurance, third-party audits have not yet become standard practice in the Green Bond market. In particular, public regulation can implement a default penalty rule to incentivize issuers to publicly disclose second opinions and third-party assurances.
- A second hybridization strategy bolsters the signalling effect of certification. Government labelling schemes could be related to Green Bonds, incorporating reference to CBI certification.
- A third hybridization strategy incentivizes participation in private governance regimes. Public regulators can provide monetary inducements to support stakeholders in organizing coalitions and engaging in private governance decision-making and consultations.

Assuming a practical perspective, lately some international and national initiatives have been implemented to increase overall regulatory standardisation. At European level, the EU Commission has established a group of 35 experts (High-Level Group on Sustainable Finance) to define the labelling criteria (so-called "Ecolabel") of funds, ETF and bonds in order to be considered "green" or - more in general - sustainable[124]. Specifically, the European Union has decided to adopt the CBI Taxonomy for Green Bonds. However, labelling is relevant but it should not be the focus of sustainable finance, according to Pietro Neri - Head of Sustainability and Corporate Governance at ANIA (Associazione Nazionale per le Imprese Assicuratrici). Indeed, if an investor is well informed regarding investments' objective of a bond - relying on publicly available disclosure measuring environmental impact - that security can be classified as "green"; procedures are more important than label. Additionally, EU interest in Green Bonds comes from the fact that this innovative asset class is considered the most efficient and effective in the market by several experts[125].

Elaborating EU initiatives to foster sustainable finance, *Action 1* clearly states the EU Commission's intention to establish an EU classification system for sustainable activities. To support this action, the

[123] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[124] D'angerio, V. (2018). Standard comuni per i green bond. Il Sole 24 Ore
[125] D'Angerio, V. (2018). Finanza sostenibile tra consulenti e green bond. Il Sole 24 Ore

Commission has presented a legislative proposal to set an EU Taxonomy for Sustainable Finance. The proposed regulation establishes[126]:

- Six environmental objectives for low-carbon economic activities (climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, waste prevention and recycling, pollution prevention and control, protection of healthy ecosystems). Environmentally sustainable activities are defined as those that have a significant impact on achieving one of the six objectives, without significantly harming the other five.
- Minimum safeguards compliance.
- Technical screening criteria, which will be introduced subsequently, as they are developed.

The 35-experts Technical Expert Group (TEG) on Sustainable Finance has to deal with the development of a proposal for the EU Taxonomy for sustainable economic activities. EU activity is nourishing global interest; in fact, the TEG is expected to set a benchmark that will strongly influence other geographies, similar to what is currently happening in the USA regarding "MiFID II" regulation. In details, the European Commission Technical Expert Group (TEG) suggests a refinement of indicators for Green Bond issuers, arguing that companies should consider disclosing their *Green Bond ratio* - namely the proportion of the total Green Bond outstanding amount over the total bond outstanding amount - or their *green debt ratio* – i.e. the total amount of Green Bond or green debt instruments over the total debt amount - in order to improve transparency and enhance disclosure on the intensity of their overall low-carbon transition plan beyond the individual Green Bond issue[127].

From a global point of view, in September 2018 it has been set up a new international partnership - the Global Green Bond Partnership (GGBP) - to foster Green Bond issuance, supporting sub-national entities such as cities, states, regions, corporations and financial institutions[128]. The founding members are a batch of supranational organisations actively involved in shaping the future of the market: World Bank, IFC - a member of the World Bank Group, Amundi, European Investment Bank (EIB), Climate Bonds Initiative (CBI), Ceres, ICLEI - Local Governments for Sustainability, Global Covenant of Mayors for Climate & Energy (GCoM) and the Low Emissions Development Strategies Global Partnership (LEDS GP). This partnership strengthens the effort towards regulatory harmonization, critical to mobilize every year USD 1,5 trillion up to 2030 to fully implement the Paris Agreement, according to UNFCCC (United Nations Framework Convention on Climate Change) estimates. According to Sean Kidney - CEO of CBI - the "*brown to green*" shift in corporate balance sheets and CapEx directions needs further support from the

[126] Climate Bonds Initiative (CBI). (2019). Green Bonds Policy: Highlights from 2018. Climate Bonds Initiative (CBI)
[127] Bachelet, M. J., Becchetti, L., & Manfredonia, S. (2019). The Green Bonds Premium Puzzle: The Role of Issuer Characteristics and Third-Party Verification. Sustainability
[128] European Investment Bank (EIB). (2018, September 14). Scaling Finance for Subnational and Corporate Climate Action through Green Bonds. Retrieved from https://www.eib.org/en/press/all/2018-229-launch-of-the-global-green-bond-partnership?media=rss&language

world's biggest banks, largest emitters and institutional investors. The international Green Bond market currently represents the platform for the large-scale shift to a low-carbon economy, given the trillions in new capital that should be directed towards climate adaptation and resilience, clean energy and green infrastructure. The members of the Global Green Bond Partnership (GGBP) will provide targeted technical assistance, capacity building, de-risking, investing and underwriting support, together with the promotion of innovative funds and other financial vehicles to mobilize investor capital. Additionally, the GGBP members intend to work together on the development of a Green Bonds Readiness Framework/Toolkit for potential issuers - tailored to sub-national entities and corporations - that will help them to rapidly assess their readiness to issue Green Bonds and identify the key gaps and barriers to issuance.

China itself has recently made significant improvements, updating its Green Bonds' regulative framework. Specifically, the People's Bank of China (PBOC) recently issued two notices regarding Green Bonds to strengthen the level of disclosure and improve the reliability of the Green Bond label: the PBC Notice on Strengthening the Supervision and Administration of the Continuation Period of Green Financial Bonds and the Information Disclosure Regulations on the Duration of Green Financial Bonds. These new rules reinforce the controls that relevant agencies need to perform during the assessment and the inspection of funds raised through Green Bond issuances, improving the supervision and the management of the duration of Green Financial Bonds, the transparency of information disclosure and the support for green development[129]. The main focus is on the issuance and the progress of "use of proceeds". On-site verification should cover all the Green Financial Bond issuers in the jurisdiction within a given year, and at least 20% of Green Bond proceeds should be verified on sight. The annual report on the use of funds raised from green financial bonds shall fully explain the overall use of funds raised in the reporting year and the expected or already proven environmental benefits. In addition, the issuer should disclose the status of green projects launched during the reporting period in the annual report. For projects where the top 10% of the amount is raised from Green Bonds and/or for projects with a value of RMB 50 million or more, they should be disclosed one by one instead of providing a summarized disclosure by category. Finally, the issuer should select a typical green project case - meaning a project with large scale or with significant environmental benefits - for detailed analysis in the annual report. In addition to the two previous notices, since 2017 various regulatory authorities have issued detailed regulations in China - including opinions and business operation guidance. In December 2017, for instance, to improve the verification standard of Green Bonds and to avoid the risk of "*greenwashing*," the People's Bank of China (BOC) and the China Securities Regulatory Commission (CSRC) jointly issued the Green Bond Assessment and Verification Guidelines: they are the world's first guiding document that "*verifies the verifiers*" of Green Bonds, identifying the

[129] International Institute of Green Finance, CUFE. (2018, March 19). Green Bond Weekly. Retrieved from http://iigf.cufe.edu.cn/earticle/content.html?id=417

minimum requirements for agencies' qualifications, bidding procedures, operations, issuing of reports and supervision and management[130].

In conclusion, there has been a growing collaboration between the EU and China regarding the development of common procedures regulating the Green Bond market. In 2017, the European Investment Bank and the Green Finance Committee jointly conducted a study on the standardization of Green Bonds in China and Europe. The objective was to promote cross-border green capital flows, strengthening the cooperation between China and Europe; in line with this effort, several Chinese-owned institutions issued offshore Green Bonds[131]. Actually, the first offshore issuance can be dated back to October 2015, when China Agricultural Bank issued a Green Bond in the United Kingdom. Subsequently, the Industrial and Commercial Bank of China, the Bank of China, and several other institutions have issued Green Bonds compliant with international standards, effectively promoting the global development of Green Bonds in a uniform way. On the other side, China should encourage State-Owned Enterprises (SOEs) to issue more offshore Green Bonds and foreign institutions to issue Green Panda Bonds in China; this latest expression denotes Chinese RMB-denominated bonds issued by a non-Chinese organization inside Mainland China. Ultimately, the EIB and China's Green Finance Committee have lately published a white paper identifying the differences between the European and the Chinese Green Bond standards, working on convergence in the future[132].

[130] Schipke, A., Rodlauer, M., & Zhang, L. (2019). The Future of China's Bond Market. International Monetary Fund (IMF)
[131] Schipke, A., Rodlauer, M., & Zhang, L. (2019). The Future of China's Bond Market. International Monetary Fund (IMF)
[132] Bachelet, M. J., Becchetti, L., & Manfredonia, S. (2019). The Green Bonds Premium Puzzle: The Role of Issuer Characteristics and Third-Party Verification. Sustainability

2. LITERATURE REVIEW AND THE ENERGY & UTILITIES CHOICE

A growing interest in companies' environmental and social performance is pushing academics to boost research on the subject, amid fears that investors are allocating capital using unsophisticated data. The proliferation of funds with ESG strategies has skyrocketed under investors' pressure to take into account sustainability as a criterion for responsible investing, leading to enhanced disclosure from companies alongside a burgeoning field of academic research[133]. Furthermore, considering the shortcomings of ESG screening and shareholder activism, Green Bonds offer a relatively inexpensive way for mainstream investors to actively support sustainability while investing in a relatively low risk/low yield instrument[134]. In many cases, institutional investors are obliged to include a certain proportion of green investments in their portfolios, following mandatory ESG guidelines; Green Bonds may represent a cost-effective solution to comply with these obligations. From a supply-side perspective, there is evidence that firms that integrate ESG criteria as part of their corporate strategy outperform less sustainable firms.

2.1 Enhancing Corporate Performance through Sustainability

Sustainable finance and socially responsible investing (SRI) are part of a broader universe of Corporate Social Responsibility (CSR)[135], making it a suitable discussion topic. From a historical perspective, there have always been two opposing schools of thought regarding the idea of "doing well by doing good", fostering the idea of "shared value creation" [136]. Indeed, some scholars argue that adopting environmental and social policies can destroy shareholder wealth, as first suggested by Milton Friedman[137] and subsequently supported by other academics following his line of thought[138]. However, the overwhelming majority of academics account this perspective as surpassed[139]; Friedman's position was founded on an inaccurate economic model because of its unrealistic attempt to isolate business from society when the two are strongly interdependent[140]. Some anecdotic cases showing the advantages of adopting a sustainable approach can be provided:

- The CDP (Carbon Disclosure Project) Climate A List - grouping the most environmental-friendly and active listed companies - shows a growing list of corporate cases underlining that operating in a socially responsible way can go hand-in-hand with being a profitable and successful business; an

[133] Allen, K. (2018). Investors turn to academia to navigate green investing boom. Financial Times
[134] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[135] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law
[136] Porter, M. E., & Kramer, M. R. (2011). Creating Shared Value. Harvard Business Review
[137] Friedman, M. (1962). Capitalism and Freedom. University of Chicago Press
[138] Henderson, D. (2001). Misguided Virtue: False Notions of Corporate Social Responsibility. New Zealand Business Roundtable and Kapstein, E. B. (2001). The Corporate Ethics Crusade. Foreign Affairs
[139] Smith, N. C. (2003). Corporate Social Responsibility: Whether or How? California Management Review
[140] Mintzberg, H. (1983). The Case for Corporate Scoial Responsibility. The Journal of Business Strategy

analysis conducted by STOXX found that companies on CDP's Climate A List outperformed the market by 5% from December 2011 to July 2018[141].

- Leonie Schreve - Global head of Sustainable Finance at ING - stresses that, from a business perspective, sustainability practices have evolved from being predominantly cost-cutting projects to revenue-driving strategies[142]. ING recent sustainable finance report shows that revenue growth was ranked first by 39% of US corporations surveyed as the most important factor for deciding to implement sustainability strategies.

Moreover, from a literature point of view there exist several studies showing the positive correlation between corporate performance and sustainable practices. Amiraslani showed that firms with high Corporate Social Responsibility (CSR) better resist financial crisis probably because they are trusted more by financial investors[143]. High-CSR firms were also capable to raise more debt capital on the primary market and those high-CSR firms that raised more debt were able to do so at lower at-issue bond spreads, better initial credit ratings and for longer maturities, highlighting solid advantages in pursuing a responsible business approach. Margolis and Walsh highlighted the positive relationship between Corporate Social Performance (CSP) and Corporate Financial Performance (CFP)[144]. Eccles, Ioannou and Serafeim shed light on the organizational and performance implications of integrating ESG issues into a company's strategy and business model through the adoption of corporate policies[145]. Specifically, they investigated the effect of corporate sustainability on organizational processes and performance, discovering that corporations that voluntarily adopted sustainability policies by 1993 - termed as High Sustainability companies - manifested by 2009 distinct organizational processes compared to a matched sample of firms that adopted almost none of these policies - termed as Low Sustainability companies. The boards of directors of High Sustainability companies were more likely to show formal initiatives aimed at enhancing sustainability and top-executive compensation incentives were more likely to be anchored to sustainability metrics. Moreover, High Sustainability companies set up processes for stakeholder engagement with a higher probability, resulted to be more long-term oriented and demonstrated higher measurement and disclosure of non-financial information. Finally, it emerged that High Sustainability companies significantly outperform their counterparts over the long-term, both in terms of stock market and accounting performance. Among the reasons that could explain why investors consider ESG/CSR as a valuable investment opportunity, Eccles and Serafeim - moving from the idea of "shared value creation" by Porter

[141] Galvin, D. (2019). What makes an environmental leader in today's world? Reuters
[142] Nixon, T. (2018). Higher ESG ratings can mean lower borrowing costs. Reuters
[143] Amiraslani, H., Lins, K. V., Servaes, H., & Tamayo, A. (2017). A Matter of Trust? The Bond Market Benefits of Corporate Social Capital during the Financial Crisis. European Corporate Governance Institute (ECGI)
[144] Margolis, J. D., & Walsh, J. P. (2001). People and Profits. Lawrence Erlbaum
[145] Eccles, R. G., Ioannou, I., & Serafeim, G. (2014). The Impact of Corporate Sustainability on Organizational Processes and Performance. The National Bureau of Economic Research (NBER)

and Kramer - suggested that reduced litigation risk coming from the integration of sustainable development policies into companies' own business model might help firms in surviving shocks in the long run.

Moving specifically on green finance, it is relevant to stress the two main tasks being promoted: *to internalise environmental externalities* and *to reduce risk perceptions* in order to encourage investments that provide environmental benefits[146]. Economic theory suggests that a first-best solution for closing the gap between the private and social costs of pollution would be a mix of lump sum taxes and subsidies, with regulations to impose implicit prices following closely behind[147]. Nevertheless, green finance can help to alleviate these externalities through market-based second-best means; in fact, it acts by increasing the flow of funds to environmentally beneficial projects, essentially reducing their costs, as well as by heightening awareness of the financial risks related to environmental change.

2.2 Drivers and Barriers of the Green Bond Market

It is possible to pinpoint several drivers fostering the growth of the Green Bond market and a similar number of barriers that could limit its development. As analysed in the previous chapter, recent initiatives towards a greater standardisation on the regulatory side - especially regarding performance measurement - represents a factor that could fuel growth. Michael Kashani - Global Head of Fixed Income ESG Portfolio Management at Goldman Sachs Asset Management - stresses the critical aspect of reaching a consensus on what is green; however, he also highlights the importance of keeping issuing costs on check since greater standardisation cannot act as a deterrent to smaller-capital market players[148]. Another possible risk that could dampen the development of Green Bonds might arise from traditional bonds themselves; indeed, some experts foresee that, rather than the Green Bond market going mainstream, this innovative asset class will affect the characteristics of the traditional bond market, stimulating increased disclosure while triggering internal discussion on sustainability performance.

The lack of appropriate institutional arrangements for Green Bond management, the minimum size of issue and high transactions costs associated with the issuance process represent some of the key barriers to the development of Green Bonds, as will be shown in the following paragraphs. A solution to these issues might be found in an efficient use of multilateral and national development banks as intermediary institutions for local Green Bond management, especially in developing countries[149]. On the other side, the success of Green Bonds might arise from the advantages generated by this financial instrument: an extended breadth of ownership, a larger investor base, potentially lower cost of capital and longer tenor compared with straight corporate bonds[150].

---

[146] Berensmann, K., & Lindenberg, N. (2016). Green Finance: Actors, Challenges And Policy Recommendations. German Development Institute (DIE)
[147] Ehlers, T., & Packer, F. (2018). Green bond finance and certification. The European Money and Finance Forum (SUERF)
[148] Allen, K. (2018). Green bonds start conversation in the market. Financial Times
[149] Banga, J. (2018). The green bond market: a potential source of climate finance for developing countries. Journal of Sustainable Finance & Investment
[150] Tang, D. Y., & Zhang, Y. (2018). Do Shareholders Benefit from Green Bonds? Journal of Corporate Finance

2.2.1 Drivers

According to Banga, it is possible to identify three main types of drivers behind the current success of the Green Bond market and its future potential[151]:

- The first driver is represented by an increased awareness about the relationship between climate change and financial stability. Eventually, investors and policymakers seem to have understood the potential risks climate change poses to businesses and the financial sector as a whole.
- The second argument refers to the political effort deriving from the 2015 Paris Agreement; indeed, this unprecedented political support for climate action has sent positive signals to investors, contributing to the development of the Green Bond market, both in advanced and emerging countries.
- The third relevant aspect is linked to the "unconventional monetary policies" implemented by the world's major central banks in the aftermath of the 2008 financial crisis. Low interest rates and accommodative monetary policies were aimed at fostering economic recovery in the shortest timeframe; however, it turned out to be a long-lasting market condition. Consequently, institutional investors are coming under pressure to find ways of making their savings products more attractive; they have realized that sustainable investing can preserve wealth and provide reliable streams of revenue while reducing volatility in the equity markets.

Other relevant drivers fostering the Green Bond market are represented by the global effort to create a common shared international regulatory framework for this innovation asset class, by the competitive pricing of the instrument compared to traditional bonds – that will be the object of a specific following section - and by the larger shareholder base and increased liquidity, providing stability while balancing risk.

2.2.2 Barriers

Considering the possible reasons behind Green Bond industry's niche status, fairly high barriers to entry - due to the additional disclosure required - rank among the most relevant ones. As proof of this, 75% of the capital raised in the market so far has gone to organisations that have sold green-labelled debt more than once, according to data from Moody's. Differently, many first-time Green Bond sellers find that issuing once is enough to exploit Green Bonds' reputational benefits without sustaining recurring higher disclosure costs[152].

[151] Banga, J. (2018). The green bond market: a potential source of climate finance for developing countries. Journal of Sustainable Finance & Investment

[152] Allen, K. (2019). Disclosure is a lure for green bond investors. Financial Times

In line with Banga findings, it is possible to identify two main kinds of barriers: *institutional* and *market* ones[153]. The first kind can be split into the following:

- Technical skills' requirements for monitoring and assessing Green Bonds' use of proceeds throughout the project's lifecycle. This is particularly true for developing countries, where the lack of such technical skills - essential to ensure that projects are implemented in accordance with the Green Bond Principles - is quite widespread. Supporting this view, a 2016 survey by the G20 Green Finance Study Group revealed that the lack of knowledge of existing international practices in Green Bond transactions was reported by respondents (up to 74%) as an important barrier for the development of the Green Bond market. However, the lack of commonly agreed standards and their relative newness could justify this gap of knowledge.
- Inappropriate institutional arrangements. Both in emerging and developed economies, the growth of the Green Bond market is slowed down by ministry departments with different mandates and skills pursuing contrasting goals in the implementation of the government's policy.

Moving to market barriers, there exist three main obstacles according to the scholar:

- The minimum size of the issue, meaning the minimum value that a Green Bond should bear to be appealing to Green Bond underwriters. Indeed, one of their major constraints affecting Green Bond issuance depends on the fact that their size must be large enough to be appealing to Green Bond purchasers, such as those of the Green Bond Underwriters League Table (GBULT)[154]. The GBULT includes some of the world largest banks as well as some institutional investors who manage trillions of dollars in assets. For these investors, the size, tenure, and liquidity of Green Bonds are a critical aspect[155]. For the world's major rating agencies - such as Moody's - Green Bonds must have a minimum value of USD 250 million to be eligible for index inclusion; over the years, the lower boundaries are growing and currently some major providers consider only USD 500 million or above for index inclusion. Unfortunately, it is worth noting that many green projects implemented in developing countries are of small size and do not comply with the minimum size required by investors for a Green Bond transaction. For smaller companies, sustainability-linked loans represent a more accessible way to tap the growing green investor base; in fact, this type of products surged 677% in 2018, stressing the market preference for green instruments[156]. The role of financial intermediaries is crucial since they can raise large amounts of funds through Green Bonds and then allocate those resource to single companies in smaller pieces.

[153] Banga, J. (2018). The green bond market: a potential source of climate finance for developing countries. Journal of Sustainable Finance & Investment

[154] Climate Bonds Initiative (CBI). (2019, May 13). Green Bonds Underwriters League Table. Retrieved from https://www.climatebonds.net/resources/league-table

[155] EY. (2018). Green Bonds: a Fresh Look at Financing Green Projects. EY

[156] Counihan, G. (2019). Is the green bond market running out of steam? Franklin Templeton Investments

- Transaction costs, referring to costs incurred by the issuer to get a green label certification from an independent reviewer. This issue becomes strongly important in emerging economies, especially if the external assurance needs to be performed on a regular basis. Such transaction costs could prove to be significant and must be added to the creditworthiness survey of the issuer required alongside the technical assessment of the potential impact of its project.
- Finally, currency of issuance. Developing countries - the majority of which have unconvertible currencies - must issue their Green Bonds in international currencies to raise large amounts of capital in international financial markets. This financing mechanism, however, exposes both lenders and borrowers to currency risk, since the revenue flows of the project to be financed relate to local currencies. Nevertheless, currency risk is not new to developing countries and it is not specific to the Green Bond market.

2.3 Green Bond Pricing

Before moving to the core theme of this section - Green Bond pricing - it seems interesting to stress ancillary evidence related to Green Bond credit risk. In fact, recent studies have highlighted that Green Bonds are more exposed to environmentally related credit risks because they are issued by companies more affected by environmental consequences and regulation on their business, such as Energy & Utilities corporations[157]. Specifically, the percentage of Green Bonds in high-risk sectors exceeds that for overall rated debt by a factor of four[158].

Focusing on the pricing issue, Sharfman and Fernando research represents a milestone - from an academic perspective; they showed that lower environmental risk is associated with lower cost of capital[159]. Their research addresses the wider relation between environmental sustainability and pricing but turns out to be particularly relevant for the Green Bond market. It provides an alternative perspective on the environmental-economic performance relationship, demonstrating that firms benefit from improved environmental risk management through a reduction in their cost of equity capital, a shift from equity to debt financing, and higher tax benefits associated with the ability to joker debt.

Moving to specific Green Bond pricing studies, it is shown by several experts the existence of a premium price at the issuance, comparing Green Bonds to traditional debt securities. Zerbib, in his research, estimated the yield differential between a Green Bond and an otherwise identical synthetic conventional bond from July 2013 to December 2017[160]. Relying on a matching method, followed by a two-step regression procedure, the academic demonstrated that Green Bonds show a small negative premium - in terms of yield differential. Consequently, the yield of a Green Bond is lower than that of a conventional

[157] *See Section 2.5 for a further explanation on environmental materiality for the Energy & Utilities sector*
[158] Ehlers, T., & Packer, F. (2018). Green bond finance and certification. The European Money and Finance Forum (SUERF)
[159] Sharfman, M. P., & Fernando, C. S. (2008). Environmental risk management and the cost of capital. Strategic Management Journal
[160] Zerbib, O. D. (2016). Is There a Green Bond Premium? The Yield Differential Between Green and Conventional Bonds. Journal of Banking and Finance

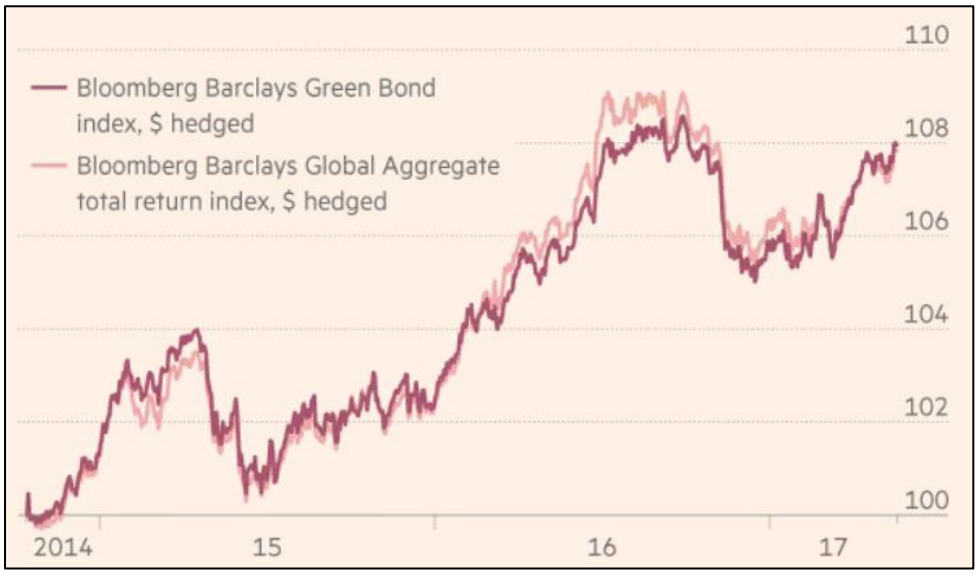
bond, meaning that Green Bonds have a higher issuance price compared to conventional bonds. The premium is 2 basis points for the entire sample as well as for EUR and USD bonds separately. Moreover, the scholar identified the main determinants of the premium: rating and issuer type. Zerbib discovered that negative premia are more pronounced for financial and low-rated bond, which can exploit to a larger extent the additional level of disclosure required by Green Bonds, particularly useful to increase the trustworthiness of riskier investments. Similar results have been reported by Ehlers and Packer, who found out that Green Bonds show higher premia compared to conventional bond, more evident for riskier lower-rating bonds[161]. The mean difference in the borrowing spread for the scholars' sample was around 18 basis points. Overall, this result reflects the high demand for Green Bonds relative to supply. Ehlers and Packer joker another piece of information, comparing the 18-basis point lower credit spread to the potential costs of a green label. Considering that the certification fee for the green label of the Climate Bonds Initiative (CBI) is a flat 0.1 basis points of the issue value, the opportunity offered by Green Bonds is evident; however, CBI also requires the engagement of an external third-party verifier, generating additional costs. Moreover, evidence in line with the above-mentioned ones comes from Baker, Bergstresser, Serafeim and Wurgler research; they studied pricing and ownership patterns of municipal Green Bonds using a framework that incorporates assets with nonpecuniary sources of utility, showing that Green Bonds are issued at a premium to otherwise similar ordinary bonds on an after-tax basis[162].

Bachelet, Becchetti, and Manfredonia analysis, instead, produces slightly different results. To be more specific, they examined the characteristics of a sample of Green Bonds matched with their closest brown bond neighbours, discovering that Green bonds have higher yields, lower variance, and are more liquid. However, the group of academics highlighted the necessity to segment the results to get a better understanding of the Green Bond performance[163]. The institutional/private issuer and the green third-party verification/non-verification breakdowns were used as segmentation drivers. They discovered that Green Bonds from institutional issuers have higher liquidity with respect to their brown bond correspondents and negative premia (lower yield) before correcting for their lower volatility. Differently, Green bonds from private issuers have much less favourable characteristics in terms of liquidity and volatility, showing positive premia with respect to their brown correspondents; positive premia are not good from issuers' point of view since they imply higher yields to investors compared to brown bonds. However, these results are reversed if private issuer commits to certify the "greenness" of the bond, suggesting that the issuer's reputation or green third-party verifications are essential to reduce informational asymmetries and avoid suspicion of *greenwashing*, producing more convenient financing conditions.

[161] Ehlers, T., & Packer, F. (2017). Green Bond Finance and Certification. Bank for International Settlement (BIS)
[162] Baker, M., Bergstresser, D., Serafeim, G., & Wurgler, J. (2018). Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds. The National Bureau of Economic Research (NBER)
[163] Bachelet, M. J., Becchetti, L., & Manfredonia, S. (2019). The Green Bonds Premium Puzzle: The Role of Issuer Characteristics and Third-Party Verification. Sustainability

Shifting to Green Bond price performance in the secondary market, currently exist contrasting results depending on the measure adopted. On the one hand, Green Bonds have not outperformed their brown "cousins" so far; indeed, the hedged Barclays Green Bond index has been broadly in line with the global aggregate equivalent since the market birth (*see* Figure 14)[164]. Additionally, Ehlers and Packer's research stressed that - while Green Bonds have been priced at issuance at a premium on average relative to conventional bonds - the performance of this new asset class in the secondary market over time has been similar[165]. Finally, Serena Tang - Morgan Stanley cross-asset strategist - underlined that, despite Green Bonds' exponential growth in volume, they performed in an orderly way, roughly in line with the broad market[166].

Figure 14. Green Bonds' Performance Aligned with Traditional Bonds



Source: FT from Bloomberg

On the other hand, there are signs that a pricing advantage is beginning to emerge for Green Bonds, pushed by the growing investors' demand for environmentally sustainable products. For instance, in 2017 the ICE/BAML indices showed that green securities' total returns had outperformed the global bond average in the year, as represented in Figure 15[167]. Morgan Stanley itself reported that comparing Green Bond performance to the broader market requires looking beyond absolute performance; the bank declared that in the decade 2007-2017 Green Bonds outperformed their conventional counterparts, both in absolute terms and on a risk-adjusted basis[168]. Specifically, it has been showed that investors can buy Green Bonds at similar spread levels to conventional bonds after adjusting for sector, curve and currency; however, there

[164] Allen, K. (2017). Sellers of green bond face a buyer's test of their credentials. Financial Times
[165] Ehlers, T., & Packer, F. (2017). Green Bond Finance and Certification. Bank for International Settlement (BIS)
[166] Morgan Stanley. (2017). Behind the Green Bond Boom. Morgan Stanley Research
[167] Allen, K. (2017). Green bond issuers are poised to charge a premium
[168] Morgan Stanley. (2017). Behind the Green Bond Boom. Morgan Stanley Research

are cases where Green Bonds are trading cheaper and where investors may find opportunities to swap traditional bonds for green securities.

Figure 15. Green Bonds Outperform Traditional Bonds

Source: FT from Bloomberg

Recent data from CBI analyses the performance of Green Bonds in the immediate secondary market, underlining tighter bid/ask spread and suggesting higher liquidity. In the 7 days after pricing, 62% of Green Bonds tightened more than comparable bonds, 90% of Green Bonds had tightened more than their comparable index. Likewise, 28 days after pricing, 59% of Green Bonds had tightened more than comparable bonds, 66% of Green Bonds had tightened more than their comparable index. This tightening effect was present in a larger number of EUR denominated Green Bonds than USD, probably due to a larger number of green or socially responsible investors in Europe[169].

In light of the premium prices characterizing the Green Bond market - especially the primary one - it is possible to identify two main reasons to explain this outperformance. The first one refers to the excess of Green Bond demand compared to the available supply, as explained by Richard Sherry - Director of Alternative Credit at M&G, a UK asset manager[170] - expecting a growth in the issuer base to meet the increasing demand. From an investor's point of view, the premium attached to Green Bonds is hard to explain. Academic literature has fallen short of demonstrating that Green Bonds are more expensive simply because they are green - in line with the fact that there is simply no credit enhancement attached to the green label[171]; a simpler explanation links higher pricing to the current excess demand for these instruments, driven by the number of market participants with an environmentally focused agenda. As proof of this reasoning, recent CBI data highlighted larger average oversubscription for Green Bonds compared to

[169] Harrison, C., & Filkova, M. (2018). Green Bond Pricing in the Primary Market: January - June 2018 (H1 2018). Climate Bond Initiatives (CBI); International Finance Corporation (IFC)
[170] Flood, C. (2017). Green bonds need global standards. Financial Times
[171] Counihan, G. (2019). Is the green bond market running out of steam? Franklin Templeton Investments

traditional vanilla securities[172]. The second reason, instead, attributes a higher pricing to additional disclosure requirements; indeed, the environmental due diligence improves the risk-return profile, justifying a higher price[173]. Moreover, enhanced disclosure gives investors greater engagement with the issuers and this is something worth paying extra money[174]; investors are willing to pay for an additional level of transparency around environmental performance[175].

2.3.1 Green Bond "Greenium"

So far, there has been a lack of clearness regarding the concept of "*greenium*" for Green Bonds. Some academics refer to a "*greenium*" effect when investor demand outstrips supply, a synonym of premium price for this market[176]. However, CBI clearly provides a definition, while measuring its existence. Starting from the assumption that a new issue premium is the extra-yield that a buyer gets and a seller pays for a new bond in comparison to where seasoned bonds from the same issuer are trading in the secondary market - a standard feature of the bond market aimed at attracting new investment - occasionally, it might happen that a bond is issued at a higher price and lower yield compared to existing debt and the bond will sit inside its own yield curve. This is known as a "new issue concession" or - when present in Green Bonds - *greenium*[177]. Regarding the market existence of a *greenium*, a recent report from CBI showed that Green Bonds priced either on or outside their curves, highlighting no sign of *greenium* mechanisms.

2.4 Corporate Green Bonds as a Source of Competitive Advantage

The available research specifically studying the relationship between Green Bond issuance and firm performance is quite limited, due to the newness of this asset class and its recent development. However, it represents a solid starting point to further deepen the understanding of Green Bonds as a potential source of competitive advantage. Tang and Zhang studied the announcement returns and real effects of Green Bonds on corporations in 23 countries during 2007-2017[178]. In their research, the two scholars demonstrated that stock market investors respond positively to Green Bond issuance; additionally, stock liquidity improves upon the issuance of Green Bonds due to the increased attention on and broadened ownership breadth of the firm. Their findings highlight that Green Bonds are a sound financial instrument to carry out CSR and ESG. In particular, Tang and Zhang tested the reaction of the stock market against firms'announcements of Green Bond issuance as a tool to carry out CSR investment projects that could potentially boost their ESG scores; in the short run event window, they found that the stock market reacts

[172] Harrison, C., & Filkova, M. (2018). Green Bond Pricing in the Primary Market: January - June 2018 (H1 2018). Climate Bond Initiatives (CBI); International Finance Corporation (IFC)
[173] Weber, O., & Saravade, V. (2019). Green Bonds: Curren Development and Their Future. CIGI Papers
[174] Allen, K. (2019). Disclosure is a lure for green bond investors. Financial Times
[175] Counihan, G. (2019). Is the green bond market running out of steam? Franklin Templeton Investments
[176] Park, S. K. (2018). Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution. Stanford Journal of International Law; Archer, O., & Tournaire, M. (2018). Green Bonds: Is the grass always greener? AON Investment Research and Insights
[177] Harrison, C., & Filkova, M. (2018). Green Bond Pricing in the Primary Market: January - June 2018 (H1 2018). Climate Bond Initiatives (CBI); International Finance Corporation (IFC)
[178] Tang, D. Y., & Zhang, Y. (2018). Do Shareholders Benefit from Green Bonds? Journal of Corporate Finance

significantly positive when firms announce their corporate action of issuing a Green Bond. The two academics explained these results considering two complementary effects:

- A "behavioural effect" due to media exposure
- A "fundamental effect" related to the additional information embedded in Green Bonds' issuances, providing value to equity investors

Furthermore, the two scholars discovered that the market tends to reward with higher liquidity only companies really carrying out green projects, rather than banks just passing through money. Only those firms concretely incorporating green investments into the essence of their business lines receive investors' appreciation.

