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The Green Bond Market Development

Evidence from French and German Debt Markets

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ABSTRACT:

A green bond is a relatively new debt instrument where the proceeds are allocated to environmentally friendly projects. The aim of this thesis is to examine French and German primary and secondary green bond markets starting from their inception. More precisely, this study investigates if investors in both markets earn lower yields for green bonds compared to bonds without the green label. Prior green bond research has focused on the pricing differences between green and conventional bonds; thus, this thesis adds to that literature by comparing French and German markets.

The first part of the study focuses on the green bond premium in the primary markets. A fixed-effects regression is applied to capture the effect of green label on bond prices. In the secondary market analysis, a matching method is implemented, in which a green bond is matched with an equivalent conventional bond. Next, a panel regression with fixed effects is executed to capture the green bond premium for each bond pair. Lastly, a regression model with different bond characteristics is built to explain the estimated green bond premium.

The primary market analysis finds a negative insignificant green bond premium for both countries. For French green bonds, the analysis finds -12 bps negative issue yield whereas for German green bonds the issue yield is -5.6 bps. However, based on the primary market results, the study does not find enough evidence that green bonds are traded at lower yields compared to conventional bonds. The secondary market analysis reveals a statistically insignificant green bond premia for both countries. On average, French green bonds trade at -0.42 bps lower yields compared to their comparable conventional bonds. The analysis finds a positive green bond premium for German green bonds. On average, the green bonds trade at 3.8 bps higher yields than comparable conventional peers. The subsample analysis shows that bonds issued by sovereign entities and bonds with Aa1 rating have a positive effect on the premium in German markets. Further research about the factors that might have an effect on the estimated premium reveals that none of the chosen characteristics could explain the premium.

KEYWORDS: Green bonds, Bond pricing, ESG, SRI

Contents

Figures

Tables

1 Introduction

The effects of climate change are becoming more and more visible. For the past decade, the world has experienced severe and more frequent weather extremes, such as wildfires, hurricanes, and floods. Consequently, this has put more pressure on government officials to act urgently to meet climate objectives and to achieve sustainable economic growth. However, according to OECD (2019), national programs to meet the global goals of the Paris Agreement are not sufficient. Paris Agreement (United Nations, 2015, p.3) states "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels". In addition, the Agreement claims that financing should be aligned with the goal of climate-resilient development.

However, change is happening in the finance sector towards greener investing. Sustainable finance is facing significantly more demand from retail and institutional investors (OECD,2020). According to The Global Sustainable Investment Alliance (2018), sustainable investing assets in Europe, the United States, Japan, Canada, and Australia/New Zealand were $30.7 trillion at the start of 2018, which was 34 per cent more than in 2016. Sustainable investing includes a group of environmental, social, and corporate governance (ESG) factors (IMF, 2019). These factors are becoming more important for investors and borrowers.

One of the recent sustainable finance innovations is the green bond. A green bond is a type of bond whose proceeds are earmarked to finance environmentally friendly projects, assets, or other activities (European Commission, 2016). The world's first climate awareness bond was issued in 2007 by the European Investment Bank (EIB, 2020). Since then, the market for green bonds has rapidly grown. In 2019, for the first time, the amount of issued green bonds exceeded $250 billion (CBI, 2020). According to the Climate Bonds Initiative's green bonds global state of the market 2019 report (2020), all regions increased volume in issuances. The report shows that Europe was the leading region by amount issued, followed by Asia-Pacific and North America. Additionally,

supranational organizations managed to increase their amount issued by 9 % compared to 2018. Since the first issuance of a green bond in 2007, the cumulative amount issued has surpassed $754 billion.

Figure 1 presents the top 10 green bond issuing countries. As can be seen from this figure, France and Germany are the leading countries in the European green bond market. According to CBI (2020), in 2019, France green bond issuance amount was $30.1 billion and Germany's $18.7 billion. The report displays that France ranks first in Europe and 3rd globally, while Germany is the 4th biggest issuer worldwide. Moreover, both countries saw a great increase in volume in 2019.

Figure 1

Green bond top 10 issuer domiciles 2019

Top 10 issuer domiciles 2019

Country	Issuers	Deals	Amount issued (USDbn)	2018-19 change (amount)
1 USA	105	1,128	51.3	44% +
2 China	79	99	31.3	1% +
3 France	19	54	30.1	113% +
4 Germany	12	25	18.7	144% +
5 Netherlands	15	17	15.1	105% +
6 Sweden	40	106	10.3	66% +
7 Japan	47	66	7.2	73% +
8 Canada	14	17	7.0	63% +
9 Italy	10	11	6.8	128% +
10 Spain	11	17	6.5	3% +
Top 10 total	**352**	**1,540**	**184.3**	**49% +**
Top 10 %	**69.6%**	**85.5%**	**71.2%**	**-0.9% -**

Although the green bond market is growing exponentially, there has been some skepticism regarding green bond guidelines, definitions, and taxonomy (Tang & Zhang, 2020). Presently, there are two main green bond standards: Green Bond Principles (GBP) and the Climate Bond Initiative (CBI). Implementing a uniform standard to evaluate

greenness that would be a generally accepted criterion to assess green bonds is a challenging task. According to critics, green bond market growth will slow down in the future due to the fragmentation of standards and labeling. In addition, investors can only access data on green bond's environmental impact through third-party verification or voluntary acknowledgment (Tang & Zhang, 2020).

1.1 Motivation and purpose of the study

The green bond market and sustainable financing have developed strong momentum over the years. Reflecting on the fact that investors and companies are focusing more on ESG factors. While green bonds account only for a small portion of a global bond market, green bonds now offer an effective tool for investors and companies to meet a variety of objectives, including diversification, and financial return. In the European green bond market, France and Germany are the leading countries. Gaining an understanding of the market characteristics can provide valuable information about the price impact of investors' preferences.

Potential price impact could indicate that green bonds are priced differently compared to the matching conventional bonds. The green bond premium has been studied in the recent academic literature and the results differ between studies. Many studies have found a negative green bond premium, such as a study from Ehlers & Packer (2017) shows a negative green bond premium of 18 basis points (bps). However, Karpf & Mandel (2017) reported a positive premium of 23 bps. Thus, this study aims to find out if French and German markets have pricing differences between green and conventional bonds.

