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Corporate Green Bonds: an empirical analysis

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Introduction

The exponential growth of world population, the scarcity of resources and the threats to the environment are the consequences that led to a much needed transition towards a greener and more sustainable worldwide economy. In recent years governments all around the world have adopted green policies and regulations in order to tackle climate change. A clear example is the Paris Agreement, established in December 2015, it is a legally binding international treaty on climate change. Its goal is to limit global warming to 1.5 degrees celsius through economic and social transformation.

The rising concerns of climate change have also influenced the financial markets. In order to direct capital and finance towards sustainable projects, innovative tools have been created. In 2007 debt securities labeled as green (or climate) bonds have been introduced in the market. These bonds differ from conventional ones because their proceeds are aimed solely at the financing of eligible green sustainable projects such as renewable energy, green buildings, or resource conservation.

In recent years the private sector has seen an increasingly high amount of emissions of *corporate green bonds*. In this paper I will analyze this new phenomenon and try to answer important questions such as: Do companies benefit by issuing green bonds? What are the implications for shareholder wealth? Do corporate green bonds actually help improve the companies' environmental footprint?

In this paper I will also conduct an empirical analysis by comparing a dataset of corporate green bonds with comparable ordinary (or brown) bonds.

Chapter 1: Corporate Green Bonds

1.1 What is a green bond?

Green or climate bonds are a fixed-income financial instrument specifically designated to raise capital for pre-specified climate and environment friendly projects. These bonds have to follow the Green Bond Principles (GBP) stated by the International Capital Market Association (ICMA). The GBP (updated as of June 2018) are guidelines recommending transparency and disclosure and promoting integrity in the development of the green bond market by clarifying the approach for issuance of a green bond. The guideline states that the issuer must specify (i) the use of proceeds for environmentally sustainable activities, (ii) the process resolving project eligibility, (iii) criteria according to which proceeds can be tracked and verified and (iv) annual reports on the actual use of proceeds. (Ehlers and Packer, 2017).

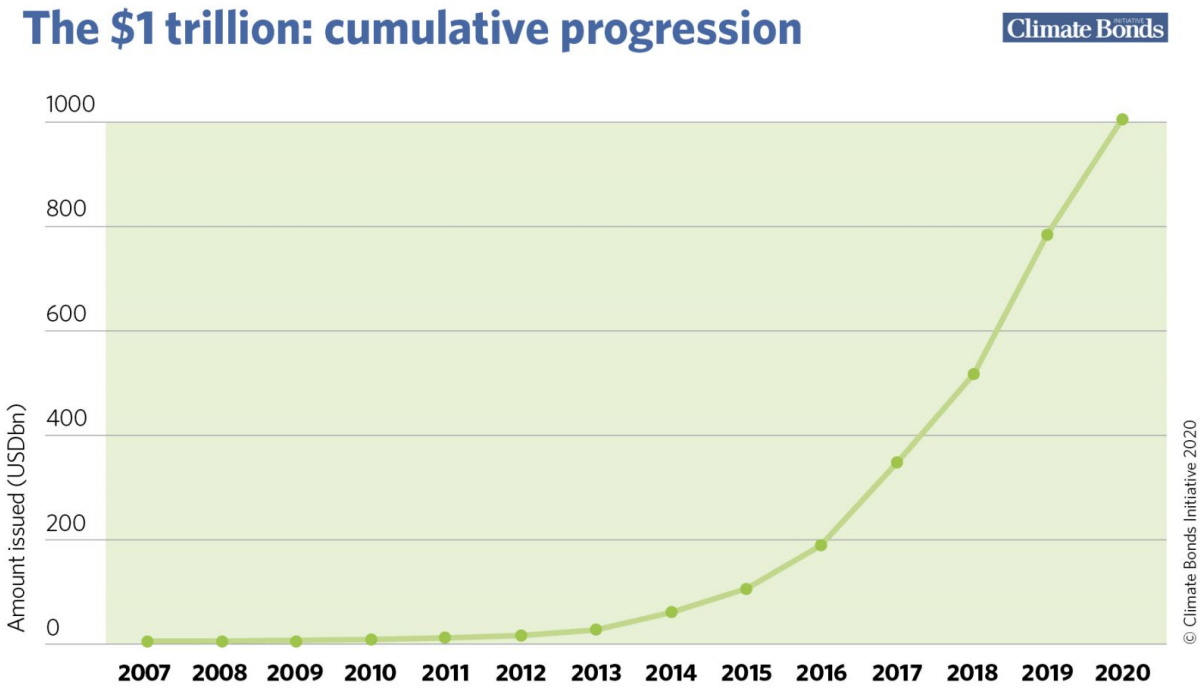
Green bonds are usually asset-linked or backed by the issuing entity's balance sheet, hence they typically carry the same credit rating of the issuer's other debt obligations. Due to this fact, green bonds have been linked to the concept of flat pricing. This has implications on the pricing and the allure of green bonds. Theoretically, investors would be more incentivized to pay a premium on a bond with a green "label", however investors would still want an acceptable financial performance of the green bond. This point is however subject to debate, as according to BNEF (Bloomberg New Energy Finance), investors are reluctant to earn lower returns just because the bond is labeled as green. Other sources, including a report from Barclay's state that green bonds do in fact trade at a premium, especially in the secondary markets.