Another study conducted by Baker, Bergstresser, Serafeim, and Wurgler - focused on the US Green Bond market - showed that ownership effects are stronger for bonds that are externally certified as green, supporting the prediction that Green Bonds are more closely held than ordinary bonds, particularly small or essentially riskless[179]. However, the most complete analysis of the relationship between Green Bonds and corporate performance probably has been conducted by Flammer in 2018[180]. The scholar adopted a matching methodology to overcome the "unobservables" affecting the outcomes of interest, explaining that the endogeneity issue could not be addressed differently since Green Bond issuance do not happen randomly. The matching approach helps to show and compare how firm-level outcomes would evolve absent the issuance of Green Bonds. Specifically, the author matches each Green Bond issuer to a traditional bond issuer in the same country, industry and year, selecting the nearest-neighbour based on a group of variables addressing size, financial and environmental performance. The results suggest that the issuance of corporate Green Bonds has become more prevalent over time, particularly in industries where the natural environment is financially material. Analysing how the stock market responds to the issuance of Green Bonds, the scholar discovered that Green Bonds yield positive announcement returns, implying that Green Bonds are value enhancing. Moreover, Flammer found out that Green Bonds generate an improvement in long-term value, operating performance and environmental performance, focusing on the analysis of Tobin's Q, Return on Assets (ROA), CO2 Emissions and the Environmental Rating provided by Thomson Reuters. Finally, the academic showed that Green Bonds increase companies' green innovations, significantly increasing their filing of green patents, and ownership levels by long-term and green investors, suggesting that Green Bonds are conducive to the adoption of a longer time horizon. This evidence is stronger for Green Bonds that are certified by independent third parties.

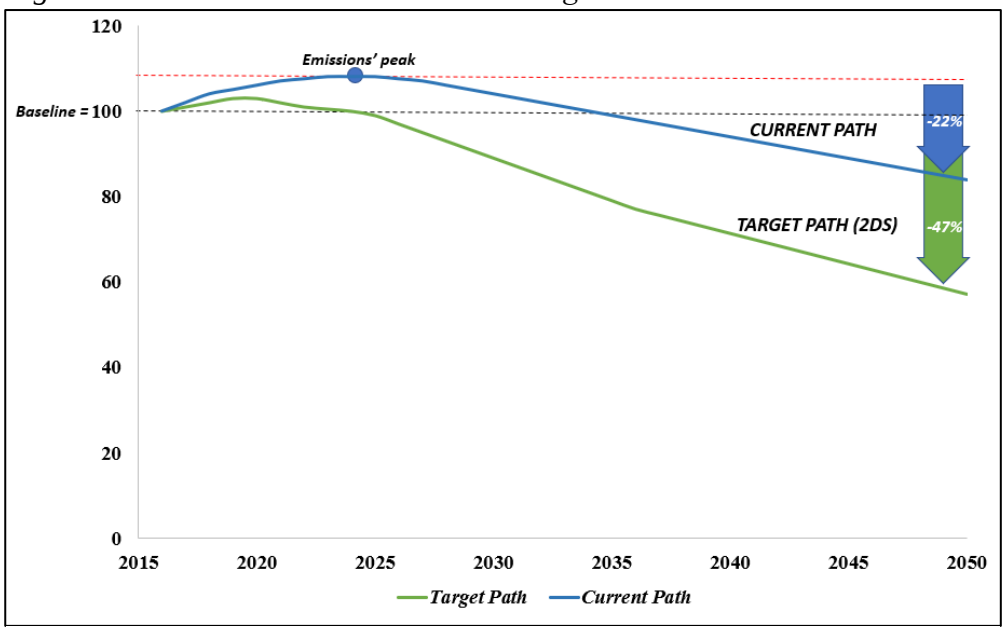
[179] Baker, M., Bergstresser, D., Serafeim, G., & Wurgler, J. (2018). Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds. The National Bureau of Economic Research (NBER)
[180] Flammer, C. (2018). Corporate Green Bond. Boston University, Global Development Policy Center

2.5 The Impact of Green Bonds on the Energy & Utilities Sector

The latest Energy Outlook report by the International Energy Agency (IEA) underlines that more than USD 2,3 trillion of annual investment in the Energy & Utilities sector is needed to meet the "sustainable development" conditions to prevent catastrophic climate change[181]. In addition, the annual commitment must rise to an average of more than USD 3,2 trillion between 2025 and 2040, channelling investments towards renewable power sources and improved efficiency[182]. In light of this gigantic need of funds to create climate-resilient infrastructures, Green Bonds represent a concrete solution to meet the internationally established sustainability goals, financing the Energy & Utilities transformation.

Furthermore, the path that is currently in place to contain global energy-related emissions is not sufficiently aggressive to meet the Paris agreement's target. Specifically - "walking" the existing path - energy-related emissions are expected to fall by 22 percent by 2050, compared to the expected 2024 peak level. This number appears to be significant, but the drop should be approximately 47 percent compared to the peak level to limit warming to 2° C or less (*see* Figure 16) [183]. This situation depicts the growing need of tools to accelerate the shift to a low-carbon economy; consequently, Green Bonds might represent one of the leverages to increase the pace of emissions' reduction for Energy and Utilities companies.

Figure 16. Current Emissions' Path vs. Target Emissions' Path



Source: Personal Elaboration on McKinsey & Co

2.5.1 Financial vs Non-Financial Corporations

Recent research conducted by Khan, Serafeim and Yoon[184] clearly highlights the relevance of identifying which sustainability investments result material for each industry, since material topics differ according to the specific sector under scrutiny. Using newly-available materiality classifications of sustainability topics, this group of scholars demonstrate that firms with good ratings on material

[181] International Energy Agency (IEA). (2018). World Energy Investment 2018. International Energy Agency (IEA)
[182] Espinoza, J. (2018). Private players plug in to the green energy revolution. Financial Times
[183] McKinsey & Company. (2019). Global Energy Perspective 2019. McKinsey & Company
[184] Khan, M., Serafeim, G., & Yoon, A. (2015). Corporate Sustainability: First Evidence on Materiality. The Accounting Review

sustainability issues significantly outperform - in terms of stock return - firms with poor ratings on these issues. In contrast, firms with good ratings on immaterial sustainability issues do not significantly outperform firms with poor ratings on the same issues. These results are confirmed also considering accounting performance.

Starting from this evidence, it seems reasonable to question the materiality of environmental topics in the Financial sector and in the Energy & Utilities one, which represent the vast majority of Corporate Green Bond issuance worldwide. The SASB Materiality Map[185] (*see* Table 3) - regarded as a leading organisation providing standards and tools to integrate ESG and sustainability considerations into investment decisions - helps to clear this doubt, underlining that Environment does impact on the performance of Energy & Utilities companies while it does not affect Financial Institutions. Consequently, Green Bonds have been created as an *ad hoc* answer to environmental sustainability issues; at the same time, the Environment does not represent a key element influencing the business of financial corporations, while it does play a critical role for the results of Energy & Utilities ones. Since this dissertation aims to assess the effects of Green Bond issuance on firm performance, it appears necessary to limit the research on Corporate Green Bonds of the Energy & Utilities sector, not only due to the fact that it is the biggest segment excluding Financials but especially because it is the only significantly influenced by environmental issues among the two[186].

Table 3. Materiality of Environment in the Financials vs Energy & Utilities Sector

Source: Personal elaboration form SASB Materiality Map

A further reason supporting the limited impact that Green Bonds should have on Financial Intermediaries' performance emerges if it is considered that financial companies do not implement themselves "green" projects; they simply raise money through bond issues to lend it to other companies. Banks and similar organisations act as "facilitators", but most of the benefits coming from low-carbon projects remain in the hands of the borrowers. Interestingly, it sounds reasonable to exclude Financials from the perimeter of this dissertation; oppositely, their inclusion might be counter-productive, invalidating the results of the study. This perspective is confirmed by Tang and Zhang research that shows how banks simply pass through

[185] Sustainable Accounting Standards Board (SASB). (2018). SASB Materiality Map. Retrieved from https://materiality.sasb.org/

[186] Industry data are taken form CBI; *see Section 3 for further explanation on Green Bonds' sector classification*

money, without incorporating green investments into the essence of their business[187]. Tang and Zhang highlight in their study that corporations issuing Green Bonds benefit more to their shareholders compared to banks. Only non-Financials companies will significantly increase their stock liquidity by 13,32% implementing green projects funded through this new asset class; on the other side, Green Bond issuance has an insignificant impact on banks' stock liquidity. The scholars explain that the reason behind Green Bond issue is different between the two groups: banks rely on Green Bonds in order to make green loans to firms, which would be used by companies to fund their green projects. Differently, corporations placing Green Bonds on the market will finance their investments directly. The common aspect is represented by the fact that only the actual implementer of a green project benefits from green finance.

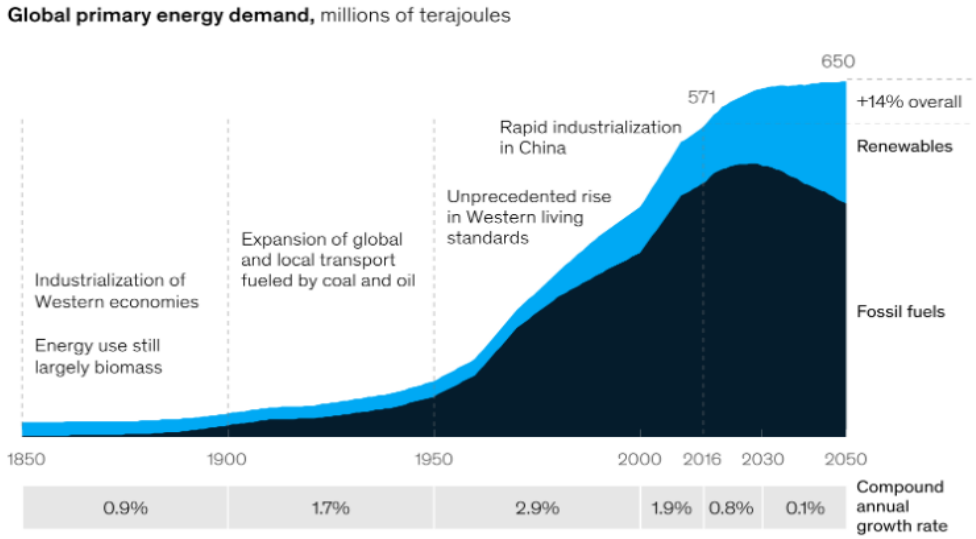
Another critical aspect linked to the previous point refers to the large share of funds raised by Financial Institutions through Green Bonds that is gradually transferred to the Energy & Utilities sector in the form of green loans for smaller companies. This phenomenon is difficult to capture separately from other ones and will not be the object of this dissertation; however, it further stresses the relevance of the Energy & Utilities sector for the Green Bond market and - in general - for the shift towards a low-carbon economy.

2.5.2 Dynamics of the Energy & Utilities Sector

The Energy & Utilities sector is currently experiencing one of its biggest transformations; energy generation and consumption's dynamics are changing at an unprecedented pace, reshaping a sector historically known for its stability and predictivity. A recent analysis conducted by Sharma, Smeets and Tryggestad, for instance, stresses that the axiomatic correlation between economic growth and energy demand is changing[188]; for centuries, as economies grew, energy demand increased; if energy was constrained, GDP growth pulled back in turn. However, nowadays, it is possible to see the beginning of a decoupling between the rates of economic growth and energy demand, which in the decades ahead will become even more pronounced. This is not a consequence of a less "energy-hungry" world; instead, it spurs from new technologies and larger trends that will cause the energy demand curve to flatten. The experts point out that the energy landscape is poised for foundational change between now and 2050, with energy demand likely to plateau around 2030 together with a decline in fossil fuels' use (*see* Figure 17).

[187] Tang, D. Y., & Zhang, Y. (2018). Do Shareholders Benefit from Green Bonds? Journal of Corporate Finance
[188] Sharma, N., Smeets, B., & Tryggestad, C. (2019). The decoupling of GDP and energy growth: A CEO guide. McKinsey & Company

Figure 17. Energy Demand Future Plateau



Source: Sharma, Smeets and Tryggestad from McKinsey & Co

The decoupling of the rates of economic growth - climbing steadily - and energy demand growth - ascending, but less steeply - will largely be a function of the following four forces:

- a steep decline in energy intensity of GDP - energy intensity is the ratio between gross inland energy consumption (GIEC) and gross domestic product (GDP), calculated for a calendar year[189] - primarily due to an ongoing shift from industrial to service economies in fast-growing countries such as India and China;
- a significant increase in energy efficiency coming from technological improvements and behavioural changes;
- the rise of electrification, a more efficient way to meet energy needs in many applications;
- the growing use of renewables, capable to flatten the primary energy demand curve.

Moreover, Sharma, Smeets and Tryggestad expect that wind and solar generation will be cheaper than electricity generated conventionally by new-build coal and natural-gas plants by 2020; interestingly, by 2025 renewables should be competitive even with the marginal cost of just running existing conventional plants in many countries and regions.

Moving to the drivers shaping the future of the Energy & Utilities sector, experts have identified three high-priority categories - the "three Ds": decarbonization, decentralization, and digitalization[190]. Focusing on the first one, coal-fired electricity generation will batman in the long term, while gas-fired and renewable generation will climb rapidly in the short-term. Meanwhile, utility-scale battery storage is expected to grow quickly, helping to manage the intermittency of wind and solar power. Shifting to decentralization, the EIA (US Energy Information Administration) projections foresee the rise of Distributed Energy Resources

[189] Definition provided by the European Environment Agency (EEA)
[190] Forbes, A. (2018). 5 Energy Industry Trends in 2018. General Electric (GE)

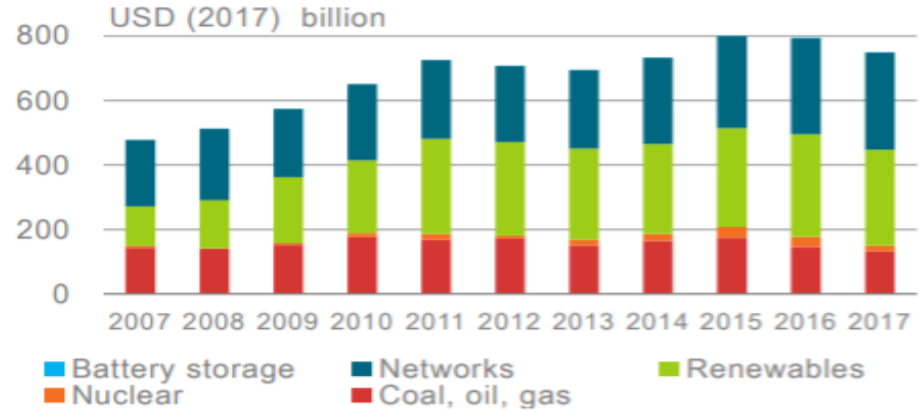
(DERs) and the increasing sophistication of Demand-Side Response (DSR) technologies, broadening consumers' options for sourcing and managing energy. Two-way power grids are giving more and more consumers the opportunity to sell the electricity they've generated themselves back to the grid. However, electric utilities and system operators face major challenges in integrating this new capacity into existing grids. Finally, digitalization will be capable to maximize the potential of renewable power-sources through efficiency solutions; currently, there is a lot of excitement around the so-called "*digital twin*". It refers to virtual copies of power plants and other industrial assets, resulting useful for predictive maintenance and training simulations. The rise of digitalization in the sector is strongly supported also by the International Energy Agency (IEA), stressing that it can increase flexibility and break down barriers between companies operating in different energy segments, enabling interrelated opportunities.

It seems clear that the upcoming change involving the Energy & Utilities industries will radically alter the present competitive dynamics; consequently, many companies are at risk of getting left behind if they fail to adapt to new energy generation and distribution models. This sector's "Great Transformation" is disrupting the conventional business model of generating and selling energy, bringing ESG topics and issues at the top of C-suite agendas[191].

Specifically analysing the key numbers currently characterizing this sector, it is possible to assess the current state of the energy transition and the areas of improvement, where more needs to be done. The electricity segment attracted the largest share of energy investments in 2017 - sustained by robust spending on grids - exceeding the oil and gas industry for the second year in row; indeed, the whole Energy & Utilities sector is moving towards greater electrification, according to the International Energy Agency's latest review of global energy spending[192]. Fewer decisions are being taken for investment in thermal coal-fired generation; in 2017 newly sanctioned coal power fell 18%, driven by a slowdown in China, India and Southeast Asia. In Figure 18 it is possible to evaluate the leading role nowadays played by "networks" and "renewables" investments.

[191] Sustainalytics. (2015). Utilities: The Great Transformation Begins. Sustainalytics
[192] International Energy Agency (IEA). (2018). World Energy Investment 2018. International Energy Agency (IEA)

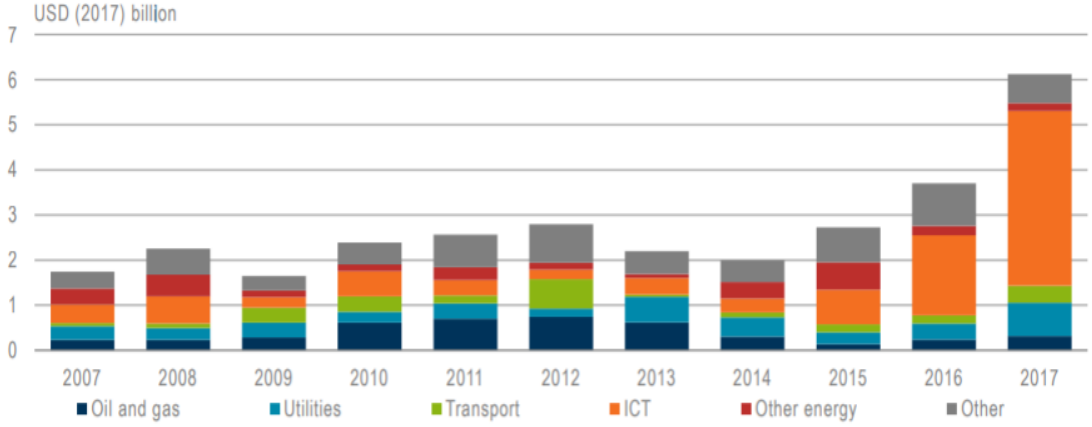
Fiaure 18. Global Power Sector Investments' Dvnamics



Source: International Energy Agency (IEA)

Looking at the most active investors in the energy transition, corporate venture capital and growth equity for energy tech start-ups reached USD 6 billion in 2017; remarking the growing pressure toward digitalisation, the larger share of investments came from the ICT sector (*see* Figure 19)[193]. Additionally, these data confirm that private actors are leading the shift to clean energy investment.

Figure 19. Corporate Investments in Energy Transition by Sector of Investing Company



Source: International energy Agency (IEA)

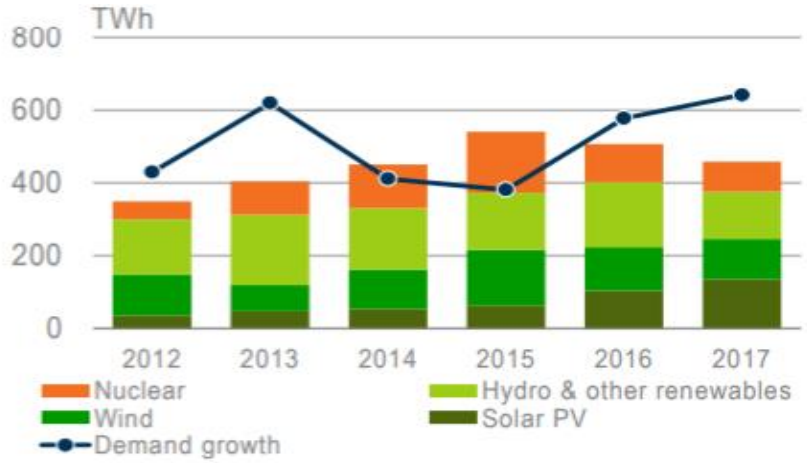
2.5.3 Green Bonds' Relevance for Energy & Utilities Companies

The relevance of an innovative financial instrument such as Green Bonds to support the implementation of "green" projects in the Energy & Utilities sector emerges from the following public release: "*The decline in global investment for renewables and energy efficiency combined could threaten the expansion of clean energy needed to meet energy security, climate and clean-air goals. While we would need this investment to go up rapidly, it is disappointing to find that it might be falling this year*[194]." (*Fatih Birol, Executive Director, International Energy Agency - IEA*). The 2018 World Energy Investment report published by the International Energy Agency (IEA) depicts a worrying situation regarding the number of investments to sustain an environmentally responsible economy. Indeed, global energy investment totalled USD 1,8 trillion in 2017 - a 2% decline in real terms compared to the previous year; more than USD 750

[193] International Energy Agency (IEA). (2018). World Energy Investment 2018. International Energy Agency (IEA)
[194] International Energy Agency (IEA). (2018). World Energy Investment 2018. International Energy Agency (IEA)

billion went to the electricity segment while the outstanding figure of USD 715 billion reached the oil and gas industry globally in 2017. These data are not comforting since there is an increasing necessity of additional renewable energy and energy efficiency investments to respond to Paris COP21 objectives; furthermore, the large share of resources still channelled towards oil and gas activity is disappointing in terms of the speed of change to an environmentally sustainable production and distribution of energy. On top of that, the global coal fleet continued to expand in 2017, despite declining capacity additions and a wave of retirements of existing plants. The report also reports that, after several years of growth, combined global investment in renewables and energy efficiency declined by 3% in 2017 and there is a risk of a steeper decrease during 2018. For instance, investment in renewable power - which accounted for two-thirds of power generation spending - dropped 7% in 2017. Additionally, recent policy changes in China limiting the promotion of solar photovoltaic - a change of route compared to the previous years' decisions - raise the risk of a slowdown in investment in 2017; indeed, China accounts for more than 40% of global investment in solar photovoltaic and its policy mutations have global implications. As a negative surprise, the share of fossil fuels in energy supply investment rose in 2017 for the first time since 2014, following a modestly increase in oil and gas spending. Finally, the expected output (power generation in TWh) from low-carbon power investments fell 10% in 2017 and did not keep pace with demand growth, as Figure 20 clearly shows[195].

Figure 20. Expected Generation from Low-Carbon Energy Investments vs Demand Growth



Source: International Energy Agency (IEA)

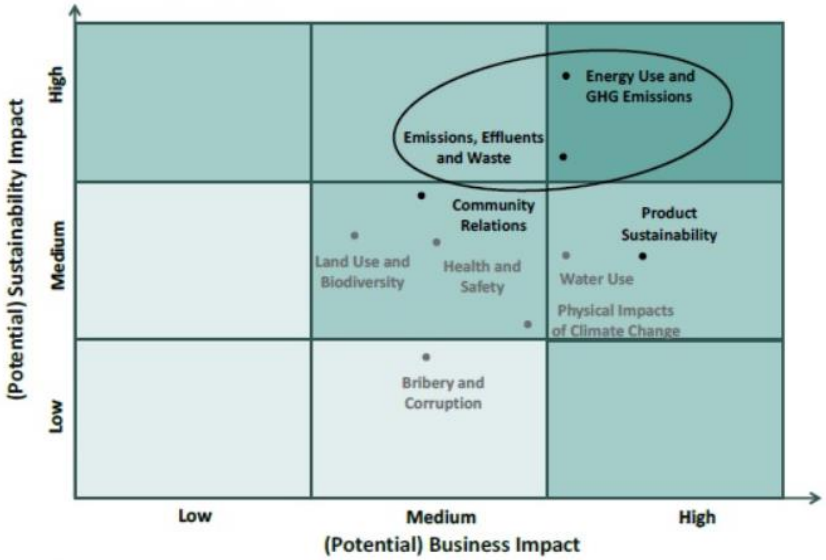
Thus, even if the long-term trend is for a strong growth of renewables and energy efficiency investments, probably this increase will not be enough to reach COP21 target, given the current state-of-the-art; furthermore, the short-term slowing down registered in 2017 is significantly troublesome. In light of the above-mentioned findings and difficulties, perhaps Green Bonds could be the solution to enable the take-off of environmentally sustainable initiatives in the Energy & Utilities sector, due to the characteristics of this innovative asset class and the potential correlation with improved firm performance suggested in recent

[195] International Energy Agency (IEA). (2018, July 17). Global energy investment in 2017 fails to keep up with energy security and sustainability goals. Retrieved from https://www.iea.org/newsroom/news/2018/july/global-energy-investment-in-2017-.html

research. Further proof of the opportunity offered by Green Bonds in this sector refers to the fact that bond financing has been identified as critical to sustaining 80-90% of investments in renewable energy, energy efficiency and low-emission vehicle within the 2° C scenario depicted by the OECD[196].

Assuming a different perspective, the relevance of Green Bonds to accelerate the shift of Energy & Utilities companies towards low-carbon businesses comes from an assessment of the most material ESG issues for this sector: "Energy Use & GHG Emissions" and "Emissions, Effluents & Waste", according to Sustainalytics[197] - a leading organisation providing research and certification for green finance products (*see* Figure 21). Energy & Utilities, indeed, is responsible for 31% of total global greenhouse gas (GHG) emissions; this information is confirmed by ROBECO - a leading international asset management firm - that reports 34% of the gases and air particles generated by this sector[198]. Within this context, many power and utilities corporations will struggle under new carbon constraints; Green Bonds may represent a business-wise solution to raise the required resource to adapt their activity to climate-resilient requirements under growing regulatory pressure. As major emitters of GHGs and other pollutants, generation and multi-utilities are significantly impacted by such regulations; water and electric utility firms are also highly exposed to the stewardship and responsible discharge of used water, due to the large quantities of water used in their processes. Surprisingly, robust programmes covering air pollutants, water and waste are structurally lacking in the sector.

Figure 21. Material ESG issues for the Energy & Utilities Sector



Source: Sustainalytics

Another interesting point of discussion regarding the Energy and Utilities sector refers to the shift towards renewables and its implications for a significant reduction of the companies' risk profile. Green Bonds' issuances, fostering this transition, would leverage the lower-than-average risk of "green energy projects" linked to renewable energy sources compared to traditional ones. Indeed, wind and solar power generation

[196] OECD. (2017). Mobilising Bond Markets for a Low-Carbon Transition. Paris: OECD Publisher
[197] Sustainalytics. (2015). Utilities: The Great Transformation Begins. Sustainalytics
[198] Ruizeveld, J., & Wiersma, T. (2014). The impact of ESG on credit portfolios: the Energy sector. ROBECO Research

projects tend to be subject to lower Beta, Cost of Equity and WACC, while exploiting on a higher extent the benefits provided by debt financing (*see* Table 4)[199].

Table 4. Renewables vs. Traditional Energy Sources: Cost of Equity and Cost of Capital

Industry Name	*Beta*	*Cost of Equity*	*Cost of Debt*	*Tax Rate*	*After-tax Cost of Debt*	*D/(D+E)*	*Cost of Capital*
Coal & Related Energy	1,41	13,17%	5,75%	8,91%	4,29%	35,33%	10,03%
Green & Renewable Energy	1,04	10,37%	5,37%	11,63%	4,01%	47,38%	7,36%
Oil/Gas (Integrated)	1,32	12,50%	5,37%	22,76%	4,01%	28,76%	10,06%
Oil/Gas (Production and Exploration)	1,56	14,24%	5,75%	3,97%	4,29%	36,12%	10,65%
Oil/Gas Distribution	1,22	11,76%	5,37%	12,00%	4,01%	48,12%	8,03%

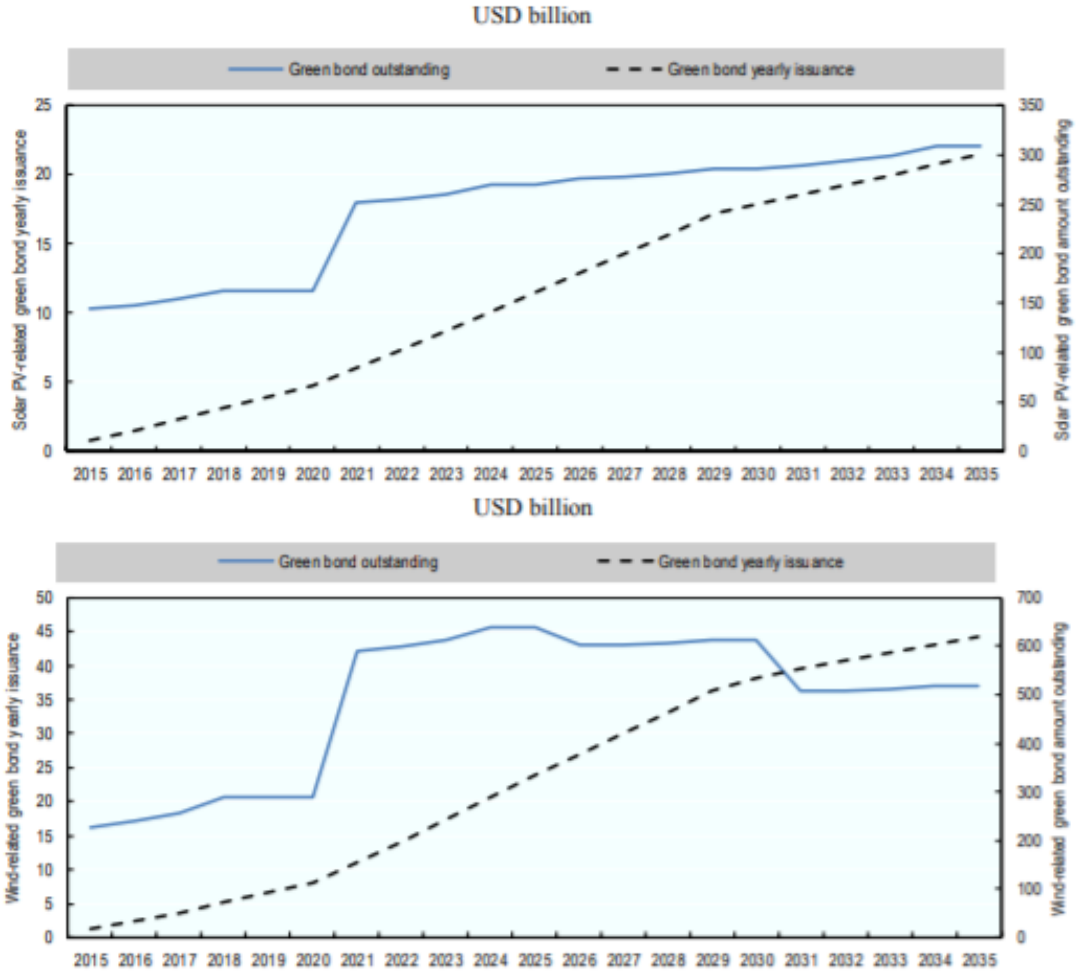
Source: Personal Elaboration from Damodaran

In conclusion, the OECD specifically studied the prospective future evolution of Green Bonds for wind and solar power generation in its recent report[200]. Within the renewable energy segment, wind energy appears to have the potential for twice as much Green Bond issuance compared to solar photovoltaic. Aggregate Green Bonds outstanding from solar photovoltaic have the potential to reach USD 265 billion in 2035 with annual issuance of around USD 20 billion, while the potential for Green Bonds to finance wind deployment is estimated at over USD 590 billion outstanding in 2035, with annual issuance of around USD 40 billion (*see* Figure 22). Annual bond issuances in the wind sector could experience a boom around 2020, as the technology reaches a satisfactory level of maturity and standardisation. Solar photovoltaic may follow, creating the circumstances to make the 2020s the "*golden years*" of renewable energy bond finance. The potential for solar photovoltaic figures is smaller than that for wind due to conservative securitisation assumptions.

[199] Damodaran, A. (2019, January 5). Global Cost of Equity and Cost of Capital by Industry. Retrieved from http://www.stern.nyu.edu/~adamodar/New_Home_Page/data.html

[200] OECD. (2017). Mobilising Bond Markets for a Low-Carbon Transition. Paris: OECD Publisher

Figure 22. Green Bonds for Wind and Solar Power Generation: Issuance and Amount Outstanding



Source: OECD

Looking at top Green Bonds' issuers, the majority belongs to the Energy & Utilities sector - excluding Financials and some exceptional cases – already showing the relevance of this asset class for the future of energy transition. According to CBI data, in the first quarter of 2019 four of the top five non-financial corporate issuers came from the energy sector, all issuing benchmark-sized bonds: MidAmerican Energy, Engie, EDP and Enel[201]. Similarly, in 2018 Iberdrola, Enel and Engie were the top three non-financial corporate issuers, with cumulative volumes of USD 4,5 billion[202]. Furthermore, in 2019 the utility industries are expected to see a 30% increase in maturities, which could provide an opportunity for additional Green Bond refinancing[203]; exploiting this short-term situation might generate positive effects in the long-run for the Energy & Utilities Green Bond market.

[201] Climate Bonds Initiative (CBI). (2019). Green Bonds Market Summary - Q1 2019. Climate Bonds Initiative (CBI)
[202] Climate Bonds Initiative (CBI). (2019). 2018 Green Bond Market Summary. Climate Bonds Initiative (CBI).
[203] Moody's Investor Service. (2019, January 31). Moody's: Green bond market poised to hit $200 billion in 2019. Retrieved from https://www.moodys.com/research/Moodys-Green-bond-market-poised-to-hit-200-billion-in--PBC_1159526

3 SAMPLE DEFINITION, DATA OVERVIEW AND REGRESSION METHODOLOGY

The initial sections of this chapter will be dedicated to the explanation of the data collection process and the *matching* procedure aimed at the construction of the most appropriate sample to perform the desired analysis. It is relevant to stress that - to the best knowledge of the author - this dissertation collects and reports the most comprehensive and updated dataset on Corporate Green Bonds; at the same time, there will be a focus on Corporate Green Bonds issued by Energy & Utilities companies, outlining similarities and differences with the aggregate dataset. Afterwards, it will be introduced the matching methodology, the drivers behind its implementation and the rationale supporting the whole procedure.

The *matching* will be critical to provide an equal number of Green Bond issuers and non-Green Bond issuers to investigate the relationship between Corporate Green Bonds and Firm Performance in a way similar to a "clinical trial": Green Bond issuers can be considered "treated cases" that have to be compared to a homogeneous number of "control cases" – i.e. non-Green Bond issuers. Thereafter, the characteristics of the resulting sample will be addressed, pointing out the most relevant statistics.

In the latest sections of the chapter, it will be possible to deepen the understanding of the variables included in the regression models and the models themselves. Specifically, the dichotomous independent variable at the core of the study is clearly the presence or absence of outstanding Green Bonds, supported by a series of covariates to strengthen the models. The effects on Firm Performance will be properly studied according to two different perspectives - Environmental and Financial - trying to give an answer to the following three questions while validating or rejecting the related hypotheses:

- *Question 1*. Does Green Bond issuance contribute to the improvement of environmental performance for Energy & Utilities companies, accelerating their reduction of CO2 emissions?
  Hypothesis 1. The issuance of Green Bonds by Energy & Utilities corporations significantly decreases their Greenhouse Gas emissions, highlighting the effectiveness of the instrument contrary to a *greenwashing* risk.