The purpose of this study is to compare French and German primary and secondary green bond markets. Furthermore, the green bond market development and the existence of yield premiums is examined in both markets. In the primary market, a fixed effects OLS is implemented to capture the potential premium. In the secondary markets, the analysis happens by comparing conventional bonds to green bonds with a matching

method. Thus, thus method has been used in several studies regarding green bond premium. Therefore, the goal is to find out if yield premium exists and whether this premium differs between the countries. Also, the secondary market analysis includes the investigation of green bond premium determinants.

1.2 Hypotheses

In this study, the French and German green bond markets are investigated and compared. The market analysis includes studying the existence of a green premium. According to Bachelet, Becchetti & Manfredonia (2019), there might be a difference in bond liquidity, pricing, and volatility on secondary markets due to the fact that the bond is issued as green. The possible reason for this is that when the same financial conditions and characteristics prevail, environmentally conscious investors could accept a lower yield for the company's responsibility towards the environment. Therefore, the yield difference should be negative between the green bond and its corresponding conventional bond. It is possible that green bonds face higher demand from risk-averse investors since green bonds are potentially relatively less exposed to the stakeholder risk related to the lack of responsibility towards the environment (Bachelet et al, 2019).

Graham, Maher & Northcut (2001) showed that companies' environmental commitments have an impact on bond ratings. Thus, analysts and investors find environmental information relevant when valuing a company. Bauer & Hann (2010) reported that environmentally concerned companies have a bigger cost of debt and lower credit ratings. The corporate actions that cause this relation are mostly linked to regulatory and climate change challenges. Amiraslani, Lins, Servaes & Tamayo (2017) conducted a study on corporate social responsibility (CSR) and they observed that companies with high-CSR had lower bond yields compared to companies with low CSR levels during crisis times. Companies with high-CSR were also able to raise more capital on the bond market. Therefore, the first hypothesis states that there is no green bond premium in French nor German green bond markets.

H_0: *No green bond premium*

Second hypothesis states that French green bonds have more demand. In other words, investors prefer French bonds in both markets, thus, causing a bigger negative green bond premium.

H_1: *French green bonds have more demand than German green bonds.*

1.3 Structure of the study

This thesis has 5 different chapters. First, the introduction presents the topic, motivates, and introduces the hypotheses. The second chapter is the literature review which presents the theory behind the study. This chapter includes bond valuation theory, green bond valuation, bond certification. In addition, this chapter investigates French and German green bond markets and tries to present the development from inception to this day.

The third chapter, data, and methodology display the data collection, the final sample, and the empirical research methods for primary and secondary analysis. The fourth chapter presents the results, followed by a discussion on the research questions and the limitations of the study. The final chapter, conclusions, continues with a discussion about the implications and limitations of the study.

2 Literature review

This chapter introduces the conventional and green bond valuation theory, yield, and volatility. Especially topics on conventional bonds are widely studied, and there seems to be a consensus on the valuation components. Bonds make a big part of debt capital markets (Choudhry, 2010). Government bond yields are important economic indicators. For instance, the US treasury long bond's yield reflects the public's view on US inflation, economic growth, interest rates, and public debt. These indicators have an effect on the whole world's economy.

2.1 Conventional bonds

A bond is a type of debt instrument in which its issuer borrows money from an investor. For lending money to the issuer, the bondholder receives cash flow until the maturity in the form of interest payments, also known as coupon payments (Choudhry, 2010). In European bond markets, coupons are often paid annually and, in the US, UK, and Japan semiannually. At maturity, the issuer will repay the principal amount to the bondholder. There are four different types of bond issuers: Companies, supranational organizations, local government entities, and sovereign governments. Each issuer has a unique set of features and payment capabilities that are rated by third party rating agencies (Choudhry, 2010).

A conventional bond price equals the present value of its coupon payments and the principal value. Both are discounted with some predetermined discount rate. This can be seen from the equation below (Choudhry, 2010):

$$Price\ of\ a\ bond = \sum_{n=1}^{N} \frac{C}{(1+r)^n} + \frac{M}{(1+r)^N} \quad (1)$$

Here the C represents annual coupon payments which is divided by the discount rate or required yield r. The bond matures in year N and over its lifetime it will make n annual coupon payments. At the maturity bondholder will receive the par value M that is also discounted with the rate r (Choudhry, 2010). Price of a bond and required yield have a negative relationship (Fabozzi, 2016). Meaning the bond price will decrease when the required yield increases and vice versa. In the equation this means that the discount rate r increases, pushing down the bond price. The explanation for this inverse relationship is that the bond price represents the present value of the coupon payments and the principal value. Thus, price-yield relationship is convex, representing how the duration of the bond varies as the interest rates change (Fabozzi, 2016).

In the secondary market, bonds are traded based on their prices. Bond prices do not necessarily give enough information for the buyers, and also different bonds create different cash flows; therefore, it is essential to compare yields instead of prices (Choudhry, 2010). There are various ways of measuring yields. The goal is to calculate the interest rate that by which using makes the present values of the cash flows equal to the price of the investment (Fabozzi, 2016). If the bond is held to maturity, this method is also called yield to maturity (YTM). Bond's cash flow patter, term to maturity and profit or loss are calculated in YTM. These elements are seen from the bond pricing equation. Calculating yield for financial instruments with this method is done by trial error.

As mentioned before, bond price and yield have an inverse relationship. This relationship is important for the volatility analysis. There are some basic bond price volatility characteristics concerning option free bonds. Firstly, if bonds are initially assumed to have the same yield with different maturity, change in required yield moves the price to opposite direction but the magnitude of the price change is different for each bond. However, if the required change in yield is minor, percentage price change for bonds is about the same. Thirdly, major increase in the required yield causes the bond prices to decrease but not the same percentage for each bond. Lastly, if there is a great change in basis points, the percentage price decreases is less than the percentage price increases.

Term to maturity and coupon are the bond characteristics that explain price volatility. Thus, the price volatility is higher if the term to maturity is longer. Same is true for coupon, the smaller it is, greater is the price volatility (Fabozzi, 2016).

