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Executive Summary of the Thesis

Green Bonds: European Taxonomy alignment and correlation with pricing

Laurea Magistrale in Management Engineering - Ingegneria Gestionale

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Introduction to Sustainable Finance and Green Bonds

The critical environmental issues affecting our planet are now fully understood by everyone. In this sense, climate change poses a serious threat to society as a whole. In addition to having a negative impact on people's health and well-being, this phenomenon also threatens the stability of the world economy and financial markets. In such a situation, all parties involved, from states and governments to corporations and investors, must contribute on their own to prevent even more severe repercussions. As far as the financial worlds are concerned, over the last years there has been an evident change in paradigm. The rise and development of so-called "sustainable finance" aims to direct increasing amounts of investments in order to finance the shift to a low-carbon economy. One tool in particular has emerged over the past few years among the many available to sustainable finance to accomplish the aforementioned goal: Green Bonds. Given the novelty of the instrument, a clear definition of the term is still ambiguous. But according to the International Capital Market Association, a "Green Bond" is any bond instrument whose proceeds are exclusively used to finance or refinance, in whole or in part, new and/or existing eligible green projects, i.e., projects that aim to mitigate climate change (ICMA, 2021).

Given their goal and the urgent state of the environment today, Green Bonds have grown significantly over the past few years. The Climate Bond Initiative estimated an average annual growth rate of about 95% since the market's start in 2007, with the total amount of green bonds issued crossing the USD 1 trillion mark in December 2020. The total amount of Green Bonds issued to date has almost reached USD 1.5 trillion, and the most recent projections indicate that by 2023, annual Green Bond issuance may surpass USD 1 trillion (Figure 1).

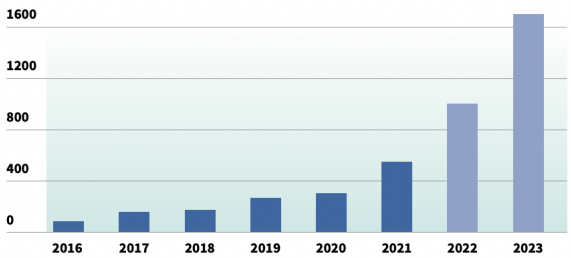

Figure 1: Green Bonds market expected growth ($bn).

Furthermore, a new, substantial branch of literature has emerged as a result of the exceptional relevance this phenomenon has taken on in academic and managerial research. Overall, this study aims to thoroughly investigate this novel phenomenon, analysing it under various perspectives, given the prominent role Green Bonds are playing and will continue to play in the near future, both from a market and academic point of view.

Literature review

In order to gain an exhaustive understanding of which studies and analyses on this topic have already been conducted, a State-of-the-Art analysis of the literature on the subject of green bonds was conducted in the first phase of this study. This analysis helped identify any potential gaps that needed to be further investigated. Despite the topic's novelty, there is a robust research environment, which can be due to the incredible importance that these financing mechanisms are taking. The existing literature concentrates on three main areas of analysis:

- the existence of a green premium;
- the existence of a liquidity premium;
- the effects of a Green Bond on the issuer.

The majority of the present literature focuses on whether there is a green premium, which is the difference in the yield between a Green Bond and a conventional bond. The greenium, then, is the premium that investors are willing to pay in order to invest in Green Bonds rather than in conventional bonds. A higher bond price translates into a lower yield to maturity for buyers, which has an effect on the issuer's cost of financing. In general, a greenium exists if the price of a conventional bond is lower (or the yield is higher) than the price of a Green Bond with the same features. The existence of this green premium has been the subject of countless investigations, but no definitive conclusion has been reached. Indeed, researchers are split into two major macro-groups: those who assert that greenium exists (such as Fatica, Panzica, and Rancan (2021), Hachenberg and Schiereck (2018), and MacAskill and colleagues (2020)) and those who believe it should be considered null (such as Hacömerolu et al. (2021), Lau, Sze, Wan, and Wong (2020), and Tang and Zhang (2018)).

Regarding the second dimension of analysis, the current literature concentrates on the analysis of the existence of a liquidity premium for Green Bonds. The presence of a liquidity premium can be explained by two key factors: the Green Bond market's disproportionate thinness and the unknown solvency profile of these green debt instruments. Contrary to predictions, the data revealed that Green Bonds are more liquid than conventional bonds.