- *Question 2*. Do Green Bond issuers in the Energy & Utilities sector outperform their "non-Green" peers in terms of Environmental Sustainability?
  Hypothesis 2. Energy & Utilities companies issuing Green Bond show significantly lower GHG emissions and higher environmental responsible behaviour.

- *Question 3*. Do Green Bond issuers in the Energy & Utilities sector perform better in terms of Total Stock Return?

  Hypothesis 3. The issuance of Green Bonds does create additional value for shareholders. More precisely, Green Bond issuers generate significantly higher stock returns over time.

3.1 Data Collection: Corporate Green Bonds and Energy & Utilities specifics

The creation of a comprehensive Corporate Green Bonds dataset relies on two extensively used and broad-based lists: the Climate Bonds Initiative (CBI) database - kindly provided by CBI itself - and Bloomberg bond data - thanks to *LUISS Guido Carli University*, granting access to this financial data and service provider. Specifically, Bloomberg information can be regarded as the baseline, accurately integrated with CBI inputs regarding external reviews' providers. As can be seen in Table 5, the research provided a total of 1.398 securities, discriminating according to the "use of proceeds" - which must be labelled as "Green Bond/Loan" - and excluding Supranationals, Sovereigns, Central banks and Government entities.

Table 5. Corporate Green Bonds' Research

Security Status	Include	Bonds : All
Use of Proceeds	Include	Green Bond/Loan
BICS Classification	Exclude [Match Any]	Sovereigns or Government Agencies or Government Regional or Supranationals or Government Development Banks or Winding Up Agencies or Central Bank or Government Local
		Number of securities: 1,398

Source: Personal elaboration from Bloomberg

However, when the same issuers place on the market several tranches on the *same day* and with the *same maturity* - this second criterion avoids the union of bonds with different risk profiles - the issuances are combined into one single Green Bond, while cumulating the amounts. Additionally, the dataset is sanitized from issuances reporting an amount issued equal to zero. Finally, only Green Bonds issued until the 31st December 2018 have been included in the analysis and all the amounts have been converted in USD to facilitate comparison. The above criteria yield the following figure:

Corporate Green Bonds = 1.088 securities

In order to facilitate the comprehension of the characteristics of this dataset, it has been decided to provide some statistics opportunely discriminating according to the fact that the issuer is a public or a private company. Additionally, the comparison between the overall dataset and the specific Energy & Utilities one will help in highlighting the most relevant discrepancies and the related reasons. First, it is important to point out some key information regarding the total amount issued and outstanding, the number of issuances and the average issue size, as shown in Table 6 and Table 7.

Table 6. Corporate Green Bonds: Amount Issued, Number of Issuances and Issue Size

	OVERALL		
	Public	**Private**	**Total**
Total Amount Issued	$ 127.472.647.476,49	$ 172.028.657.432,29	$ 299.501.304.908,78
Total Amount Outstanding	$ 115.072.070.716,49	$ 144.637.345.575,67	$ 259.709.416.292,17
% of Total Amount Issued	*90,27%*	*84,08%*	*86,71%*
Number of issuances	259	829	1088
Average Issue Size	$ 492.172.384,08	$ 207.513.458,91	$ 275.276.934,66
Std Dev of Issue Size	*$ 719.694.274*	*$ 367.733.626*	*$ 490.567.344*

Source: Personal elaboration

Table 7. Energy & Utilities Green Bonds: Amount Issued, Number of Issuances and Issue Size

	ENERGY & UTILITIES		
	Public	**Private**	**Total**
Total Amount Issued	$ 31.057.791.517,49	$ 69.362.391.316,92	$ 100.420.182.834,41
Total Amount Outstanding	$ 27.669.291.357,49	$ 57.590.285.425,71	$ 85.259.576.783,20
% of Total Amount Issued	*89,09%*	*83,03%*	*84,90%*
Number of issuances	67	385	452
Average Issue Size	$ 463.549.127,13	$ 180.162.055,37	$ 222.168.546,09
Std Dev of Issue Size	*$ 581.232.879*	*$ 318.280.963*	*$ 381.908.589*

Source: Personal elaboration

From the analysis of the Tables above, it clearly emerges that both the amount issued and amount outstanding by private corporations are bigger than the ones by public companies; this evidence is confirmed looking at the statistics of the Energy & Utilities sector. However, the proportion of amount outstanding on amount issued is higher for public firms, suggesting their capability to rely on longer maturities due to their higher standing. At the Energy & Utilities level, this proportion holds true, even if on unexpected slightly lower terms; indeed, Energy & Utilities companies tend to issue debt with distant reimbursement in order to finance their infrastructure projects, relying on stable cash flows and lower-than-

average riskiness. However, it seems that the reason behind these numbers can be identified in changing market conditions that have pushed more Energy and Utilities corporations to refinance their debt with new Green Bond issues, compared with the same practice at an overall sample level, as clearly outlined by Table 8. Regarding the issue size, public firms tend to issue amounts 2,5 times larger than their private peers, while the number of issuances is heavily higher for private organisations. The average issue size for Energy & Utilities companies is smaller than the overall sample, but this figure mainly depends on the "mega-deals" characterizing issuances of Green Bonds from Financials; additionally, the standard deviation for public Energy & Utilities' issue size is lower than the one for the overall public sample, underlining a greater stability in "big size" issuances.

Table 8. Use of Proceeds: Focus on Refinancing Purpose

OVERALL		
Use of Proceeds	***Total Amount Issued***	***% of Total Amount Issued***
Other (lower than 2%)	$ 26.100.666.794,24	*8,71%*
General Corporate Purposes Green Bond/Loan	$ 6.755.305.740,00	*2,26%*
Project Finance Green Bond/Loan	$ 6.820.669.201,61	*2,28%*
Working Capital Project Finance Green Bond/Loan	$ 6.899.327.700,00	*2,30%*
Green Bond/Loan Bail-in	$ 14.381.809.600,00	*4,80%*
Refinance Green Bond/Loan	$ 27.901.427.787,00	*9,32%*
Green Bond/Loan	$ 210.642.098.085,94	*70,33%*
TOTAL	**$ 299.501.304.908,78**	***100,00%***
TOTAL for Refinancing Purpose	**$ 47.500.832.063,00**	**15,86%**

ENERGY & UTILITIES		
Use of Proceeds	***Total Amount Issued***	***% of Total Amount Issued***
Other (lower than 3%)	$ 11.568.405.062,52	*11,52%*
General Corporate Purposes Refinance Green Bond/Loan	$ 3.276.991.000,00	*3,26%*
Working Capital Project Finance Green Bond/Loan	$ 3.402.105.500,00	*3,39%*
Project Finance Refinance Green Bond/Loan	$ 3.494.501.250,00	*3,48%*
Project Finance Green Bond/Loan	$ 3.974.975.579,00	*3,96%*
Refinance Green Bond/Loan	$ 10.915.717.400,00	*10,87%*
Green Bond/Loan	$ 63.777.627.025,41	*63,51%*
TOTAL	**$ 100.420.182.834,41**	***100,00%***
TOTAL for Refinancing Purpose	**$ 24.060.932.750,00**	**23,96%**

Source: Personal Elaboration

Furthermore, it is interesting to consider the following relevant statistics regarding the Corporate Green Bonds dataset. Not surprisingly, public corporations tend to show longer maturities and lower coupons

compared to private firms, benefiting from the higher credit rating that their issuances experience and the enhanced control and monitoring that investors can carry out on listed companies. At the same time, Energy & Utilities' Green Bonds are characterized by longer maturities than the overall sample; this is particularly true for public businesses, due to the extraordinary dimension of their long-term infrastructure projects requiring a lot of funds that need to be repaid over a long period of time. Finally, the Energy & Utilities' coupon results slightly higher, perfectly in line with longer maturity. In Table 9 below it is provided a snapshot of these numbers.

Table 9. Corporate Green Bonds: Maturity, Coupon and Rating

	OVERALL			ENERGY & UTILITIES		
	Public	**Private**	**Total**	**Public**	**Private**	**Total**
Average Maturity at Issuance (years)	9,32	7,36	7,81	21,23	8,55	10,37
Std Dev of Maturity	*60*	*6*	*29*	*120*	*6*	*46*
Average Coupon (Fixed Rate only)	2,976	3,727	3,555	3,197	3,879	3,781
Std Dev of Coupon	*2,24*	*2,22*	*2,24*	*2,36*	*1,96*	*2,04*
Fitch Median Rating	A	BBB+	BBB+	BBB+	BBB+	BBB+
Moody's Median Rating	A2	A3	A3	A3	Baa1	Baa1
S&P's Median Rating	A-	A-	A-	BBB+	BBB+	BBB+

Source: Personal elaboration

Focusing on the currency of issuance and the country of risk, it is possible to point out the clear dominance of the Eurozone countries. The two main evidences that should be stressed refer to the higher proportion of Green Bonds issued by Energy & Utilities companies in the Euro Area compared to the overall dataset and the fact that a significant portion of Chinese issuers prefer to adopt either USD or EUR currency to attract a greater number of investors (*see* Figure 23).

Figure 23. Corporate Green Bonds: Currency and Country of Risk

Source: Personal elaboration

Moving to sector analysis, the dataset clearly shows the dominance of Financials in terms of amount issued, followed by Energy and Utilities. The two sectors together represent more than 80% of cumulative Corporate Green Bonds issuances (*see* Table 10). Deepening the understanding of the Energy and Utilities sector, in Table 11 is proposed a breakdown by industry according to the BICS Level 1 classification system[204], where the prevalence of Utilities companies stands out.

Table 10. Corporate Green Bonds by Sector

OVERALL			
Sector	**Amount Issued**		***Amount Issued (%)***
Communications	$	58.720.000,00	*0,02%*
Health Care	$	691.123.295,61	*0,23%*
Consumer Staples	$	1.898.175.100,00	*0,63%*
Technology	$	3.197.736.900,00	*1,07%*
Materials	$	4.879.068.000,00	*1,63%*
Consumer Discretionary	$	11.485.031.457,00	*3,83%*
Industrials	$	28.620.852.113,80	*9,56%*
Energy & Utilities	$	100.420.182.834,41	*33,53%*
Financials	$	148.250.415.207,96	*49,50%*
TOTAL	**$**	**299.501.304.908,78**	***100,00%***

Source: Personal elaboration

[204] BICS classification relies on a proprietary taxonomy elaborated by Bloomberg

Table 11. Energy & Utilities' Industry Breakdown

ENERGY & UTILITIES			
Industies	**Amount Issued**		***Amount Issued (%)***
Energy	$	15.421.798.689,41	*15,36%*
Utilities	$	84.998.384.145,00	*84,64%*
TOTAL	**$**	**100.420.182.834,41**	***100,00%***

Source: Personal elaboration

In conclusion, adopting an issuer-level perspective, it emerges a higher number of private companies issuing Green Bonds compared to public ones; these data are confirmed in the Energy & Utilities. Regarding the proportion of externally verified issuers - based on CBI information - more than 4 out of 5 corporations relies on a consulting/assuring opinion from an external accredited party. This proportion is higher for private firms, probably in light of the greater pressure from investors that want to protect themselves against the risk of greenwashing, given the limited disclosure of information by non-listed entities (*see* Table 12).

Table 12. Green Bond Issuers & External review

	OVERALL		
	Public	**Private**	**Total**
Number of issuers	146	228	374
Extranally Reviewed Issuers (%)	83,01%	85,52%	84,93%
Std Dev of External reviews	*0,38*	*0,35*	*0,36*
	ENERGY & UTILITIES		
	Public	**Private**	**Total**
Number of issuers	32	70	102
Extranally Reviewed Issuers (%)	79,10%	88,31%	86,95%
Std Dev of External reviews	*0,41*	*0,32*	*0,34*

Source: Personal elaboration

The evidence in the Table above suggests a number of public Energy & Utilities companies issuing Green Bonds equal to 32. These data reflect Bloomberg classification; however, it seems more appropriate to adopt a different categorization taking into account the fact that a considerable number of private companies are subsidiaries of listed corporations acting as final guarantors to the bond issuance. This data reclassification leads to a final number of public Energy & Utilities companies equal to 50, as highlighted in Table 13.

Table 13. Listed Corporate Green Bond Issuers in the Energy & Utilities Sector: main figures

ENERGY & UTILITIES		
Number of Listed Issuers		50
Total Amount Issued	$	62.539.514.877,49
Average Amount Issued	$	1.250.790.297,55
Median Amount Issued	$	582.650.000,00
Std Dev of Amount Issued	*$*	*1.888.928.492*
Issue Period	2013 - 2018	

Source: Personal elaboration

This subset of listed Energy & Utilities corporations represents the "treated group" that needs to be matched with the most appropriate "control group" of public Energy & Utilities companies that are non-Green Bond issuers, as shown in the next section. In addition, only listed firms will be used to test the hypotheses outlined at the beginning of this chapter, due to the wider data availability; thus, the information on the public final guarantor will be considered when the Green Bond issuer is a private subsidiary of a public company. Finally, data will be collected between 2013 - when the first Corporate Green Bond by an Energy & Utilities firm was issued - and 2018 - the latest available fiscal year - covering a six-year timeframe.

3.2 The Matching Methodology

The core reason behind the need for a *matching* procedure responds to the willingness of creating two homogeneous sub-groups of equal numerosity and similar characteristics to address the actual effectiveness of Green Bonds. Indeed, this methodology represents the best available approach to address the Green Bond phenomenon consistently with a "clinical experiment", assessing the consequences of Green Bond issuance on the "treated" sub-sample against a paired "control" one. As clearly explained by Flammer[205], the *first best* solution to test the hypotheses of this research is not implementable since it is impossible to study what would have happened if the same bonds were not "green". Additionally, performing a randomized experiment is not feasible due to the high difficulty in establishing and satisfying *ad hoc* random procedures, with both Green Bonds and traditional ones specifically issued after the start of the experiment. Consequently, the *matching* methodology represents the *third best* approach to analyse the results of Green Bond issuance, enabling the consideration of similarities with the "control" sub-sample.

From a theoretical perspective, matching procedures respond to the issue of estimating treatment effects in observational studies, trying to solve one of the main problems of causal inference; indeed, while it results

[205] Flammer, C. (2018). Corporate Green Bond. Boston University, Global Development Policy Center.

quite simple to identify the sample exposed to a well-defined treatment, the maintenance of the control group is complicated and there are no systematic methods of experimental design[206]. Additionally, comparing a "treated" units with a nonexperimental comparison group could produce biased results and conclusions due to self-selection and systematic judgement issues. Matching methodologies correct sample selection bias by pairing treatment and comparison units according to observable characteristics; the resulting sub-groups turn out to be similar on the selected covariates. In this dissertation, it has been decided to adopt a *Propensity Score-Matching* (PSM) method to create a sample of paired Green Bond issuers and non-Green Bond ones. In particular - as explained by Dehejia and Wahba - the selected matching approach is suggested when the dimensionality of the observable characteristics is high; due to the fact that it is necessary to deal with many variables, it results difficult to identify along which dimension to match units or which weighting scheme to adopt. Therefore, Propensity Score-Matching helps to provide a natural weighting scheme that yields unbiased estimates of the treatment impact, increasing the balance between treatment and control sub-groups. Recent research[207] seems to criticize the random matching provided by PSM, analysing its degrading effects on inference; the scholars supporting this perspective suggest other techniques – such as Mahalanobis Distance Matching (MDM) or Coarsened Exact Matching (CEM) – to construct an unbiased sample, stressing the relevance of controlling the matching phenomenon instead of relying on a random process. However, current literature is contrasting and it is difficult to identify an approach that performs better in all the aspects of interest.

Specifically, it has been decided to rely on the MatchIt package[208] of R - a free software environment for statistical computing - to perform a Propensity Score-Matching combining exact and nearest-neighbour approaches. *Exact matching* pairs each treated unit with a control one that has the same values on each covariate, while *nearest-neighbour* technique matches a treated unit to a control unit that is closest in terms of *logit* distance[209] - one logit is the distance along the line of the variable that increases the odds of observing the event specified in the measurement model by a factor of 2.718.., the value of "e"[210]. Logit-based PSM collapses the multidimensional pre-treatment data to a unidimensional zero to one scale and identifies the appropriate controls for the treated observations; the result provides treated and control groups with the greatest overlap in their propensity scores.

From an economic perspective, the 50 Green Bond issuers identified in the previous section have been matched with 50 Energy & Utilities corporations that have not relied on this innovative instrument during

[206] Dehejia, R. H., & Wahba, S. (2002). Propensity Score-Matching Methods for Nonexperimental Causal Studies. The Review of Economics and Statistics

[207] King, G., Nielsen, R., Coberley, C., & Pope, J. E. (2011). Comparative Effectiveness of Matching Methods for Causal Inference

[208] Ho, D. E., Imai, K., King, G., & Stuart, E. A. (2011). MatchIt: Nonparametric Preprocessing for Parametric Causal Inference. Journal of Statistical Software

[209] Randolph, J., Falbe, K., Manuel, A., & Balloun, J. (2014). A step-by-step guide to propensity score matching in R. Practical Assessment, Research & Evaluation (PARE)

[210] Linacre, J. M., & Wright, B. (1989). The "Length" of a Logit. Rasch Measurement Transactions

the period under observation. The 50 "control units" have been taken out of a sample of 577 Energy and Utilities companies belonging to the same geographic area and the same Bloomberg BICS Level 2 industry of the Green Bond issuers' sub-sample (*see* Table 14). The matching has been performed on a set of covariates that grant a similar financial performance of the "treated" and "control" companies over the years of analysis.

Table 14. The Pre- and Post-Matching Numerosity of the Sample

```
Sample sizes:
          Control Treated
All           577      50
Matched        50      50
Unmatched     527       0
Discarded       0       0
```

Source: Personal elaboration in R

In particular, the following five matching drivers have been selected in order to study the potential environmental and stock outperformance of Green Bond issuers while ensuring a similar financial performance of the 100 sample firms based on geographic and sector variables and companies' fundamentals data:

- *BICS Level 2 Industry classification system*. Companies belonging to the same industry are characterized by similar business models and face equivalent business risks. Companies in the sample are part of these five industries: Utility Networks, Power Generation, Oil Refining & Marketing, Integrated Utilities and Renewable Energy.
- *Geographic Area*. Firms belonging to the same region operate in a similar normative environment and are affected by comparable macro-economic forces. Corporations in the sample are part of these six geographic areas: Western Europe, USA & Canada, Greater China, Nordics, Indian Peninsula, Australia & New Zealand.
- *Size.* Companies sharing an equal dimension should be in a similar maturity stage and have access to similar resources - financial, intellectual and technology - while being characterized by likewise developed governance structures and operating rigidity. All the firms in the sample are listed; therefore, a minimum dimension is taken for granted. However, from a market capitalisation perspective, the sample includes not only Big Cap and Mid Cap corporations but also Small Cap, stressing the dimension's variety. Notwithstanding, in this study company size is not represented by market capitalisation; on the contrary, the dollar amount of balance sheet assets represents more appropriate and concrete magnitude information for Energy and Utilities firms, given the heavy reliance on their own infrastructural network to generate and distribute energy. In particular, the natural logarithm on Total Assets has been used as a proxy for size to standardize measures in light of the significant difference in the value of Total Assets over time and among different companies, enabling outliers' correction.

$$Size = Ln\,(Total\ Assets)$$

- *Operating performance*. Corporations that have aligned profitability from core activities should be characterized by comparable operating efficiency, implying a similar capability to generate resources by exploiting their own assets. Among the 100 sample's units, there are both profitable and unprofitable businesses. Specifically, operating performance has been measured relating a company's Net Operating Profit After Taxes (NOPAT) to its own Total Assets, indirectly assessing the cash-flow potential of the company's assets.

$$Operating\ Performance = \frac{NOPAT}{Total\ Assets}$$

- *Capital Structure*. Firms having a similar gearing should experience a comparable risk profile, cost of funding, ease to access new capital and pressure from creditors. The 100 companies of the sample show different leverage policies; while some of them are highly exposed towards banks and bondholders, others have taken on little debt. Additionally, some corporations seem to stick to a fixed leverage ratio over the years, while it continuously fluctuates for other organisations. In this dissertation, capital structure is measured through the relationship between Total Debt and Total Assets to understand how a company is financing the maintenance and the expansion of its value-generating resources.

$$Capital\ Structure = \frac{Total\ Debt}{Total\ Assets} \times 100$$

To build up the 100 companies' sample, it has been set up a matching procedure requiring an exact pairing on the "BICS Level 2" and "Geographic Area" variables, created through the combination of these two covariates into a single unique identifier (*as shown in the column "BICS…Geo" in* Table 15 *below*). At the same time - in order to grant analogy from a financial point of view over the six-year period of study - Green Bond issuers have been matched with the most similar "control" peers on the basis of the other three drivers mentioned above - size, operating performance and capital structure - following a nearest-neighbour requirement. Specifically, "treated" and "control" units have been paired according to the following four different variables for each of the three nearest-neighbour drivers, totalling 12 matching variables that need to be added to the "Industry & Geography" variable previously explained:

- *Arithmetic mean over the six-year period.* It enables to provide a measure of the central tendency of the driver under analysis considering the effect of extreme values and significant changes over years.
- *Median of the six-year period.* It refers to the central-point value of the driver under analysis, providing a rigid measure not affected by potential outliers.
- *Trend of the six-year period.* It seizes the drivers' growth/drop in the analysed timeframe assuming a dichotomous value: either "1" if there has been an increase or "0" if there has been a decrease.

$$if\ \frac{\sum_{t=2016}^{2018} Driver_t}{3} > \frac{\sum_{i=2013}^{2015} Driver_i}{3}, then\ Trend = 1$$

$$if\ \frac{\sum_{t=2016}^{2018} Driver_t}{3} < \frac{\sum_{i=2013}^{2015} Driver_i}{3}, then\ Trend = 0$$

- *Standard deviation over the six-year period*. It is a measure of dispersion and variation that helps to understand the driver's fluctuations over time.

In Table 15 is provided a representation of the first 5 Energy & Utilities companies out of the 627 firms' sample - given by the sum of the 50 "treated" companies and 577 potential "control" ones; for each company, the name and the 13 variables' values are reported. Instead, Figure 24 reports the coding formula used to perform the matching.

Table 15. Matching Variables

	Ticker	Name	ISIN	BICS...Geo	BICS...Geo.NUM	Green.Bond.Issuer	X6Y.Debt.Asset.Average	X6Y.Debt.Asset.Median
1	NG/ LN Equity	NATIONAL GRID PLC	GB00BDR05C01	Utility NetworksWestern Europe	1	0	47.46830	47.56375
2	SRE US Equity	SEMPRA ENERGY	US8168511090	Utility NetworksUS & Canada	2	0	37.11420	35.99665
3	ED US Equity	CONSOLIDATED EDISON INC	US2091151041	Utility NetworksUS & Canada	2	0	32.80937	32.03725
4	ES US Equity	EVERSOURCE ENERGY	US30040W1080	Utility NetworksUS & Canada	2	0	34.53325	33.68660
5	AWK US Equity	AMERICAN WATER WORKS CO INC	US0304201033	Utility NetworksUS & Canada	2	0	38.86063	38.89710

	X5Y.Debt.Asset.Trend	X6Y.Debt.Asset.Std.Dev	X6Y.NOPAT.Asset.Average	X6Y.NOPAT.Asset.Median	X5Y.NOPAT.Asset.Trend	X6Y.NOPAT.AssetT.Std.Dev	X6Y.LN.Asset..Average
1	0	2.598331	0.05638517	0.05811857	0	0.009102421	25.14881
2	1	2.393178	0.02958218	0.03257777	0	0.010591756	24.54420
3	1	3.002248	0.04537285	0.04390808	0	0.004469608	24.56828
4	1	1.645132	0.03660703	0.03681508	0	0.002551834	24.19940
5	1	1.103083	0.03659761	0.03728226	0	0.002411643	23.60474

	X6Y.LN.Asset..Median	X5Y.LN.Asset..Trend	X6Y.LN.Asset..Std.Dev
1	25.14030	0	0.02350061
2	24.51524	1	0.17006820
3	24.57044	1	0.09332527
4	24.16714	1	0.11583308
5	23.60531	1	0.11816333

Source: Personal elaboration in R

Figure 24. Matching Code

```
> database.matched = matchit(Green.Bond.Issuer ~ BICS...Geo.NUM + X6Y.LN.Asset..Average + X6Y.LN.Asset..Median + X6Y.LN.Asset..Std.Dev + X5Y.LN.Asset..Trend + X6Y.NOPAT.Asset.Average
 + X6Y.NOPAT.Asset.Median + X6Y.NOPAT.AssetT.Std.Dev + X5Y.NOPAT.Asset.Trend + X6Y.Debt.Asset.Average + X6Y.Debt.Asset.Median + X6Y.Debt.Asset.Std.Dev + X5Y.Debt.Asset.Trend, data = a
lldata2, method = "nearest", exact = "BICS...Geo.NUM", ratio = 1)
```

Source: personal elaboration in R

Moving to the analysis of the resulting sample of 100 one-to-one paired companies - 50 Energy & Utilities Green Bond issuers and the financially most similar 50 Energy & Utilities firms non-Green Bond issuers - it is possible to assess the relevant improvements that the matching procedure has produced. Indeed, comparing the "100 sample" to the overall "627 dataset", it is immediately possible to identify the fact that each Green Bond issuer has been paired with an exactly similar "control" company for the BICS Level 2 and Geographic Area variables - as underlined in Table 16 by looking at the 100% balance improvement in the mean difference (column 2) for the "BICS…Geo.NUM" variable and the mean difference moving to zero in the matched database compared to 7.45 in the overall dataset. At the same time, it is relevant to stress that the "operating performance" driver has shown all positive percent balance improvements in mean difference and a similar dataset enhancement can be identified looking at the percent balance improvements for "size" mean difference. On the contrary, a slightly worse mean difference performance on the "capital structure" driver has emerged. However, the concrete improvement in the matched dataset is embedded in

the median, mean and maximum quartile-differences (eQQ) between the "treated" and "control" data; indeed, regarding the quartile-differences, the matched sample has shown 37 out of 39 positive percent balance improvements (column 3, 4 and 5), suggesting a relevant reduction in the empirical distribution differences. Looking at the QQ plots in Figure 25, the fact that the matched sample has evidenced less deviation from the 45-degree line for each of the 13 variables represents a graphical proof of the matched sample improvements.

Table 16. Post-Matching "Control" Group Percent Balance Improvement and Summary

Percent Balance Improvement:

	Mean Diff.	eQQ Med	eQQ Mean	eQQ Max
distance	74.0444	79.2733	73.5856	59.3941
BICS...Geo.NUM	100.0000	100.0000	100.0000	100.0000
X6Y.LN.Asset..Average	73.3887	80.1028	74.0470	50.1912
X6Y.LN.Asset..Median	73.6196	79.9355	74.3406	50.4744
X6Y.LN.Asset..Std.Dev	-2.5822	28.5862	19.3595	4.1779
X5Y.LN.Asset..Trend	-20.8799	0.0000	-50.0000	0.0000
X6Y.NOPAT.Asset.Average	29.4183	52.3163	86.4043	89.9659
X6Y.NOPAT.Asset.Median	38.3703	23.0289	90.4081	93.6356
X6Y.NOPAT.AssetT.Std.Dev	74.3747	45.3194	87.4687	94.5160
X5Y.NOPAT.Asset.Trend	100.0000	0.0000	100.0000	100.0000
X6Y.Debt.Asset.Average	-669.4395	57.7966	42.8643	38.7890
X6Y.Debt.Asset.Median	-154.4792	58.4222	19.9765	0.0000
X6Y.Debt.Asset.Std.Dev	12.9102	59.5175	85.3908	86.2924
X5Y.Debt.Asset.Trend	-120.4160	0.0000	-125.0000	0.0000

Summary of balance for all data:

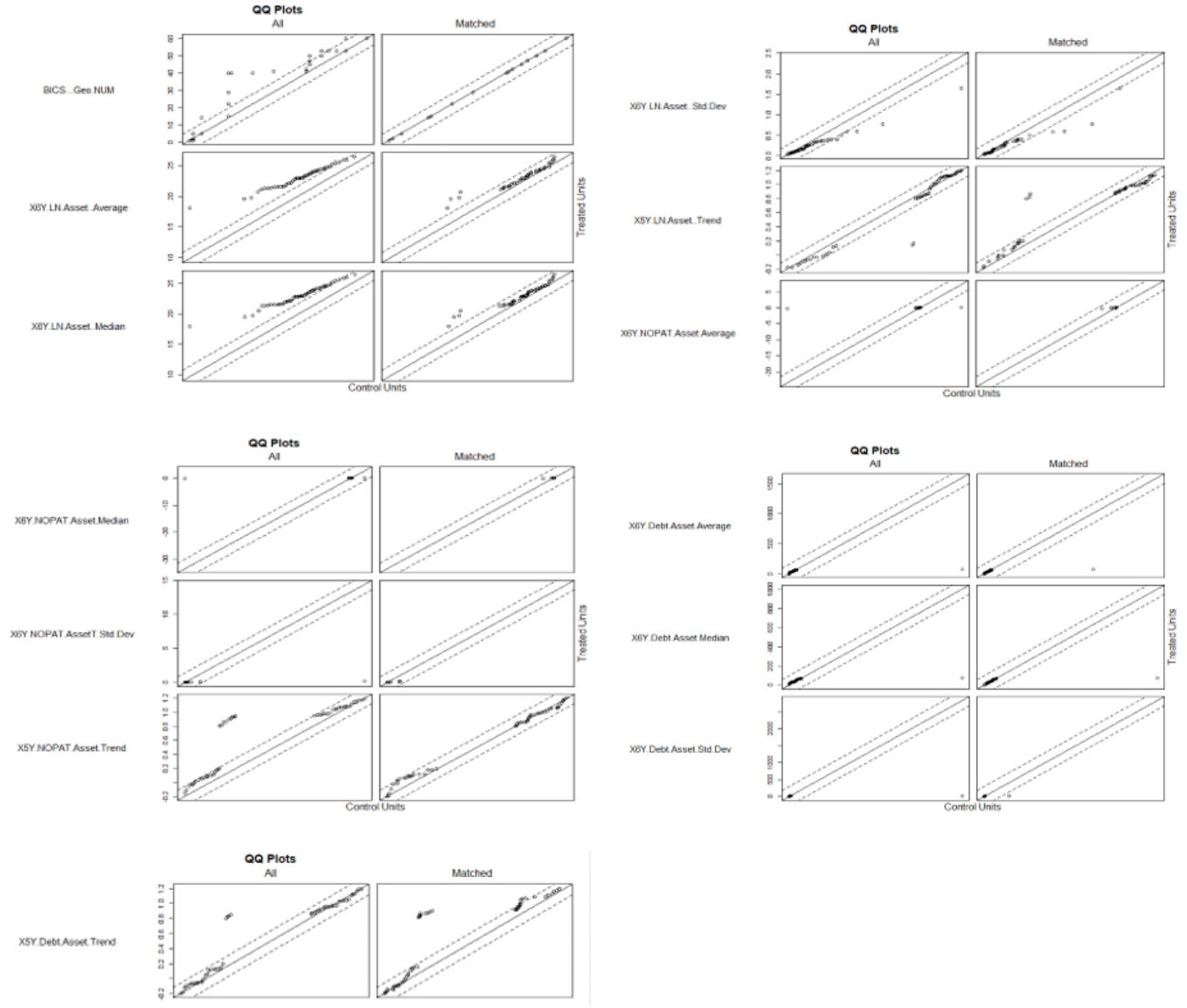
	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
distance	0.2477	0.0652	0.0975	0.1825	0.1945	0.1793	0.3676
BICS...Geo.NUM	30.3800	22.9341	17.9011	7.4459	4.0000	7.5200	26.0000
X6Y.LN.Asset..Average	23.0141	20.2052	2.4510	2.8089	2.6737	2.8923	8.1836
X6Y.LN.Asset..Median	23.0363	20.2043	2.4712	2.8320	2.6338	2.9123	8.2971
X6Y.LN.Asset..Std.Dev	0.2402	0.3149	0.3227	-0.0747	0.0484	0.0961	0.7696
X5Y.LN.Asset..Trend	0.6800	0.7296	0.4445	-0.0496	0.0000	0.0400	1.0000
X6Y.NOPAT.Asset.Average	0.0249	-0.0981	1.3412	0.1230	0.0136	0.6573	23.0815
X6Y.NOPAT.Asset.Median	0.0306	-0.0838	1.5456	0.1144	0.0103	0.7607	33.4077
X6Y.NOPAT.AssetT.Std.Dev	0.0205	0.1849	1.1442	-0.1644	0.0109	0.3362	14.1828
X5Y.NOPAT.Asset.Trend	0.6200	0.4454	0.4974	0.1746	0.0000	0.1800	1.0000
X6Y.Debt.Asset.Average	40.0198	38.0126	84.9710	2.0072	7.5357	38.5875	1522.6374
X6Y.Debt.Asset.Median	40.1662	34.0137	46.4973	6.1525	8.6439	27.4223	932.1105
X6Y.Debt.Asset.Std.Dev	4.0260	13.8399	124.9546	-9.8139	2.1174	58.5107	2813.8098
X5Y.Debt.Asset.Trend	0.5600	0.4783	0.5000	0.0817	0.0000	0.0800	1.0000

Summary of balance for matched data:

	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
distance	0.2477	0.2003	0.1524	0.0474	0.0403	0.0474	0.1493
BICS...Geo.NUM	30.3800	30.3800	19.3727	0.0000	0.0000	0.0000	0.0000
X6Y.LN.Asset..Average	23.0141	22.2666	2.3734	0.7475	0.5320	0.7506	4.0762
X6Y.LN.Asset..Median	23.0363	22.2892	2.3500	0.7471	0.5285	0.7473	4.1092
X6Y.LN.Asset..Std.Dev	0.2402	0.3168	0.3654	-0.0766	0.0346	0.0775	0.7374
X5Y.LN.Asset..Trend	0.6800	0.6200	0.4903	0.0600	0.0000	0.0600	1.0000
X6Y.NOPAT.Asset.Average	0.0249	-0.0619	0.3909	0.0868	0.0065	0.0894	2.3160
X6Y.NOPAT.Asset.Median	0.0306	-0.0399	0.3299	0.0705	0.0079	0.0730	2.1262
X6Y.NOPAT.AssetT.Std.Dev	0.0205	0.0626	0.1909	-0.0421	0.0060	0.0421	0.7778
X5Y.NOPAT.Asset.Trend	0.6200	0.6200	0.4903	0.0000	0.0000	0.0000	0.0000
X6Y.Debt.Asset.Average	40.0198	55.4644	137.7843	-15.4445	3.1803	22.0473	932.0220
X6Y.Debt.Asset.Median	40.1662	55.8230	138.0686	-15.6568	3.5939	21.9443	932.1105
X6Y.Debt.Asset.Std.Dev	4.0260	12.5729	56.3916	-8.5469	0.8572	8.5479	385.7057
X5Y.Debt.Asset.Trend	0.5600	0.3800	0.4903	0.1800	0.0000	0.1800	1.0000

Source: Personal elaboration in R

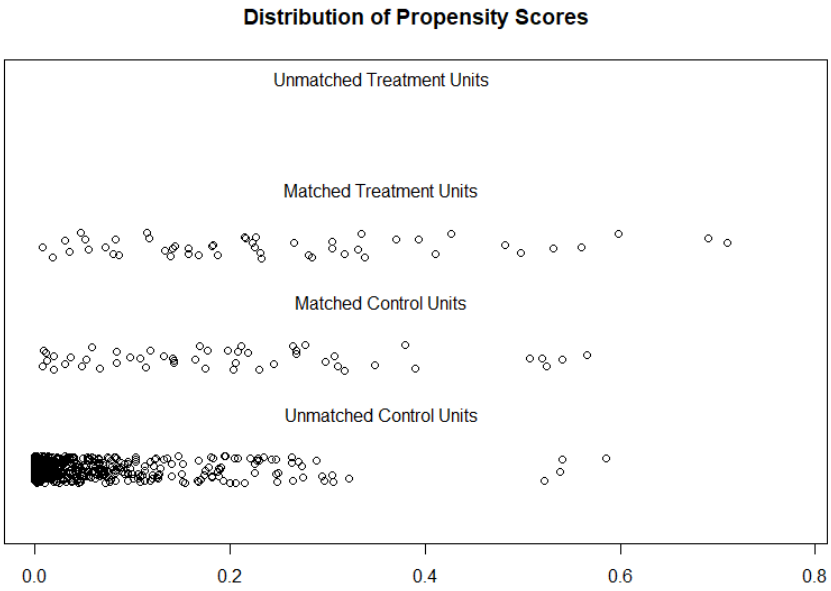
Figure 25. QQ Plot to Graphically Assess the Empirical Distribution Improvements along the 13 Matching Variables



Source: Personal elaboration in R

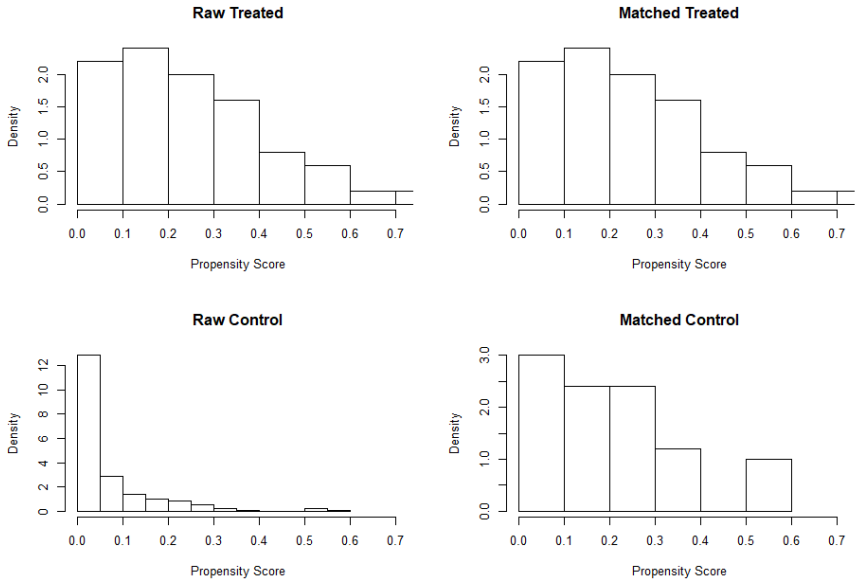
Furthermore, the distribution of propensity scores in Figure 26 and the histograms of propensity scores before and after the matching in Figure 27 represent other two visual pieces of evidence of the substantial enhancement of the matched database compared to the overall pre-matching dataset. To be more specific, the distribution of propensity scores shows that there are not unmatched treatment units - as a consequence of the nearest-neighbour methodology - while evidencing the similarity of the second and third level of Figure 26, representing the closeness of Green Bond issuers with their "non-Green" peers; instead, the last layer depicts those unmatched units that are not included in the "100 sample". On the other side, in Figure 27 the histograms on the left - before the matching - differ to a wider extent compared to the ones on the right - after the matching. Indeed, the graphs on the right result highly similar in terms of propensity score density, stressing the positive effects of the matching procedure on the construction of the desired paired sample.