1.1.1 The green bond market

The market for green bonds is relatively new but has seen an exponential growth in recent years. In 2007 the European Investment Bank (EIB) issued the first fixed-income asset that was designated for environmental projects. The "Climate awareness bond" was used to fund

renewable energy and energy efficiency projects. The market then started to kick-off in early 2013, when the International Finance Corporation (IFC) issued the first USD1bn green bond, which sold within one hour from issuance. A decisive moment in the market was November 2013, when Vasakronan issued the first corporate green bond. After Vasakronan, other large corporations such as Apple, SNCF, Berlin Hyp, Engie, ICBC, and Credit Agricole began to issue corporate green bonds. By the end of 2015 the green bond market reached the USD100bn mark in cumulative issuances. In November 2017 during the Climate change conference (COP23) in Bonn, green bonds were identified as a crucial financial instrument to contribute to climate finance and to reach Paris Accord agreements. In 2017 the green bond market had also reached the 250bn mark in cumulative issuances. In early December 2020, the total issuance for green bonds reached the USD 1 trillion mark.

The Climate Bond Initiative has estimated that in the 13 years since market inception the average annual growth rate is approximately 95%.



1.2 Corporate green bonds

"The green bond boom" (Morgan Stanley, 2017)

Corporate green bonds are a relatively new financial instrument but their usage has seen an exponential growth in recent years. In 2013, the total issuance of corporate green bonds was around 3B dollars, since then the issuances have more than doubled every year.

Similarly to green bonds in the public sector, corporate green bonds are fixed-income financial tools whose proceeds are committed to finance environmental and climate-friendly projects, such as renewable energy, green buildings, or resource conservation. For example Apple issued a $1B green bond to finance investments in renewable energy, "which we believe is an example of something that's good for our planet and makes good business sense as well" (Forbes, 2017).

Green bonds are becoming more and more appealing to investors, their liquidity has speedily increased as they become available in many different stock markets worldwide and enter investors portfolios. This boom is due to the fact that investors are becoming more conscious and interested in the environment and climate change, green bonds are reported to be the best financial investment vehicle to finance low carbon development (Monasterolo and Raberto, 2018).

1.2.1 Corporate green bonds across industries and countries

Table 1 reports the total issuance amounts (in $B) and number of corporate green bonds across industries. The data was collected in the period 2013-2018 and partitioned according to Bloomberg's BICS (Bloomberg Industry Classification System) codes. Looking at the data it is clear that corporate green bonds are more common in industries were the environment is an essential part of business operations (e.g., utilities, energy, transportation). Corporate green bond issuance is also common in the financials industry, in particular in the banking sector, where major private banks worldwide are increasing the issuance of green bonds every year.

Industry	# Bonds	$ Amount (billion)
Financials	554	151.0
Banking	322	117.3
Real estate	178	22.0
Others	54	11.7
Industrials	635	150.3
Utilities	112	53.1
Power generation	149	34.7
Renewable energy	223	14.9
Transportation and logistics	25	13.8
Waste and environment services and equipment	28	8.5
Forest and paper products manufacturing	10	3.7
Automobiles manufacturing	8	3.5
Travel and lodging	15	3.4
Communications equipment	2	2.5
Food and beverage	3	1.3
Containers and packaging	2	1.0
Consumer products	4	0.7
Electrical equipment manufacturing	4	0.6
Others	50	8.7
Total	1189	301.2

(Table 1, source: C.Flammer, Corporate Green Bonds, 2021)

Table 2 considers the same data of *Table 1* and reports total issuance (in $B) and number of corporate green bonds across countries. As is shown, corporate green bonds are more prevalent in China, the United States of America and Europe (in particular the Netherlands, France and Germany).

Country	# Bonds	$ Amount (billion)
China	190	75.1
Netherlands	46	33.2
United States	194	31.5
France	157	30.8
Germany	57	19.4
Mexico	9	12.2
Sweden	140	11.6
United Kingdom	25	10.8
Luxembourg	20	8.9
Spain	17	7.6
Hong Kong	31	7.4
Japan	37	6.7
Australia	15	5.4
Italy	10	4.6
Norway	20	4.4
India	17	4.2
Brazil	6	3.4
Canada	10	3.4
Denmark	4	2.1
Austria	5	1.7
South Korea	5	1.7
United Arab Emirates	3	1.6
Taiwan	21	1.6
Singapore	10	1.2
Others	140	10.9
Total	1189	301.2

(Table 2, source: C.Flammer, Corporate Green Bonds, 2021)

1.2.2 Do shareholders benefit with green bonds?

Green bond issuance comes with both benefits and costs. In this segment I will analyze a paper ,written by Dragon Yongjun Tang and Yupu Zhang of the University of Hong Kong, that predicts two main hypothesis for the issuance of green bonds:

Hypothesis I: (Green benefit) Stock prices increase after firms' green bond announcement.

The potential positive stock market reaction when a firm issues a green bond can derive from the visibility and attention a firm receives after issuing such bonds. When a firm issues a green bond, media exposure will increase exponentially compared to ordinary corporate bond issuance. Green bond issuers usually hold formal press conferences to reveal the fact they are issuing a corporate bond which follows the GBP and as such is labeled as "green". The fact that a third party certifies the commitment of the firm towards sustainable and environmental friendly projects sends strong signals to investors and the market. The so called "label effect" has a pivotal role in the issuance of corporate green bonds, because it leads to media attention which leads to investor's attention, generating more trades in the stock market, hence resulting in an improvement in stock liquidity.

Hypothesis II: Green bond issuance reveals valuable investment opportunities.

The "fundamental channel" explanation suggests that green bond issuance contains more information about valuable investment opportunities, which reduces information asymmetry and leads to the positive announcement effect (Myers and Majluf (1984), Kang and Stulz (1996)). This is due to the fact that corporate green bond issuers have to specifically illustrate the use of the proceeds of the bonds and other additional information. While, under normal circumstances, firms issuing ordinary corporate bonds disclose much less information. As a result, investors will benefit greatly from the additional information disclosed by the green bond issuers, creating positive effects in the stock market.