2.2 Green bonds

2.2.1 Definition and principles

A green bond is a relatively new debt instrument. It is a type of bond where the proceeds are channeled for environmentally friendly projects (International Capital Market Association, 2018). The proceeds can be used fully or partially to finance or re-finance projects that follow the green bond principles. Thus, the issuer has committed to raising financing to advance green projects, track outcomes, and report this information to investors (World Bank, 2018). There are four different types of green bonds: Standard Green Use of Proceeds, Green Revenue Bond, Green Project Bond, and Green Securitized Bond.

The green bond principles (GBP) were founded in 2014 by major private financial institutions. The development and monitoring of these principles are done by the International Capital Market Association (ICMA). According to ICMA (2018), The green bond principles are voluntary guidelines that offer information for the different green bond market participants. For the issuers, the guidelines provide information about the issuance process. Investors and other stakeholders are offered access to available transparent information on the environmental impact of green bonds. Therefore, as the green bond market is developing, integrity is being promoted by making the issuance process of a green bond clear for all market participants.

The GBP highlights the information transparency, correctness, and truthfulness that will be reported by issuers to stakeholders (ICMA, 2018). The four main principles of the GBP

are Use of proceeds, Process for project evaluation and selection, management of proceeds, and Reporting.

1. Use of Proceeds

As the GBP's idea is to provide guidelines and information for the green bond market, one of the most crucial components of the principles is the use of proceeds. The green bond legal documentation needs to provide accurate information on how the proceeds will be used. Also, so-called environmentally friendly projects should cause a positive impact on the environment. This positive impact will be evaluated and if possible, measured by the issuer. There are numerous categories suitable for green projects such as (ICMA, 2018):

- Renewable energy
- Energy efficiency
- Pollution prevention and control
- Environmentally sustainable management of living natural resources and land use
- Terrestrial and aquatic biodiversity conservation
- Clean transportation
- Sustainable water and wastewater management
- Climate change adaptation
- Eco-efficient and/or circular economy adapted products, production technologies and processes
- Green buildings

2. Process for Project Evaluation and Selection

Green bond issuers should be transparent to investors. Hence, they should communicate the environmental sustainability objectives, the process of determining which projects

are suitable for the green project categories mentioned previously, as well as the process of identifying and managing social and environmental risks. In addition, issuers are encouraged to use an external assessment for project evaluation and selection (ICMA, 2018).

3. Management of Proceeds

The net proceeds gained from issuing a green bond should be tracked by the issuer. As long as the green bond is outstanding, the tracked proceeds should be adjusted according to the allocations made to green projects. Thus, issuers must be sure that Investors are aware of the placement of the unallocated net proceeds. Also, the GBP recommends issuers to use an external auditor to confirm the tracking method and use of the proceeds (ICMA, 2018).

4. Reporting

Information on the use of proceeds should be up to date and renewed annually until the proceeds have been fully allocated. Investors and stakeholders should have easy access to this annual report. In addition, the report should state to which projects the bond proceed have been allocated, description of the project type and amount allocated, and the expected impact on the environment. The GBP recommends issuers to use qualitative and quantitative methods when measuring the impact on the environment (ICMA,2018).

2.2.2 Certification and external reviews

As mentioned in the Green Bond Principles, it is recommended to use an external review to verify that the issuers pre and post issuance actions and communication is aligned with the GBP components. However, the Green Bond Principles are very general process guidelines. Thus, more specific green bond certification and identification schemes have been founded, such as, CBI Climate Bonds Certification, Green bond indices, CICERO

Second Opinions, Moody's Green Bond Assessments and Standard & Poor's Green Evaluations (Ehlers & Packer, 2017). Table 1 shows the different features of green bond identification and certification schemes. These parties offer procedures and standards of certification. However, each has its approach to assessing the green bond issue process. For example, CBI Climate Bond Certification has form sector-specific criteria to evaluate the sustainability of green bond issuance. Issuers are eligible for the Climate Bond Certification only after receiving a positive external verification on the green bond issuance process and everything related to it (Ehlers & Packer, 2017).

Green bond indices provide investors with a possibility of investing in a portfolio made of green bonds. Hence, operate in a way as certifiers since they decide which bonds are green enough to be taken into the indices. Currently, there are multiple different index providers, and each has its unique index construction procedures. Hence, consistency with the Green Bond Principles is advertised with some specific factors such as liquidity and size. Green bond index providers can add and remove bonds from the indices, and they do so based on continuous monitoring (Ehlers & Packer, 2017).

Table 1

Green bond identification and certification schemes

Features	CBI	Green bond indices	CICERO	Moody's	Standard & Poor's
Use of funds tied to green investment	Yes	Yes	Yes	Yes	Yes
Eligibility criteria differ by sector	Yes	Yes	No	No	Yes
Ex post monitoring/assessment	No	No	No	Yes	No
Granular assessments of greenness	No	No	Yes	Yes	Yes
Quantitative weights for certain factors	No	No	No	Yes	Yes

CICERO, Moody's Green Bond Assessments & Standard & Poor's Green Evaluations differ from previously mentioned CBI and Green bond indices by more granular assessment. This assessment could offer investors broader information such as the degree of greenness instead of only addressing the question: is the bond green or not? (Ehlers & Packer,

2017). CICERO is a climate research institute. It is the leading second opinion giver in green bonds (CICERO, 2016). In its assessment process, CICERO evaluates green bond issuers' governance, potential climate risk, and transparency. As a result, a shade of green is granted based on the assessment results. CICERO introduced shading methodology in 2015. It covers four shades: Dark green, medium green, light green, and brown. Assessment is only done at the time of issuance and CICERO does not monitor ex-post changes (CICERO, 2016).

Moody's Green Bond Assessment is a comprehensive evaluation of the issuer. The evaluation includes five different factors, and each factor has its quantitative weight (Moody's, 2018). These factors are:

- Use of proceeds (40 %)
- Ongoing reporting (20%)
- Organization (15 %)
- Management of proceeds (15 %)
- Disclosure on use of proceeds (10%).