The final major area of study included in most of the existing literature is the impact of a Green Bond issue on the issuers themselves, both financially and environmentally. In literature, we can find different papers and research aimed at analysing this topic (Tang and Zhang (2018), 2022 (Yue Wu)and Fatica and Panzica (2021)). Regarding the environmental perspective, the research appears to agree on the presence of a beneficial impact on issuers' environmental performance, both in terms of real physical emissions and the ESG score assigned to the company itself. On the other hand, regarding the financial perspective, despite the fact that the majority of the literature is inclined to affirm the existence of a positive relationship between the issuance of Green Bonds and a company's financial performance, there is a small branch of literature that claims that the issuance of a Green Bond has no impact on a company's financial results.

Green Bond Market and Regulatory Framework

Since the day the European Investment Bank (EIB) issued the first Green Bond in 2007, the global market for Green Bonds has grown incredibly. Indeed, Despite a necessary slowdown in 2020 caused on by the Covid-19 crisis, this encouraging path has permitted for the achievement of the $1.6 trillion cumulative issuance milestone in 2021 (Figure 2).

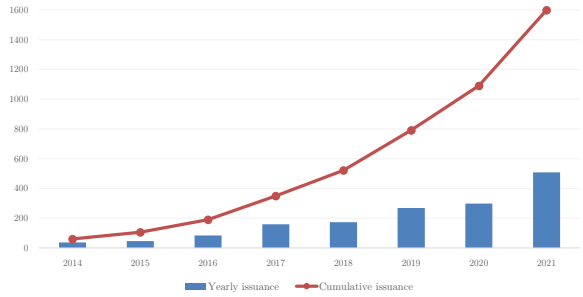

Figure 2: Green Bonds annual and cumulative issuance (2014-2021).

In particular, despite all the uncertainty that Covid-19 brought, in 2021, annual Green Bond issuance surpassed $500 billion for the first time (a 75% increase over volumes in the previous year).

Shifting the discussion to the geographic scope, the United States has historically been the largest emitter, with a cumulative emission value of almost EUR 304 billion, followed by China, France and Germany. Despite this result, on a regional level, Europe and Asia are the geographic areas with both the largest amount issued and the largest number of different issuers (until 2021). Finally, considering the types of issuers, Financial Corporates and Non-Financial Corporates are the most active in this field, both in terms of total amount and in terms of number of issuers, followed by Government-Backed Entities and Development Banks.

If the global Green Bonds market is constantly developing, the same can be said about the various regulations and standards that, especially in recent years, have been introduced to better define and regulate the market for these debt instruments. Among the various standards and guidelines, the most relevant are:

- *Sustainable Development Goals* (SDGs), a collection of 17 environmental and social objectives established by the United Nations. In particular, these objectives, applied to sustainable finance instruments, aim to mitigate climate change and ensure the protection of ecosystems, with a target date of 2030;
- *Green Bond Principles*, introduced by the International Capital Market Association (ICMA), are best practice guidelines that encourage openness, disclosure and support integrity in the growth of the Green Bond market by outlining the procedure for the issuance of a Green Bond;
- *Climate Bonds Standards*, developed by the Climate Bonds Initiative, represents one of the market's most reliable and well-regarded enforcement mechanisms. This certification apply a "mark" on a Green Bonds, and this allows investors, governments and other stakeholders to identify and prioritize low-carbon and climate resilient investments and avoid greenwashing;
- *European Green Bond Standard*, introduced by the European Commission, introduces a rigorous standard to which all issuers can voluntarily adhere, certifying the alignment of projects to be financed with the EU Taxonomy and guaranteeing investors protection from greenwashing. The application to this standard can take place by both public and private entities, even outside the European Union.

EU Taxonomy and Alignment Analysis (Mitigation)

In order to meet the EU's climate and energy targets for 2030 and reach the objectives of the European Green Deal, the Action Plan on Financing Sustainable Growth called for the development of the "EU Taxonomy", a unified classification scheme for sustainable economic activities. The EU Taxonomy is the cornerstone of the EU Action Plan on Sustainable Finance, which outlines areas of intervention to support the allocation of capital into more sustainable investments or economic activities. In particular, it represents a classification system that establish a list of economically environmentally sustainable activities. The other objective of the EU Taxonomy is to provide an appropriate definition of what economic activities qualify as environmentally sustainable, both for companies, investors and policymakers. Going more specific, the Taxonomy Regulation establishes six main environmental objectives, that businesses have to support but also not violate:

1. Climate change mitigation;
2. Climate change adaptation;
3. The sustainable use and protection of water

and marine resources;
4. The transition to a circular economy;
5. Pollution prevention and control;
6. The protection and restoration of biodiversity and ecosystems.