Recent studies have shown that Corporate Social Responsibility (CSR) and Environmental, Social and Governance (ESG) performance have significant effects on firm value and financial

performance and are associated with a lower cost of loans, lower costs of capital and superior credit rating. Corporate green bonds attract investors with a green mandate and socially responsible funds, which will push up the bond price and lower the cost of capital for the firm (Dragon Yongjun Tang and Yupu Zhang, 2020). The constant growing demand for green bonds and lower cost of capital for issuing firms, suggests that green bonds will be priced at a premium (lower yield) in the primary market.

Moreover, a study conducted in 2018 (Flammer C., Corporate Green Bonds, 2021) analyzing corporate green bonds issued by public companies globally from January 1, 2013 to December 31, 2017 revealed that green bonds yield a (i) positive stock market reaction, (ii) improvements in financial performance, an (iii) increase in environmental performance and green innovations, and an (iv) increase in stock ownership by long-term and green investors.

(i) At announcement, the issuer's stock price increases. This shows that investors expect the bonds to contribute to shareholder value. Over this period the study indicates that on average the cumulative abnormal return (CAR) was 0,67%. So, if the stock market (say, the S&P500 index) goes up by 1% over these two days, the stock of the green bond issuer increases, on average, by about 1.67%. All other periods before and after the two-day event window yield insignificant CARs, which confirms that the results are not driven by unrelated trends around the time of the announcement (Flammer, 2021). It is also important to denote that corporate green bonds which are certified by credible third-parties, such as Sustainalytics, Vigeo Eiris, Ernst & Young, and CICERO, have a much larger impact on issuer's stock prices. This is because investors know that certification is rigorous and costly, hence it shows commitment of the issuer towards the environment and establishes that the proceeds are actually going to fund sustainable projects.
(ii) Corporate green bond issuance is also associated with a 2.4% increase in long-term value, measured by the ratio of the firm's market value to the book value of its assets. The study showed that green bond issuers, in comparison with ordinary bond issuers, saw an improvement in operating performance as measured by the return on assets (ROA). Two

years after issuance, ROA increases by 0,6% points. No effects are found in the short run since investments in green projects take time to pay off.

(iii) The study clearly indicates that after green bond issuances, the firms improve their environmental performance. Their environmental score rose 6.1 percentage points on the Thomson Reuters' ASSET4 scale, which is based on more than 250 key performance indicators such as CO2 emissions, hazardous waste, recycling, and so on. They reduced their emissions by 17 tons of CO2 per $1 million of assets (Flammer, 2018). Companies also increased their green innovations by 2,1% points.

(iv) The long-term index (a measure of long-term orientation based on a textual analysis of the firms' annual reports) of green bond issuers increases by 3.9 percentage points. Corporate green bonds attract investors who are morally invested in the environment, these investors are interested in changes in the long-term and as a consequence the share of long-term investors increased from 7.1% to 8.6% (a 21% increase), and the share of green investors from 3% to 7% (a 75% increase).

1.2.3 Corporate green bonds and CSR

1.2.3a What is Corporate Social Responsibility (CSR)?

Corporate Social Responsibility (CSR) is an internal organization of private industries that aims at societal goals of a philanthropic, activist, or charitable nature. While it has always been considered as a form of self-regulation, in recent years it has moved from voluntary decisions at the level of individual organizations to mandatory schemes at regional, national, and international levels. However firm's tend to implement CSR beyond compliance with regulatory requirement in order to boost brand reputation. Recent studies have demonstrated that a positive relationship exists between a firm's corporate social responsibility policies and corporate financial performance — most notable researches have been conducted by Sang Jun Cho, Chune Young Chung, and Jason Young in which they conducted a regression analysis with the provision of several measures that they utilized to serve as proxies for key financial performance indicators (i.e. return on assets serves as a proxy for profitability).

1.2.3b CSR in relation to corporate green bonds

The economic and social purpose of a corporation is to create and distribute increased wealth and value to all of its primary stakeholder groups, without favoring one group at the expense of others (Clarkson, 1995). — This means that companies must go beyond the sole objective of profit and must also consider human, social, and environmental values, ensuring that their activities contribute to the protection of the environment, consumers, and society. Many studies have shown that there is a positive relation between CSR activities and financial performance for firms. Flammer's research showed that CSR has a significantly positive impact on companies' stock prices (Flammer, 2018). Cho et al. found a significant correlation between the level of CSR and information asymmetry. Companies can positively influence investor perception by reducing information asymmetry (Cho, Corporate social responsibility performance and information asymmetry, 2013). Thus, we can conclude that companies with a high level of CSR activities benefit both financially and in terms of brand reputation.

Studies have been conducted examining correlations among green bond issuance, CSR, and environmental performance. Two main factors have been considered, issuance significance and issuance costs. Issuance of green bonds demonstrates the commitment of a corporation to move towards a climate-friendly perspective. The issuance of green bonds also helps corporations to reduce financing costs and improve efficiency of using resources.

1.2.4 Corporate green bond concerns — "green washing"

We can define as "green washing" the practice of making unsubstantiated or misleading claims about a company's environmental commitment. A firm could issue green bonds in order to boost their public image without actually delivering the environmental projects. This has risen major concerns among practitioners for the fact that there is a lack of public governance regulating the issuance of green bonds. Third parties who can certificate green bonds exist, but firms are in no way legally required to consult them. Also, guidelines for green bond issuance such as GBP are not mandatory for firms to follow. If the greenwashing motive prevails, corporate green bonds are unlikely to have any real impact.