As a result, a grade is given from a scale of GB1 to GB5 to express the issuer's ability to manage and allocate the proceeds as well as report on a continuous basis on the green projects that have been financed with green bonds. In addition, multiple other sub-factors affect the final grade (Moody's, 2018).

Standard & Poor's Green Evaluations offers a second party opinion on the green bond issuers framework and/or how well the transaction follows the Green Bond Principles (S&P, 2020). Compared to Moody's GBA, Standard & Poor's rating system is more comprehensive since it takes into account the environmental impact component, as well as transparency and governance components (Ehlers & Packer, 2017). Thus, a weight is given to different factors and in the end, the result is expressed using a scale between 0 and 100.

2.3 Green Bond market

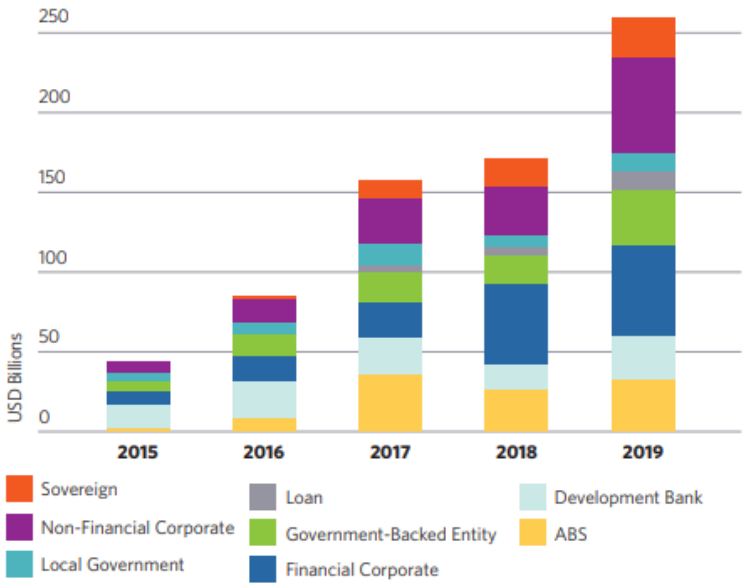
The market for green bonds has exponentially grown since the issuance of the first climate awareness bond in 2007 by the European Investment Bank. The growth has been rapid especially after the establishment of the Green Bond Principles (GBP) by the International Capital Market Association in 2014 (Reboredo, 2018). The GBP enabled investors with more information about green bonds and their possible impact on the environment. Thus, the growth was supported by the GBP, and the possibility to compare labeled and unlabeled bonds. In spite of the fast growth, green bond market form less than 1 % of the overall bond market (Reboredo, 2018).

Figure 2 presents the green bond issued amount by issuer type. The issued amount has almost quintupled from almost $50 billion in 2015 to over $250 billion in 2019 (CBI, 2020). The figure also demonstrates how different types of entities have issued green bonds over the years. In 2019, every issuer type grew in terms of volume and non-financial corporations had the biggest share of the issued amount. However, when the green bond market was established, development banks were dominating the issuances. Over time, other entities got interested in the green bond market and they began to issue more and more, including sovereign issuers. Poland was the first sovereign issuer in 2016, followed by France in 2017. Since then, the green bond issuances have emerged from many different countries (Tang & Zhang, 2020).

Between 2015 and 2019, the green bond market growth was mainly fueled by non-financial and financial corporates. According to CBI (2020), private non-financial corporates were the first issuer type in 2019, followed by financial corporates. Moreover, they managed to more than double their amount issued to $59.1 billion. Non-financial corporates growth was more moderate, only 12 % growth compared to the previous year. Although green loans represent a small fraction of the issuer type ranking, their amount issued grew 98 % compared to the previous year (CBI, 2020).

Figure 2

Green bond issuance by type

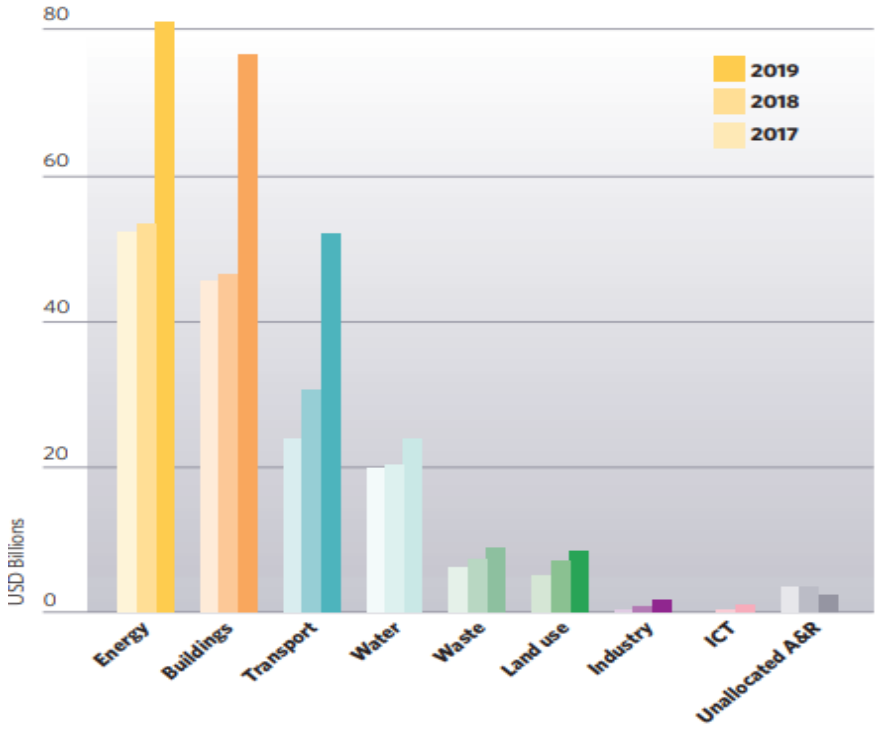


Public entities also increased their amount issued. This group includes Local Governments, government-Backed entities, and Development banks. Local governments were the only group that did not grow in 2019. Over the years, growth rate for the amount issued has been moderate. However, government-backed entities drove the growth in the public sector issuances.