Regarding these six environmental objectives, the Taxonomy Regulation introduces the Technical Screening Criteria (TSC), that define the specific requirements and thresholds for an activity to be considered as significantly contributing to a sustainability objective. In practice, for each type of activity or project financed by a bond, the TSCs define whether that activity or project is aligned with the European Taxonomy. At this stage, this level of alignment can also be "partial". This is the case when an activity or project meets certain technical requirements while not meeting others. Therefore, a bond may be 100% aligned or 0% aligned to the Taxonomy, but cases of intermediate percentages may also occur.

Taking advantage of the alignment calculation methodology, directly defined within the European Taxonomy, we decided to perform an alignment analysis, focusing on the first environmental objective (Climate change mitigation). This analysis was performed in collaboration with MainStreet Partners, a London-based ESG advisory company. In particular, the main objective of this study was to investigate how many bonds are already well advanced in terms of compliance with the Taxonomy Regulation. In addition, this type of analysis allowed us to determine the most virtuous geographical regions and issuer types in terms of Taxonomy-alignement. Leveraging a database of 462 Green and Sustainability Bonds provided to us by MainStreet Partners, a meticulous data collection phase kicked off the study. Specifically, for each individual bond, we analysed, through the available documentation, every single activity and then defined the degree of alignment of the bond with the EU Taxonomy, based on whether it met the technical requirements of the latter.

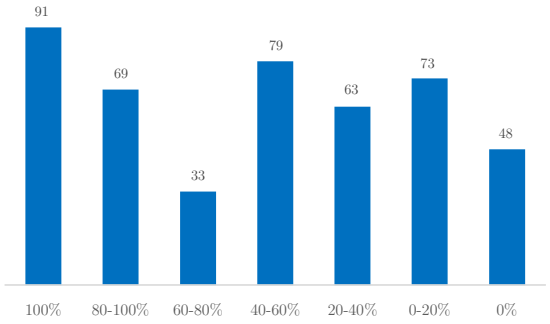

Figure 3: Number of bonds per alignment percentage obtained.

The final outcomes of this analysis, displayed in Figure 3, saw numerous bonds (20% of the database) achieving the highest degree of alignment, while 10.5% of the bonds were found to be completely non-compliant. In general, however, the overall situation cannot be considered satisfactory, as the majority of bonds (57.7%) achieved an alignment below 60%, while only the remaining 42.3% exceeded this threshold. This is probably mainly due to businesses' or institutions' lack of readiness to make investments in light of the standards set by the European Commission.

Shifting the discussion to the most virtuous geographical regions in terms of taxonomy compliance, we ascertained that Europe and Asia are the best performers to date if we consider Green Bonds, followed by the North American continent. The outcome for Europe might have been expected, given the sizeable market share that this region contributes to for Green Bonds and that the EU Taxonomy is primarily focused on Eurozone issues. Extending the discussion by considering the types of issuers, we found that corporates are the best performers considering Green Bonds, while governmental issues dominate in terms of Sustainability Bonds. Going on to analyse the average bond alignment in the different years of issuance (Figure 4), we noticed that in the period 2016-2020 the alignment is almost stable around 63-64%, in the case of Green Bonds. The big shift observed in 2021, however, is not very reliable as it refers to a very small number of observations. Talking about Sustainability Bonds, besides confirming the fact that the average alignment level of these instruments is

lower than their green counterparts, we noticed that there is a similar trend as in the previous case in the years 2017-2020, as the average alignment stands around 20%.

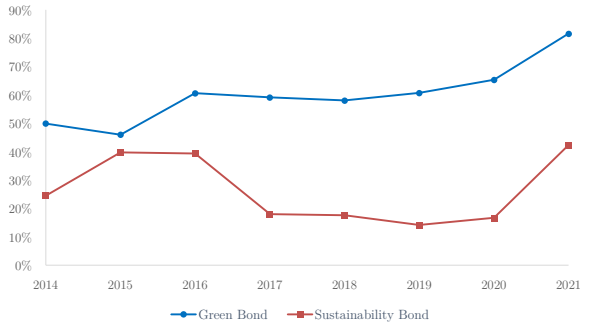

Figure 4: Average Taxonomy alignment progress per year.