In 2018 Caroline Flammer of Boston University conducted an empirical study to analyze this phenomenon. She analyzed a dataset of green bonds to study if these bonds have an actual impact on the environmental footprint of the issuing companies or whether they are merely a tool of greenwashing. The results of the study indicate that after green bond issuance, firms register large improvements in environmental performance. Respectively, "i) an increase in the company's environmental score (measured by the environmental rating of Thomson Reuters' ASSET4), and ii) a decrease in CO_2 emissions. Second, the results indicate an increase in the filing of green patents. Overall, these results indicate that green bond issuers do invest the proceeds in green projects that improve their environmental footprint" (Flammer, Corporate Green Bonds, 2018).

As such, the results are inconsistent with the greenwashing motive and indicate that on average firms do improve their environmental footprint following the issuance of green bonds. However, this is only observed among green bonds that are certified by independent third parties. For non-certified green bonds, there are no significant changes in environmental performance, which could be symptomatic of greenwashing.

Chapter 2: Empirical Analysis

In this second part of my thesis I will conduct an empirical analysis on a dataset of corporate green bonds in comparison to a comparable set of conventional corporate bonds. The objective is to analyze how much and in which way different factors influence the yields of corporate green bonds. I will do this by elaborating an econometric model, specifically I will focus on the bonds Yield To Maturity (YTM) by running two main multivariate linear regressions. The first regressions dependent variable is the YTM of the corporate green bonds while the second one's is the delta (difference) between the YTM of the green bonds and the brown bonds. The independent variables will be the same for both the first and the second regression and will be the volatility, S&P rating, ESG score, term to maturity, and the sector regarding the corporate green bonds.

The choosing criterion of the dataset consists in considering for each issuing firm (selected randomly from firms that issued at least 1 green bond) one or more pair of bonds (one being green and the other conventional) of which some key features must be equal or at least similar. In my research, green and brown bonds are similar in: *(a) Amount issued* — the issued amount of a bond offering is the number of bonds issued multiplied by the face value. *(b) Issue date* — the date on which a bond is issued and begins to accrue interest. *(c) Maturity date* — The maturity date is the date on which an investor can expect to have their principal repaid. For each pair of bonds I computed the deltaYTM by subtracting the value of the "conventional" YTM from the "green" YTM.

The linear regressions are conducted on a sample of 45 corporate green bonds and their comparable counterpart from the same issuer. The bonds were issued in the period 2014-2020 by firms that operate in the financial, utilities, consumer staples, consumer discretionary, and communications sectors. The data was exported from Bloomberg and the values are as of June 2021.

2.1 Introducing the data

2.1.1 Key variables

In this study I will consider data for both corporate green bonds and corporate "brown" bonds. For "brown" bonds I am referring to ordinary debt securities that are issued by firms and sold to investors. All the data that I will use on this paper can be found on Bloomberg. The variables that I will consider are the following:

i. Yield to maturity (YTM)

Yield to maturity (YTM) is the total return anticipated on a bond if the bond is held until it matures. Meaning it is essentially the internal rate of return (IRR) associated with buying that bond and holding it until its maturity date. In other words, it is the return on investment associated with buying the bond and reinvesting its coupon payments at a constant interest rate. All else being equal, the YTM of a bond will be higher if the price paid for the bond is lower, and vice-versa.

ii. Volatility

The volatility of a bond is the standard deviation of the bond price. In the regression the volatility refers to 260 days prior the exportation of the data.

iii. ESG Score

Environmental, social, and governance (ESG) criteria are a set of standards for a company's operations. In my sample of bonds the ESG scores are those given by Bloomberg and can range from [0,100]. Socially conscious investors can use the ESG score to screen potential investments.

iv. Standard & Poor's rating

S&P rating indicates the creditworthiness of the issuer, defined as the likelihood of default or inability to pay debts in a timely manner. S&P rating values are associated to letters with the maximum value being AAA and the minimum D. To fit this variable in the regressions I assigned a value from [1 to 8] to each bond's S&P rating (see Table below).

AAA	AA	A	BBB	BB	B	CCC	D
8	7	6	5	4	3	2	1

v. Dummy sector

This is a dummy variable — a variable that can assume two values [0,1]. In the case of our sample, the dummy variable assumes the value [1] when the bond is issued by a company in the services sector and [0] in manufacturing.

vi. Term to maturity

The last independent variable is the term to maturity. Which is simply the value in years (or fraction of years) of the bond from its issue date to its maturity date.

Term to maturity (years) = Issue date — Maturity date

2.1.2 Dataset

Table 1 illustrates the data regarding the 90 green and brown bonds I have exported from Bloomberg. On the far left you can see the (i) issuing company's name. Next, moving right on the table there is the (ii) sector in which the company operates and the value of the (iii) dummy variable which can be [0 or 1]. Then we find the (iv) ESG score and the (v) S&P rating which are described in the above paragraph. Next we have the (vi) issued amount, the (vii) issue date, and the (viii) term to maturity. Lastly we find the (ix) 90 day bond volatility, (x) 260 day bond volatility, and (xi) the mid value of the YTM, which is simply the mean between the ask and bid values of YTM.