Figure 3 demonstrates to which sectors the proceeds gained from green bond issuances have been allocated between the years 2017 - 2019. According to CBI (2020), the biggest sectors were energy, buildings, and transportation, which have dominated the use of proceeds (UoP) for the last three years. These categories made $80 billion of the total $88 billion added. However, growth in water, waste, and land use categories have been relatively modest (CBI, 2020)

Figure 3

Use of proceeds



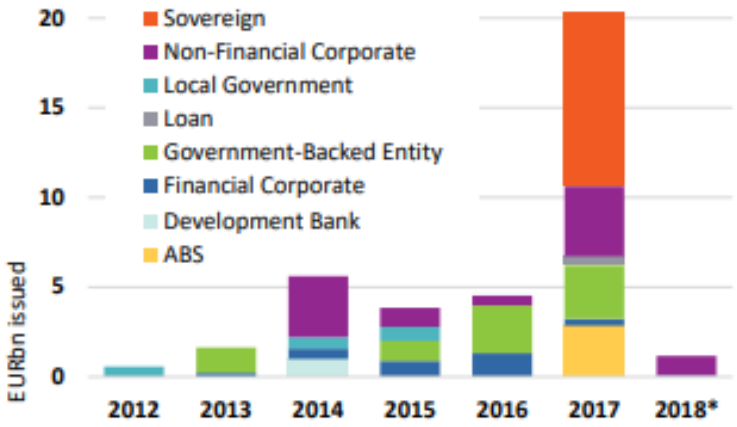
2.3.1 The green bond market in France

French green bond market is one of the world's largest. In 2019, France ranked globally 3rd with a $30.1 billion amount issued after the USA and China (CBI, 2020). France has had an important role in the development of the green bond market, especially in Europe, where it is the biggest issuer. Thus, figure 4 shows how the market has evolved between 2012 – 2017 (CBI, 2018). Local government entities, Provence-Alpes-Côte d'Azur, Île-de-France, and Hauts-de-France laid a solid foundation for France's market in 2012 by issuing their first green bonds. Since 2012, the market has become more diverse with different issuer types and instruments. Before the year 2017, the growth was relatively modest. However, in 2017 the amount issued quadrupled compared to the previous year (CBI, 2018). In 2018 and 2019, the amount issued was $14.2 billion and $30.1 billion, continuing the solid growth (CBI, 2020). From the issuer types, the non-financial corporates have contributed the most to the market if the year 2017 sovereign green

bond is excluded. In addition, figure 4 shows that French government-backed entities have been active in the green bond market. For example, the French public sector financial institution Caisse des Dépôts et Consignations, and public transportation company RATP issued their first green bonds in 2017.

Figure 4

France green bond market amount issued and issuer type



According to CBI (2018), 61 % of the cumulative proceeds from issuances have been allocated to buildings and clean energy sectors. This is aligned with the global green bond market proceeds allocations. The third biggest sector is transportation which had 17 % of the cumulative proceeds allocated in 2017. However, other sectors, such as land use, adaptation, water, and waste have had relatively small allocations (CBI,2018).

French public sector has issued longer tenors compared to the private sector issuers. In 2017, most of the private sector tenor were between 10 – 15 years. Compared to plain vanilla bonds in France, green bond tenors seem to be longer. A few private companies have issued green bonds with tenors between 15 – 20 years and energy company Engie has issued a perpetual green bond. As mentioned, the French public sector has longer tenors. Most of its bonds fall under 20 + years tenor category. The longest tenor is from a French national railway company SNCF that issued 30-year green bond. The €9.7 billion green sovereign OAT issued in 2017 was the largest green bond at the time with 22 years

tenor. Early green bonds issued by local governments are tenors with 10 – 15 years and green bonds fall in the 5 – 10 years tenor category. Thus, long-term infrastructure plans and green bonds with long tenor attracts institutional investors such as insurers and pension funds since the financing is more secure. Also, most of the green bonds (84%) issued by public and private sector are denominated in EUR while USD denominated bonds make up 11 % of the issuances (CBI, 2018).

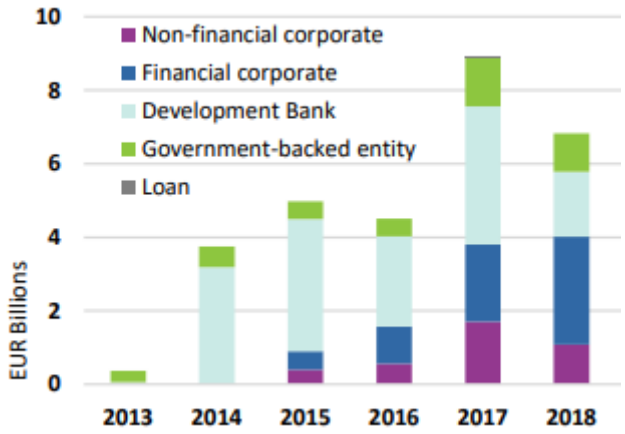
CBI (2018) reports that French issuers are good at using external reviews and certifications. In fact, 94 % of the issued bonds had an external review. In addition, issuers are obtaining certification for their bonds. For example, since 2016, SNCF had issued three green bonds to which they obtained the Climate Bonds Standard certification for low carbon transport. French issuer's annual reporting has been broad as 84 % of the bonds had a report made on the use of proceeds. However, CBI (2018) states that this number is lower than in some other European markets, but the quality of reporting is excellent.

2.3.2 The green bond market in Germany

As well as France, Germany has one of the biggest green bond markets worldwide. Germany ranks 4th globally and 2nd in Europe after France. However, there are some key differences between the countries. Figure 5 displays Germany's green bond market development between 2013 – 2019 (CBI, 2019). The overall trend has been up and in 2019 Germany's amount issued was $18.7 billion which was 144 % more than in 2018 (CBI, 2020). As can be seen, over the years the development banks have been active and one of the biggest issuer types. In 2018, Germany's biggest issuer, development bank KfW contributed 25 % of the overall volume. However, since 2015, financial corporates have started to increase their share of the market. In fact, financial corporates had 43 % of the total amount issued in 2018. Almost 75 % of financial corporates share came from mortgage banks such as Deutsche Hypo and Berlin Hyp. In recent years, government-backed entities have begun to issue more, and they are expected to keep growing (CBI, 2019).