Figure 26. Distribution of Propensity Scores in terms of Matched-Unmatched Units



Source: Personal elaboration in R

Figure 27. Histograms of Propensity Scores Pre- and Post-Matching



Source: Personal elaboration in R

In conclusion, it has been decided to perform a two-tailed Z-test to statistically verify the effectiveness of matching; specifically, through the Z-test it is possible to assess whether the means of the "treated" group and the "control" one statistically differ, given the variances knowledge of the two populations. The null hypothesis is represented by the equality of the two means and the desired objective is to not be capable to reject the null hypothesis in order to ensure from a statistically significant perspective the similarity of the Green Bond issuers sub-group with the non-Green Bond issuers one. Z-tests are conducted on the 6-year averages of the three financial drivers described above - size, operating performance and capital structure; they are performed both on the pre-matching 627 companies' sample and the post-matched 100 firms' sample. Table 17 sums up the results for the pre-matching sample. It clearly shows that that "size" significantly differs at 1 percent, 5 percent and 10 percent levels; moreover, "operating performance" significantly differs at 10 percent level, while the null hypothesis for "capital structure" cannot be rejected.

These numbers stress that both the means of size - in a strongly significant way - and operating performance - in a poorly significant way - are different between the "treated" and "control" group in the pre-matched "627 sample".

Table 17. Pre-Matching Sample Two-Tailed Z-Tests on Size, Operating Performance and Capital Structure

z-Test: Two Sample for Means						
	LN (Total Assets)* **		**NOPAT/Total Assets***		**Total Debt/Total Assets**	
	Green Bond Issuers	*Non-Green Bond Issuers*	*Green Bond Issuers*	*Non-Green Bond Issuers*	*Green Bond Issuers*	*Non-Green Bond Issuers*
Mean	23,0140555	20,2051987	0,024929286	-0,0980747	40,01983776	38,0125951
Known Variance	3,123517	6,199893	0,003534	3,136939	291,2953	22985,7
Observations	50	577	50	577	50	577
Hypothesized Mean Difference	0		0		0	
z	10,3807424		1,657482763		0,297043576	
P(Z<=z) one-tail	0		0,048710955		0,38321662	
z Critical one-tail	2,326347***		1,281551565*		1,64485362**	
P(Z<=z) two-tail	0		0,097421911		0,76643324	
z Critical two-tail	2,575829***		1,644853626*		1,95996398**	
*** 1% significance level, ** 5% significance level, * 10% significance level						

Source: Personal elaboration

Replicating the Z-tests on the drivers' post-matching means, it emerges that there is no statistically significant difference for all the three variables, except for a 10% level poorly significant difference for "size". Table 18 sums up this evidence that shows the substantial improvement provided by the matching methodology in constructing a homogeneous sample from a financial performance's point of view.

Table 18. Post-Matching Sample Two-Tailed Z-Tests on Size, Operating Performance and Capital Structure

z-Test: Two Sample for Means						
	LN (Total Assets)*		**NOPAT/Total Assets**		**Total Debt/Total Assets**	
	Green Bond Issuers	*Non-Green Bond Issuers*	*Green Bond Issuers*	*Non-Green Bond Issuers*	*Green Bond Issuers*	*Non-Green Bond Issuers*
Mean	23,01405548	22,2665819	0,024929286	-0,061889	40,01983776	55,464356
Known Variance	3,123517	5,751478	0,003534	0,189369	291,2953	21879,32
Observations	50	50	50	50	50	50
Hypothesized Mean Difference	0		0		0	
z	1,774176303		1,397741056		-0,73344997	
P(Z<=z) one-tail	0,038016996		0,08109542		0,231642016	
z Critical one-tail	1,28155156*		1,28155156*		1,6448536**	
P(Z<=z) two-tail	0,076033993		0,162190841		0,463284031	
z Critical two-tail	1,64485362*		1,64485362*		1,9599639**	
*** 1% significance level, ** 5% significance level, * 10% significance level						

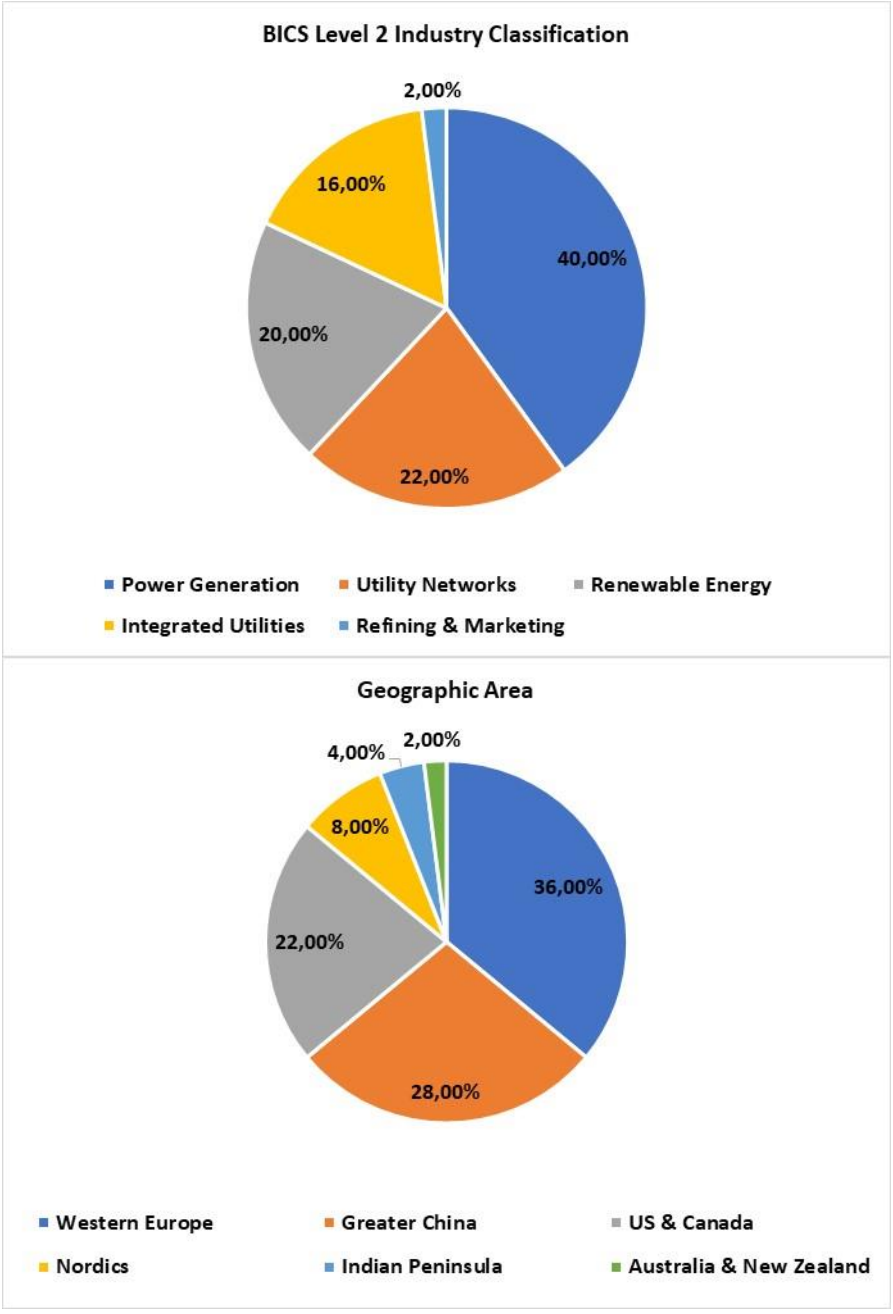
Source: Personal elaboration

3.3 Sample Characteristics and Statistics

The post-matching sample shows a numerosity of 100 companies: specifically, 50 one-to-one paired couples of Energy and Utilities corporations; the full list is available in the Appendix section. Focusing on

the industry representativity, 4 out of 10 companies belong the Power Generation BICS Level 2 classification; the second and third spots are occupied by Utility Networks and Renewable Energy companies, followed by Integrated Utilities. Finally, only 2 companies in the sample belong to the Oil Refining and Marketing industry. From a geographical perspective, 36 firms are part of the Western Europe area, 28 of the Greater China one and 22 belongs to US & Canada geography. The remaining 14% is divided among Nordics, Indian Peninsula and Australia & New Zealand (*see* Figure 28).

Figure 28. Post-matching Sample Composition by Industry and Geography



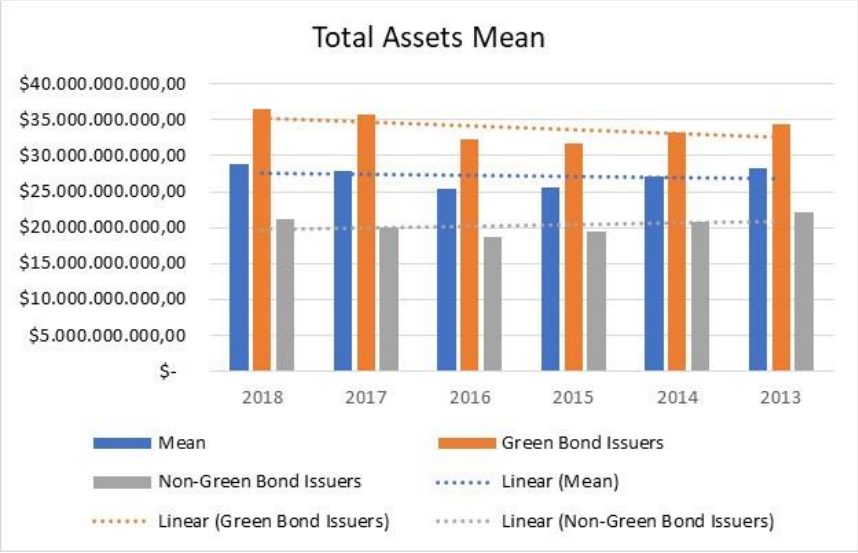
Source: Personal elaboration

Moving to the analysis of the post-matching sample's characteristics regarding the above-mentioned three financial drivers, below it has been provided some descriptive statistics - opportunely discriminating between Green Bond issuers and non-Green Bond Issuers – of the 100 Energy & Utilities firms. For all the three drivers, it has been investigated the sample mean, median, standard deviation, minimum and maximum values per year to understand the dynamics over time, while identifying specific sample's

peculiarities. Table 19 sums up the main information regarding size; for this driver, it has been decided to provide information on the value of Total Assets instead of the natural logarithm of them to facilitate data comprehension. It can be appreciated the wide difference between the smallest and the largest companies; however, this phenomenon characterizes both Green Bond issuers and non-Green Bond ones. Focusing on the analysis of dynamics of Total Assets' mean - the median in this specific case shows similar movements since there are not outliers that create an imbalance in the two samples' sub-groups - it results clear the consistently higher average value of Total Assets for Green Bond companies over years; however, it has already been demonstrated the statistical similarity of the two sub-samples' means. Looking at the period's trend lines, it emerges a divergence between the two sub-groups' means; Green Bond issuers have experienced a growth in the average value of Total Assets, while non-Green Bond firms reported a slight drop. This evidence depends on the peculiar abnormal movements characterizing some of the biggest Green Bond corporations.

Table 19. Sample Statistics – Size as Total Assets

	Size - Total Assets					
	2018	**2017**	**2016**	**2015**	**2014**	**2013**
Total	$ 2.888.108.606.652,72	$ 2.785.680.040.176,69	$ 2.546.506.669.359,95	$ 2.561.459.689.063,89	$ 2.706.239.565.959,36	$ 2.823.929.016.159,46
Green Bond Issuers	*$ 1.824.218.651.121,18*	*$ 1.786.770.321.751,08*	*$ 1.612.260.557.694,31*	*$ 1.590.840.337.155,36*	*$ 1.663.415.281.286,06*	*$ 1.715.778.663.629,50*
Non-Green Bond Issuers	*$ 1.063.889.955.531,54*	*$ 998.909.718.425,61*	*$ 934.246.111.665,65*	*$ 970.619.351.908,53*	*$ 1.042.824.284.673,29*	*$ 1.108.150.352.529,96*
Mean	$ 28.881.086.066,53	$ 27.856.800.401,77	$ 25.465.066.693,60	$ 25.614.596.890,64	$ 27.062.395.659,59	$ 28.239.290.161,59
Green Bond Issuers	*$ 36.484.373.022,42*	*$ 35.735.406.435,02*	*$ 32.245.211.153,89*	*$ 31.816.806.743,11*	*$ 33.268.305.625,72*	*$ 34.315.573.272,59*
Non-Green Bond Issuers	*$ 21.277.799.110,63*	*$ 19.978.194.368,51*	*$ 18.684.922.233,31*	*$ 19.412.387.038,17*	*$ 20.856.485.693,47*	*$ 22.163.007.050,60*
Median	$ 10.241.394.317,67	$ 9.413.629.638,69	$ 8.699.647.668,20	$ 8.065.221.419,59	$ 7.654.041.907,32	$ 6.874.783.882,22
Green Bond Issuers	*$ 13.352.786.872,04*	*$ 12.364.396.355,81*	*$ 10.182.635.922,26*	*$ 9.150.801.341,11*	*$ 9.074.983.801,97*	*$ 9.168.196.504,00*
Non-Green Bond Issuers	*$ 9.343.250.311,58*	*$ 7.793.127.456,29*	*$ 7.131.837.472,90*	*$ 6.049.086.529,19*	*$ 5.101.544.003,39*	*$ 5.710.600.163,57*
Standard Deviation	$ 48.634.343.230,52	$ 48.261.415.005,17	$ 43.783.142.564,82	$ 44.807.218.449,98	$ 48.988.773.543,43	$ 53.096.044.339,33
Green Bond Issuers	*$ 60.738.218.909,28*	*$ 61.477.380.943,65*	*$ 55.088.326.452,23*	*$ 55.791.675.882,44*	*$ 60.782.890.419,53*	*$ 65.405.579.594,67*
Non-Green Bond Issuers	*$ 30.427.742.301,88*	*$ 27.472.078.968,60*	*$ 26.594.411.378,89*	*$ 28.735.478.742,64*	*$ 32.065.767.756,45*	*$ 35.869.870.002,05*
Min	$ 5.057.612,92	$ 4.408.823,82	$ 6.119.416,75	$ 3.696.760,59	$ 2.154.496,10	$ 1.077.248,05
Green Bond Issuers	*$ 36.573.615,08*	*$ 56.185.021,55*	*$ 74.010.375,84*	*$ 106.704.219,01*	*$ 61.585.362,26*	*$ 97.174.526,30*
Non-Green Bond Issuers	*$ 5.057.612,92*	*$ 4.408.823,82*	*$ 6.119.416,75*	*$ 3.696.760,59*	*$ 2.154.496,10*	*$ 1.077.248,05*
Max	$ 324.285.139.791,75	$ 337.520.066.182,56	$ 297.045.723.041,07	$ 303.097.284.097,05	$ 324.266.690.542,97	$ 345.992.213.542,50
Green Bond Issuers	*$ 324.285.139.791,75*	*$ 337.520.066.182,56*	*$ 297.045.723.041,07*	*$ 303.097.284.097,05*	*$ 324.266.690.542,97*	*$ 345.992.213.542,50*
Non-Green Bond Issuers	*$ 121.593.004.032,00*	*$ 116.699.996.160,00*	*$ 114.903.998.464,00*	*$ 123.538.807.315,37*	*$ 152.084.908.976,45*	*$ 182.469.838.645,83*

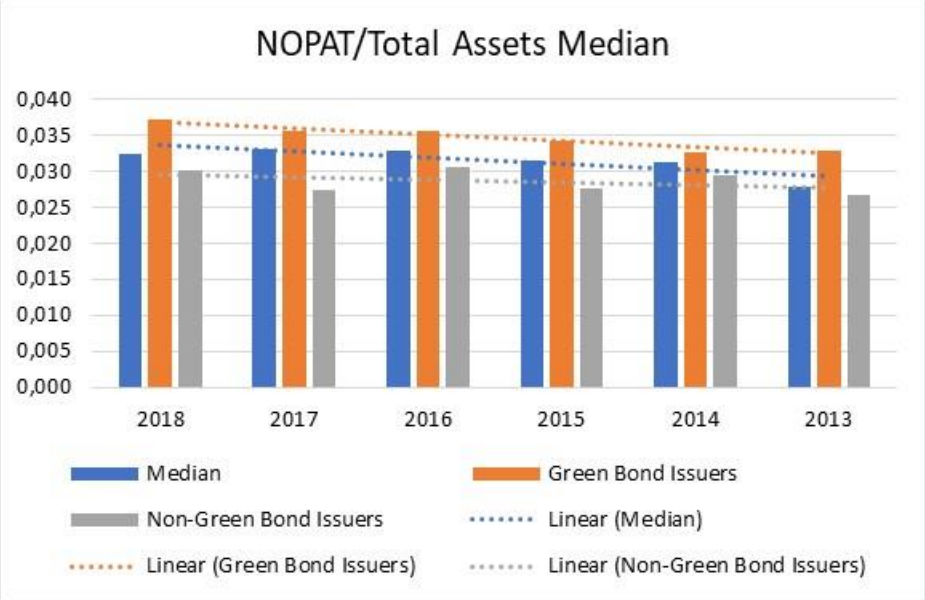


Source: Personal elaboration

Additionally, Table 20 highlights the core data regarding operating performance, measured as NOPAT on Total Assets. For this financial driver, looking at the means, it emerges that - over time - non-Green Bond issuers generate negative operating results, contrary to their peers; however, it is clear that this statistic is significantly biased by the presence of an outlier in the non-Green Bond group: *Proton Power Systems Plc*. Indeed, this company' extremely negative performance can be appreciated looking at the minimum values that non-Green Bond companies report. Consequently, an analysis on the mean would not be informative and it results more appropriate to study the median dynamics. Green Bond issuers have a slightly better operating performance; looking at the trends, both the sub-groups experience growing operating profitability, outlining the availability of resources to drive an industry shift towards low-carbon businesses.

Table 20. Sample Statistics – Operating Performance as NOPAT/Total Assets

	Operating Perfromance - NOPAT/Total Assets					
	2018	**2017**	**2016**	**2015**	**2014**	**2013**
Mean	-0,012	0,001	-0,008	-0,013	-0,051	-0,027
Green Bond Issuers	*0,019*	*0,030*	*0,025*	*0,029*	*0,030*	*0,016*
Non-Green Bond Issuers	*-0,043*	*-0,029*	*-0,040*	*-0,056*	*-0,133*	*-0,070*
Median	0,033	0,033	0,033	0,032	0,031	0,028
Green Bond Issuers	*0,037*	*0,036*	*0,036*	*0,034*	*0,033*	*0,033*
Non-Green Bond Issuers	*0,030*	*0,027*	*0,031*	*0,028*	*0,030*	*0,027*
Standard Deviation	0,270	0,220	0,242	0,249	0,520	0,275
Green Bond Issuers	*0,096*	*0,033*	*0,074*	*0,024*	*0,025*	*0,063*
Non-Green Bond Issuers	*0,367*	*0,307*	*0,331*	*0,347*	*0,726*	*0,379*
Min	-2,535	-2,103	-2,191	-2,245	-4,695	-2,196
Green Bond Issuers	*-0,633*	*-0,112*	*-0,470*	*-0,072*	*-0,060*	*-0,337*
Non-Green Bond Issuers	*-2,535*	*-2,103*	*-2,191*	*-2,245*	*-4,695*	*-2,196*
Max	0,113	0,095	0,113	0,119	0,119	0,119
Green Bond Issuers	*0,113*	*0,095*	*0,113*	*0,080*	*0,085*	*0,059*
Non-Green Bond Issuers	*0,104*	*0,085*	*0,101*	*0,119*	*0,119*	*0,119*



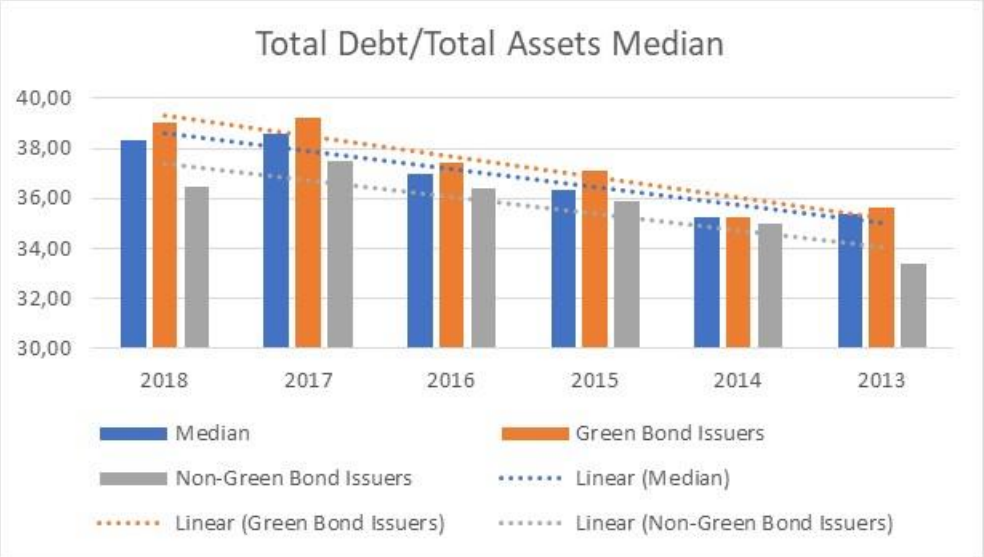
Source: Personal elaboration

Finally, moving to the third financial driver - capital structure - in Table 21 is again evident the existence of an outlier significantly distorting mean values, generating a relevant difference between the two sub-samples. The outlier is the same company of the previous driver - *Proton Power Systems Plc* - with its excessively high level of debt compared to its own assets - as can be appreciated by the analysis of the

maximum Total Debt on Total Assets values reported by non-Green Bond issuers. Also in this situation, studying the mean is not informative; therefore, the attention is moved to median values. Green Bond issuers show a non-statistically significant higher leverage level, perhaps due to the additional financing capability that green financial instruments provide at a relatively low cost. Both the sub-groups experience growing leverage levels that might be explained in light of a situation of low interest rates and easy access to credit.

Table 21. Sample Statistics – Capital Structure as Total Debt/Total Assets

	Capital Structure - Total Debt/Total Assets					
	2018	**2017**	**2016**	**2015**	**2014**	**2013**
Mean	51,99	52,68	45,45	47,71	48,13	40,49
Green Bond Issuers	*40,95*	*41,09*	*40,30*	*40,49*	*38,49*	*38,80*
Non-Green Bond Issuers	*63,04*	*64,27*	*50,61*	*54,93*	*57,76*	*42,18*
Median	38,30	38,56	36,98	36,34	35,25	35,37
Green Bond Issuers	*39,03*	*39,19*	*37,40*	*37,12*	*35,26*	*35,65*
Non-Green Bond Issuers	*36,44*	*37,47*	*36,37*	*35,88*	*35,01*	*33,36*
Standard Deviation	143,50	142,14	75,47	89,86	105,78	31,81
Green Bond Issuers	*17,78*	*16,58*	*16,85*	*17,28*	*16,95*	*16,76*
Non-Green Bond Issuers	*201,56*	*199,67*	*105,15*	*125,48*	*148,00*	*41,68*
Min	0,21	0,21	0,21	0,22	0,23	0,24
Green Bond Issuers	*0,77*	*0,78*	*0,80*	*0,83*	*0,85*	*0,87*
Non-Green Bond Issuers	*0,21*	*0,21*	*0,21*	*0,22*	*0,23*	*0,24*
Max	1468,62	1456,10	776,18	924,19	1086,30	306,13
Green Bond Issuers	*72,91*	*70,66*	*77,34*	*76,65*	*73,36*	*74,99*
Non-Green Bond Issuers	*1468,62*	*1456,10*	*776,18*	*924,19*	*1086,30*	*306,13*



Source: Personal elaboration

3.4 Variables and Measures

To respond to the three questions identified at the beginning of this third chapter and to consequently test the relative hypotheses, it has been decided to elaborate three different Regression Models. In each of the models, a different independent variable represents the object of the study in order to provide a statistically tested answer to the specific enquiry under investigation.

The independent variable of the first regression model is an *Emission Score* resulting from a personal elaboration of the reported Energy & Utilities companies' CO2 emissions. The level of CO2 emissions - measured in tons - is obtained from Thomson Reuters ASSET4 proprietary data. Indeed, ASSET4

represents Refinitiv database for environmental, social and governance (ESG) information based on more than 250 key performance indicators (KPIs). To be more specific, for this analysis the data referring to *Total CO2 and CO2 equivalents emissions in tons* have been used (code ENERDP023 from ASSET4); emission total is given by the sum of direct (Scope 1) and indirect (Scope 2) GHG emissions[211]. Reuters reports for this measure: "*When the company reports CO2 and CO2 equivalent emissions according to various protocols (e.g. GHG Protocol, Kyoto Protocol, EU Trading Scheme), the GHG Protocol takes priority over the others and is the one reported as value"*. Understood how to measure CO2 emissions, it has been important to identify an appropriate variable to standardize air pollution according to companies' scale of activity in order to grant comparability. Therefore, it has been decided to create a ratio with CO2 emissions at the numerator and company size - measured through Total Assets - at the denominator, as shown in the following formula:

$$Standard\ CO2\ Emissions = \frac{Total\ CO2\ and\ CO2\ Equivalents\ Emissions\ in\ Tons}{Total\ Assets}$$

This measure of CO2 emissions' levels has been previously applied in literature[212] when companies differed for dimension. The final step to build up the Emission Score has required the definition of a common cross-sample starting point for the measurement of Standard CO2 Emissions, since the Score has been elaborated with the aim of assessing the movements of Standard CO2 Emissions over time to test the impact of Green Bond issuance. Specifically, for each company in the sample, the initial Emission Score - in 2013 - has been set equal to 100; the value for the following years has been calculated according to this equation:

$$Emission\ Score_t = \frac{Standard\ CO2\ Emissions_t \times 100}{Standard\ CO2\ Emmissions_{2013}}, with\ t = \{2014, 2015, 2016, 2017, 2018\}$$

Consequently, higher Emission Scores mean greater air pollution generated by an Energy & Utilities company of the sample and values above 100 should be interpreted as a relatively deteriorating environmental performance over years for the specific firm under investigation. By evaluating the dynamics of the Emission Score in conjunction with Green Bond issuance, in the first model it has been possible to evaluate the effectiveness of Green Bonds in improving Energy & Utilities corporations' environmental responsibility.

Moreover, the first regression model is completed by one independent nominal variable represented by a dichotomous variable and two control variables whose effects on the regression outcome are closely monitored. Concretely, *Green Bond Issuance* has been selected as nominal variable: for each company in each year it has been assigned a "0" value to this dummy if the Energy & Utilities company has not issued its first Green Bond yet, while the dummy turns to "1" the year of the first Green Bond issuance and remains

[211] Three "Scopes" have been globally defined to improve environmental reporting purposes: Scope 1 - Direct GHG Emissions; Scope 2 - Electricity Indirect GHG Emissions; Scope 3 - Other Indirect GHG Emissions
[212] Flammer, C. (2018). Corporate Green Bond. Boston University, Global Development Policy Center

"1" thereafter. Together with the dichotomous variable, it has been decided to control for companies' *Size* and *Size Change* year-over-year - respectively the natural logarithm of Total Assets and the annual percentage change in the natural logarithm of Total Assets. It is important to remember that the matched sample has been constructed in order to have one-to-one paired couples similar in terms of dimension; however, in the previous section it has been showed the great size variability within each of the two 50 companies' sub-samples. Therefore, controlling for size and size change helps to monitor whether a superior/inferior asset base is related to better/worse environmental performance.

Moving to the second model, the *Environmental Pillar Score* provided by Thomson Reuters ASSET4 corresponds to the dependent variable that has been used to assess the environmental performance shown by Energy & Utilities Green Bond issuers and non-Green Bond companies over the six-year period of analysis. The independent variable is calculated as an equal-weighted average of three environmental Category Scores created by Reuters: Resource Use, Emissions and Environmental Innovation[213]. The Environmental Pillar Score ranges between 1 and 100; the higher the Environmental Pillar Score of a company, the better its environmental performance. In this second regression model, the independent variable is represented by the so-called *Green Bond Issuer* dummy; it assumes a value equal to "0" if the Energy and Utilities company is not a Green Bond issuer, while it is equal to "1" if the Energy & Utility company has ever issued Green Bonds in the observed timeframe. As control variable, the natural logarithm of Total Assets has been chosen to monitor the *Size* effect. In this case, controlling for the annual change in size does not seem necessary since the independent variable is not built to assess the environmental performance variation over time.

Finally, the dependent variable to test the third hypothesis - measured over the six-year period - is represented by the difference between the monthly Total Stock Returns of a portfolio made up of the 50 Energy and Utilities Green Bond issuers' stocks and the monthly Risk-Free Rates of Return, measured through the 1-month US Treasury Bill rates. This variable has been identified as *Energy & Utilities Green Bond Portfolio Stock Performance* and can be computed through the following formula:

$$Energy\ \&\ Utilities\ Green\ Bond\ Portfolio\ Stock\ Performance_t = \frac{(V_t + V_{t-1}) + D_t}{V_{t-1}} - risk - free_t$$

$$\text{With } t = \{1..72\}$$

Where:

[213] Relying on Reuters' definitions: *Resource Use* category score reflects a company's performance and capacity to reduce its use of materials, energy or water, and to find more eco-efficient solutions by improving supply chain management; *Emissions* category score measures a company's commitment and effectiveness towards reducing environmental emission in the production and operational processes; *Environmental Innovation* category score reflects a company's capacity to reduce the environmental costs and burdens for its customers, and thereby creating new market opportunities through new environmental technologies and processes or eco-designed products

V_t = market value of the portfolio at the end of the month

V_{t-1} = market value of the portfolio at the end of the previous month

D_t = value of dividends distributed during the month

Risk-free$_t$ = risk-free rate of return of the month calculated on a monthly basis

In this last regression model, the independent variable is structured as the dependent one except for the fact that the stocks included in the portfolio are the ones of the 50 non-Green Bond issuers' sub-sample; indeed, it measures the difference between the monthly Total Stock Returns of a portfolio made up of the 50 Energy and Utilities non-Green Bond issuers' stocks and the monthly Risk-Free Rates of Return, measured through the 1-month US Treasury Bill rates. This variable has been named *Energy & Utilities non-Green Bond Portfolio Stock Performance*. In this case, no control variables have been included.