Table 1: Descriptive data. In color green (green corporate bonds), In color brown (ordinary corporate bonds). Source: Bloomberg

Issuer Name	Sector	Dummy sector	ESG Score	S&P Rating	Amt Issued	Issue Date	Term to Maturity	90D Volatility	260D Volatility	Yld to Mty (Mid)
ALD SA	Consumer Discr.	0	37.6	BBB	500,000,000	10/11/2018	4.0	0.21	0.75	-0.31
ALD SA	Consumer Discr.	0	37.6	BBB	500,000,000	7/18/2019	4.0	0.36	1.06	-0.15
Bank of Nova Scotia/The	Financials	1	53.5	A-	445,471,000	7/18/2019	3.5	0.42	0.79	0.23
Bank of Nova Scotia/The	Financials	1	53.5	A-	414,722,000	12/5/2019	4.0	0.91	1.12	0.61
Barclays PLC	Financials	1	49.1	BBB	500,000,000	11/14/2017	6.0	0.28	0.85	-0.13
Barclays PLC	Financials	1	49.1	BBB	662,822,250	11/15/2018	4.3	1.07	1.12	1.06
BNP Paribas SA	Financials	1	53.1	A+	500,000,000	12/1/2016	5.5	0.12	0.30	-0.50
BNP Paribas SA	Financials	1	53.1	A+	578,385,000	8/16/2016	6.0	0.36	0.57	0.28
BNP Paribas SA	Financials	1	53.1	A-	500,000,000	4/17/2018	6.0	0.68	1.09	-0.14
BNP Paribas SA	Financials	1	53.1	A-	500,000,000	1/19/2018	5.0	0.13	0.34	-0.41
BNP Paribas SA	Financials	1	53.1	A-	750,000,000	12/4/2019	6.5	1.24	1.67	0.08
BNP Paribas SA	Financials	1	53.1	A-	850,000,000	3/19/2018	7.0	1.12	1.51	0.02
BNP Paribas SA	Financials	1	53.1	A-	750,000,000	2/28/2019	5.5	0.86	1.28	-0.08
BNP Paribas SA	Financials	1	53.1	A-	875,000,000	5/22/2018	5.5	0.52	0.94	-0.22
BRF SA	Consumer Staples	0	63.2	BB-	500,000,000	6/3/2015	7.0	0.34	0.94	0.20
BRF SA	Consumer Staples	0	63.2	BB-	549,440,250	5/22/2014	10.0	2.41	2.84	2.48
BRF SA	Consumer Staples	0	63.2	BB-	500,000,000	6/3/2015	7.0	0.42	1.33	0.23
BRF SA	Consumer Staples	0	63.2	BB-	549,440,250	5/22/2014	10.0	2.25	3.10	2.48
CNP Assurances	Financials	1	55.3	BBB+	750,000,000	11/27/2019	30.7	4.26	4.64	2.00
CNP Assurances	Financials	1	55.3	BBB+	750,000,000	12/10/2015	31.5	1.71	2.90	3.07
Commonwealth Bank of Australia	Financials	1	50.0	AA-	321,642,000	3/31/2017	5.0	0.24	0.23	0.18
Commonwealth Bank of Australia	Financials	1	50.0	AA-	335,168,400	9/18/2017	5.0	0.21	0.37	0.22
Covivio	Financials	1	47.9	BBB+	500,000,000	5/20/2016	10.0	1.51	1.68	0.01
Covivio	Financials	1	47.9	BBB+	595,000,000	6/21/2017	10.0	1.93	2.05	0.31
Covivio	Financials	1	47.9	BBB+	500,000,000	9/17/2019	12.0	4.01	3.81	0.71
Covivio	Financials	1	47.9	BBB+	300,000,000	2/20/2018	10.0	2.31	2.30	0.60
Credit Agricole SA	Financials	1	55.7	A-	1,000,000,000	10/21/2019	6.0	1.41	2.01	0.11
Credit Agricole SA	Financials	1	55.7	A+	336,990,000	10/2/2019	5.0	1.37	1.45	0.79
Credit Agricole SA/London	Financials	1	55.7	A+	1,000,000,000	12/5/2018	5.0	0.46	0.80	-0.30
Credit Agricole SA/London	Financials	1	55.7	A-	1,021,196,250	4/24/2018	5.0	1.20	2.00	0.45
Engie SA	Utilities	1	57.0	BBB+	750,000,000	3/27/2020	8.0	2.32	2.40	0.20
Engie SA	Utilities	1	57.0	BBB+	750,000,000	6/11/2020	7.0	2.04	2.13	0.07
Engie SA	Utilities	1	57.0	BBB+	750,000,000	6/21/2019	8.0	2.00	2.15	0.05
Engie SA	Utilities	1	57.0	BBB+	750,000,000	9/4/2019	7.5	1.98	2.07	0.04
Engie SA	Utilities	1	57.0	BBB+	900,000,000	10/24/2019	11.0	3.67	3.70	0.38
Engie SA	Utilities	1	57.0	BBB+	500,000,000	9/19/2018	15.0	4.10	4.16	0.68
Engie SA	Utilities	1	57.0	BBB+	500,000,000	9/28/2017	5.4	0.24	0.46	-0.23
Engie SA	Utilities	1	57.0	BBB+	750,000,000	3/13/2015	7.0	0.08	0.26	-0.11
Engie SA	Utilities	1	57.0	BBB+	750,000,000	6/21/2019	20.0	6.58	6.81	0.95
Engie SA	Utilities	1	57.0	BBB+	600,000,000	10/24/2019	22.0	7.46	7.67	1.04
Engie SA	Utilities	1	57.0	BBB+	700,000,000	3/27/2017	7.0	0.55	0.82	-0.18
Engie SA	Utilities	1	57.0	BBB+	500,000,000	9/19/2018	7.0	1.21	1.42	-0.06
Engie SA	Utilities	1	57.0	BBB+	1,300,000,000	5/19/2014	12.0	1.02	1.40	-0.06
Engie SA	Utilities	1	57.0	BBB+	750,000,000	3/13/2015	11.0	1.19	1.45	-0.02
Fibria Overseas Finance Ltd	Materials	0	61.2	BBB-	654,245,200	1/17/2017	10.0	2.48	3.91	2.45
Fibria Overseas Finance Ltd	Materials	0	61.2	BBB-	509,271,000	11/14/2017	7.2	1.71	2.80	1.66
KBC Group NV	Financials	1	56.6	A-	500,000,000	6/27/2018	5.0	0.36	0.72	-0.32
KBC Group NV	Financials	1	56.6	A-	500,000,000	4/10/2019	6.0	1.11	1.42	-0.02
La Banque Postale SA	Financials	1	38.2	BBB	750,000,000	4/24/2019	10.0	3.14	3.30	0.44
La Banque Postale SA	Financials	1	38.2	BBB	750,000,000	7/13/2018	10.0	2.65	2.86	0.39
MAF Sukuk Ltd	Financials	1	34.3	BBB	535,239,000	5/14/2019	10.0	5.00	5.49	2.74
MAF Sukuk Ltd	Financials	1	34.3	BBB	456,254,500	11/3/2015	10.0	2.74	3.02	1.73
Manulife Financial Corp	Financials	1	49.6	A-	393,876,600	5/9/2018	10.0	0.70	0.80	1.14
Manulife Financial Corp	Financials	1	49.6	A-	507,774,000	8/18/2017	12.0	1.41	1.29	1.35
MTR Corp Ltd	Consumer Discr.	0	38.0	AA+	37,104,964	7/27/2017	30.0	12.95	16.28	2.58
MTR Corp Ltd	Consumer Discr.	0	38.0	AA+	35,448,440	6/13/2016	30.0	12.90	12.33	3.13
MTR Corp Ltd	Consumer Discr.	0	38.0	AA+	85,090,100	9/27/2017	30.0	13.16	12.59	3.12
MTR Corp Ltd	Consumer Discr.	0	38.0	AA+	79,100,010	6/28/2017	30.0	13.00	12.50	3.14
National Australia Bank Ltd	Financials	1	61.8	AA-	197,059,500	12/16/2014	7.0	0.24	0.23	0.18
National Australia Bank Ltd	Financials	1	61.8	AA-	187,455,600	8/5/2015	7.0	0.27	0.75	-0.57
Nordea Bank Abp	Financials	1	44.3	#N/A N/A	500,000,000	6/30/2017	5.0	0.12	0.31	-0.50
Nordea Bank Abp	Financials	1	44.3	A	643,379,250	8/30/2018	5.0	2.21	2.64	0.56
Ontario Power Generation Inc	Utilities	1	31.0	BBB+	525,102,400	4/8/2020	10.0	5.57	4.71	2.23
Ontario Power Generation Inc	Utilities	1	31.0	BBB+	340,337,500	9/13/2019	10.0	5.40	4.46	2.08
Ontario Power Generation Inc	Utilities	1	31.0	BBB+	331,985,000	1/18/2019	30.0	11.92	11.58	3.39
Ontario Power Generation Inc	Utilities	1	31.0	BBB+	204,202,500	9/13/2019	31.0	12.98	11.59	3.38
Raiffeisen Bank International AG	Financials	1	53.1	A-	500,000,000	7/5/2018	3.0	0.10	0.17	-0.52
Raiffeisen Bank International AG	Financials	1	53.1	#N/A N/A	500,000,000	12/4/2018	5.0	0.47	0.73	-0.18
Royal Bank of Canada	Financials	1	46.9	A	500,000,000	5/2/2019	5.0	0.71	1.02	-0.18
Royal Bank of Canada	Financials	1	46.9	A	462,968,000	10/29/2019	5.1	1.45	1.52	0.71
Schneider Electric SE	Industrials	0	59.1	A-	300,000,000	10/13/2015	10.0	1.27	1.63	-0.27
Schneider Electric SE	Industrials	0	59.1	A-	750,000,000	3/11/2015	10.0	0.97	1.17	-0.20
Societe Generale SA	Financials	1	59.2	A	500,000,000	10/5/2016	5.0	0.04	0.16	-0.53
Societe Generale SA	Financials	1	59.2	A	444,159,144	6/3/2016	7.0	0.18	0.22	0.29
Stockland Trust	Financials	1	59.9	A-	300,000,000	11/3/2014	7.0	0.17	0.37	0.87
Stockland Trust	Financials	1	59.9	A-	169,420,750	11/23/2015	7.0	0.44	1.91	1.15
Suzano Austria GmbH	Materials	0	61.2	BBB-	629,870,500	7/14/2016	10.0	3.24	3.47	2.07
Suzano Austria GmbH	Materials	0	61.2	BBB-	1,488,336,500	9/20/2018	10.3	15.42	16.66	3.12
Suzano Austria GmbH	Materials	0	61.2	BBB-	629,870,500	7/14/2016	10.0	2.50	3.16	2.08