Figure 5

Germany green bond market amount issued and issuer type



Cumulative use of proceeds has been relatively one sided. Hence, 70 % of the proceeds have been allocated to renewable energy (CBI, 2019). In 2018, proceeds allocated to energy was 60 % of all sectors. Different banks such as commercial, state and development, have contributed the most to energy sector. Buildings is the second largest allocation sector with 25 %. Moreover, other sectors like transport, water, waste, land use, ICT and industry made up the remaining 5 %.

Most of the German green bonds have tenors of 5-10 years (CBI, 2019). 53 % of the bonds belong to the medium term and 45 % to short term group (up to 5 years). The biggest issuer type is development banks, and they seem to be preferring shorter tenors. Financial and non-financial corporates prefer medium-term tenors. Tenors of 10 years or more are only 2 % of bonds. Non-financial corporates such as Volkswagen Immobilien, EnBW, and MEP Werke have issued tenors between 15 and 20 years. Also, German green bonds are mostly denominated in EUR. Of the accumulated amount issued, 76 % is denominated in EUR. The second most used currency, USD, has a volume of 16 %. Currencies SEK, GBP, and AUD make up for the remaining 8 % (CBI, 2019).

According to the CBI's (2019) country report on Germany, almost every issuer (99 %) has had an external review on the issue. Also, second party opinion is widely used among

issuers and 86 % of the issuances benefit from it. The biggest second opinion provider for German green bond issuances has been CICERO that has been used in 51 % of the issuances by volume. In-addition, post-issuance reporting is widely done by the issuers. Thus, 91 % of the deals by number has been reported by the issuer after the issuance. Indeed, it is noticeable that companies are not only reporting on the use of proceeds but also on the level of impact the proceeds are supposed to have on the environment (CBI, 2019)

Green bond issuance size has been EUR 500 million and above (CBI, 2019). Indeed, over 87 % of the issuances were 500 million or more. In 2019, KfW's €3 billion green bond was the largest green bond in the country. Smaller size categories include up to 100 million and 100 – 500 million. Few issuers fall into these categories such as mortgage bank Deutsche Hypo and energy company Encavis AG (CBI, 2019).

2.4 Greenwashing

Since the green bond market has rapidly grown and different types of issuers are joining the market, one of the potential and relevant risks for investors and sustainable finance is a phenomenon called "greenwashing". In greenwashing, companies are reporting positively about their environmental activities, when in fact their environmental performance is the opposite (Delmas & Burbas, 2011). A firm-level greenwashing occurs when a company is deceptively communicating about its environmental practices. A product-level greenwashing occurs when a company is communicating wrongly about the environmental benefits of its service or product. Delmas & Burbas (2011) also demonstrates four different drivers of green washing:

- Market external
- Nonmarket external (Regulatory)
- Psychological
- Organizational

Du (2014) investigated how the market reacts to greenwashing in China. He found that investors negatively value a company if it has been exposed of using greenwashing. Thus, showing significantly negative cumulative abnormal returns (CAR). Greenwashing can have negative implications for companies that are operating environmentally and socially responsible. The reason is that greenwashing can reduce investors and consumers trust in environmentally responsible companies (Delmas & Burbas, 2011). Furthermore, it can lead to an unwillingness to reward companies for their environmental performance. This gives companies an incentive to promote discouraging environmental actions that can cause negative externalities.

Without proper regulatory measures, companies might take part in greenwashing (Ramus & Montiel, 2005). Companies can make environmental policy statements without implementing them. Therefore, third-party audits and verification process are playing an important role of assuring stakeholders about companies' environmental policies and implementation. In the green bond market, different guidelines, such as green bond principles, standards, third-party verifications, and guidelines are trying to combat and mitigate the problem of greenwashing.

2.5 Green bond pricing

Multiple academic studies have been conducted regarding the possible existence of a green bond premium. The green bond premium is the yield difference between a green bond and a corresponding conventional bond (Zerbib, 2017). Thus, different research has tried to find if it is beneficial to issue green bonds. The results differ between the studies. One limiting factor seems to have been the amount of data available.

However, plenty of studies have found either a negative or a positive green bond premium. Like in this research paper, many other studies have focused on how green bonds are priced compared to conventional bonds. Karpf & Mandel (2017) conducted a study

on almost 1900 US municipal green bonds. They found a statistically significant negative green bond premium of 7.8 basis points (bps). However, authors state that the difference in the mean spread might be explained by other company characteristics.

Zerbib (2019) studied the effect of pro-environmental preferences on bond prices. He matched green bonds with two similar conventional bonds that satisfied the matching criteria. A synthetical bond was created out of the two conventional bonds to match a green bond. The next step in the study was to run a fixed-effects panel regression where the yield difference was the dependent variable and liquidity difference independent variable. He found a negative green bond premium of 2 bps. Besides, the study finds that a negative premium is bigger for low graded and financial bonds. The matching method used in Zerbib's study is widely used in the research concerning a green bond premium.

Another study regarding the green bond premium is done by Baker, Bergstresser, Serafeim & Wurgler (2018). They study 2102 green bonds that are mainly US municipal bonds. A negative after-tax green bond premium of 6 bps was found. The study also stated that if the issuer had a third-party verification and a confirmation about its greenness by Bloomberg, bond premiums at least doubled.

Also, the green bond market reaction to issuances have been studied. Tang & Zhang (2020) studied market reaction and precisely how issuing green bonds benefit shareholders. On a [-10,10] and [-5,10] event window, they find that market reacts positively and statistically significantly around the green bond issuance. Cumulative abnormal return (CAR) is approximately 1.04 % and a green bond premium of -6.94 bps is also documented. However, the evidence found is weak and it does not seem that the main benefit of issuing green bonds is the cheaper cost of debt. Instead, companies benefit from the larger investor base since the media exposure might be higher for the issuing company and thus this can attract new investors.