3.5 Regression Models and Expected Results

As already introduced in the previous section, this dissertation includes three different regression models to verify the fairness of the hypotheses under investigation. Moving backwards, the last model - built to test the existence of a stock outperformance for the Energy & Utilities Green Bond issuers compared to their non-Green Bond peers - is the one characterized by the simplest structure. Indeed, it has been applied a simple linear regression methodology estimating the relationship between a single X regressor and a response variable Y along a straight line. Here is provided the basic formula for this kind of relationship:

$$Y = \beta_0 + \beta_1 X + \varepsilon$$

Where β_0 represents the unknown intercept constant, β_1 the unknown slope constant and ε the random error component that includes all the factors different from X that may influence Y but are not explicitly included in the model. In order to estimate β_0 and β_1 coefficients, it is necessary to calculate sample statistics and produce a straight line that cuts into the data. Among all the possible lines, the Ordinary Least Squares (OLS) line, minimizing the sum of the squared differences between the line and the data points, has been chosen. Given the fact that the least squares method will produce a regression line irrespective of whether or not there is a linear relationship between X and Y, it is important to assess how well the estimated linear model fits the data. A measure of the quality of the regression – more precisely of the badness of the fit - is the sum of the squared errors, SSE, that is the sum of the squared differences between the observed points and the estimated regression line. However, the SSE is an absolute measure and its value depends on the units of measurement; consequently, it is important to identify a relative measurement's indicator: the R Squared (R^2).

$$R^2 = 1 - \frac{SSE}{SST}$$

Where SST (Total Sum of Squares) is the sum of the squared deviations of the y-values from their mean. R^2 takes on any value between 0 and 1; the higher the R^2 value, the more the variation in the Y is explained by the variation in the X. This kind of model relies on proper assumptions on the error component ε to provided unbiased estimators and enrich inference by testing statistical hypotheses:

- The error term is a random variable with expected value zero: $E(\varepsilon) = 0$ (weak assumption); consequently, the point on the regression line represents the expected value of Y_i (and not a specific Y_i).
- The standard deviation of is ε is $\sigma_\epsilon$for all values of x (*homoscedasticity*): $Var(\varepsilon) = \sigma_\varepsilon^2$ (weak assumption); consequently, the variance (and the standard deviation) of Y_i does not depend on X_i.
- The values of ε, ε_1, …, ε_n are not correlated (weak assumption).
- The error term ε is a normally distributed random variable (strong assumption).

Under the normality assumption, being the distribution of the least squares' estimators normal, it is possible to build confidence intervals and to test hypotheses on the parameters β_0 and β_1.

To perform the regression, it has been used the statistical software R in combination with Excel Data Analysis ToolPak, a powerful add-in package to develop complex statistical or engineering analyses. The following information is provided:

- A measure of the goodness of the fit through the R Squared and the Adjusted R Squared[214];
- A measure of the overall model significance through the F Statistics (the lower its value, the better it is);
- An estimate of the model's coefficient;
- The standard errors of the coefficients, representing a measure of the estimate's uncertainty;
- T Statistics to test the coefficients' significance at various α levels;
- An additional measure of significance for the model's single coefficients through the p-values (the lower, the better)
- Confidence Intervals for the coefficients in order to understand the range of possible values that they can assume, provided an α level of significance.

Additionally, from the analysis of the Normal Probability Plot it is possible to investigate whether the normality assumption holds true and from the study of the Residuals Plot it is possible to verify the homoscedasticity assumption, the existence of patterns in the error component or the presence of outliers.

Moving to the regression methodology applied in the first two models - used to verify the assumptions on the potential superior environmental performance of Energy & Utilities Green Bond issuers and the

[214] The Adjusted R Squared considers at the same time the goodness of the fit and the model's complexity (related to number of regressors inserted in the model and the sample size)

effectiveness of the Green Bond instrument - the level of complexity increases due to the implementation of a multiple linear regression on a bidimensional panel dataset. The above-mentioned analysis on the simple linear regression model can be easily extended to the multiple one, characterized by the following formula:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon$$

However, it is worth to deeper understand the consequences of a study performed considering data collected over time (t) and over the same companies (i) together, empowering the possibility to consider individual heterogeneity:

$$Y_{it} = \beta_0 + \beta_1 X_{1_{it}} + \beta_2 X_{2_{it}} + \ldots + \beta_n X_{n_{it}} + \varepsilon_{it}$$

This results particularly relevant for the first regression model; indeed, by combining data in two dimensions, panel data gives more data variation, less collinearity and more degrees of freedom. Additionally, panel data are better suited for the study of the dynamics of change. Table 22 provides a visual representation of panel data structure in the first model; in this specific situation, the black cells account for the fact that the company has issued its first Green Bond in that specific year, equivalent to the value of "1" for the *Green Bond Issuance* variable described above.

Table 22. Panel Data Structure for the First Model and Dummy Variable Representation

	2018	2017	2016	2015	2014	2013
A2A IM Equity						
D US Equity						
DTE US Equity						
DUK US Equity						
EDF FP Equity						
EDPR PL Equity						
ELE SM Equity						
EOAN GR Equity						
EXC US Equity						
HER IM Equity						
IBE SM Equity						
LNT US Equity						
NEE US Equity						
PCG US Equity						
PNN LN Equity						
PPL US Equity						
RWE GR Equity						
SO US Equity						
SSE LN Equity						
TRN IM Equity						
VER AV Equity						
XEL US Equity						

Source: Personal elaboration

3.5.1 The First Regression Model

The first multiple linear regression can be described through the following formula:

$$Emission\ Score = \beta_0 + \beta_1 \cdot Green\ Bond\ Issuance + \beta_2 \cdot\ Size\ +\ \beta_3 \cdot Size\ Change + \varepsilon$$

The first model, based on panel data, test the effectiveness of Green Bonds in improving the environmental performance of Energy and Utilities corporations in light of the companies' first Green Bond issuance. The companies in the sample are characterized by a one-to-one aligned financial performance due to the matching procedure; this information - in addition to the equal starting level for CO2 emissions resulting from the definition of the Emission Score itself – helps to isolate the impact of the Green Bond issuance phenomenon from other possible "noise" factors. The importance of the study seems to be clear: Green Bonds have been created with the specific aim of fighting climate change and improving firms' environmental responsibility; moreover, this innovative financial instrument is currently regarded as the most promising tool to accelerate Energy & Utilities companies' transition to low-carbon businesses. Concretely verifying Green Bonds effectiveness in reducing the sector's GHG emissions results even more relevant if the materiality of the environmental topic for Energy and Utilities corporations is taken into account.

Considering *Hypothesis 1*, the expected result is the existence of a significantly lower level of CO2 emissions - standardized for company size - in concomitance with Energy & Utilities issuance of their first Green Bond. It is an assessment performed on the dynamics of companies' air pollution levels and the potential reduction of GHG emissions compared to the previous years' ones. Whether the reduction should turn out statistically significant, it becomes important to verify through *Hypothesis 2* if Energy & Utilities companies that have issued Green Bonds environmentally outperform their non-Green Bond "control" units over the six-year timeframe. On the contrary, a non-significant relationship should not imply the ineffectiveness of the financial instrument in fighting climate change; the results could be affected by the fact that the environmental benefits of Green Bonds tend to emerge on longer time horizons and a sizeable number of firms in the sample have only issued Green Bonds in the last three years.

3.5.2 The Second Regression Model

The second multiple linear regression can be described through the following formula:

$$Environmental\ Pillar\ Score\ = \beta_0 + \beta_1 \cdot Green\ Bond\ Issuer + \beta_2 \cdot\ Size + \varepsilon$$

The second model, based on panel data, assesses the existence of a significantly better environmental performance for Energy & Utilities companies issuing Green Bonds compared to Energy & Utilities firms not relying on this innovative financial instrument. It is relevant to remember that the 100 companies belonging to the paired sample show statistically significant similar financial characteristics by sample' construction, due to the Propensity Score Matching itself. However, differently from other previous research[215], corporations have not been matched along the environmental dimension, otherwise the hypothesis' test and the second model itself would have lost any informative value. Indeed, the question

[215] Flammer, C. (2018). Corporate Green Bond. Boston University, Global Development Policy Center

that the second model tries to answer reflects the possibility that financially comparable Energy & Utilities companies significantly differ in terms of environmental performance over the 6-year period of analysis due the fact that a sub-sample of these companies has issued Green Bonds. The enquiry seems particularly relevant to assess, in this short timeframe, the impact of Green Bond issuance on the overall environmental performance of Green Bond issuers, specifically addressing the pace at which environmental performance changes in light of the Green Bonds' placement on the market. It is true that regression models simply provide an explanation regarding the existence of a statistically significant relationship between the independent variable and the dependent one, while not investigating the cause-effect relationships between the two variables; however, if Green Bond issuer significantly outperformed their "non-Green" control peers over the six-year timeframe, it would result that Energy & Utilities corporations perform relatively better in environmental terms in conjunction with Green Bond issuance, provided the same financial performance with non-Green Bond issuers. Indeed, the existence of this relationship would demonstrate that - even if Green Bonds are not the cause of lower GHG emissions for Energy & Utilities companies - their issuance should be read as a concrete indicator of an Energy & Utility corporation's environmental effort in shifting towards a low-carbon business approach. This is particularly important considering the difficulty in measuring and assessing a company's commitment to ESG topics.

In light of *Hypothesis 2*, the expected result is the existence of a significant outperformance in environmental terms for Energy & Utilities Green Bond issuers compared their peers not relying on this financial innovation. However, even if the results of the second regression model should bring to the rejection of *Hypothesis 2*, this evidence should not be read in a negative way, especially considering a potential positive verification of the previous *Hypothesis 1* on the effectiveness of Green Bonds in reducing CO2 emissions. In fact, the absence of a significantly different environmental performance between the "treated" sub-group and "control" one could simply be the consequence of the short timeframe on which the analysis has been performed, due to the newness of Corporate Green Bonds. Whether Green Bond issuance should result significant in reducing pollution, it would simply be a matter of time before Energy & Utilities Green Bond firms start to outperform non-Green Bond players from an environmental point of view.

3.5.3 The Third Regression Model

The third simple linear regression can be described through the following formula:

$$Energy\ \&\ Utilities\ Green\ Bond\ Portfolio\ Stock\ Performance =$$

$$= \beta_0 + \beta_1 \cdot Energy\ \&\ Utilities\ non - Green\ Bond\ Portfolio\ Stock\ Performance + \varepsilon$$

The third regression model, based on monthly data collected over a six-year period, studies whether Green Bond issuers experience a significantly better stock performance compared to the "control" group. In particular, this analysis is focused on the Total Portfolio Return in excess of the risk-free rate generated by

an equally weighted portfolio where 2% of the total capital invested is allocated on each of the 50 Energy & Utilities Green Bond issuers' stocks; this return is assessed over the Total Portfolio Return in excess of the risk-free rate generated by an equally weighted portfolio where 2% of the total capital invested is allocated on each of the 50 Energy & Utilities non-Green Bond issuers' stocks. As an additional verification source, the analysis has also been performed on portfolios weighted based on companies' market capitalization. The intercept of the regression model is analysed to assess the presence of statistically significant excess returns of the "Green" portfolio compared to the "Brown" one in the period under investigation. Differently, the coefficient of the independent variable measures how the Green Bond issuers' portfolio moves in light of a unitary change in the "control" portfolio and can be used as a proxy to assess whether one of the two portfolios is riskier. This research seems absolutely relevant to assess the possibility of experiencing significantly higher returns by investing in financially similar companies, belonging to the same sector and the same geographic area, that differ only for the issuance of Green Bonds. It represents a rough measure of the potential value embedded in the Green Bond phenomenon. Additionally, depending on the evidence of the second regression model introduced in the previous section, the interpretation might change to take into account a statically significant higher environmental performance as a source of excess return, instead of the simple "Green Bond issuance" event. Looking and the overall structure of the model and at the independent and dependent variables included, it resembles Sharpe's Single Index Model framework[216].

Considering *Hypothesis 3*, the expected result is to verify that the Green Bond issuers' portfolio shows significantly higher returns over the non-green Bond issuers' one - resulting in a positive significant intercept coefficient - while sharing a similar level of risk - demonstrated by an independent variable's coefficient around one. However, as already explained, the results should be read in light of the evidence that might emerge from model one and model two. Indeed, *Hypothesis 3* could simply be rejected in light of the fact that Green Bonds *per se* are not a source of value (and investors know it) if, concurrently, they do not significantly contribute in accelerating environmental performance improvements or - better off - do not imply significantly higher environmental scores for Energy & Utilities Green Bond issuers in the six-year timeframe.

[216] Sharpe, W. F. (1963). A Simplified Model for Portfolio Analysis. Management Science

4 RESULTS AND ANALYSIS

In this fourth chapter, the main findings emerged from the three models introduced in the previous sections will be discussed in order to provide an answer to three questions that this study is investigating. In particular, by testing three different hypotheses, the results of the relationship between Green Bond issuance in the Energy & Utilities sector and Corporate Performance - declined according to two different perspectives: Environmental and Financial - will be addressed.

Through the first model, the effectiveness of Green Bond issuance for Energy & Utilities companies will be studied by analysing the dynamics of a self-elaborated Emission Score taking into account the ratio of CO2 Emissions on Total Assets. Provided a similar starting point, the level of air pollution will be verified along a six-year period and the first issuance of Green Bonds by Energy & Utilities corporations will be used as a discriminating factor to understand how this innovative financial instrument affects GHG emissions.

The second model, differently, relies on the fact that an Energy & Utilities firm is a Green Bond issuer to assess the results of the regression. Indeed, by testing *Hypothesis 2*, the aim is to verify whether one-to-one paired Energy & Utilities companies sharing similar business characteristics and accounting fundamentals do differ in terms of environmental performance in the considered timeframe in light of the issuance of Green Bonds by some players.

Finally, the third model evaluates the monthly performance of a Green Bond issuers' portfolio against the monthly performance of a non-Green Bond issuers' portfolio to understand whether the stocks of Energy & Utilities companies that have issued Green Bonds generated significant abnormal returns compared to their "non-green" peers between 2013 and 2018.

4.1 First Model's Results: Assessing the Effectiveness of Green Bond Issuance for Energy & Utilities companies

Before moving to the detailed results of the regression model, it seems appropriate to report and analyse some descriptive statistics about the Emission Score - the dependent variable of the first model - opportunely discriminating on the basis of the dummy *Green Bond Issuance*, whose value is affected by the first Green Bond issuance year. In Table 23 it is possible to see that - on average – in both cases there has been a reduction of CO2 Emissions on Total Assets compared to the initial year of analysis (2013), but the performance of "*After Green Bond Issuance*" is widely lower in terms of air pollution. Median data confirm mean evidence. In some isolated cases the reduction could have happened also "*Before Green Bond Issuance*". It is interesting to stress that not always standardized CO2 emissions have decreased over the years; however, it seems important to stress that Green Bonds have helped to contain the growth in these situations. This rough data analysis on descriptive statistics foresees *Hypothesis 1* confirmation: Green Bonds are an effective tool to challenge GHG emissions.

Table 23. Emission Score Descriptive Statistics

	Green Bond Impact - Emission Score	
	Before Green Bond Issuance	***After Green Bond Issuance***
Mean	95,63445022	76,15434224
Median	90,77668876	75,44436066
Standard Deviation	37,05749701	21,60099107
Min	31,98096942	36,37348073
Max	196,9987981	120,9917987

Source: Personal elaboration

The first multiple linear regression model based on panel data is structured according to the previously introduced equation:

$$Emission\ Score = \beta_0 + \beta_1 \cdot Green\ Bond\ Issuance + \beta_2 \cdot\ Size\ + \beta_3 \cdot Size\ Change + \varepsilon$$

In Table 24 information about the goodness of the fit is summed up. Looking at the Adjusted R Square, it results equal to 0,276; it means that 27,6 percent of the variation in the *Emission Score* is explained by the three covariates inserted in the model. The number of observations reported is 110; indeed, only 37 out of 100 companies in the matched sample had information on CO2 Emissions in Reuters ASSET4 database. Additionally, due to the fact that 15 of these 37 firms were not paired with their "counterpart", this model included only 22 Energy & Utilities paired companies. Regarding the timeframe, only *Emission Score* data ranging from 2014 to 2018 (5 years) have been included, since - by construction - for all the firms the *Emission Score* in 2013 was equal to 100. For the readers' sake, the model has been run also on the 37 companies' group, showing similar but less solid results (*see* Appendix).

Table 24. First Model: Goodness of Fit and Observations

Regression Statistics	
Multiple R	0,543642288
R Square	0,295546937
Adjusted R Square	0,275609587
Standard Error	29,5509677
Observations	110

Source: Personal elaboration

Moving to the model global significance, it has been implemented an F-test whose results show a significant relationship existing between *Emission Score* and the set of all the three covariates. Looking at Table 25, the F Statistics assumes a large value (14,82) and the correspondent p-value is extremely low, meaning that the null hypothesis regarding the non-significance of the model can be rejected at 10 percent, 5 percent and 1 percent significance levels.

Focusing on the *Green Bond Issuance* coefficient, it is relevant to highlight that it results negative and significant at 10 percent, 5 percent and 1 percent levels – as shown by a p-value equal to 0,005. Consequently, it is possible to confirm *Hypothesis 1*: in concurrence with the issuance of their first Green Bond, companies belonging to the Energy & Utilities sector show a significantly lower level of Greenhouse Gas emissions. This evidence seems to confirm the effectiveness of the instrument in fighting air pollution

for Energy & Utilities corporations, contrary to a *greenwashing* risk that associated Green Bonds simply to a promotion leverage used by companies of the sector to appear greener in the eyes of stakeholders while attracting additional investors and raising more funds. On average, corresponding to the issuance of their first Green Bond, Energy & Utilities companies show an Emission Score nearly 18 points lower, given a fixed level of *Size* and *Size Change*.

Looking at the performance of the two control variables, it is interesting to notice that both their coefficients result negative and significant. In particular, as the *Size* (expressed through the natural logarithm of Total Assets) of Energy & Utilities companies increases, standardized CO2 Emissions decrease. Bigger companies are capable to perform better from an environmental perspective, probably due to the wider arrange of resources they can count on. Moreover, as Energy & Utilities corporations expand their Total Assets base, measured through *Size Change* (the year-on-year percentage increase in the natural logarithm of Total Assets), their Emission Score decreases. This result can be read in the following way: the additional assets that Energy and Utilities companies bring in are "greener" assets.

Table 25. First Model Significance: F-test and t-tests

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	38835,033	12945,011	14,824	3,967E-08
Residual	106	92565,527	873,260		
Total	109	131400,561			

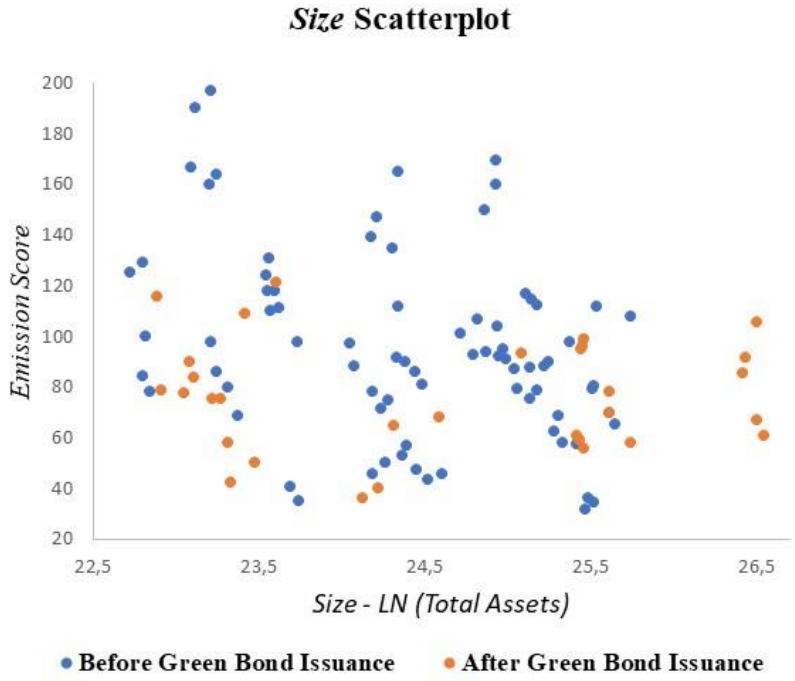
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	264,289	70,596	3,744	0,0003	124,325	404,253
*Green Bond Issuance****	-17,890	6,291	-2,844	0,0053	-30,363	-5,418
*Size Change****	-2639,389	513,519	-5,140	0,0000	-3657,490	-1621,287
*Size***	-6,854	2,890	-2,372	0,0195	-12,584	-1,125

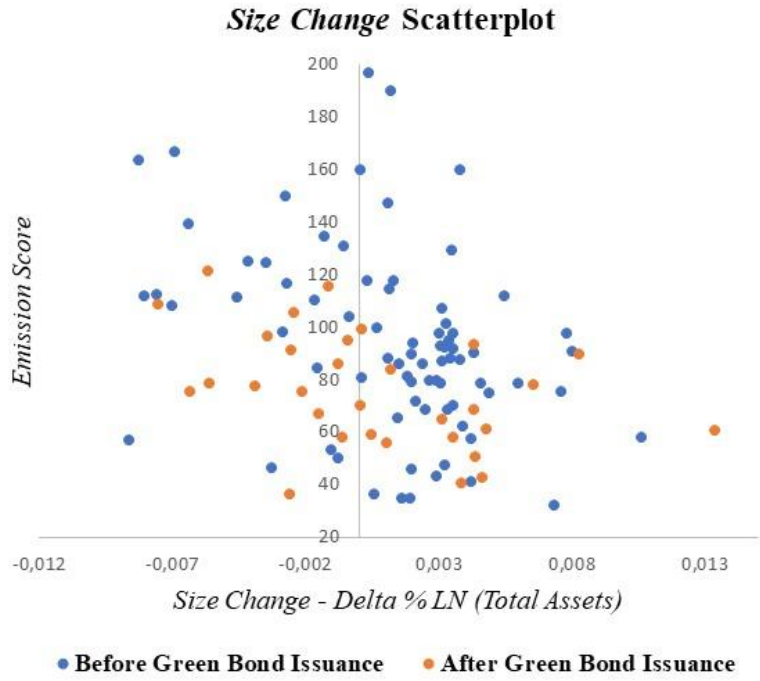
**** 1% significance level, ** 5% significance level, * 10% significance level*

Source: Personal elaboration

In Figure 29 there is a graphical representation of the regression through two scatterplots. Specifically, *Emission Score* is plotted on *Size* and *Size Change* respectively, while considering the dummy *Green Bond Issuance* by colouring the dots in a different way. Also visually, it is quite clear that that the *Emission Score* is lower in concomitance with Energy & Utilities first Green Bond issuance.

Figure 29. First Model Scatterplots

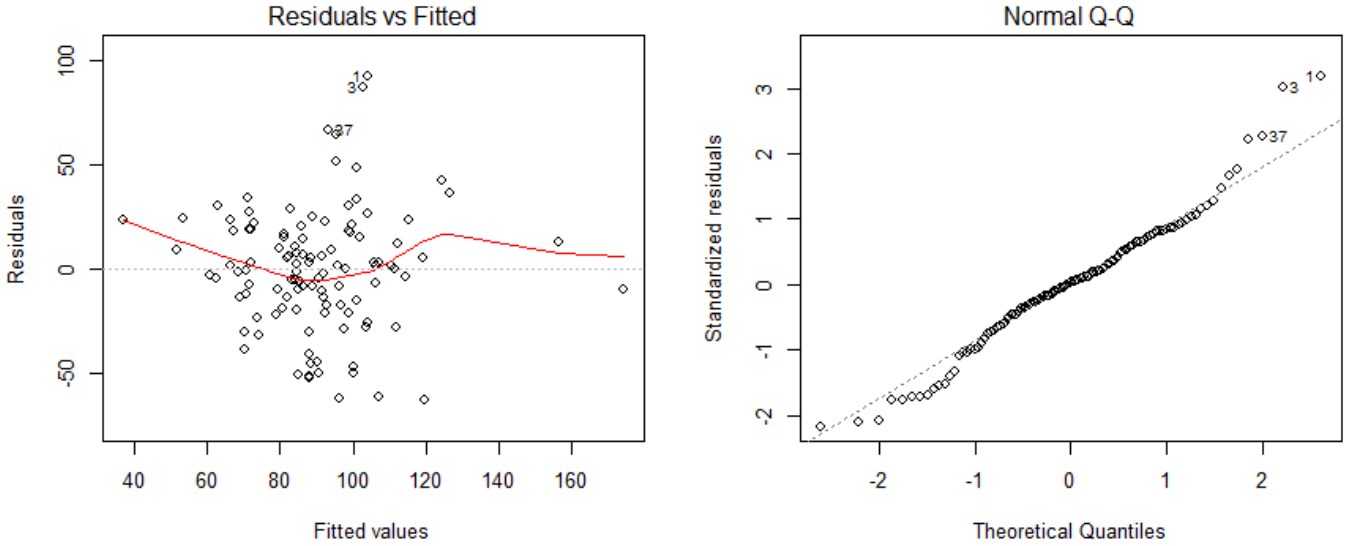




Source: Personal elaboration

Furthermore, looking at the plot of the residuals of the first model, it does not show any particular pattern or heteroscedasticity issue, Indeed, the Residuals vs Fitted analysis seems to confirm the assumption that the variance of the errors does not depend on the regressors' values. Checking for the error term's normality, the Normal Quantile-Quantile (Q-Q) plot seems to confirm this assumption since the standardized residuals are mostly disposed along the ideal straight line (*see* Figure 30).

Figure 30. First Model: Residuals' Check



Source: Personal elaboration in R

Finally, relying on the VIF (*Variance Inflation Factors*) index, it seems clear that the three covariates do not show collinearity issues. Indeed, VIF can be equal or greater than 1; values higher than 5 represents a warning for potential linearity problems, while 10 can be set as a threshold limit (*see* Table 26).

Table 26. First Model: Variance Inflation Factors

	VIF
Green Bond Issuance	1,008954
Size Change	1,018918
Size	1,00992

Source: Personal elaboration in R

In conclusion, it should be pointed out that the other two financial drivers used to perform the matching - Operating Performance and Capital Structure - had been inserted in the first model as control variables, but they did not show any kind of statistical significance and did not improve the goodness of the fit; consequently, it has been decided to remove them from the final model.

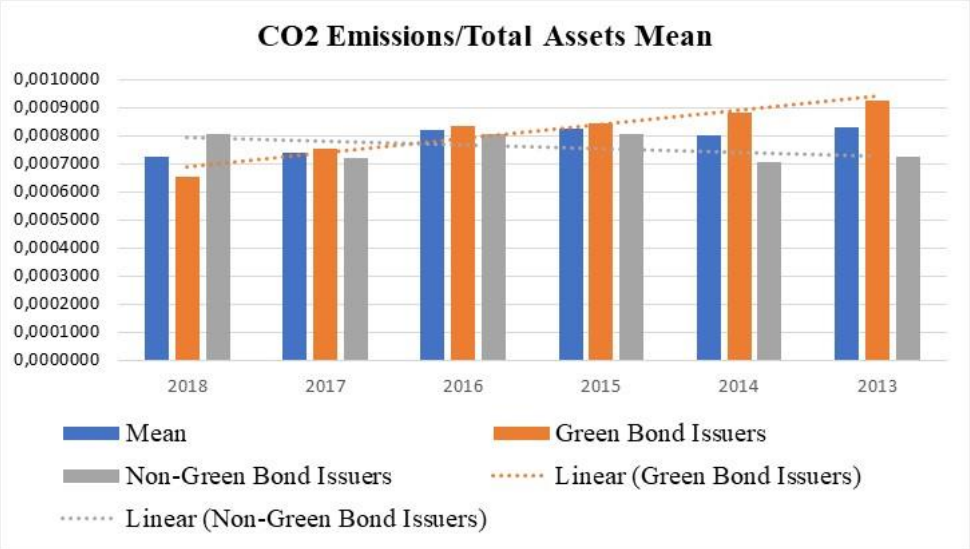
4.2 Second Model's Results: Verifying the Environmental Outperformance of Energy & Utilities Green Bond Issuers

It seems appropriate to anticipate a thorough analysis of the second model by looking at some descriptive statistics about the CO2 Emissions on Total Assets and the *Environmental Pillar Score* - the dependent variable of the second model - opportunely discriminating on the basis of the dummy *Green Bond Issuer*, assessing whether the Energy & Utilities company under scrutiny have issued Green Bonds between 2013 and 2018. By looking at the minimum values shown in Table 27, non-Green Bond issuers highlight a particularly good performing case positively influencing the mean level of standardized CO2 Emissions; on the contrary, by looking at the maximum values, Green Bond issuers show a relatively bad performing case negatively influencing the mean level of CO2 Emission on total Assets. However, looking at the two sub-samples' means over the six-year period, the difference appears to be not relevant; in addition, median data confirm the similarity over years regarding this parameter. It is interesting to notice

the overall GHG emissions' reduction trend characterizing Green Bond issuers; however, the higher initial level and the extent of the decrease foresees a rejection of *Hypothesis 2*: Energy & Utilities Green Bond issuers do not significantly outperform their "non-green" peers between 2013 and 2018, despite the effectiveness of Green Bonds in controlling and reducing air pollution demonstrated in the previous section.

Table 27. CO2 Emissions/Total Assets Descriptive Statistics

	CO2 Emission Performance - CO2 Emissions/Total Assets					
	2018	**2017**	**2016**	**2015**	**2014**	**2013**
Mean	0,0007242	0,0007389	0,0008203	0,0008262	0,0008013	0,0008318
Green Bond Issuers	*0,0006545*	*0,0007538*	*0,0008347*	*0,0008425*	*0,0008838*	*0,0009229*
Non-Green Bond Issuers	*0,0008062*	*0,0007213*	*0,0008032*	*0,0008071*	*0,0007044*	*0,0007246*
Median	0,0003944	0,0003851	0,0004846	0,0004142	0,0005629	0,0005642
Green Bond Issuers	*0,0004067*	*0,0003370*	*0,0004307*	*0,0003820*	*0,0003670*	*0,0005073*
Non-Green Bond Issuers	*0,0003944*	*0,0005498*	*0,0006545*	*0,0006019*	*0,0005986*	*0,0006869*
Standard Deviation	0,0011028	0,0010834	0,0011324	0,0010876	0,0010631	0,0010441
Green Bond Issuers	*0,0010181*	*0,0012882*	*0,0013330*	*0,0012382*	*0,0013130*	*0,0012733*
Non-Green Bond Issuers	*0,0011897*	*0,0007758*	*0,0008367*	*0,0008777*	*0,0006436*	*0,0006662*
Min	0,0000005	0,0000006	0,0000016	0,0000018	0,0000015	0,0000014
Green Bond Issuers	*0,0000073*	*0,0000066*	*0,0000080*	*0,0000079*	*0,0000077*	*0,0000069*
Non-Green Bond Issuers	*0,0000005*	*0,0000006*	*0,0000016*	*0,0000018*	*0,0000015*	*0,0000014*
Max	0,0050608	0,0060472	0,0062754	0,0057035	0,0060176	0,0057923
Green Bond Issuers	*0,0048318*	*0,0060472*	*0,0062754*	*0,0057035*	*0,0060176*	*0,0057923*
Non-Green Bond Issuers	*0,0050608*	*0,0028303*	*0,0028433*	*0,0031321*	*0,0020881*	*0,0023209*

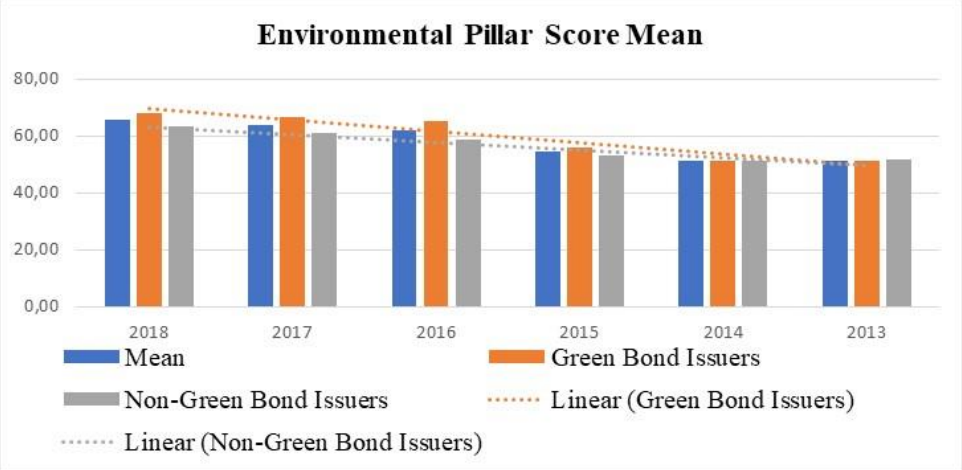


Source: Personal elaboration

In Table 28, instead, it is possible to see that - according to mean and median data - both Green Bond issuers and non-Green Bond ones have improved their environmental performance over the six-year timeframe; Energy & Utilities Green Bond firms seem to perform better than the "control" group in the latest years; however, these data do not seem to justify a significant outperformance of Green Bond issuers.

Table 28. Environmental Pillar Score Descriptive Statistics

	Enivronmental Performance - Reuters Environmental Pillar Score					
	2018	**2017**	**2016**	**2015**	**2014**	**2013**
Mean	65,60	63,87	61,98	54,47	51,12	51,28
Green Bond Issuers	*67,88*	*66,55*	*65,17*	*55,98*	*51,06*	*50,98*
Non-Green Bond Issuers	*63,14*	*60,98*	*58,52*	*52,84*	*51,18*	*51,60*
Median	70,95	71,18	69,34	62,63	58,71	60,76
Green Bond Issuers	*74,09*	*73,41*	*72,61*	*65,28*	*59,04*	*62,99*
Non-Green Bond Issuers	*68,81*	*66,45*	*65,12*	*59,87*	*57,25*	*59,10*
Standard Deviation	17,81	18,85	20,67	25,06	28,20	29,62
Green Bond Issuers	*16,65*	*17,93*	*17,60*	*23,60*	*28,08*	*29,85*
Non-Green Bond Issuers	*18,67*	*19,38*	*23,04*	*26,45*	*28,34*	*29,36*
Min	21,87	22,75	13,68	0,00	0,00	0,00
Green Bond Issuers	*30,09*	*23,09*	*26,59*	*0,00*	*0,00*	*0,00*
Non-Green Bond Issuers	*21,87*	*22,75*	*13,68*	*0,00*	*0,00*	*0,00*
Max	93,38	96,48	91,43	87,96	89,19	90,72
Green Bond Issuers	*89,14*	*91,78*	*91,43*	*81,91*	*86,84*	*87,98*
Non-Green Bond Issuers	*93,38*	*96,48*	*87,00*	*87,96*	*89,19*	*90,72*



Source: Personal elaboration

The second multiple linear regression model based on panel data is structured according to the previously introduced equation:

$$Environmental\ Pillar\ Score\ = \beta_0 + \beta_1 \cdot Green\ Bond\ Issuer + \beta_2 \cdot\ Size + \varepsilon$$

In Table 29 information about the goodness of the fit is summed up. Looking at the Adjusted R Square, it results equal to 0,255; it means that 25,5 percent of the variation in the *Environmental Pillar Score* is explained by the two covariates inserted in the model. The number of observations reported is 213; indeed, only 52 out of 100 companies in the matched sample had information on the *Environmental Pillar Score* in Reuters ASSET4 database. Additionally, due to the fact that 14 of these 52 firms were not paired with their "counterpart", this model included only 38 Energy & Utilities paired companies. Regarding the timeframe, data ranging from 2013 to 2018 (6 years) have been included; however; 6 companies did not have information about their *Environmental Pillar Score* in the first years of the timeframe under consideration. For the readers' sake, the model has been run also on the 52 companies' group, showing similar but less solid results (*see* Appendix).