Suzano Austria GmbH	Materials	0	61.2	BBB-	1,488,336,500	9/20/2018	10.3	4.87	6.01	3.12
TenneT Holding BV	Utilities	1	39.7	#N/A N/A	500,000,000	5/12/2016	6.0	1.11	0.76	-0.30
TenneT Holding BV	Utilities	1	39.7	A-	500,000,000	2/9/2010	12.0	0.21	0.29	-0.44
TenneT Holding BV	Utilities	1	39.7	#N/A N/A	500,000,000	5/12/2016	8.0	1.72	1.28	-0.18
TenneT Holding BV	Utilities	1	39.7	A-	500,000,000	2/21/2011	12.0	0.36	1.21	-0.37
Vodafone Group PLC	Communications	1	50.6	BBB	750,000,000	5/24/2019	7.5	1.85	1.97	0.07
Vodafone Group PLC	Communications	1	50.6	#N/A N/A	500,000,000	7/24/2017	10.0	2.18	2.21	0.14
Westpac Banking Corp	Financials	1	56.1	AA-	74,817,576	2/27/2018	5.0	0.77	1.25	0.66
Westpac Banking Corp	Financials	1	56.1	AA-	63,654,000	7/13/2018	5.0	0.70	1.88	2.64
Woolworths Group Ltd	Consumer Staples	0	48.8	BBB	253,109,200	4/23/2019	5.0	1.13	0.90	0.72
Woolworths Group Ltd	Consumer Staples	0	48.8	BBB	240,122,000	5/20/2020	5.0	2.07	1.52	1.07