Impact Reporting Analysis

Impact reporting is one regulatory component that enables the enormous potential of Green Bonds to support society's transition to a low-carbon economy to be explicitly stated. As one of the four elements of the Green Bond Principles, along with the use of proceed statement, this document details the environmental impacts made possible by the projects and/or assets financed with proceeds from Green Bonds (ICMA, 2021). It has been possible to carry out an extensive impact analysis using this kind of information, whether disclosed or not, presenting a dual objective. By identifying the most advantageous geographic areas and issuer types in terms of impact reporting availability, this analysis on the one hand enabled the identification of the most pertinent trends in impact reporting. Exploiting this kind of information, it has been possible to perform an in-depth impact analysis that allowed us to identify the most relevant impact reporting trends, by determining the most virtuous geographical regions and issuer types in terms of impact reporting availability, and investigate the true impact that Green, Social and Sustainability Bonds have on society, highlighting the geographical areas and classes of players which contribute the most in fostering a true environmental impact.

Through the use of an ad-hoc dataset created in collaboration with Main Street Partners, a meticulous data collection was required to obtain the impact information voluntarily provided by the Green, Social and Sustainability Bonds' issuers taken into consideration. Once the available impact data were gathered, these were used in order to compute cumulative and average measures on the basis of a set of meaningful environmental and social metrics. In particular, as displayed in Figure 5, it was observed that almost all the bonds in the dataset reported on the volume of greenhouse gases avoided and/or reduced. The amount of energy produced from renewable energy added and the increase in renewable energy capacity are the two additional impact metrics that are the most frequently reported.

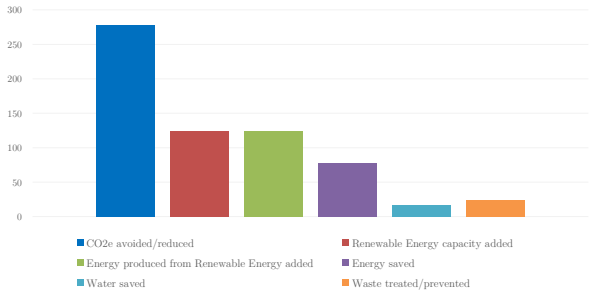

Figure 5: Number of bonds reporting on different environmental metrics.

Overall, taking into account the average results for these three environmental metrics, Green and Sustainability Bonds issued by European and Asian players ended up having the biggest environmental impacts, at least in terms of CO_2 avoided/reduced, MWh of renewable energy generated, and MW of renewable energy capacity added. In particular, this result demonstrated that, when compared to other geographical regions, the European Green Bond market represents the most mature and developed. With regard to the North America region, and the United States in particular, the results were disappointing as, despite being one of the largest issuers of Green and Sustainability Bonds, the US state has environmental impact values well below expectations, underperforming other geographical areas. Extending the discussion by considering the types of issuers, we found that financial and non-financial private players overcame Supranational, Governmental and Municipal entities both in terms of CO_2 avoided/reduced, renewable energy produced and renewable energy capacity installed.

This seems to indicate that, on average, green debt instruments issued by private entities tend to have a greater environmental impact than green products of a similar nature issued by public entities.

Empirical Research

Despite the extensive academic research that has already been done on the topic of Green Bonds, it is still possible to find new research areas. Indeed, none of the papers in the current literature takes into consideration a fundamental aspect: the bonds' alignment to the European Taxonomy. This dissertation, therefore, seeks to enrich the existing literature by attempting to include this parameter, which today, but especially in the future, will be of fundamental importance and will be a determining factor in the choices of Green Bond issuers and, above all, investors. Indeed, with the implementation of the new regulations such as the European Taxonomy, corporates and institutions will be required to invest in more sustainable projects in the coming years, and investors will be more and more likely to allocate their capital to investments that adhere to standards and regulations. Moreover, investor interest in environmental and social issues is clearly rising, both for regulatory compliance and risk mitigation purposes as well as to take advantage of new financial market opportunities. In particular, this dissertation will investigate the relationship between the yield at issuance of a group of Green Bonds and their alignment to the EU Taxonomy, in order to determine whether this important factor has any influence on the price of these financial instruments at the time of issuance. More specifically, given that a correlation exists, we expect a negative correlation between the Green Bond's yield at issuance and its degree of alignment with the EU Taxonomy. This means that a Green Bond with a high alignment score to the European Taxonomy will have a lower yield at issuance than a Green Bond with a lower alignment. Indeed, it is reasonable to assume that an investor would be willing to "give up" a portion of his financial return in order to obtain a Green Bond with the highest degree of alignment to the EU Taxonomy, and thus a debt instrument that is as close to the regulatory criteria as possible. Overall, the initial research question was formulated as follows:

> **H1a**: The yield at issuance of a Green Bond is correlated to its level of alignment with the European Taxonomy.