Table 29. Second Model: Goodness of Fit and Observations

Regression Statistics	
Multiple R	0,5120065
R Square	0,26215066
Adjusted R Square	0,25512352
Standard Error	16,9867391
Observations	213

Source: Personal elaboration

Moving to the model global significance, it has been implemented an F-test whose results show a significant relationship existing between the *Environmental Pillar Score* and the set of all the two covariates. Looking at Table 30, the F Statistics assumes a large value (37,31) and the correspondent p-value is extremely low, meaning that the null hypothesis regarding the non-significance of the model can be rejected at 10 percent, 5 percent and 1 percent significance levels.

Focusing on the *Green Bond Issuer* coefficient, it is relevant to highlight that it results positive but not significant at any percent level - as shown by a p-value equal to 0,54. Looking at upper and lower boundaries of the 95% confidence interval, it is clear that *Green Bond Issuer* coefficient might vary between positive and negative values, stressing the fact that it is not significantly different from zero. Consequently, it seems necessary to reject *Hypothesis 1*: Energy & Utilities Green Bond issuer do not seem to environmentally outperform their non-Green Bond paired peers over the period 2013-2018. However, this result should not be read in a negative way; indeed, through the first model, it has been demonstrated the effectiveness of Green Bonds in limiting and reducing GHG emissions for Energy & Utilities companies. Consequently, it seems simply a matter of time before this outperformance significantly comes out; over a longer period of time, the same analysis should highlight an environmental outperformance for Green Bond issuers, provided the same financial fundamentals and business characteristics.

Looking at the performance of the control variable, it is interesting to notice that its coefficients result positive and significant. In particular, as the *Size* (expressed through the natural logarithm of Total Assets) of Energy & Utilities companies grows, the *Environmental Pillar Score* increases as well. Bigger companies are capable to perform better from an environmental perspective, probably due to the wider arrange of resources they can count on; this result is in line with the finding of the first model.

Table 30. Second Model Significance: F-test and t-tests

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	21528,937	10764,469	37,30547393	1,370E-14
Residual	210	60595,354	288,549		
Total	212	82124,291			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-155,423	25,140	-6,182	3,2420E-09	-204,982	-105,865
Green Bond Issuer	1,437	2,330	0,617	0,5382	-3,157	6,030
*Size****	8,996	1,048	8,581	2,0913E-15	6,929	11,062

**** 1% significance level, ** 5% significance level, * 10% significance level*

Source: Personal elaboration

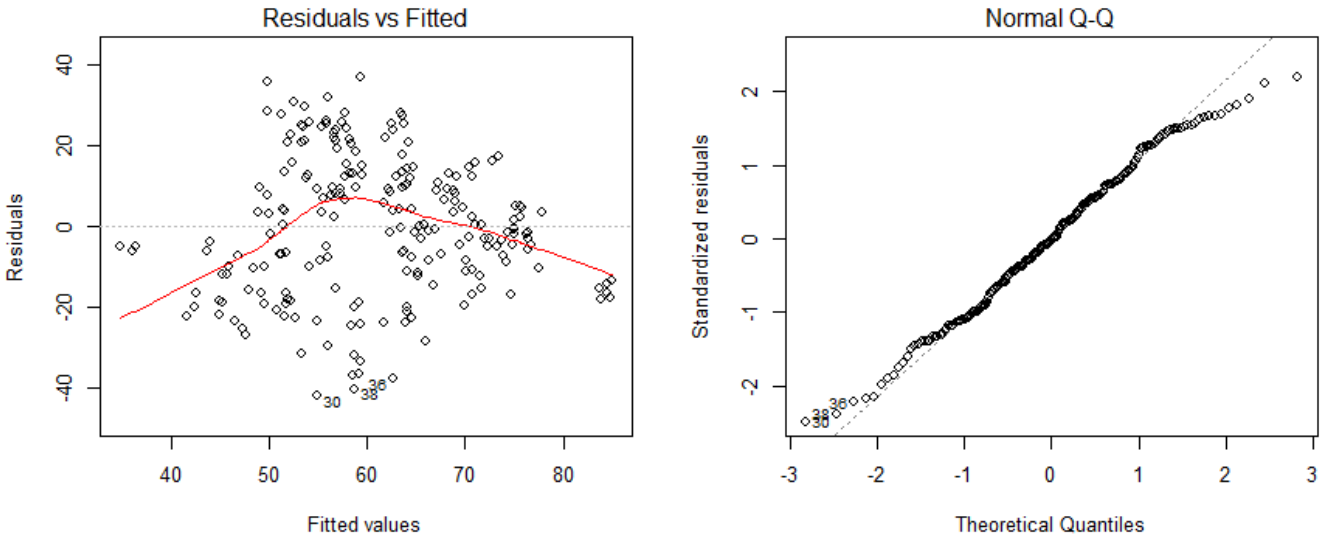
In Figure 31 there is a graphical representation of the regression through one scatterplot. Specifically, the *Environmental Pillar Score* is plotted on *Size*, while considering the dummy *Green Bond Issuer* by colouring the dots in a different way. Also visually, it is quite clear that that the *Environmental Pillar Score* does not appear higher for Energy & Utilities Green Bond issuers.

Figure 31. Second Model Scatterplot

Source: Personal elaboration

Furthermore, looking at the plot of the residuals of the second model, it does not show any particular pattern or heteroscedasticity issue, Indeed, the Residuals vs Fitted analysis seems to confirm the assumption that the variance of the errors does not depend on the regressors' values. Checking for the error term's normality, the Normal Quantile-Quantile (Q-Q) plot seems to confirm this assumption since the standardized residuals are mostly disposed along the ideal straight line (*see* Figure 32).

Figure 32. Second Model: Residuals' Check



Source: Personal elaboration in R

Finally, relying on the VIF (*Variance Inflation Factors*) index, it seems clear that the two covariates do not show collinearity issues. Indeed, VIF can be equal or greater than 1; values higher than 5 represents a warning for potential linearity problems, while 10 can be set as a threshold limit (*see* Table 31).

Table 31. Second Model: Variance Inflation Factors

	VIF
Green Bond Issuer	1,001857
Size	1,001857

Source: Personal elaboration in R

In conclusion, it should be pointed out that the other two financial drivers used to perform the matching - Operating Performance and Capital Structure - had been inserted in the second model as control variables, but they did not show any kind of statistical significance and did not improve the goodness of the fit; consequently, it has been decided to remove them from the final model.

4.3 Third Model's Results: Evaluating the Existence of Higher Stock Returns for Energy & Utilities Corporations Issuing Green Bonds

Before moving to the detailed understanding of the third model dealing with stocks' returns, it seems appropriate to report additional information regarding market capitalization of the Energy & Utilities companies of the sample in order to get an idea of the firms' market value of equity and its relative dynamics over the six-year period under investigation. In particular, Table 32 classifies the corporations belonging to the sample according to their average capitalization between 2013 and 2018. It is possible to see that there is nearly an equal proportion of Big Cap, Mid Cap and Small Cap, both for Green Bond issuers and non-Green Bond issuers. Additionally, mean and median data show the similarity between the two sub-groups regarding the central tendency of the dataset.

Table 32. Market Capitalization Classification

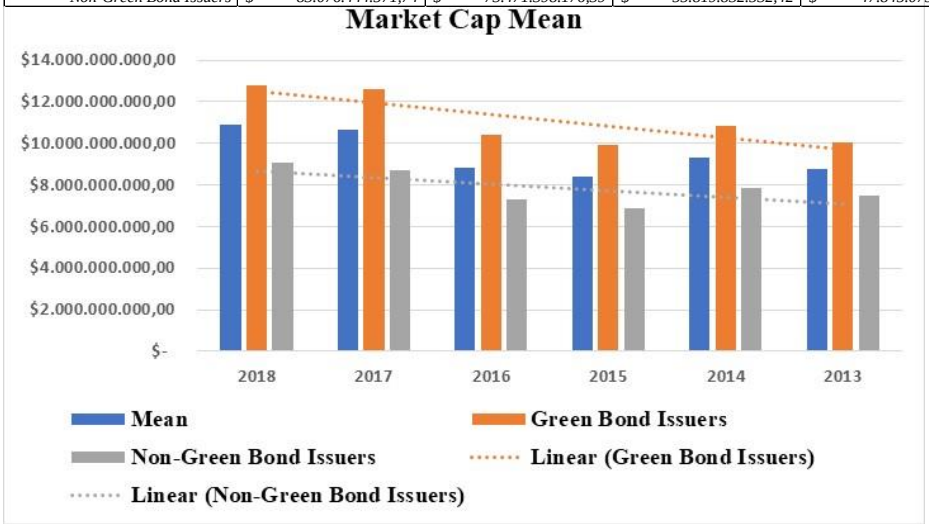
	Market Capitalization - Classification		
	Number	***Mean***	***Median***
Big Cap (> USD 10 billion)	30	$ 25.604.503.186,46	$ 21.011.388.811,17
Green Bond Issuers	*18*	*$ 26.139.519.793,38*	*$ 20.156.269.099,25*
Non-Green Bond Issuers	*12*	*$ 24.801.978.276,08*	*$ 22.213.451.043,56*
Mid Cap (> USD 2 billion)	35	$ 4.545.253.041,00	$ 3.965.494.906,13
Green Bond Issuers	*15*	*$ 4.827.100.421,42*	*$ 3.985.689.491,71*
Non-Green Bond Issuers	*20*	*$ 4.333.867.505,69*	*$ 3.606.697.177,14*
Small Cap (< USD 2 billion)	35	$ 648.353.114,09	$ 621.359.152,71
Green Bond Issuers	*17*	*$ 742.918.442,00*	*$ 656.627.665,65*
Non-Green Bond Issuers	*18*	*$ 559.041.415,52*	*$ 576.663.358,94*

Source: Personal elaboration

Differently, Table 33 facilitates the investigation of market capitalization dynamics. It shows that Green Bond issuers' market capitalization is slightly higher than their paired peers, both in absolute and average terms; nonetheless, both the sub-samples show a similar growth pattern over time and the difference does not seem to be relevant, taking into account standard deviation values. Finally, the analysis of minimum values shows that some companies were not listed until 2018 in both the sub-groups.

Table 33. Market Capitalization Descriptive Statistics

	Market Capitalization - Equity Dynamics					
	2018	**2017**	**2016**	**2015**	**2014**	**2013**
Total	$ 1.092.924.021.678,81	$ 1.067.395.812.770,68	$ 886.089.335.439,82	$ 842.332.959.395,47	$ 933.505.647.358,28	$ 877.220.089.488,98
Green Bond Issuers	*$ 639.438.201.101,27*	*$ 631.286.064.508,54*	*$ 522.043.254.136,09*	*$ 497.300.891.934,91*	*$ 541.732.677.969,06*	*$ 501.483.767.046,24*
Non-Green Bond Issuers	*$ 453.485.820.577,54*	*$ 436.109.748.262,14*	*$ 364.046.081.303,73*	*$ 345.032.067.460,56*	*$ 391.772.969.389,22*	*$ 375.736.322.442,74*
Mean	$ 10.929.240.216,79	$ 10.673.958.127,71	$ 8.860.893.354,40	$ 8.423.329.593,95	$ 9.335.056.473,58	$ 8.772.200.894,89
Green Bond Issuers	*$ 12.788.764.022,03*	*$ 12.625.721.290,17*	*$ 10.440.865.082,72*	*$ 9.946.017.838,70*	*$ 10.834.653.559,38*	*$ 10.029.675.340,92*
Non-Green Bond Issuers	*$ 9.069.716.411,55*	*$ 8.722.194.965,24*	*$ 7.280.921.626,07*	*$ 6.900.641.349,21*	*$ 7.835.459.387,78*	*$ 7.514.726.448,85*
Median	$ 3.817.718.429,68	$ 3.801.805.583,94	$ 3.026.184.717,48	$ 2.895.192.577,87	$ 3.028.179.600,21	$ 2.533.665.943,08
Green Bond Issuers	*$ 4.715.581.861,20*	*$ 5.459.503.549,90*	*$ 4.435.374.777,67*	*$ 3.872.116.448,87*	*$ 3.646.598.468,13*	*$ 3.162.048.308,02*
Non-Green Bond Issuers	*$ 3.261.141.196,08*	*$ 3.593.844.317,34*	*$ 2.750.812.908,66*	*$ 2.447.898.390,86*	*$ 2.206.947.236,90*	*$ 2.220.057.292,60*
Standard Deviation	$ 15.628.151.171,80	$ 14.998.465.515,00	$ 12.695.907.227,76	$ 12.069.379.150,31	$ 14.053.074.443,24	$ 13.679.397.571,88
Green Bond Issuers	*$ 16.327.206.349,67*	*$ 15.931.273.626,32*	*$ 13.301.348.296,87*	*$ 13.366.228.368,07*	*$ 15.912.654.929,43*	*$ 15.760.649.980,06*
Non-Green Bond Issuers	*$ 14.662.363.157,01*	*$ 13.728.936.498,06*	*$ 11.851.313.548,83*	*$ 10.394.546.954,02*	*$ 11.716.127.042,34*	*$ 11.076.608.871,87*
Min	$ 7.084.900,99	$ -	$ -	$ -	$ -	$ -
Green Bond Issuers	*$ 7.084.900,99*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*
Non-Green Bond Issuers	*$ 9.447.641,60*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*
Max	$ 83.076.444.571,74	$ 73.471.398.176,39	$ 55.819.832.532,42	$ 49.139.911.253,84	$ 59.062.780.000,00	$ 65.665.554.472,03
Green Bond Issuers	*$ 61.521.333.255,40*	*$ 62.565.310.064,63*	*$ 53.475.629.294,64*	*$ 49.139.911.253,84*	*$ 59.062.780.000,00*	*$ 65.665.554.472,03*
Non-Green Bond Issuers	*$ 83.076.444.571,74*	*$ 73.471.398.176,39*	*$ 55.819.832.532,42*	*$ 47.845.075.274,34*	*$ 47.216.304.304,74*	*$ 37.950.244.824,72*



Source: Personal elaboration

The third simple linear regression model based on panel data is structured according to the previously introduced equation:

$$Energy\ \&\ Utilities\ Green\ Bond\ Portfolio\ Stock\ Performance =$$

$$= \beta_0 + \beta_1 \cdot Energy\ \&\ Utilities\ non - Green\ Bond\ Portfolio\ Stock\ Performance + \varepsilon$$

As already mentioned, the focus will be on the relationship between an equally weighted Gren Bond issuers' portfolio and an equally weighted non-Green bond issuers' portfolio, while using portfolios based on market capitalization as control[217]. Focusing on the monthly return of equally weighted and capitalization weighted portfolios in excess of the risk-free rate, the descriptive statistics show that it does not seem to exist a difference between Green Bond issuers' stock performance and non-Green Bond issuers' one (*see* Table 34). Consequently, this analysis foresees a possible rejection of *Hypothesis 3*: Energy & Utilities Green Bond issuers' monthly Portfolio Returns are in line with their "control" group's ones, not evidencing relevantly higher performance. It is not surprising, given the fact that also *Hypothesis 2* - related to environmental outperformance - has been previously confuted. Indeed, the presence of a significantly higher environmental performance for Green Bond issuers was one of the core reasons that might have justified *Hypothesis 3*.

Table 34. Portfolio Performance Descriptive Statistics

	Portfolio Performance - Monthly Return in excess of Risk-free Rate			
	Capitalization Weighted		**Equally Weighted**	
	Green Bond Issuers	*Non-Green Bond Issuers*	*Green Bond Issuers*	*Non-Green Bond Issuers*
Mean	0,862%	0,825%	1,026%	1,070%
Median	0,716%	0,776%	1,682%	1,672%
Standard Deviation	3,977%	3,656%	4,196%	3,858%
Min	-7,563%	-7,888%	-9,827%	-8,652%
Max	10,913%	10,491%	10,755%	10,571%

Source: Personal elaboration

In Table 35 information about the third regression model for equally weighted portfolios are summed up. In this specific case, the Adjusted R Square - representing the goodness of the fit - results equal to 0,777; it means that 77,7 percent of the variation in the *Energy & Utilities Green Bond Portfolio Performance* is explained by the variation of the *Energy & Utilities non-Green Bond Portfolio Performance*. Actually, this high Adjusted R Square should be read in the following way: the movements of the two portfolios are highly correlated; when the non-Green Bond portfolio moves, it is quite easy to understand what will happen to the Green Bond one, since nearly 80% of the movements of the Green Bond portfolio can be read through the non-Green Bond one. The number of observations reported is 72; indeed, data on the

[217] Equally weighted portfolio analysis seems to be more appropriate than capitalization-weighted one in this case, given the similar composition of the two sub-samples regarding Big Cap, Mid Cap and Small Cap companies and the slightly bigger market capitalization shown by Green Bond issuers

performance of the portfolios are collected on a monthly basis over a six-year period between 2013 and 2018.

Table 35. Third Model Equally Weighted Portfolios: Goodness of Fit and Significance

Regression Statistics	
Multiple R	0,8832348
R Square	0,7801037
Adjusted R Square	0,7769623
Standard Error	0,0199542
Observations	72

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,0989	0,0989	248,332	1,0179E-24
Residual	70	0,0279	0,0004		
Total	71	0,1267			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0,000015	0,0024	-0,0060	0,995245	-0,0049	0,0049
*Non-Green Bond Portfolio Performance****	0,9605	0,0610	15,7585	0,000000	0,8389	1,0821

**** 1% significance level, ** 5% significance level, * 10% significance level*

Source: Personal elaboration

From the Table above, the high F Statistics (248,33) shows the overall model significance for any significance level. In order to understand a possible outperformance of the Green Bond portfolio, the attention should be focused on the intercept coefficient, representing the excess return over the non-Green Bond portfolio. Looking at the intercept coefficient t-stat (near zero) and at its relative p-value (extremely high), it is clear that an abnormal return does not exist. Consequently, *Hypothesis 3* should be rejected: Energy & Utilities Green Bond issuers do not outperform their "control" group from a Total Stock Return perspective in the period under investigation. The Green Bond label alone does not support the presence of abnormal returns, especially considering that in this six-year timeframe Green Bond issuers did not show a significantly higher environmental performance, as shown in the second model. However, the effectiveness of Green Bond is real and concrete (*Hypothesis 1* confirmation); consequently, over a longer period of time it is expected that potential excessive returns might emerge in concomitance with significantly better environmental results for Energy & Utilities Green Bond issuers. Indeed, provided similar business characteristics and financial fundamentals, enhanced air pollution levels do have an economic and financial value for investors, meaning superior stock performance.

Looking at the coefficient of *Energy & Utilities non-Green Bond Portfolio Performance*, it results positive and highly significant (10 percent, 5 percent and 1 percent levels) – as shown by a p-value equal to 0,0000. As the *Energy & Utilities non-Green Bond Portfolio Performance* increases by one percent, the *Energy &*

Utilities Green Bond Portfolio Performance grows by 0,96 percent, on average. This evidence suggests that the Green Bond portfolio and the non-Green Bond one show similar risk level, since they highlight movements in the same direction according to a one-to-one proportion: for instance, when the non-Green Bond portfolio doubles, also the Green Bond one doubles.

In Table 36 the results for Gren Bond and non-Green Bond portfolios weighted according to Energy & Utilities companies market capitalization are exposed, outlining the same information of the equally weighted portfolios.

Table 36. Third Model Capitalization Weighted Portfolios: Goodness of Fit and Significance

Regression Statistics	
Multiple R	0,858852
R Square	0,737627
Adjusted R Square	0,733878
Standard Error	0,020662
Observations	72

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,08401457	0,08401457	196,795398	5,058E-22
Residual	70	0,02988393	0,00042691		
Total	71	0,1138985			

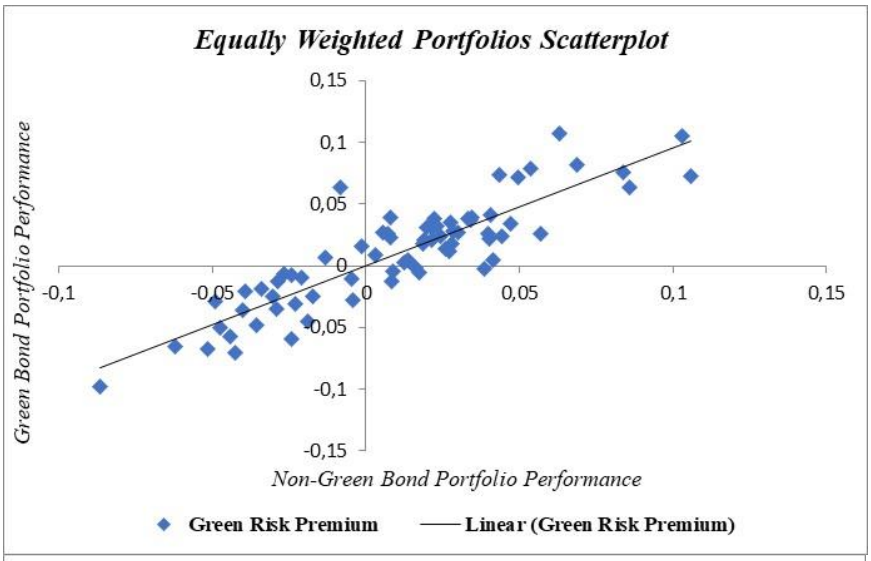
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0,00091	0,0025	0,3652	0,7161	-0,0041	0,0059
*Non-Green Bond Portfolio Performance****	0,93437	0,0666	14,0284	0,0000	0,8015	1,0672

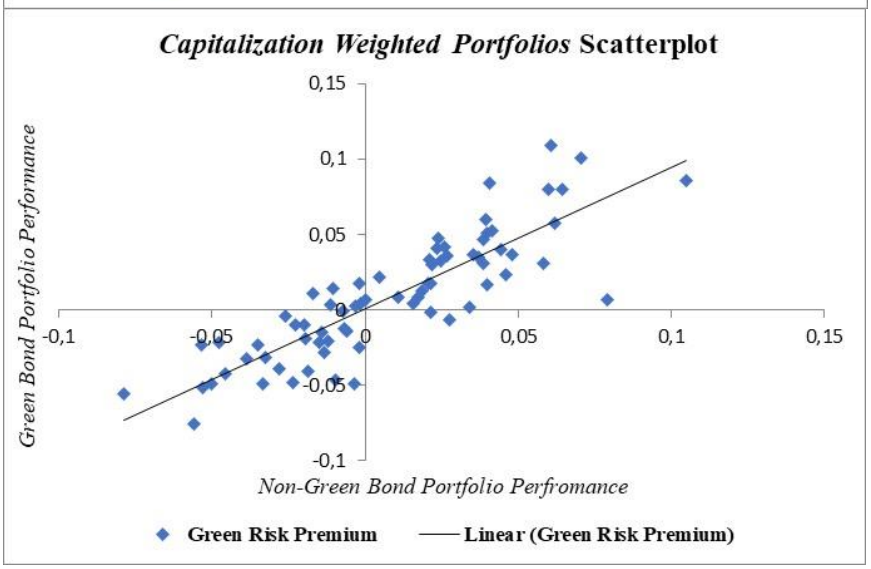
**** 1% significance level, ** 5% significance level, * 10% significance level*

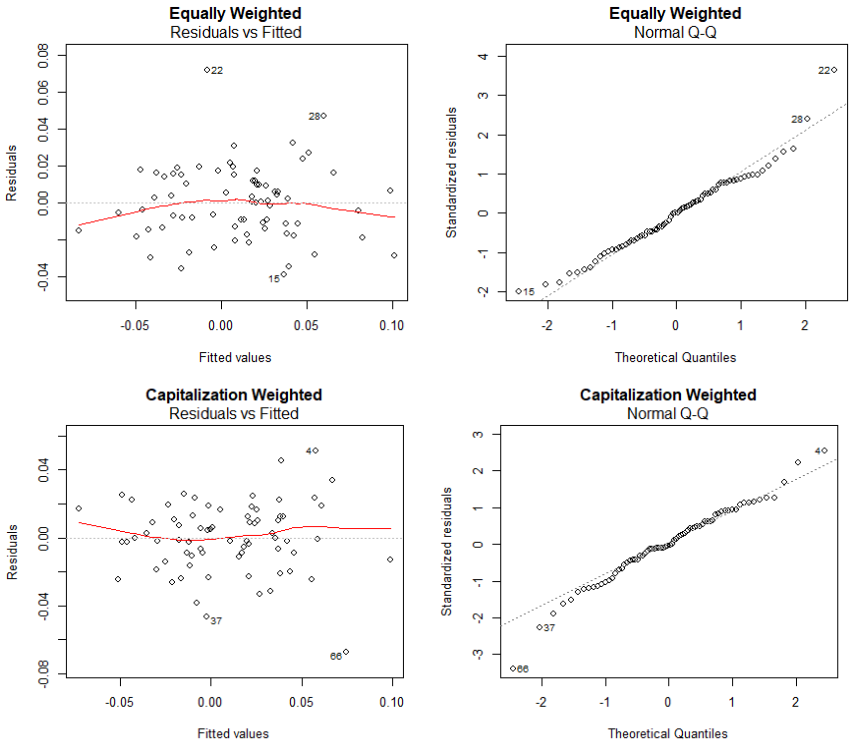
Source: Personal elaboration

In Figure 33 the scatterplots of the equally weighted and the capitalization weighted portfolios are depicted. Additionally, the plot of the residuals of the third model does not show any particular pattern or heteroscedasticity issues; also the normality assumption seems to hold true.

Figure 33. Third Model Scatterplots and Residuals' Check







Source: Personal elaboration

In addition, the performance of the Green Bond portfolio and the non-Green Bond one has been assessed against the market performance, in both the equally weighted and capitalization weighted cases (*see* Appendix). The S&P Global 1200 has been used as a proxy of the market in the Sharpe's Single Index Model framework adopted; indeed, it provides an efficient exposure to the global equity market, capturing 70 percent of global market capitalization. It has been considered the most appropriate proxy for its globality and coverage. In Table 37 the Beta of the Green Bond portfolio and the non-Green Bond one has been represented, together with the models' goodness of fit (Adjusted R Squared), assessing the percentage of portfolio's movements that can be explained by movements in the benchmark - the proportion of total risk (variance) of the portfolio that can be attributed to market risk. It can be seen that in the equally weighted case, the systematic risk of the Green Bond portfolio and the non-Green Bond one is the same and in line with market risk; moreover, the explanatory power is quite high. Instead, the Green Bond portfolio and the non-Green Bond one in the capitalization weighted case evidence lower than the market systemic risk, with the Green Bond portfolio slightly riskier than the "control" one. However, the proportion of total risk that can be attributed to market risk decreases by a relevant extent with capitalization weighted portfolios.

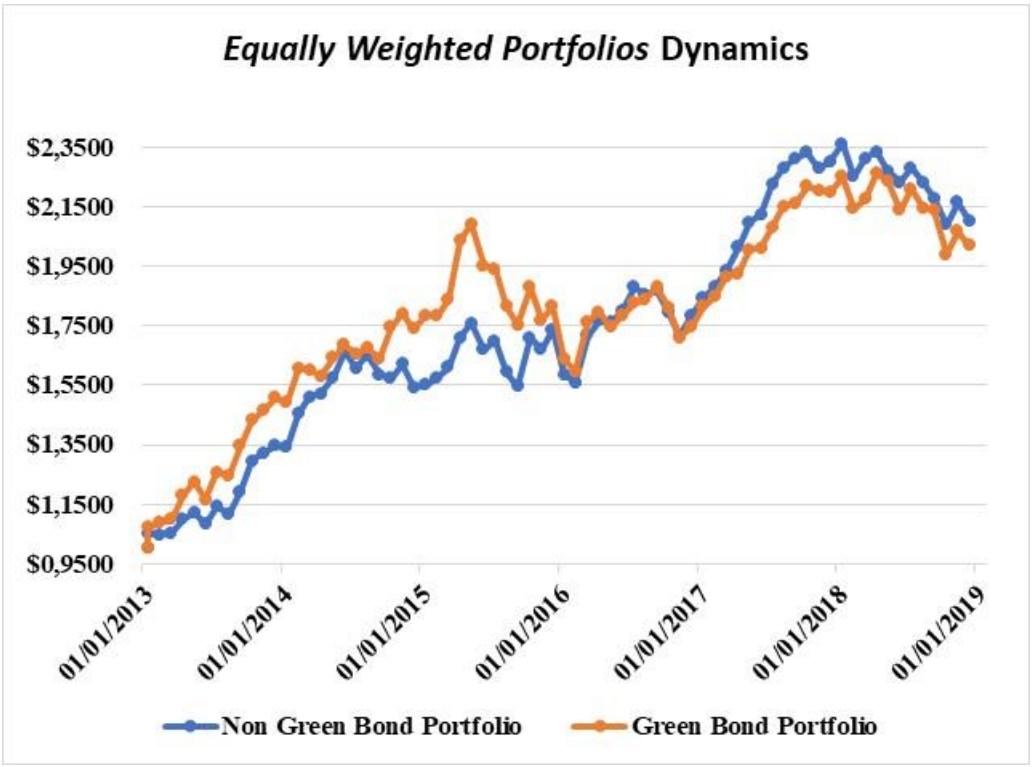
Table 37. Green and Non-Green Bond Portfolios Parameters

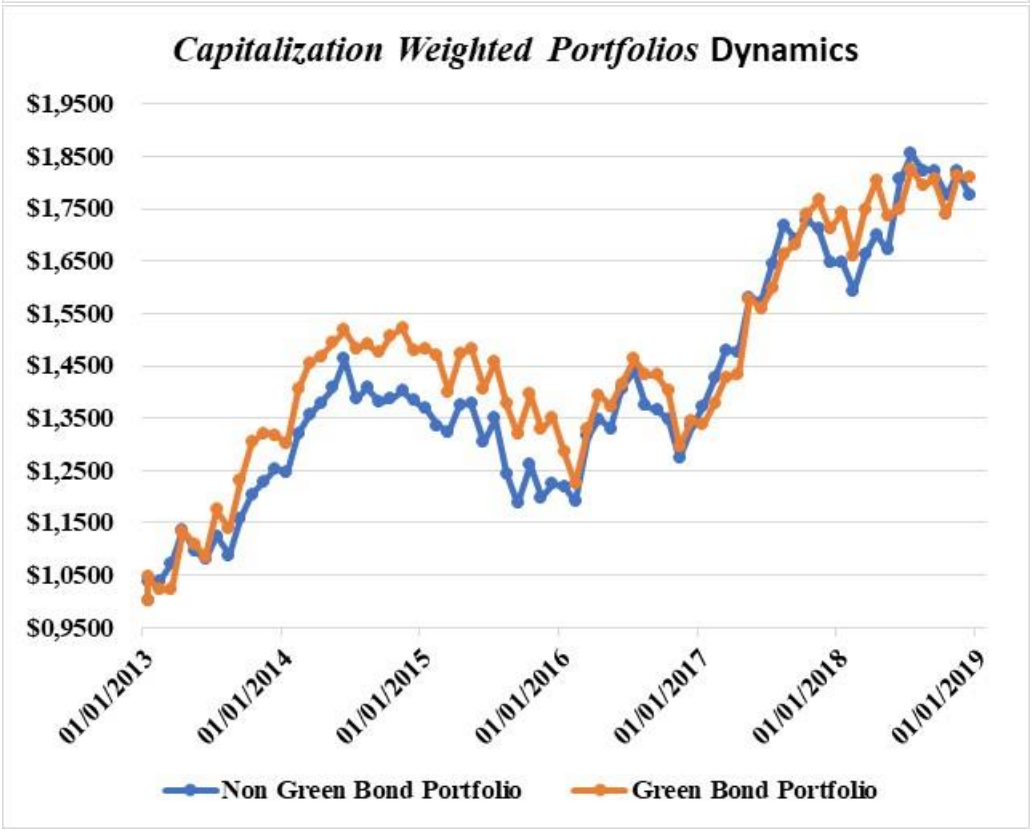
	Systematic Risk and Explanatory Power			
	Equally Weighted		**Capitaization Weighted**	
	Green Bond Portfolio	*Non-Green Bond Portfolio*	*Green Bond Portfolio*	*Non-Green Bond Portfolio*
Beta	0,993	0,974	0,828	0,701
R Squared	51,68%	58,98%	39,73%	33,48%

Source: Personal elaboration

In conclusion, in the below Figure 34 it is possible to see the results of a one-dollar investment at the beginning of 2013 depending on the chosen portfolio. In the six-year timeframe, a consistent and significant outperformance does not seem to be evident, also considering the portfolios' similar systematic risk.

Figure 34. Green and Non-Green Bond Portfolios' Dynamics





Source: Personal elaboration

CONCLUSIONS

This dissertation has been written in order to provide a comprehensive overview of the current situation of the Green Bond market, its main criticalities and its potential future developments. Specifically, at the core of this research there has been the investigation of the effectiveness of Green Bonds in limiting and reducing GHG emissions for Energy & Utilities companies, provided the urgency of the sector' s transition toward low-carbon environmentally-responsible businesses. In addition, it has been assessed whether the Corporate Performance of Energy & Utilities firms issuing Green Bond results significantly better than the one shown by Energy & Utilities corporations that have not relied on this innovative asset class; in particular, this potential superior performance has been evaluated according to environmental parameters and in terms of stock returns.

Through this study, it has been possible to confirm that Energy & Utilities companies experience lower CO2 Emissions - standardized for the size of the company - in concomitance with the issuance of their first Green Bond. Before performing this analysis, it has been decided to pair the companies of the sample through a *matching* procedure in order to ensure similar business characteristics and financial fundamentals over the six-year period under investigation (2013-2018). The empirical findings seem to suggest the effectiveness of Green Bonds in accelerating the shift of the Energy & Utilities sector towards a greener way of doing business. Indeed, Green Bonds should be seen as a concrete and tangible proof of the effort of Energy & Utilities firms regarding sustainability and environmental-friendly behaviours, provided the difficulty in assessing companies' attitude towards ESG topics and the troublesome procedure of evaluating the actual impact of the implemented initiatives.

In addition, the results of this research highlight that Energy & Utilities Green Bond issuers do not significantly outperform the "control" group of non-Green Bond issuers from an environmental point of view between 2013 - the first time a Corporate Green Bond has been placed on the market by an Energy & Utilities corporations - and 2018 - the latest available fiscal year. However, these findings should not be read in a negative way, demonstrated the effectiveness of Green Bonds in fighting and limiting air pollution. Indeed, over a longer period of analysis, it is expected that financially similar Energy & Utilities corporations issuing Green Bonds will show significantly lower GHG emission levels compared to their peers not relying on this innovative financial instrument. At the same time, Energy & Utilities Green Bond issuers do not seem to experience significantly higher stock performance compared to non-Green Bond issuers. In particular, by investigating the existence of potential abnormal returns of a Green Bond issuers' portfolio compared to a non-Green Bond issuers' one, the results appear to confirm comparable results. The explanation emerges from the fact that Green Bonds *per se* do not affect in a relevant way the performance of Energy & Utilities firms; however, whether a superior environmental performance should emerge to be true over a longer period, then Green Bonds would result as effective instruments to create added value in the sector.