Table 2: Descriptive data on corporate green bonds by sector. Source: Bloomberg

	Amt Issued	Term to Maturity	S&P Rating	ESG Score	260D Volatility	YTM (Mid)
Sector	Total	Mean	Mean	Mean	Mean %	Mean %
Financials	12,268,105,676	7.55	5.87	51.63	1.43	0.27
Utilities	7,507,087,400	11.40	5.18	49.14	3.28	0.57
Materials	1,913,986,200	10.00	5.00	61.16	3.52	2.20
Consumer Staples	1,253,109,200	6.33	4.33	58.40	1.06	0.39
Communications	750,000,000	7.50	5.00	50.62	1.97	0.07
Consumer Discretionary	622,195,064	21.33	6.33	37.88	9.87	1.80
Industrials	300,000,000	10.00	6.00	59.09	1.63	(0.27)
	24,614,483,540	**9.55**	**5.56**	**51.33**	**2.58**	**0.56**

Table 3: Descriptive data on corporate brown bonds by sector. Source: Bloomberg

	Amt Issued	Term to Maturity	S&P Rating	ESG Score	260D Volatility	YTM (Mid)
Sector	Total	Mean	Mean	Mean	Mean %	Mean %
Financials	11,904,349,144	7.71	5.87	51.63	1.52	0.65
Utilities	6,144,540,000	12.86	5.18	49.14	3.34	0.57
Materials	3,485,944,000	9.27	5.00	61.16	8.49	2.64
Consumer Staples	1,339,002,500	8.33	4.33	58.40	2.49	2.01
Industrials	750,000,000	10.00	6.00	59.09	1.17	(0.20)
Consumer Discretionary	614,548,450	21.33	6.33	37.88	8.63	2.04
Communications	500,000,000	10.00	5.00	50.62	2.21	0.14
	24,738,384,094	**10.13**	**5.56**	**51.33**	**2.97**	**0.91**

The mean value of YTM regarding corporate green bonds is 0.56% as shown in Table 2. The value is 38% lower than the mean of the YTM of ordinary corporate bonds (see Table 3). This indicates that investors are willing to pay a premium (a lower yield) on green bonds. The total issuances in billions of dollars are 24.61 for the 45 green bonds and 24.74 for the 45 brown bonds. In both typologies the financials sector is the most prominent with approximately 12B of issuances each.

Regarding Green Bonds: The range of bonds amounts issued vary from a minimum of approximately 37M to a maximum of 1.3B. While the range of the YTM's is (-0.53%; 3.39%). The range of the term to maturity is (3 years; 30 years). Lastly the volatility ranges from a minimum of 0.16% to a maximum of 16.3%.

Regarding Brown Bonds: The range of bonds amounts issued vary from a minimum of approximately 35M to a maximum of 1.49B. While the range of the YTM's is (-0.57%; 3.38%). The term to maturity is (4 years; 31.5 years). Lastly the volatility ranges from a minimum of 0.22% to a maximum of 16.66%.

Tables 2 and 3 indicate that the mean value for both ESG scores and S&P ratings are the same for both green and brown bonds. This is because these variables are tied to the issuing firms and not the single bonds. On the other hand we can see that on average the brown bonds present a higher volatility (2.97%) than the green bonds (2.58%). Indicating that green bonds prices are more stable.

2.2 Multivariate linear regressions

Now that the data has been introduced, we can proceed with the multivariate linear regressions. As stated in the first paragraph of Chapter 2, I will run two linear regressions in order to analyze which factors influence the yields of corporate green bonds. These regressions are made on the program SPSS.

2.2.1 Regression on YTM (green)

The first regression illustrates the effects of different variables on the Yield To Maturity (YTM) on the sample of 45 corporate green bonds.

Dependent variable: Yield To Maturity (mid)

Independent variables: ESG score, S&P rating, Volatility 260 days, Term to maturity, and the dummy variable regarding the sector

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,815[a]	,664	,621	,665431093345

Coefficients[a]

Model		Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1,201	1,115		1,077	,288
	ESG Score	-,006	,014	-,052	-,456	,651
	S&P Rating	-,142	,139	-,100	-1,027	,311
	260D Volatility	,175	,077	,545	2,254	,030
	Term to Maturity	,032	,032	,213	1,004	,322
	Dummy sector	-,355	,278	-,138	-1,276	,209

The adjusted R-squared is quite relevant and it's equal to 0.621. The only statistically significant regressor is the 260d volatility, it presents a p-value ≤ 3%. The other four are not statistically significant. However we can study the sign and magnitude of the beta coefficients for all the variables. All of the coefficients are coherent with standard economic predictions. Volatility is positive and relevant, the YTM varies 0.175% for every 1% increase of volatility.