Moreover, Flammer (2018) studied how the financial market reacts to the issuance of green bonds. She reports that the issuance of green bond has positive effects on the financial and environmental performance of the issuing company. On a [-5,10] event window, the average CAR is 0.49 % at 5 % significance level. Furthermore, CAR tends to be higher for the first-time issuers and companies that have acquired third party certification. Moreover, issuing green bonds attract long-term investors and improves the environmental performance of the issuing company.

Baulakaran (2019) examined the stock market reaction to green bond issuances. This study tries to understand the company and bond characteristics that can possibly explain the market reaction by using cross-section analysis. As a research methodology, the abnormal returns were estimated by using the market model with domestic stock indices and the MSCI world index. An event window of [-10,10] was conducted with a sample of 54 companies. On the announcement day, the mean abnormal returns were – 0.17 % and statistically insignificant. One possible explanation for this can be information leakage. However, CAR [-10,10] resulted in 1.48 % and was statistically significant at a 5 % level. Higher coupon rates and operating cash flow are negatively related to the CAR while asset growth, Tobin's Q, and company size are positively related to the CAR. The study concludes that shareholders think of green bond issuances as value-adding events. Hence, the proceeds can be used for funding growth opportunities or mitigating regulatory, reputational, and economic risks.

Research vis-à-vis the primary green bond market has been studied, even though less, compared to the secondary market. Kaupraun & Scheins (2019) studied both, primary and secondary green bond market using 1520 green bonds. This study's primary market analysis followed Baker et al. (2018) fixed effects regression analysis. The primary market in-depth analysis shows a negative green bond premium between 20 to 35 bps. The authors state that the premium varies across issuer types, currencies, and time. For instance, issuances in USD yielded on average 41 bps premium compared to EUR 17 bps premium. Green bonds issued by supranational and government entities yielded a

higher negative premium compared to corporate green bonds. The green bond premium for corporate green bonds was close to zero, indicating that issuances from governments and supranational organizations have higher trust from the investors concerning the greenness of the bond. Moreover, the secondary market analysis reveals on average 43 bps higher yields for corporate bonds compared to conventional bonds. Governments and supranational organizations yielded a small -2 bps premium. The study further explores that green bonds that have either low or a high ESG rating, yield more than conventional bonds. Companies that have low ESG ratings might raise skepticism in greenwashing and on the other hand, companies with a great ESG reputation might cause the question concerning green labeling effects. Furthermore, bonds that are traded at stock exchanges dedicated to green bonds, yield negatively compared to conventional bonds. Thus, implying the importance of transparency and standards for the green bond market.

Furthermore, Ehlers & Packer (2017) studied the green bond market and the certification mechanism. They conducted a primary and secondary market analysis regarding the green bond premium. The authors compared 21 green bonds' credit spread at issuance to conventional bonds with close issuance date from the same issuers. The research paper documented that green bonds yielded on average – 18bps at issuance compared to conventional bonds. Also, if the bond rating was lower, the difference in yield was larger. Since the study compared credit spread at issuance, this result does not explain the difference in risk or other factors across issuers in the same rating group. A secondary market analysis was done by comparing green bond indices to global bond indices. The analysis reveals that green bonds were not priced at a premium compared to the conventional bonds in the secondary market when the currency risk was taken into account. Finally, there are room for improvement in the green bond market since at the moment there are many different labels for green bonds. Investors and issuers could benefit from a common standard.

Nanayakkara & Colombage (2019) conducted a research where they applied Option Adjusted spread (OAS) calculation in order to find out if investors pay green bond premium.

This study follows partially Preclaw & Bakshi (2015) research on green bond market by using quarterly OAS data. They discovered a negative green bond premium of 20 bps. By using OAS, it is possible to control macroeconomic, global and bond specific features that might affect the spread (Nanayakkara & Colombage, 2019). This study concluded a green bond premium of 63 BPS, suggesting that investors are willing to accept lower returns over comparable bonds in the market. Moreover, bond that were denominated in local currency were traded with a smaller premium compared to bonds traded with a foreign currency. Indeed, investors are willing to get smaller return from green bonds over conventional bonds since green bonds are viewed as a smaller risk investment. Investors also are looking for to diverse their portfolios with environmentally friendly investment and green bonds are a great fit for this. The authors also state that the green bond issuers can then benefit from a cheaper cost of capital. Therefore, the demand and supply of the green bond market will be larger.

3 Data & Methodology

This section describes the data and methodology used to test the research paper hypotheses. The purpose of this thesis is to find out if green bonds are priced differently compared to conventional bonds. In addition, green bond markets in France and Germany are compared. Since these two countries are globally one of the biggest issuers, it is important to investigate how the markets differ and what is the potential price impact. The first section describes the collected data for the primary and market as well as the research methodologies used in the analysis. The second section is done the same way, first the data collected for the secondary market is presented and after that the used research methodologies are presented.

3.1 Primary market data

This section examines the green bond issuance yield compared to convention bond issuances in France and Germany primary markets. Thus, analysis is executed by using a fixed-effects regression. In the primary bond markets, companies issue bonds to raise capital. The market participants are investors, borrowers, and investment banks which operate as an underwriter for the issuance. After the issuance, bonds start to trade in the secondary market (Choudhry, 2001). If there is a high demand for green bond issuance, the price will be lower and vice versa.