On the other hand, it is also reasonable to assume that, to date, a correlation between these two parameters does not exist. This assertion derives from the fact that the EU Taxonomy is, nowadays, just a best practice and not a strict regulation. Therefore, it is possible that companies, institutions and governments are not yet fully taking into account all the standards and criteria introduced by this new regulation. As a result, the following additional research question was proposed:

> **H1b**: The yield at issuance of a Green Bond is not correlated to its level of alignment with the European Taxonomy.

After outlining the research questions, an accurate methodology was implemented to test them. Firstly, it was important to adjust the starting dataset in order to assure the consistency and quality of the results acquired from our analysis. Following an initial skimming of the data we already had, a data collection phase was required. Specifically, we perform a manual bond-by-bond examination and collect the data needed to continue with the research. To be more specific, the parameters we needed were the yield at issuance, the coupon type, the bond's rating, the bond's "callability", the issue amount, the maturity and the issuer's type. Then, it has been decided to utilize a cross-sectional OLS (Ordinary Least Squares) regression model to test our hypothesis.

The regression analysis was performed on a final database of 271 Green Bonds, and the results are displayed in Figure 6

	coefficient	std. error	t-ratio	p-value	
const	2.89424	0.652620	4.435	1.36e-05	***
Alignment	−0.198428	0.231960	−0.8554	0.3931	
Rating_Score	−0.0767206	0.0174903	−4.386	1.68e-05	***
Issue_Amount	−0.198580	0.0682298	−2.910	0.0039	***
DMaturity_Range_1	0.782684	0.397700	1.968	0.0501	*
DMaturity_Range_2	1.19229	0.409988	2.908	0.0040	***
DCallability_1	0.638689	0.215336	2.966	0.0033	***
DIssuer_Type_1	−1.17032	0.474143	−2.468	0.0142	**
DIssuer_Type_2	−0.292605	0.599213	−0.4883	0.6257	
DIssuer_Type_3	−1.13520	0.465868	−2.437	0.0155	**
DIssuer_Type_4	−0.691703	0.489151	−1.414	0.1585	

Figure 6: Results of the OLS regression model.

Results show that the alignment would be negatively correlated with yield as the coefficient turns out to be negative at -0.198428. This

finding implies that yield declines as alignment rises. This outcome is consistent with H1a, but negates H1b, since not only the correlation coefficient is not null, but it is also negative; this result would suggest that investors should be willing to accept a lower return in exchange for a higher alignment to the taxonomy of the bond in question. However, the p-value is much above the threshold (0.3931) and the standard error is extremely high (0.231960). As a result, this number is not statistically significant and so unreliable. Consequently, we cannot attribute a correlation between alignment and yield, and so the first research question is rejected, while the second one is verified.

Conclusions

This dissertation tried to contribute to the scientific literature about Green Bonds through the investigation of a possible correlation between the yield at issuance of a bond and its alignment to the European Taxonomy. In fact, after having constructed an entire database of Green Bonds by calculating the alignment to the Taxonomy for each of them, an econometric regression analysis was carried out with the aim of validating one of our research questions.
On the basis of the analysis' results, we can state that, to date, there is no evidence of a correlation between the yield at issuance of a bond and its alignment to the European Taxonomy. The feeling is that investors are not yet ready to take the next step toward entirely sustainable investments at the expense of a partial reduction in economic return. Despite the fact that there appears to be a rising interest in greener financial instruments, as we have seen, the rules set forth by the European Taxonomy do not appear to have a significant impact on practitioners' actions.

However, this study calls for further research in the future. The fact that Green Bonds have evolved over the past few years from being a niche financial instrument to a mainstream product shows how quickly changing the current situation is. Once the regulatory framework is, hopefully, more harmonized and once enforcement mechanisms are better defined, future research may provide more precise and reliable evidence of Green Bonds' dependence on their alignment with the EU Taxonomy. In particular, we recommend repeating this research once the Taxonomy's requirements are enforced to verify whether the pricing of Green Bonds can be correlated with the green quality of the investments financed with these instruments, as we firstly hypothesized in this thesis.

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