The ESG score is not statically relevant (p-value ≤ 65%) and the coefficient's magnitude is relatively small. We can however state that the sign of the coefficient is negative as predicted — since higher ESG scores indicate that a company is more invested in environmental and social causes, meaning that investors are willing to receive lower yields (a reason could be that investors consider the companies more reliable). The same can be said about the S&P rating, as a matter of fact the coefficient's sign is negative. The magnitude (0.14% every rating point) and the statistic significance (p-value ≤ 31%) are also more relevant.

The term to maturity is in line with standard economic theories. The sign of the coefficient is positive, indicating that for longer periods of time, investors ask for higher yields.

The last variable analyzed is the issuing firms sector. The sign of the coefficient is negative meaning that in the services sector (financials, utilities, communications) the yields to maturity are lower than those in the manufacturing sector. This may be due to the fact that in the services sector it is much harder for firms not to deliver the green project associated with the green bond. While in the manufacturing sector greenwashing practices are much easier to achieve.

2.2.2 Regression on deltaYTM (green - brown)

This regression illustrates the effects of different variables on the delta Yield To Maturity (YTM) on the sample of 45 corporate green bonds and 45 corporate brown bonds.

Dependent variable: ΔYTM = YTM (green) — YTM (brown), for each pair of comparable bonds

Independent variables: ESG score, S&P rating, Volatility 260 days, Term to maturity, and the dummy variable regarding the sector

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
2	,444[a]	,197	,094	,659711067525

Coefficients[a]

Model		Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	T3	Sig.
2	(Constant)	-,040	1,106		-,037	,971
	ESG Score	-,018	,014	-,236	-1,333	,190
	S&P Rating	,057	,138	,062	,413	,682
	260D Volatility	,064	,077	,310	,830	,412
	Term to Maturity	-,021	,032	-,221	-,674	,504
	Dummy sector	,466	,276	,283	1,691	,099

In this regression the adjusted R-squared is lower than the one in the previous regression, and it is equal to 0.094. In this case the only statistically significant beta is the dummy variable

associated to the sector of the issuing firm. The p-value is ≤ 10%. The coefficient's sign is positive, and there is an increment of 0.466% in the deltaYTM when we switch the dummy variable value. This might seem in contradiction with the statement about greenwashing in the above paragraph. In fact, this relation indicates that the premium investors are paying on green bonds, diminishes when we move from the manufacturing to the services sector (in which it's harder to implement greenwashing practices). However, if we observe the premiums in percentage terms compared to the means of the YTM of both the sectors (in the services sector YTM is much lower) the situation turns and the premium increases from 30% to 40%.

The ESG score variable — although not acceptable under statistical standards (≤ 5%; ≤ 10%) presents a p-value ≤19%, the second most significant in the regression. The coefficient's sign is negative indicating that the premium on green bonds is higher for companies more invested in environmental causes.

The S&P rating coefficient presents a positive sign. The potential reason being that the boost to the creditworthiness of a firm given by the issuance of green bonds is less relevant when the firms S&P rating is higher.

The beta associated with the 260 day volatility indicates a positive sign. Hence, the premium on green bonds diminishes for higher values of volatility. If the bond price is particularly volatile the distinction between green and brown bonds tends to be less relevant.

In regards to variable *term to maturity* of the bonds, the coefficient's sign is negative meaning that for bonds with longer duration the premium increases.

Conclusions

In recent years both investors and corporations have realized that climate change is a serious threat to our society. This is mirrored by the exponential growth of sustainable financial instruments like green bonds. The evidence suggests that corporate green bonds are a win-win, as they benefit both companies and shareholders but more importantly the environment. However the market for green bonds is still at its early stages and in order to draw conclusions on wether green bonds will be a viable tool to tackle climate change, we will have to wait for the market to reach a much bigger scale.

The lack of clear regulation and governance on green bonds poses serious concerns. Studies suggest that for third-party certified green bonds the effects on the environment are positive. On the other hand non-certified green bonds don't seem to have a real impact on the environment. This is of course symptomatic of greenwashing practices which are probably the biggest concern when analyzing green bonds, since they were created as a tool to tackle environmental issues.

The positive reactions of the stock market when firms announce green bonds highlight investors awareness on climate change issues. Commitments towards sustainable finance with issuance of green bonds seems beneficial for both companies and investors. The reduction of information asymmetry given by the additional information that companies disclose when issuing green bonds — in comparison with the information given for ordinary ones — helps investors make more informed decisions.

The empirical analysis conducted on this thesis has also shown that corporate green bonds come with a premium (lower yields) when compared to ordinary bonds. At first glance one may think that investors are willing to pay a premium because of their moral standpoint on environmental issues. In my opinion this is partly true, however, my analysis has shown that green bond issuance sends positive signals of creditworthiness of the firm to investors — this is probably because investors view a company's commitment to sustainable causes as a "label of trust". This point is highlighted in the second multivariate linear regression (2.2.2 Regression on deltaYTM). The positive coefficient of the S&P rating, illustrates that when the rating is higher

the delta between the YTM of green and brown bonds diminishes. This indicates that if a company already has a high rating (is already reliable) the financial effects that arise with green bond issuance are less relevant.

All things considered, it might be too early to give clear assessments of the real impact of corporate green bonds on the financial markets. These new financial instruments are extremely interesting, and have the potential to be crucial tools in the financial scenario.

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