Moving to a comparison with previous literature, the results of this research partially diverge due to the unique perspective and scope of this paper. Eccles, Ioannou and Serafeim[218] shed light on the performance implications of integrating ESG issues into a company's strategy and business model, proving that High Sustainability companies significantly outperform Low Sustainability ones in terms of accounting and stock performance. Their findings seem in contrast with the result of this dissertation; however, they took into account ESG as a whole and elaborated their results over a longer period of time. In addition, their research was not focused on a single sector, considered only US companies and the matching was performed in order to ensure similarity at the beginning of the study, not for the entire period under investigation. Instead, this research is in line with Flammer's findings[219] regarding the effectiveness of Green Bonds in fighting pollution; however, differently from Flammer, it has been decided to match companies only along business and financial fundamentals characteristics, without pairing them on the basis of environmental performance. In addition, this paper specifically focuses on the Energy & Utilities sector - the one where the environment represents the most material topic - excluding Financial Institutions due to their simple intermediary role in moving resources from investors to corporations. Finally, Flammer adopted a difference-in-difference methodologic approach since she was mainly interested in assessing the changes in outcomes before and after Green Bond issuance; on the contrary, this dissertation has dealt with the overall environmental and portfolio performance of Energy & Utilities firms to investigate the relationship between their Corporate Performance and their being Green Bond issuers.

It should be underlined that some limitations have been found while implementing this study. In detail, data availability regarding the environmental performance and the CO2 Emissions of the 100 one-to-one paired companies belonging to the post-matching sample represented an issue. Due to this, from an environmental point of view, the analyses have been performed on a reduced number of Energy & Utilities corporations; consequently, the results are statistically and economically solid, but do not take into account the whole group of Energy & Utilities Green Bond issuers. More importantly, the time horizon considered in this dissertation seems to be a major obstacle in drawing definitive conclusions, since the Green Bond phenomenon is currently still underway. Indeed, Green Bonds are a relatively new asset class whose impact cannot be properly evaluated in a six-year period. Over a longer timeframe, the re-iteration of this analysis might show a significantly better environmental performance of Energy & Utilities companies issuing Green Bonds, provided the effectiveness of the instrument in limiting air pollution. Additionally, it is expected that this enhanced environmental performance would result in better stock performance for Energy & Utilities Green Bond issuers, since their higher capability of dealing with environmental risk, their higher level of disclosure and monitoring due to Green Bond verification's requirements and their

[218] Eccles, R. G., Ioannou, I., & Serafeim, G. (2014). The Impact of Corporate Sustainability on Organizational Processes and Performance. The National Bureau of Economic Research (NBER)
[219] Flammer, C. (2018). Corporate Green Bond. Boston University, Global Development Policy Center

accelerated shift towards low-carbon regulatory-friendly businesses will represent a financially quantifiable added value, provided the same fundamentals among companies.

In conclusion, future research should repeat the same analysis over a longer time interval to assess whether the positive impact of Green Bond issuance on Energy & Utilities' GHG emissions might produce significantly higher environmental scores for Green Bond issuers themselves - controlling for the same sub-sector, geographic area and financial fundamentals. In addition, enhanced intelligence might emerge further discriminating between Energy companies and Utilities ones. Another interesting area of improvement might be linked to the impact of external third-party certification on Green Bond issuance, to understand whether this kind of verification provides substantially different environmental and financial performance for Energy & Utilities Green Bond issuers. Last but not least, inserting a parameter that takes into account the peculiar characteristics of the regulatory environment influencing Green Bond issuance would help to improve the analysis in light of the current governance fragmentation characterizing the Green Bond market.

REFERENCES

Abbott, K. W., & Snidal, D. (1998). *Why States Act through Formal International Organizations.* The Journal of Conflict Resolution.

Allen, K. (2017). Green bond issuers are poised to charge a premium. *Financial Times*.

Allen, K. (2017). Green bond issues hit record high on ‘sustained global momentum'. *Financial Times*.

Allen, K. (2017). Sellers of green bond face a buyer’s test of their credentials. *Financial Times*.

Allen, K. (2018). Green bond market faces its first real test. *Financial Times*.

Allen, K. (2018). Green bonds start conversation in the market. *Financial Times*.

Allen, K. (2018). Investors turn to academia to navigate green investing boom. *Financial Times*.

Allen, K. (2019). Disclosure is a lure for green bond investors. *Financial Times*.

Amiraslani, H., Lins, K. V., Servaes, H., & Tamayo, A. (2017). *A Matter of Trust? The Bond Market Benefits of Corporate Social Capital during the Financial Crisis.* European Corporate Governance Institute (ECGI).

Amundi Asset Management; International Finance Corporation (IFC). (2019). *Emerging Market Green Bonds Report 2018.* Amundi Asset Management; International Finance Corporation (IFC).

Archer, O., & Tournaire, M. (2018). *Green Bonds: Is the grass always greener?* AON Investment Research and Insights.

Bachelet, M. J., Becchetti, L., & Manfredonia, S. (2019). *The Green Bonds Premium Puzzle: The Role of Issuer Characteristics and Third-Party Verification.* Sustainability.

Baker, M., Bergstresser, D., Serafeim, G., & Wurgler, J. (2018). *Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds.* The National Bureau of Economic Research (NBER).

Banga, J. (2018). *The green bond market: a potential source of climate finance for developing countries.* Journal of Sustainable Finance & Investment.

Berensmann, K., & Lindenberg, N. (2016). *Green Finance: Actors, Challenges And Policy Recommendations.* German Development Institute (DIE).

Borsa Italiana. (2019, May 13). *Cosa sono i Green Bond - Green Bond o "obbligazioni verdi": scopri la definizione e da chi sono emesse. Approfondisci le linee guida per la certificazione "green".* Retrieved from https://www.borsaitaliana.it/notizie/sotto-la-lente/green-bond-definizione.htm

Caparello, A. (2019, May 13). *Mercati emergenti, green bond destinati a raddoppiare entro 2021*. Retrieved from https://www.finanzaonline.com/notizie/mercati-emergenti-green-bond-destinati-a-raddoppiare-entro-2021

Climate Bonds Initiative (CBI). (2019). *2018 Green Bond Market Summary*. Climate Bonds Initiative (CBI).

Climate Bonds Initiative (CBI). (2019, May 13). *Explaining green bonds.* Retrieved from https://www.climatebonds.net/market/explaining-green-bonds

Climate Bonds Initiative (CBI). (2019, May 13). *Green Bond Segments on Stock Exchanges.* Retrieved from https://www.climatebonds.net/green-bond-segments-stock-exchanges

Climate Bonds Initiative (CBI). (2019). *Green Bonds Market Summary - Q1 2019.* Climate Bonds Initiative (CBI).

Climate Bonds Initiative (CBI). (2019). *Green Bonds Policy: Highlights from 2018.* Climate Bonds Initiative (CBI).

Climate Bonds Initiative (CBI). (2019, May 13). *Green Bonds Underwriters League Table.* Retrieved from https://www.climatebonds.net/resources/league-table

Climate Bonds Initiative (CBI). (2019). *Growing green bond markets: The development of taxonomies to identify green assets* . Climate Bonds Initiative (CBI).

Climate Bonds Initiative (CBI). (2019, March 22). *Labelled green bonds data*. Retrieved from https://www.climatebonds.net/cbi/pub/data/bonds

Columbia University - Mailman School of Public Health. (2013). *Difference-in-Difference Estimation.* Retrieved from https://www.mailman.columbia.edu/research/population-health-methods/difference-difference-estimation

Counihan, G. (2019). *Is the green bond market running out of steam?* Franklin Templeton Investments.

Damodaran, A. (2019, January 5). *Global Cost of Equity and Cost of Capital by Industry.* Retrieved from http://www.stern.nyu.edu/~adamodar/New_Home_Page/data.html

D'Angerio, V. (2018). Finanza sostenibile tra consulenti e green bond. *Il Sole 24 Ore*.

D'angerio, V. (2018). Standard comuni per i green bond. *Il Sole 24 Ore*.

Dehejia, R. H., & Wahba, S. (2002). *Propensity Score-Matching Methods for Nonexperimental Causal Studies.* The Review of Economics and Statistics.

Eccles, R. G., Ioannou, I., & Serafeim, G. (2014). *The Impact of Corporate Sustainability on Organizational Processes and Performance.* The National Bureau of Economic Research (NBER).

Ehlers, T., & Packer, F. (2017). *Green Bond Finance and Certification.* Bank for International Settlement (BIS).

Ehlers, T., & Packer, F. (2018). *Green bond finance and certification.* The European Money and Finance Forum (SUERF).

Espinoza, J. (2018). Private players plug in to the green energy revolution. *Financial Times*.

European Investment Bank (EIB). (2018, September 14). *Scaling Finance for Subnational and Corporate Climate Action through Green Bonds.* Retrieved from https://www.eib.org/en/press/all/2018-229-launch-of-the-global-green-bond-partnership?media=rss&language=EN

EY. (2018). *Green Bonds: a Fresh Look at Financing Green Projects.* EY.

Filkova, M., Frandon-Martinez, C., & Giorgi, A. (2019). *Green bonds: The state of the market 2018.* Climate Bonds Initiative (CBI).

Flammer, C. (2018). *Corporate Green Bond.* Boston University, Global Development Policy Center.

Flood, C. (2017). Green bonds need global standards. *Financial Times*.

Forbes, A. (2018). *5 Energy Industry Trends in 2018.* General Electric (GE).

Friedman, M. (1962). *Capitalism and Freedom.* University of Chicago Press.

Galvin, D. (2019). *What makes an environmental leader in today's world?* Reuters.

Green Bond Principles (GBP). (2018). *Summary of Green – Social - Sustainable Fixed Income Indices Providers.* Green Bond Principles (GBP).

Green Finance Committee of China Society of Finance and Banking (GFC). (2015). *China Green Bond Endorsed Project Catalogue (2015 Edition).* Green Finance Committee of China Society of Finance and Banking (GFC).

Hale, T. (2018). The green bond that wasn't. *Financial Times*.

Harrison, C., & Filkova, M. (2018). *Green Bond Pricing in the Primary Market: January - June 2018 (H1 2018).* Climate Bond Initiatives (CBI); International Finance Corporation (IFC).

Henderson, D. (2001). *Misguided Virtue: False Notions of Corporate Social Responsibility.* New Zealand Business Roundtable.

Ho, D. E., Imai, K., King, G., & Stuart, E. A. (2011). *MatchIt: Nonparametric Preprocessing for Parametric Causal Inference.* Journal of Statistical Software.

International Capital Market Association (ICMA). (2014). *Green Bond Principles, 2014 - Voluntary Process Guidelines for Issuing Green Bonds.* International Capital Market Association (ICMA).

International Capital Market Association (ICMA). (2018). *Green & Social Bond Market Update.* International Capital Market Association (ICMA).

International Capital Market Association (ICMA). (2018). *Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds.*

International Capital Market Association (ICMA). (2019, January 31). *Green, Social & Sustainability Bonds - Quarterly Newsletter from the Green and Social Bond Principles.* Retrieved from https://www.icmagroup.org/Emails/ICMA-events/quarterly-newsletter-2019.html

International Capital Market Association (ICMA). (2019, April 1). *Green, Social and Sustainability bonds database*. Retrieved from https://www.icmagroup.org/green-social-and-sustainability-bonds/green-social-and-sustainability-bonds-database#HomeContent

International Energy Agency (IEA). (2018, July 17). *Global energy investment in 2017 fails to keep up with energy security and sustainability goals.* Retrieved from https://www.iea.org/newsroom/news/2018/july/global-energy-investment-in-2017-.html

International Energy Agency (IEA). (2018). *World Energy Investment 2018.* International Energy Agency (IEA).

International Institute of Green Finance, CUFE. (2018, March 19). *Green Bond Weekly.* Retrieved from http://iigf.cufe.edu.cn/earticle/content.html?id=417

ISTAT. (2017). *Rapporto Annuale 2016 - Note Metodologiche.* Retrieved from https://www.istat.it/it/files/2016/05/4-Modello-difference-in-difference.pdf

Kapstein, E. B. (2001). *The Corporate Ethics Crusade.* Foreign Affairs.

Khan, M., Serafeim, G., & Yoon, A. (2015). *Corporate Sustainability: First Evidence on Materiality.* The Accounting Review.

King, G., Nielsen, R., Coberley, C., & Pope, J. E. (2011). *Comparative Effectiveness of Matching Methods for Causal Inference.*

Linacre, J. M., & Wright, B. (1989). *The "Length" of a Logit.* Rasch Measurement Transactions.

Margolis, J. D., & Walsh, J. P. (2001). *People and Profits.* Lawrence Erlbaum.

McKinsey & Company. (2019). *Global Energy Perspective 2019.* McKinsey & Company.

Mintzberg, H. (1983). *The Case for Corporate Scoial Responsibility.* The Journal of Business Strategy.

Moody's Investor Service. (2019, January 31). *Moody's: Green bond market poised to hit $200 billion in 2019.* Retrieved from https://www.moodys.com/research/Moodys-Green-bond-market-poised-to-hit-200-billion-in--PBC_1159526

Morgan Stanley. (2017). *Behind the Green Bond Boom.* Morgan Stanley Research.

Nixon, T. (2017). *Values and impact are increasingly relevant to investors.* Reuters.

Nixon, T. (2018). *Higher ESG ratings can mean lower borrowing costs.* Reuters.

OECD. (2017). *Mobilising Bond Markets for a Low-Carbon Transition.* Paris: OECD Publisher.

Park, S. K. (2018). *Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution.* Stanford Journal of International Law.

Porter, M. E., & Kramer, M. R. (2011). *Creating Shared Value.* Harvard Business Review.

Randolph, J., Falbe, K., Manuel, A., & Balloun, J. (2014). *A step-by-step guide to propensity score matching in R.* Practical Assessment, Research & Evaluation (PARE).

Reichelt, H. (2010). *Green bonds: a model to mobilise private capital to fund climate change mitigation and adaptation projects.* World Bank.

Ruizeveld, J., & Wiersma, T. (2014). *The impact of ESG on credit portfolios: the Energy sector.* ROBECO Research.

Schipke, A., Rodlauer, M., & Zhang, L. (2019). *The Future of China's Bond Market.* International Monetary Fund (IMF).

Sharfman, M. P., & Fernando, C. S. (2008). *Environmental risk management and the cost of capital.* Strategic Management Journal.

Sharma, N., Smeets, B., & Tryggestad, C. (2019). *The decoupling of GDP and energy growth: A CEO guide.* McKinsey & Company.

Sharpe, W. F. (1963). *A Simplified Model for Portfolio Analysis.* Management Science.

Shishlov, I., Morel, R., & Cochran, I. (2016). *Beyond transparency: unlocking the full potential of green bonds.* Institute for Climate Economics (I4CE).

Smith, N. C. (2003). *Corporate Social Responsibility: Whether or How?* California Management Review.

Stigler, G. J. (1971). *The Theory of Economic Regulation.* The Bell Journal of Economics and Management Science.

Sustainable Accounting Standards Board (SASB). (2018). *SASB Materiality Map.* Retrieved from https://materiality.sasb.org/

Sustainalytics. (2015). *Utilities: The Great Transformation Begins.* Sustainalytics.

Tang, D. Y., & Zhang, Y. (2018). *Do Shareholders Benefit from Green Bonds?* Journal of Corporate Finance.

Unruh, G., & al., e. (2016). *Investing for a Sustainable Future.* M.I.T. SLOAN Management Review.

Vigeo Eiris. (2018). *The Energy Sector: Vigeo Eiris releases its exclusive research & opinion on emerging & strategic issues.* Vigeo Eiris.

Weber, O., & Saravade, V. (2019). *Green Bonds: Curren Development and Their Future.* CIGI Papers.

Zerbib, O. D. (2016). *Is There a Green Bond Premium? The Yield Differential Between Green and Conventional Bonds.* Journal of Banking and Finance.

APPENDIX

Here is provided the post-matching sample list of 50 one-to-one paired couples of Energy & Utilities companies. The variable "Green Bond Issuer" is a dummy equal to 1 when the company is a Green Bond issuer, 0 otherwise.

Table 38. Post-Matching Sample List

Ticker	*Name*	*ISIN*	*Paired*	*Green Bond Issuer*	*BICS Level 2*	*Geographic Area*
3 HK Equity	HONG KONG & CHINA GAS	HK0003000038	1	1	Utility Networks	Greater China
392 HK Equity	BEIJING ENTERPRISES HLDGS	HK0392044647	1	0	Utility Networks	Greater China
NTGY SM Equity	NATURGY ENERGY GROUP SA	ES0116870314	2	1	Utility Networks	Western Europe
EVN AV Equity	EVN AG	AT0000741053	2	0	Utility Networks	Western Europe
IGY GR Equity	INNOGY SE	DE000A2AADD2	3	1	Utility Networks	Western Europe
CNA LN Equity	CENTRICA PLC	GB00B033F229	3	0	Utility Networks	Western Europe
AGR US Equity	AVANGRID INC	US05351W1036	4	1	Utility Networks	US & Canada
CNP US Equity	CENTERPOINT ENERGY INC	US15189T1079	4	0	Utility Networks	US & Canada
TRN IM Equity	TERNA SPA	IT0003242622	5	1	Utility Networks	Western Europe
RWE GR Equity	RWE AG	DE0007037129	5	0	Utility Networks	Western Europe
HER IM Equity	HERA SPA	IT0001250932	6	1	Utility Networks	Western Europe
PNN LN Equity	PENNON GROUP PLC	GB00B18V8630	6	0	Utility Networks	Western Europe
371 HK Equity	BEIJING ENTERPRISES WATER GR	BMG0957L1090	7	1	Utility Networks	Greater China
384 HK Equity	CHINA GAS HOLDINGS LTD	BMG2109G1033	7	0	Utility Networks	Greater China
000027 CH Equity	SHENZHEN ENERGY GROUP CO L-A	CNE000000933	8	1	Utility Networks	Greater China
600008 CH Equity	BEIJING CAPITAL CO LTD-A	CNE000001295	8	0	Utility Networks	Greater China
IRE IM Equity	IREN SPA	IT0003027817	9	1	Utility Networks	Western Europe
SRG IM Equity	SNAM SPA	IT0003153415	9	0	Utility Networks	Western Europe
956 HK Equity	CHINA SUNTIEN GREEN ENERGY-H	CNE100000TW9	10	1	Utility Networks	Greater China
1193 HK Equity	CHINA RESOURCES GAS GROUP LT	BMG2113B1081	10	0	Utility Networks	Greater China
CEWL SP Equity	CHINA EVERBRIGHT WATER LTD	BMG2116Y1057	11	1	Utility Networks	Greater China
855 HK Equity	CHINA WATER AFFAIRS GROUP	BMG210901242	11	0	Utility Networks	Greater China
VWS DC Equity	VESTAS WIND SYSTEMS A/S	DK0010268606	12	1	Renewable Energy	Nordics
MYFC SS Equity	MYFC HOLDING AB	SE0005505898	12	0	Renewable Energy	Nordics
002202 CH Equity	XINJIANG GOLDWIND SCI&TECH-A	CNE100000853	13	1	Renewable Energy	Greater China
300750 CH Equity	CONTEMPORARY AMPEREX TECHN-A	CNE100003662	13	0	Renewable Energy	Greater China
601016 CH Equity	CECEP WIND POWER CORP-A	CNE100001T15	14	1	Renewable Energy	Greater China
002060 CH Equity	GUANGDONG NO.2 HYDROPOWER -A	CNE000001NC3	14	0	Renewable Energy	Greater China
NDX1 GR Equity	NORDEX SE	DE000A0D6554	15	1	Renewable Energy	Western Europe
S92 GR Equity	SMA SOLAR TECHNOLOGY AG	DE000A0DJ6J9	15	0	Renewable Energy	Western Europe
SSO NO Equity	SCATEC SOLAR ASA	NO0010715139	16	1	Renewable Energy	Nordics
PCELL SS Equity	POWERCELL SWEDEN AB	SE0006425815	16	0	Renewable Energy	Nordics
686 HK Equity	PANDA GREEN ENERGY GROUP LTD	BMG6889V1072	17	1	Renewable Energy	Greater China
438 HK Equity	IRICO GROUP NEW ENERGY COM-H	CNE1000003H9	17	0	Renewable Energy	Greater China
SEN GR Equity	SENVION SA	LU1377527517	18	1	Renewable Energy	Western Europe
SGRE SM Equity	SIEMENS GAMESA RENEWABLE ENE	ES0143416115	18	0	Renewable Energy	Western Europe
INC IM Equity	INNOVATEC SPA	IT0004981038	19	1	Renewable Energy	Western Europe
PPS LN Equity	PROTON POWER SYSTEMS PLC	GB00B140Y116	19	0	Renewable Energy	Western Europe
002221 CH Equity	ORIENTAL ENERGY CO LTD -A	CNE100000953	20	1	Refining & Marketing	Greater China
933 HK Equity	BRIGHTOIL PETROLEUM HOLDINGS	BMG1371C1212	20	0	Refining & Marketing	Greater China
IBE SM Equity	IBERDROLA SA	ES0144580Y14	21	1	Power Generation	Western Europe
EOAN GR Equity	E.ON SE	DE000ENAG999	21	0	Power Generation	Western Europe
EDF FP Equity	EDF	FR0010242511	22	1	Power Generation	Western Europe
ELE SM Equity	ENDESA SA	ES0130670112	22	0	Power Generation	Western Europe
ENGI FP Equity	ENGIE	FR0010208488	23	1	Power Generation	Western Europe
UN01 GR Equity	UNIPER SE	DE000UNSE018	23	0	Power Generation	Western Europe
NTPC IN Equity	NTPC LTD	INE733E01010	24	1	Power Generation	Indian Peninsula
RPWR IN Equity	RELIANCE POWER LTD	INE614G01033	24	0	Power Generation	Indian Peninsula
VER AV Equity	VERBUND AG	AT0000746409	25	1	Power Generation	Western Europe
EDPR PL Equity	EDP RENOVAVEIS SA	ES0127797019	25	0	Power Generation	Western Europe
SSE LN Equity	SSE PLC	GB0007908733	26	1	Power Generation	Western Europe
A2A IM Equity	A2A SPA	IT0001233417	26	0	Power Generation	Western Europe
EBK GR Equity	ENBW ENERGIE BADEN-WUERTTEMB	DE0005220008	27	1	Power Generation	Western Europe
NEOEN FP Equity	NEOEN SA	FR0011675362	27	0	Power Generation	Western Europe
BEP-U CN Equity	BROOKFIELD RENEWABLE PARTNER	BMG162581083	28	1	Power Generation	US & Canada
NEP US Equity	NEXTERA ENERGY PARTNERS LP	US65341B1061	28	0	Power Generation	US & Canada
916 HK Equity	CHINA LONGYUAN POWER GROUP-H	CNE100000HD4	29	1	Power Generation	Greater China
295 HK Equity	KONG SUN HOLDINGS LTD	HK0000120151	29	0	Power Generation	Greater China
TERP US Equity	TERRAFORM POWER INC - A	US88104R2094	30	1	Power Generation	US & Canada
NRG US Equity	NRG ENERGY INC	US6293775085	30	0	Power Generation	US & Canada
CEN NZ Equity	CONTACT ENERGY LTD	NZCENE0001S6	31	1	Power Generation	Australia & New Zealand
TPW NZ Equity	TRUSTPOWER LTD	NZTPXE0001S5	31	0	Power Generation	Australia & New Zealand
CWEN/A US Equity	CLEARWAY ENERGY INC-A	US18539C1053	32	1	Power Generation	US & Canada
AQN CN Equity	ALGONQUIN POWER & UTILITIES	CA0158571053	32	0	Power Generation	US & Canada
PEGI US Equity	PATTERN ENERGY GROUP INC -A	US70338P1003	33	1	Power Generation	US & Canada
CPX CN Equity	CAPITAL POWER CORP	CA14042M1023	33	0	Power Generation	US & Canada
GLO LN Equity	CONTOURGLOBAL PLC	GB00BF448H58	34	1	Power Generation	Western Europe
ERG IM Equity	ERG SPA	IT0001157020	34	0	Power Generation	Western Europe
1798 HK Equity	CHINA DATANG CORP RENEWABL-H	CNE100000X69	35	1	Power Generation	Greater China
958 HK Equity	HUANENG RENEWABLES CORP-H	CNE100000WS1	35	0	Power Generation	Greater China
CAP GR Equity	ENCAVIS AG	DE0006095003	36	1	Power Generation	Western Europe
FTRN FP Equity	FUTUREN SA	FR0011284991	36	0	Power Generation	Western Europe
451 HK Equity	GCL NEW ENERGY HOLDINGS LTD	BMG3775G1380	37	1	Power Generation	Greater China
991 HK Equity	DATANG INTL POWER GEN CO-H	CNE1000002Z3	37	0	Power Generation	Greater China
AZRE US Equity	AZURE POWER GLOBAL LTD	MU0527S00004	38	1	Power Generation	Indian Peninsula
KSK IN Equity	KSK ENERGY VENTURES LTD	INE143H01015	38	0	Power Generation	Indian Peninsula
182 HK Equity	CONCORD NEW ENERGY GROUP LTD	BMG2345T1099	39	1	Power Generation	Greater China
000862 CH Equity	NINGXIA YINXING ENERGY CO-A	CNE000000WZ7	39	0	Power Generation	Greater China
ARISE SS Equity	ARISE AB	SE0002095604	40	1	Power Generation	Nordics
AFK NO Equity	ARENDALS FOSSEKOMPANI ASA	NO0003572802	40	0	Power Generation	Nordics
DUK US Equity	DUKE ENERGY CORP	US26441C2044	41	1	Integrated Utilities	US & Canada
D US Equity	DOMINION ENERGY INC	US25746U1097	41	0	Integrated Utilities	US & Canada
ENEL IM Equity	ENEL SPA	IT0003128367	42	1	Integrated Utilities	Western Europe
BKW SW Equity	BKW AG	CH0130293662	42	0	Integrated Utilities	Western Europe
SO US Equity	SOUTHERN CO/THE	US8425871071	43	1	Integrated Utilities	US & Canada
NEE US Equity	NEXTERA ENERGY INC	US65339F1012	43	0	Integrated Utilities	US & Canada
XEL US Equity	XCEL ENERGY INC	US98389B1008	44	1	Integrated Utilities	US & Canada
PPL US Equity	PPL CORP	US69351T1060	44	0	Integrated Utilities	US & Canada
DTE US Equity	DTE ENERGY COMPANY	US2333311072	45	1	Integrated Utilities	US & Canada
EXC US Equity	EXELON CORP	US30161N1019	45	0	Integrated Utilities	US & Canada
EDP PL Equity	EDP-ENERGIAS DE PORTUGAL SA	PTEDP0AM0009	46	1	Integrated Utilities	Western Europe
WASR SW Equity	WASSERWERKE-REG	CH0002620893	46	0	Integrated Utilities	Western Europe
EVRG US Equity	EVERGY INC	US30034W1062	47	1	Integrated Utilities	US & Canada
ALE US Equity	ALLETE INC	US0185223007	47	0	Integrated Utilities	US & Canada
LNT US Equity	ALLIANT ENERGY CORP	US0188021085	48	1	Integrated Utilities	US & Canada
PCG US Equity	P G & E CORP	US69331C1080	48	0	Integrated Utilities	US & Canada
ORSTED DC Equity	ORSTED A/S	DK0060094928	49	1	Renewable Energy	Nordics
ALELIO SS Equity	ALELION ENERGY SYSTEMS AB	SE0008348072	49	0	Renewable Energy	Nordics
601615 CH Equity	MING YANG SMART ENERGY GRO-A	CNE100003HQ0	50	1	Renewable Energy	Greater China
600525 CH Equity	CHANGYUAN GROUP LTD - A	CNE000001D64	50	0	Renewable Energy	Greater China

Source: Personal elaboration

Here the results of the first regression model run on the 37 companies' group are reported in a concise way.

Regression Statistics	
Multiple R	0,43652
R Square	0,19055
Adjusted R Square	0,177134
Standard Error	45,68783
Observations	185

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	88940,34	29646,78	14,20288	2,36E-08
Residual	181	377815,5	2087,378		
Total	184	466755,8			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	223,7792	77,47554	2,888386	0,004345	70,90784	376,6507
Green Bond per Date	-14,4727	7,310557	-1,9797	0,049253	-28,8976	-0,04783
Delta LN(Asset)	-2822,01	489,5472	-5,76452	3,47E-08	-3787,96	-1856,05
LN(Asset)	-4,9605	3,196968	-1,55163	0,122499	-11,2686	1,347623

Here the results of the second regression model run on the 52 companies' group are reported in a concise way.

Regression Statistics	
Multiple R	0,479666
R Square	0,230079
Adjusted R Square	0,224751
Standard Error	17,79884
Observations	292

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	27359,76	13679,88	43,18162	3,9E-17
Residual	289	91554,81	316,7987		
Total	291	118914,6			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-146,04	22,82163	-6,39921	6,28E-10	-190,958	-101,123
LN(Asset)	8,651054	0,958232	9,028142	2,53E-17	6,765055	10,53705
Green Bond Issuer	1,001663	2,12159	0,472129	0,637191	-3,17406	5,17739

Here the regression of the equally weighted portfolios on the market (S&P Global 1200) is provided.

Equally Weighted Green Bond Portfolio vs. Market

Regression Statistics	
Multiple R	0,723573
R Square	0,523558
Adjusted R Square	0,516752
Standard Error	0,029372
Observations	72

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,066361	0,066361	76,92251	6,97E-13
Residual	70	0,060389	0,000863		
Total	71	0,126749			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0,005786	0,003499	1,653561	0,102695	-0,00119	0,012764
Market Risk Premium	0,992619	0,113176	8,770548	6,97E-13	0,766896	1,218343

Equally Weighted Non-Green Bond Portfolio vs. Market

Regression Statistics	
Multiple R	0,771733
R Square	0,595571
Adjusted R Square	0,589794
Standard Error	0,024884
Observations	72

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,063831	0,063831	103,0836	2,12E-15
Residual	70	0,043345	0,000619		
Total	71	0,107175			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0,006309	0,002964	2,128236	0,03684	0,000397	0,012221
Market Risk Premium	0,973513	0,095884	10,15301	2,12E-15	0,782278	1,164747

Here the regression of the portfolios weighted on the basis of Energy & Utilities companies market capitalization on the market (S&P Global 1200) is provided.

Capitalization Weighted Green Bond Portfolio vs. Market

Regression Statistics	
Multiple R	0,637014
R Square	0,405787
Adjusted R Square	0,397299
Standard Error	0,031094
Observations	72

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,046219	0,046219	47,80296	1,79E-09
Residual	70	0,06768	0,000967		
Total	71	0,113898			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0,004892	0,003704	1,320641	0,190923	-0,0025	0,012279
Market Risk Premium	0,828391	0,119814	6,913968	1,79E-09	0,58943	1,067353

Capitalization Weighted Non-Green Bond Portfolio vs. Market

Regression Statistics	
Multiple R	0,586636
R Square	0,344142
Adjusted R Square	0,334772
Standard Error	0,030027
Observations	72

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,033117	0,033117	36,73035	6,12E-08
Residual	70	0,063114	0,000902		
Total	71	0,096232			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0,005095	0,003577	1,424377	0,15878	-0,00204	0,012229
Market Risk Premium	0,701221	0,115702	6,060557	6,12E-08	0,47046	0,931983

Department of
Economics and Finance
and
Business and Management

Chair of
Corporate Governance

The impact of Green Bonds on Corporate Performance in the Energy & Utilities Sector

(Summary)

SUPERVISOR
Prof. Giovanni Fiori

CANDIDATE
Pierfrancesco Sebastiani
190901

CO-SUPERVISOR
Prof. Simone Scettri

Academic Year 2018/2019

Introduction

This dissertation aims at investigating the existing relationship between Green Bond issuance and Corporate Performance for Energy & Utilities companies. By analysing the effectiveness of this innovative asset class in helping the Energy & Utilities sector's transition towards a low-carbon economy, this research represents an additional step in understanding the reasons behind the exponential growth of Green Bonds over years, enriching the available literature on this newly-introduced financial innovation.

This paper, after having introduced the Green Bond topic and the characteristics of this market, provides the most comprehensive and up-to-date analysis of the Green Bond phenomenon, taking into account the main parties involved in shaping the future of this market and evaluating the current governance and regulatory challenges that might prevent Green Bonds to go mainstream.

The value added embedded in this research emerges by observing the effectiveness of Green Bonds in limiting and reducing air pollution for Energy & Utilities companies. The materiality of the environmental topic for this sector and the growing regulatory pressure pushing power and utilities industries towards a radical responsible business change represent key factors behind the overwhelming growth of Green Bonds issued by Energy & Utilities firms. Together with the expansion, a risk of "greenwashing" has emerged - meaning companies promoting themselves as "green" while issuing self-labelled Green Bonds that actually do not contribute to the improvement of their environmental performance. Consequently, questioning whether Energy & Utilities Green Bond issuers significantly enhance their emission and environmental scores in concomitance with their first Green Bond issuance appears to be particularly relevant.

In addition to the first research question focused on the effectiveness of the Green Bond tool, this study helps in understanding whether Energy & Utilities Green Bond issuers are more environmentally sustainable than a "control" group of Energy & Utilities companies that have not relied on Green Bonds. This query helps to investigate a possible relationship between superior environmental performance and Green Bond issuance for companies of the sector, implying the fact that this innovative financial instrument might be read as a concrete proof of Energy & Utilities firms' overall effort in dealing with environmental topics. Moreover, by analysing the total stock returns of Green Bond issuers compared to non-Green Bond ones, this paper wants to show whether Green Bond issuance is *per se* a value adding factor for Energy & Utilities companies. Investors, indeed, might read in Green Bonds a concrete proof of an Energy & Utilities firm's attention towards Environmental, Social and Governance (ESG) issues, independently of the concrete Green Bond instrument's effectiveness in generating better environmental performance.

Green Bonds' Pillars And Regulatory Framework

Relying on the Green Bond Principles definition, Green Bonds can be described as "*any type of bond instrument where the proceeds will be exclusively applied to finance or re-finance, in part or in full, new*

and/or existing eligible Green Projects". This innovative financial instrument is a regular bond; the difference lies in the purpose of the bond: to provide funding to foster the transition to a low-carbon economy. Bonds that disclose the use of proceeds for environmental projects are called "labelled Green Bonds" (International Capital Market Association (ICMA), 2014); in details, the principal collected through the issuance is exclusively earmarked[220] to finance "green" projects, assets or business activities (Park, 2018).

In order to streamline Green Bond issuance and provide enhanced clarity about the investable Green Bond universe, the International Capital Market Association (ICMA) established the Green Bond Principles to encourage a high level of transparency, in particular regarding four key components: use of proceeds; process for project evaluation and selection; management of proceeds and reporting. The proceeds of a Green Bond can only finance climate and/ or ecological friendly projects, promoting climate mitigation and climate adaptation activities. According to the ICMA guidance, the information on the use of proceeds should be made and keep readily available and up-to-date, underlining the need of a revision at least on an annual basis. Additionally, the reliance on an external review provider is strongly supported to confirm the alignment of the single Green Bond or whole Green Bond programme to international guidelines. Investors require assurance that proceeds from Green Bonds are going towards genuine 'green' projects; consequently, external independent reviewers provide additional due diligence on Green Bond issues. However, independent external reviews vary in scope and purpose; it is possible to identify three main types of external review: second party reviews and consultation; audits and third-party certifications (OECD, 2017).

From an historic perspective, in slightly more than ten years, Green Bonds have moved from a niche experiment of financial innovation to a consolidated reality. According to the 2018 CBI Report on the state of the market, the cumulative numbers testify this success path: since 2007, there have been more than USD 521 billion of cumulative Green Bonds' issuances at a global level (Filkova, Frandon-Martinez, & Giorgi, 2019). In the short-term, Green Bond market is expected to continue its growth path, leveraging on 2018 consolidation; the good progress in the development of taxonomies and the harmonisation effort have created solid bases for the Green Bond's future evolution. CBI's target for Green Bond issuance in 2019 is USD 250 billion; it seems an ambitious target, but it is the threshold level that it is necessary to reach to slow down the impacts of climate change - according to the organisation. Shifting to a long-term perspective, the OECD proposes two main scenarios for the Green Bond market to keep pace with the "2°C pathway (2DS)" agreed in Paris (OECD, 2017). The results of the analysis suggest that by 2035 in a 2DS, bonds financing and refinancing have the potential to scale to USD 4.7-5.6 trillion in outstanding securities globally and USD 620-720 billion in annual issuance. While these figures may seem large on an absolute

[220] *Earmarking* consists of funds, such as from a bond issuance, which are set aside to pay for a specific project or event. The process of *earmarking* is a fundamental component of the Green Bond market

basis, they as small as approximately 4% of the scale of debt securities markets. Emerging markets are the most exposed area to climate change risks; indeed, they need to reduce the reliance of their economies on fossil fuels while following a solid sustainable growth path. According to recent estimates, untapped investment opportunities in "*greenification*" projects amount to a total of USD 29.000 billion in emerging markets up to 2030 (Caparello, 2019). The current situation suggests that Green Bonds may represent the right instrument to finance sustainable growth in developing countries. For instance, looking at the Chinese case, although the Green Bond market was launched only in December 2015, it became one of the world's largest within a single year, making up 40 % of total "self-labelled" Green Bond issuance in 2017 (Schipke, Rodlauer, & Zhang, 2019). It is necessary to clarify that the 40% data refer to a "wide concept" of green projects - including coal and nuclear energy production.

The major actors driving the development of green finance include banks, institutional investors and international financial institutions as well as central banks and financial regulators. Indeed, public budgets fall far short of the required funding. For this reason, a large amount of private capital is needed (Berensmann & Lindenberg, 2016). Currently, the Green Bond market unlocks a number of benefits by increasing the transparency of information available to investors on underlying assets and companies (Shishlov, Morel, & Cochran, 2016). Green Bonds can help bond issuers communicate their sustainability strategies, create internal synergies between financial and sustainability departments, expanding and enhancing the relationships between borrowers and debt providers. From an institutional investors' perspective, appetite for sustainable investment product has constantly grown due to the escalating pressure towards ESG topics coming from beneficiaries. Recent data shows that over 70 percent of mainstream institutional investors consider sustainability as central to their investment decisions (Unruh & al., 2016). Another relevant topic is the opportunity that Green Bonds provide to move from the traditional shareholder activism to bondholder activism (Allen, Sellers of green bond face a buyer's test of their credentials, 2017). In addition, Green Bonds have a structurally embedded advantage compared to traditional fixed income products: they are similar to bonds in all aspects but give more intelligence; consequently, they have a sort of *free option* that is worth money (Park, 2018). Moving to Self-Regulatory Organizations (SROs), they play a leading role in shaping the dimension and the boundaries of the Green Bond market: the *International Capital Market Association (ICMA)* through the Green Bonds Principles (GBP); the *Climate Bonds Initiative (CBI)* that offers accreditation and certification; external reviewers and second-opinion providers; rating agencies and market indices.

Finally, concerning the regulatory framework, a decentralized private governance system predominates in the Green Bond market but public regulation is becoming increasingly relevant. In comparison to public regulation, private governance is often faster to implement and more responsive to the needs of market participants but may suffer from a lack of legitimacy, accountability, and consistency and be prone to *greenwashing* - meaning bond proceeds get allocated to assets that have little or no environmental value,

shaking market confidence (Weber & Saravade, 2019). Public choice economists and administrative law scholars have long discussed and criticized the extra-legal influence of firms on the regulatory process (*regulatory capture*), maximized in a private governance framework (Stigler, 1971). The second type of governance challenge is represented by the existence of multiple private governance regimes - with non-exclusive jurisdiction between them - that allow a firm to select the regulatory framework that is most in line with its interests (*regulatory arbitrage*). This issue particularly applies in more opaque markets – especially the Chinese one, which represents nearly a third of 2018 Green Bond issuance. Stephen Park recently published a theoretical framework proposing a solution for regulatory inconsistency (Park, 2018); it is a stakeholder-oriented conceptual framework based on the theory of *hybridity*. It is based on the coexistence of legal and quasi-legal structures that govern any given legal phenomenon. Assuming a practical perspective, lately some international and national initiatives have been implemented to increase overall regulatory standardisation. At European level, the EU Commission has established the 35-experts Technical Expert Group (TEG) on Sustainable Finance; in September 2018 it has been set up a new international partnership - the Global Green Bond Partnership (GGBP); China itself has recently made significant improvements, updating its Green Bonds' regulative framework; finally, a growing collaboration between the EU and China regarding the development of common procedures regulating the Green Bond market.

Literature Review and the Energy & Utilities Choice

Sustainable finance and socially responsible investing (SRI) are part of a broader universe of Corporate Social Responsibility (CSR). From a historical perspective, there have always been two opposing schools of thought regarding the idea of "doing well by doing good", fostering the idea of "shared value creation" (Porter & Kramer, 2011). Indeed, some scholars argue that adopting environmental and social policies can destroy shareholder wealth, as first suggested by Milton Friedman and subsequently supported by other academics following his line of thought (Friedman, 1962) (Henderson, 2001) (Kapstein, 2001). However, the overwhelming majority of academics account this perspective as surpassed (Smith, 2003); Friedman's position was founded on an inaccurate economic model because of its unrealistic attempt to isolate business from society when the two are strongly interdependent (Mintzberg, 1983). Moreover, from a literature point of view there exist several studies showing the positive correlation between corporate performance and sustainable practices. Amiraslani showed that firms with high Corporate Social Responsibility (CSR) better resist financial crisis probably because they are trusted more by financial investors (Amiraslani, Lins, Servaes, & Tamayo, 2017). High-CSR firms were also capable to raise more debt capital on the primary market and those high-CSR firms that raised more debt were able to do so at lower at-issue bond spreads, better initial credit ratings and for longer maturities. Margolis and Walsh highlighted the positive relationship between Corporate Social Performance (CSP) and Corporate Financial Performance (CFP) (Margolis & Walsh, 2001). Eccles, Ioannou and Serafeim shed light on the organizational and performance

implications of integrating ESG issues into a company's strategy and business model through the adoption of corporate policies, discovering that corporations that voluntarily adopted sustainability policies manifested distinct organizational processes and higher stock market and accounting performance (Eccles, Ioannou, & Serafeim, 2014). Moving specifically on green finance, it is relevant to stress the two main tasks being promoted: *to internalise environmental externalities* and *to reduce risk perceptions* in order to encourage investments that provide environmental benefits (Berensmann & Lindenberg, 2016).

Specifically focusing on the adoption of Green Bonds to improve firm performance, the lack of appropriate institutional arrangements for Green Bond management, the minimum size of issue and high transactions costs associated with the issuance process represent some of the key barriers to the development of Green Bonds (Banga, 2018). On the other side, the success of Green Bonds might arise from the advantages generated by this financial instrument: an extended breadth of ownership, a larger investor base, potentially lower cost of capital and longer tenor compared with straight corporate bonds (Tang & Zhang, 2018). Interestingly, recent studies have highlighted that Green Bonds are more exposed to environmentally related credit risks because they are issued by companies more affected by environmental regulation on their business, such as Energy & Utilities corporations. Moving to specific Green Bond pricing studies, it is shown by several experts the existence of a premium price at the issuance - comparing Green Bonds to traditional debt securities - meaning that Green Bonds have a higher issuance price compared to conventional bonds (Zerbib, 2016). In light of the premium prices characterizing the Green Bond market - especially the primary one - it is possible to identify two main reasons to explain this outperformance. The first one refers to the excess of Green Bond demand compared to the available supply; the second reason, instead, attributes a higher pricing to additional disclosure requirements.

Tang and Zhang studied the announcement returns and real effects of Green Bonds on corporations and demonstrated that stock market investors respond positively to Green Bond issuance due to a "behavioural effect" linked to media exposure and a "fundamental effect" related to additional information; moreover, stock liquidity improves (Tang & Zhang, 2018). Differently, Flammer adopted a *matching* methodology to show and compare how firm-level outcomes would evolve absent the issuance of Green Bonds (Flammer, 2018). The results suggest that the issuance of corporate Green Bonds has become more prevalent over time, particularly in industries where the natural environment is financially material. The scholar found out that Green Bonds generate an improvement in long-term value, operating performance and environmental performance; Green Bonds increase companies' green innovations and ownership levels by long-term and green investors, suggesting that Green Bonds are conducive to the adoption of a longer time horizon.

In conclusion, concentrating on the reasons behind the choice of the Energy & Utilities sector, it should be pointed out that the latest Energy Outlook report by the International Energy Agency (IEA) underlines that more than USD 2,3 trillion of annual investment in the Energy & Utilities sector is needed to meet the "sustainable development" conditions to prevent catastrophic climate change (International Energy Agency

(IEA), 2018). In light of this gigantic need of funds to create climate-resilient infrastructures, Green Bonds represent a concrete solution to meet the internationally established sustainability goals, financing the Energy & Utilities transformation. Recent research conducted by Khan, Serafeim and Yoon clearly highlights the relevance of identifying which sustainability investments result material for each industry, since material topics differ according to the specific sector under scrutiny (Khan, Serafeim, & Yoon, 2015). This group of scholars demonstrate that firms with good ratings on material sustainability issues significantly outperform - in terms of stock return and accounting performance - firms with poor ratings on these issues. In contrast, firms with good ratings on immaterial sustainability issues do not significantly outperform firms with poor ratings on the same issues. Starting from this evidence, it seems reasonable to question the materiality of environmental topics in the Financial sector and in the Energy & Utilities one, which represent the vast majority of Corporate Green Bond issuance worldwide. The SASB Materiality Map helps to clear this doubt, underlining that Environment does impact on the performance of Energy & Utilities companies while it does not affect Financial Institutions (Sustainable Accounting Standards Board (SASB), 2018). Since this dissertation aims to assess the effects of Green Bond issuance on firm performance, it appears necessary to limit the research on Corporate Green Bonds of the Energy & Utilities sector, not only due to the fact that it is the biggest segment excluding Financials but especially because it is the only significantly influenced by environmental issues among the two[221]. A further reason supporting the limited impact that Green Bonds should have on Financial Intermediaries' performance emerges if it is considered that financial companies do not implement themselves "green" projects; they simply raise money through bond issues to lend it to other companies. Banks and similar organisations act as "facilitators", but most of the benefits coming from low-carbon projects remain in the hands of the borrowers.

Moving to the drivers shaping the future of the Energy & Utilities sector, experts have identified three high-priority categories - the "three Ds": decarbonization, decentralization, and digitalization (Forbes, 2018). It seems clear that the upcoming change involving the Energy & Utilities industries will radically alter the present competitive dynamics. This sector's "Great Transformation" is disrupting the conventional business model of generating and selling energy, bringing ESG topics and issues at the top of C-suite agendas (Sustainalytics, 2015). The relevance of an innovative financial instrument such as Green Bonds to support the implementation of "green" projects in the Energy & Utilities sector emerges from the 2018 World Energy Investment report published by the International Energy Agency (IEA), which depicts a worrying situation regarding the number of investments to sustain an environmentally responsible economy. Indeed, global energy investment totalled USD 1,8 trillion in 2017 - a 2% decline in real terms compared to the previous year; more than USD 750 billion went to the electricity segment while the outstanding figure of USD 715 billion reached the oil and gas industry globally in 2017. These data are not comforting since

[221] Industry data are taken form CBI

there is an increasing necessity of additional renewable energy and energy efficiency investments to respond to Paris COP21 objectives; furthermore, the large share of resources still channelled towards oil and gas activity is disappointing. Thus, even if the long-term trend is for a strong growth of renewables and energy efficiency investments, probably this increase will not be enough to reach COP21 target, given the current state-of-the-art; furthermore, the short-term slowing down registered in 2017 is significantly troublesome. In light of the above-mentioned findings and difficulties, perhaps Green Bonds could be the solution to enable the take-off of environmentally sustainable initiatives in the Energy & Utilities sector. Furthermore, Energy & Utilities is responsible for 31% of total global greenhouse gas (GHG) emissions (Sustainalytics, 2015). Within this context, many power and utilities corporations will struggle under new carbon constraints; Green Bonds may represent a business-wise solution to raise the required resource to adapt their activity to climate-resilient requirements under growing regulatory pressure. Another interesting point of discussion regarding the Energy and Utilities sector refers to the shift towards renewables and its implications for a significant reduction of the companies' risk profile. Green Bonds' issuances, fostering this transition, would leverage the lower-than-average risk of "green energy projects" linked to renewable energy sources compared to traditional ones. Indeed, wind and solar power generation projects tend to be subject to lower Beta, Cost of Equity and WACC, while exploiting on a higher extent the benefits provided by debt financing.

Sample Definition, Data Overview and Regression Methodology

In order to investigate the relationship between Green Bond issuance and Firm Performance for Energy & Utilities corporations, three questions have been raised and the related hypotheses have been tested:

- *Question 1*. Does Green Bond issuance contribute to the improvement of environmental performance for Energy & Utilities companies, accelerating their reduction of CO2 emissions?
  Hypothesis 1. The issuance of Green Bonds by Energy & Utilities corporations significantly decreases their Greenhouse Gas emissions, highlighting the effectiveness of the instrument contrary to a *greenwashing* risk.
- *Question 2*. Do Green Bond issuers in the Energy & Utilities sector outperform their "non-Green" peers in terms of Environmental Sustainability?
  Hypothesis 2. Energy & Utilities companies issuing Green Bond show significantly lower GHG emissions and higher environmental responsible behaviour.
- *Question 3*. Do Green Bond issuers in the Energy & Utilities sector perform better in terms of Total Stock Return?
  Hypothesis 3. The issuance of Green Bonds does create additional value for shareholders. More precisely, Green Bond issuers generate significantly higher stock returns over time.

However, before trying to provide an answer to these queries, a proper sample to either validate or reject these hypotheses need to be constructed. The creation of a comprehensive Corporate Green Bonds dataset relies on two extensively used and broad-based lists: the Climate Bonds Initiative (CBI) database and Bloomberg bond data. When the same issuers place on the market several tranches on the same day and with the same maturity - this second criterion avoids the union of bonds with different risk profiles - the issuances are combined into one single Green Bond, while cumulating the amounts. Additionally, the dataset is sanitized from issuances reporting an amount issued equal to zero. Finally, only Green Bonds issued until the 31st December 2018 have been included in the analysis. Consequently, the above criteria yield to *1.088 Corporate Green Bonds*. Discriminating according to the public/private *status* of issuing companies and highlighting the peculiarities of Energy and Utilities Green Bonds, it emerges that both the amount issued and amount outstanding by private corporations are bigger than the ones by public companies; this evidence is confirmed looking at the statistics of the Energy & Utilities sector. However, the proportion of amount outstanding on amount issued is higher for public firms, suggesting their capability to rely on longer maturities due to their higher standing. Regarding the issue size, public firms tend to issue amounts 2,5 times larger than their private peers, while the number of issuances is heavily higher for private organisations. The average issue size for Energy & Utilities companies is smaller than the overall sample, but this figure mainly depends on the "mega-deals" characterizing issuances of Green Bonds from Financials. Not surprisingly, public corporations tend to show longer maturities and lower coupons compared to private firms, benefiting from the higher credit rating that their issuances experience and the enhanced control that investors can carry out on listed companies. At the same time, Energy & Utilities' Green Bonds are characterized by longer maturities than the overall sample; this is particularly true for public businesses, due to the extraordinary dimension of their long-term infrastructure projects requiring a lot of funds that need to be repaid over a long period of time. Moving to sector analysis, the dataset clearly shows the dominance of Financials in terms of amount issued, followed by Energy and Utilities. The two sectors represent more than 80% of cumulative Corporate Green Bonds issuances. In conclusion, adopting an issuer-level perspective, it emerges a higher number of private companies issuing Green Bonds compared to public ones; these data are confirmed in the Energy & Utilities. Regarding the proportion of externally verified issuers - based on CBI information - more than 4 out of 5 corporations relies on a consulting/assuring opinion from an external accredited party. This proportion is higher for private firms, probably in light of the greater pressure from investors that want to protect themselves against the risk of greenwashing, given the limited disclosure of information by non-listed entities.

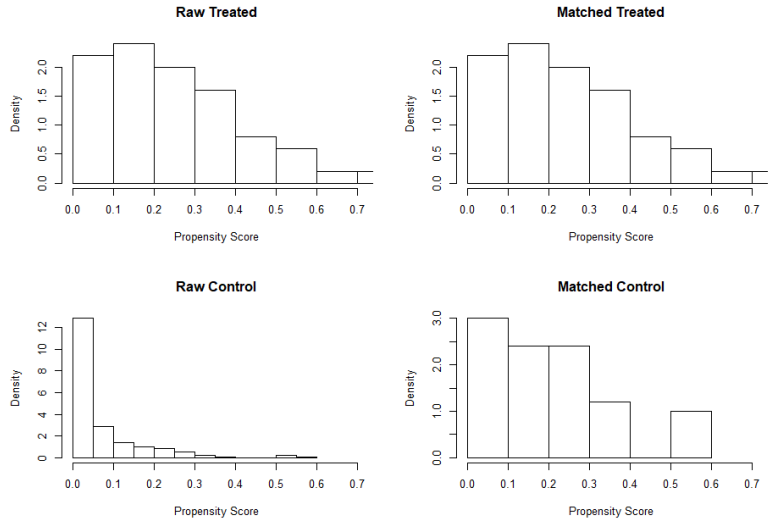
Specifically focusing on the Energy & Utilities sector, after data reclassification it results *a final number of public Energy & Utilities companies issuing Green Bonds equal to 50*; this subset of listed Energy & Utilities corporations represents the "treated group" that needs to be matched with the most appropriate "control group" of public Energy & Utilities companies that are non-Green Bond issuers. Only listed firms have been used to test the hypotheses outlined above, due to the wider data availability; thus, the

information on the public final guarantor will be considered when the Green Bond issuer is a private subsidiary of a public company. Finally, data will be collected between 2013 - when the first Corporate Green Bond by an Energy & Utilities firm was issued - and 2018, covering a six-year timeframe.

The core reason behind the need for a *matching* procedure responds to the willingness of creating two homogeneous sub-groups of equal numerosity and similar characteristics to investigate the relationship between Corporate Green Bonds and Firm Performance in a way similar to a "clinical trial": Green Bond issuers can be considered "treated cases" that have to be compared to a homogeneous number of "control cases" – i.e. non-Green Bond issuers. . In this dissertation, it has been decided to adopt a *Propensity Score-Matching* (PSM) method implemented through the statistical software R, combining exact and nearest-neighbour approaches. *Exact matching* pairs each treated unit with a control one that has the same values on each covariate, while *nearest-neighbour* technique matches a treated unit to a control unit that is closest in terms of *logit* distance (Randolph, Falbe, Manuel, & Balloun, 2014). From an economic perspective, the 50 Green Bond issuers identified in the previous section have been matched with 50 Energy & Utilities corporations that have not relied on this innovative instrument during the period under observation. The 50 "control units" have been taken out of a sample of 577 Energy and Utilities companies belonging to the same geographic area and the same Bloomberg BICS Level 2 industry of the Green Bond issuers' sub-sample. In particular, *five matching drivers* have been selected in order to study the potential environmental and stock outperformance of Green Bond issuers while ensuring a similar financial performance of the 100 sample firms based on geographic and sector variables and companies' fundamentals data. To build up the 100 companies' sample, it has been set up a matching procedure requiring an exact pairing on the "*BICS Level 2 Industry*" and "*Geographic Area*" variables. At the same time - in order to grant analogy from a financial point of view over the six-year period of study - Green Bond issuers have been matched with the most similar "control" peers (nearest-neighbour requirement) on the basis of other three drivers: "*Size*" measured through the natural logarithm of Total Assets; "*Operating Performance*" measured relating a company's Net Operating Profit After Taxes (NOPAT) to its own Total Assets; finally, "*Capital Structure*" measured through the relationship between Total Debt and Total Assets.

Comparing the "100 sample" to the overall "627 dataset", it is immediately possible to identify the fact that each Green Bond issuer has been paired with an exactly similar "control" company for the BICS Level 2 and Geographic Area variables, generating a 100% balance improvement in the mean difference. Looking at the median, mean and maximum quartile-differences (eQQ) between the "treated" and "control" data - measuring the concrete improvement in the matched dataset for the other three drivers - the matched sample has shown 37 out of 39 positive percent balance improvements, suggesting a relevant reduction in the empirical distribution differences. The graphs below visually outline the *matching* improvements; the histograms on the left - before the matching - differ to a wider extent compared to the ones on the right -

after the matching. Indeed, the graphs on the right result highly similar in terms of propensity score density, stressing the positive effects of the matching procedure on the construction of the desired paired sample.



In conclusion, it has been decided to perform a two-tailed Z-test to statistically verify the effectiveness of matching, assessing whether the means of the "treated" group and the "control" one statistically differ. The results statistically prove the higher similarity reached after the *matching*.

Furthermore, to respond to the three above-mentioned questions, it has been decided to elaborate three different Regression Models. In each of the models, a different independent variable represents the object of the study in order to provide a statistically tested answer to the specific enquiry under investigation. The *independent variable* of the *first regression model* is an *Emission Score* resulting from a personal elaboration of the reported Energy & Utilities companies' CO2 emissions. The level of CO2 emissions - measured in tons - is obtained from Thomson Reuters ASSET4 proprietary data. It has been important to identify an appropriate variable to standardize air pollution according to companies' scale of activity in order to grant comparability. Therefore, it has been decided to create a ratio with CO2 emissions at the numerator and company size - measured through Total Assets - at the denominator. This measure of CO2 emissions' levels has been previously applied in literature when companies differed for dimension (Flammer, 2018). The final step to build up the Emission Score has required the definition of a common cross-sample starting point for the measurement of Standard CO2 Emissions, since the Score has been elaborated with the aim of assessing the movements of Standard CO2 Emissions over time to test the impact of Green Bond issuance. Consequently, higher Emission Scores mean greater air pollution generated by an Energy & Utilities company of the sample. By evaluating the dynamics of the Emission Score in conjunction with Green Bond issuance, in the first model it has been possible to evaluate the effectiveness of Green Bonds in improving Energy & Utilities corporations' environmental responsibility. Moreover, the first regression model is completed by one independent nominal variable represented by a dichotomous variable and two control variables whose effects on the regression outcome are closely monitored. Concretely, *Green Bond Issuance* has been selected as nominal variable: for each company in each year it

has been assigned a "0" value to this dummy if the Energy & Utilities company has not issued its first Green Bond yet, while the dummy turns to "1" the year of the first Green Bond issuance and remains "1" thereafter. Together with the dichotomous variable, it has been decided to control for companies' *Size* and *Size Change* year-over-year - respectively the natural logarithm of Total Assets and the annual percentage change in the natural logarithm of Total Assets. Controlling for size and size change helps to monitor whether a superior/inferior asset base is related to better/worse environmental performance.

Moving to the *second model*, the *Environmental Pillar Score* provided by Thomson Reuters ASSET4 corresponds to the *independent variable* that has been used to assess the environmental performance shown by Energy & Utilities Green Bond issuers and non-Green Bond companies over the six-year period of analysis. In this second regression model, the independent variable is represented by the so-called *Green Bond Issuer* dummy; it assumes a value equal to "0" if the Energy and Utilities company is not a Green Bond issuer, while it is equal to "1" if the Energy & Utility company has ever issued Green Bonds in the observed timeframe. As control variable, the natural logarithm of Total Assets has been chosen to monitor the *Size* effect.

Finally, the *dependent variable* to test the *third hypothesis* - measured over the six-year period - is represented by the difference between the monthly Total Stock Returns of an equally weighted portfolio made up of the 50 Energy and Utilities Green Bond issuers' stocks and the monthly Risk-Free Rates of Return, measured through the 1-month US Treasury Bill rates. This variable has been identified as *Energy & Utilities Green Bond Portfolio Stock Performance*. In this last regression model, the independent variable is structured as the dependent one except for the fact that the stocks included in the portfolio are the ones of the 50 non-Green Bond issuers' sub-sample; this variable has been named *Energy & Utilities non-Green Bond Portfolio Stock Performance*. In this case, no control variables have been included.

Results and Analysis

The first model, based on panel data[222] and testing the effectiveness of Green Bonds in improving the environmental performance of Energy and Utilities corporations in light of the companies' first Green Bond issuance, can be described through the following formula:

$$Emission\ Score = \beta_0 + \beta_1 \cdot Green\ Bond\ Issuance + \beta_2 \cdot\ Size\ +\ \beta_3 \cdot Size\ Change + \varepsilon$$

The result of the regression shows that the *Green Bond Issuance* coefficient results negative and significant at 10 percent, 5 percent and 1 percent levels. Consequently, it is possible to confirm *Hypothesis 1*: in concurrence with the issuance of their first Green Bond, companies belonging to the Energy & Utilities sector show a significantly lower level of Greenhouse Gas emissions. This evidence seems to confirm the effectiveness of the instrument in fighting air pollution for Energy & Utilities corporations, contrary to a

[222] Two-dimensional data combining temporal and company-specific information

greenwashing risk that associated Green Bonds simply to a promotion leverage used by companies of the sector to appear greener in the eyes of stakeholders while attracting additional investors and raising more funds. On average, corresponding to the issuance of their first Green Bond, Energy & Utilities companies show an Emission Score nearly 18 points lower, given a fixed level of *Size* and *Size Change*. Looking at the performance of the two control variables, it is interesting to notice that both their coefficients result negative and significant. In particular, as the *Size* of Energy & Utilities companies increases, standardized CO2 Emissions decrease. Bigger companies are capable to perform better from an environmental perspective, probably due to the wider arrange of resources they can count on. Moreover, as Energy & Utilities corporations expand their Total Assets base, measured through *Size Change*, their Emission Score decreases. This result can be read in the following way: the additional assets that Energy and Utilities companies bring in are "greener" assets.

The second model, based on panel data and assessing the existence of a significantly better environmental performance for Energy & Utilities companies issuing Green Bonds compared to Energy & Utilities firms not relying on this innovative financial instrument, can be describe through the following formula:

$$Environmental\ Pillar\ Score\ = \beta_0 + \beta_1 \cdot Green\ Bond\ Issuer + \beta_2 \cdot\ Size + \varepsilon$$

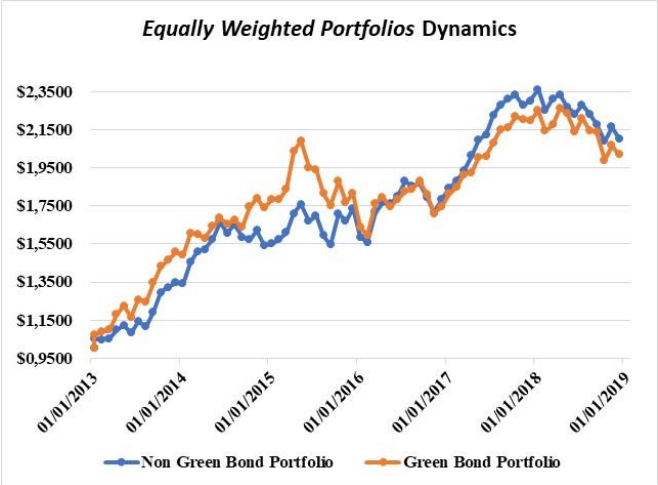
The result of the regression stresses that the *Green Bond Issuer* coefficient but not significant at any percent level. Looking at upper and lower boundaries of the 95% confidence interval, it is clear that *Green Bond Issuer* coefficient might vary between positive and negative values, stressing the fact that it is not significantly different from zero. Consequently, it seems necessary to reject *Hypothesis 1*: Energy & Utilities Green Bond issuer do not seem to environmentally outperform their non-Green Bond paired peers over the period 2013-2018. However, this result should not be read in a negative way; indeed, through the first model, it has been demonstrated the effectiveness of Green Bonds in limiting and reducing GHG emissions for Energy & Utilities companies. Consequently, it seems simply a matter of time before this outperformance significantly comes out; over a longer period of time, the same analysis should highlight an environmental outperformance for Green Bond issuers, provided the same financial fundamentals and business characteristics. Looking at the performance of the control variable, it is interesting to notice that its coefficients result positive and significant. In particular, as the *Size* of Energy & Utilities companies grows, the *Environmental Pillar Score* increases as well. Bigger companies are capable to perform better from an environmental perspective, probably due to the wider arrange of resources they can count on; this result is in line with the finding of the first model.

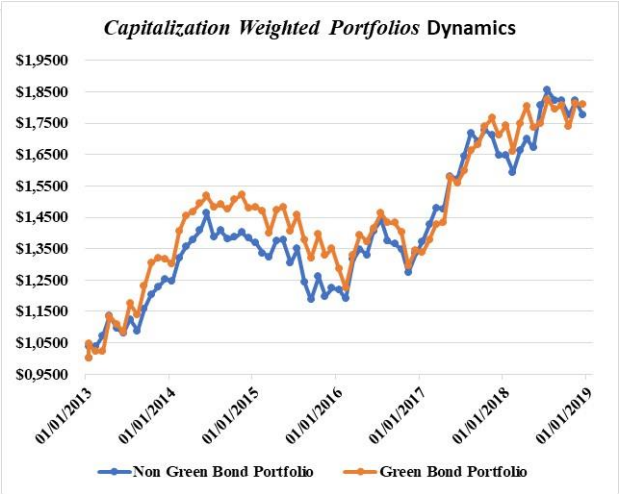
In conclusion, the third regression model, based on monthly data collected over a six-year period, studies whether Green Bond issuers experience a significantly better stock performance compared to the "control" group. It is based on the following formula:

$$Energy\ \&\ Utilities\ Green\ Bond\ Portfolio\ Stock\ Performance\ =$$

$$= \beta_0 + \beta_1 \cdot Energy\ \&\ Utilities\ non - Green\ Bond\ Portfolio\ Stock\ Performance + \varepsilon$$

The Adjusted R Square - representing the goodness of the fit - results equal to 0,777; it means that 77,7 percent of the variation in the *Energy & Utilities Green Bond Portfolio Performance* is explained by the variation of the *Energy & Utilities non-Green Bond Portfolio Performance*. Actually, this high Adjusted R Square should be read in the following way: the movements of the two portfolios are highly correlated; when the non-Green Bond portfolio moves, it is quite easy to understand what will happen to the Green Bond one, since nearly 80% of the movements of the Green Bond portfolio can be read through the non-Green Bond one. In order to understand a possible outperformance of the Green Bond portfolio, the attention should be focused on the intercept coefficient, representing the excess return over the non-Green Bond portfolio. Looking at the intercept coefficient t-stat (near zero) and at its relative p-value (extremely high), it is clear that an abnormal return does not exist. Consequently, *Hypothesis 3* should be rejected: Energy & Utilities Green Bond issuers do not outperform their "control" group from a Total Stock Return perspective in the period under investigation. The Green Bond label alone does not support the presence of abnormal returns, especially considering that in this six-year timeframe Green Bond issuers did not show a significantly higher environmental performance, as shown in the second model. However, the effectiveness of Green Bond is real and concrete (*Hypothesis 1* confirmation); consequently, over a longer period of time it is expected that potential excessive returns might emerge in concomitance with significantly better environmental results for Energy & Utilities Green Bond issuers. Indeed, provided similar business characteristics and financial fundamentals, enhanced air pollution levels do have an economic and financial value for investors, meaning superior stock performance. Looking at the coefficient of *Energy & Utilities non-Green Bond Portfolio Performance*, it results positive and highly significant (10 percent, 5 percent and 1 percent levels). As the *Energy & Utilities non-Green Bond Portfolio Performance* increases by one percent, the *Energy & Utilities Green Bond Portfolio Performance* grows by 0,96 percent, on average. This evidence suggests that the Green Bond portfolio and the non-Green Bond one show similar risk level, since they highlight movements in the same direction according to a one-to-one proportion: for instance, when the non-Green Bond portfolio doubles, also the Green Bond one doubles. These findings emerged considering both equal weighted portfolios and a capitalization weighted ones. In conclusion, in the below picture it is possible to see the results of a one-dollar investment at the beginning of 2013 depending on the chosen portfolio. In the six-year timeframe, a consistent and significant outperformance does not seem to be evident, also considering the portfolios' similar systematic risk.





Conclusions

This dissertation has been written in order to provide a comprehensive overview of the current situation of the Green Bond market, its main criticalities and its potential future developments. Specifically, at the core of this research there has been the investigation of the effectiveness of Green Bonds in limiting and reducing GHG emissions for Energy & Utilities companies, provided the urgency of the sector' s transition toward low-carbon environmentally-responsible businesses. In addition, it has been assessed whether the Corporate Performance of Energy & Utilities firms issuing Green Bond results significantly better than the one shown by Energy & Utilities corporations that have not relied on this innovative asset class; in particular, this potential superior performance has been evaluated according to environmental parameters and in terms of stock returns.

In order to perform these analyses, it has been decided to pair the companies of the sample through a *matching* procedure in order to ensure similar business characteristics and financial fundamentals over the six-year period under investigation (2013-2018). The empirical findings seem to suggest the effectiveness of Green Bonds in accelerating the shift of the Energy & Utilities sector towards a greener way of doing business. it has been possible to confirm that Energy & Utilities companies experience lower CO2 Emissions - standardized for the size of the company - in concomitance with the issuance of their first Green Bond. However, Energy & Utilities Green Bond issuers do not significantly outperform the "control" group of non-Green Bond issuers from an environmental point of view and do not seem to experience significantly higher stock performance. these findings should not be read in a negative way, demonstrated the effectiveness of Green Bonds in fighting and limiting air pollution. Over a longer period of analysis, it is expected that financially similar Energy & Utilities corporations issuing Green Bonds will show significantly lower GHG emission levels; in concomitance with superior environmental performance, then Green Bonds would result as effective instruments to create added value in the sector, generating superior stock returns for green Bond issuers.

Some limitations have been found while implementing this study. In detail, data availability regarding the environmental performance and the CO2 Emissions of the 100 one-to-one paired companies belonging to the post-matching sample represented an issue. Due to this, from an environmental point of view, the analyses have been performed on a reduced number of Energy & Utilities corporations. More importantly, the time horizon considered in this dissertation seems to be a major obstacle in drawing definitive conclusions, since the Green Bond phenomenon is currently still underway. Indeed, Green Bonds are a relatively new asset class whose impact cannot be properly evaluated in a six-year period. Over a longer timeframe, the re-iteration of this analysis might show a significantly better environmental and stock performance of Energy & Utilities companies issuing Green Bonds.

Future research should repeat the same analysis over a longer time interval and enhanced intelligence might emerge further discriminating between Energy companies and Utilities ones. Another interesting area of improvement might be linked to the impact of external third-party certification on Green Bond issuance, to understand whether this kind of verification provides substantially different environmental and financial performance for Energy & Utilities Green Bond issuers. Last but not least, inserting a parameter that takes into account the peculiar characteristics of the regulatory environment influencing Green Bond issuance would help to improve the analysis in light of the current governance fragmentation.