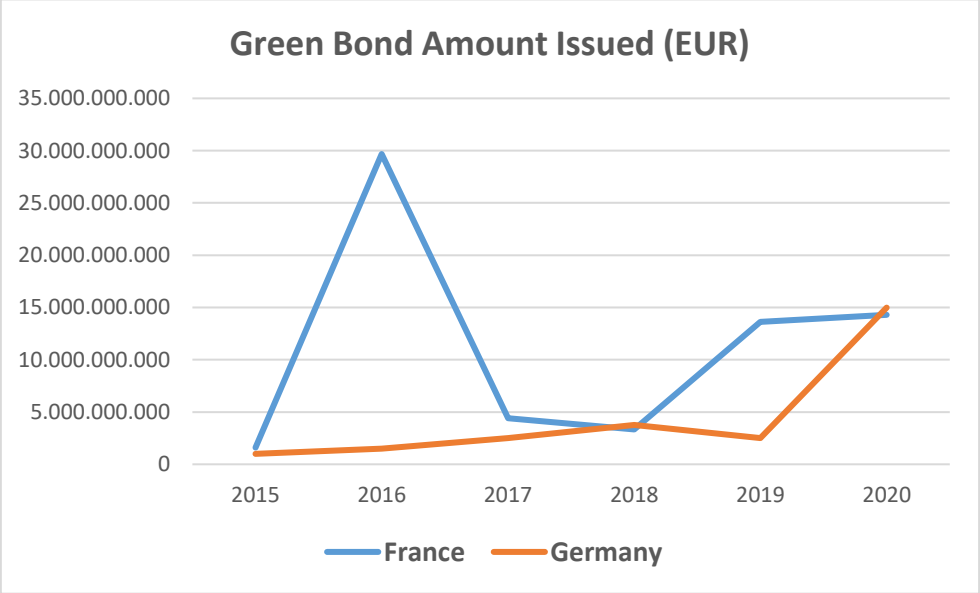
The data collected for this research paper is mainly from Thompson Reuters Eikon which has comprehensive data on conventional and green bonds. The building of the data set starts by downloading a list of all France and Germany's conventional and green bonds issued between 2015 and 24th November 2020. Moreover, the data on bond characteristic such as issuer, issue date, issue price, maturity, ISIN, amount issued, issuer type, coupon, coupon type, Moody's rating, coupon frequency, debt seniority and currency are downloaded from Thompson Reuters Eikon database. Green bonds are selected by using a green bond indicator. The initial list of green bonds issued within this time frame

is 197. Furthermore, the study finds 13,947 conventional bonds issued from 2015 to 2020.

Next, the data is sorted so the analysis can be done. First, the coupon type is chosen as fixed since the zero-coupon bonds and floating rates might cause biases for the analysis because of the different pricing mechanism. This study only includes the local currency since almost all the green bond issuances were made in euros. Thus, other currencies are excluded from the study. Figure 6 demonstrates countries green bond issuance from 2015 to 2020. In 2016, France government issued first green bonds to fund energy transition. At the time it was the green bond market's biggest opening issuance, and it gained a lot of demand. Excluding France sovereign green bond, both countries have increased their issuances over the years and 2020 was the biggest issuance year for Germany with almost EUR 15bn issued.

Figure 6

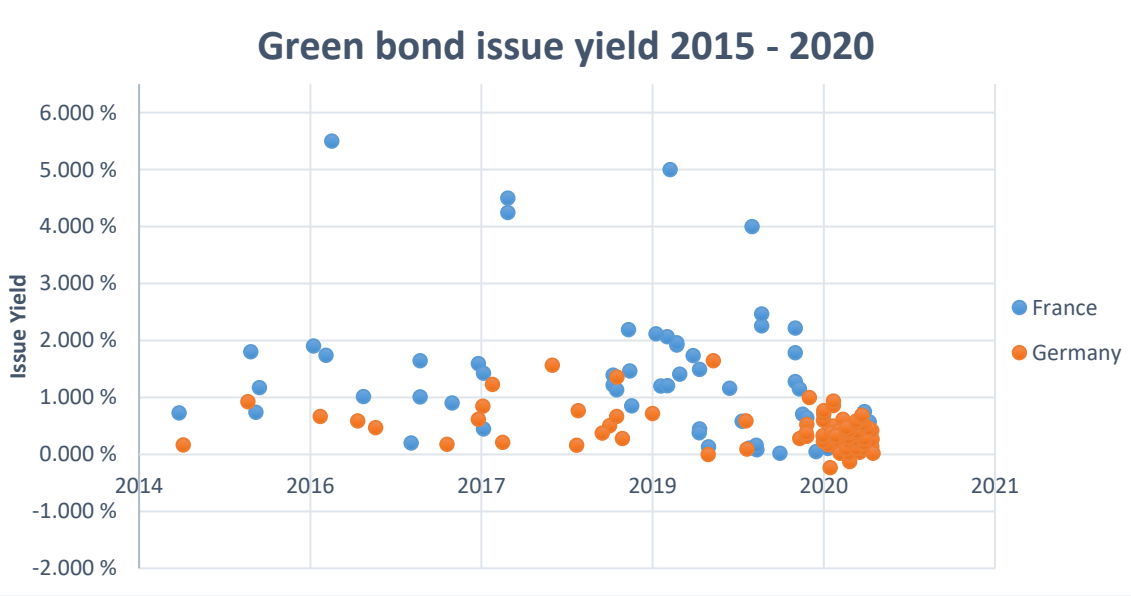
France & Germany Green Bond Amount Issued 2015 – 2020



In order to calculate historical issue yields, the green and conventional bond samples are adjusted by removing all perpetual bonds, zero-coupon bonds, and bonds that do not have an issue price. The yield to maturity from issue is calculated using coupon, coupon maturity, issue price and amount issued. Thus, the final sample consisted 145 green bonds and 7177conventional bonds. Moreover, the sample consisted 57 French green bonds and 88 German green bonds. Figure 7 shows a plotted comparison between France and Germany YTM from issuance from 2015 to 2020. Here we can see that France green bonds have had a slightly higher YTM over the time period.

Figure 7

Green bonds YTM from issuance



In the next step, French green bond and conventional bond markets are compared. Tables 2 & 3 illustrate the differences between the green bond market and the conventional bond market. During 2015 – 2020, green bonds have had a higher mean coupon and issue yield. This result might be expected during this period. However, with a longer time frame, higher coupons could have been expected for conventional bonds due to higher historical coupon levels. There also seems to be more variation in the green bond characteristics over conventional bonds. The standard deviation has been higher for

each bond characteristics compared to conventional bonds. The sample size for green bonds is noticeably smaller which can be linked to this. Another clear difference in the bond characteristics is the amount issued which has been around 60 % higher for green bonds. Furthermore, this can be related to the issuer type. Most of the green bond data consist of sovereign and financial bonds when conventional bonds data has more corporate bonds issued.

Table 2

France green bonds, primary market sample

	AMOUNT ISSUED (M)	*MATURITY (Yr)*	*COUPON (%)*	*ISSUE YIELD (%)*
Mean	1.095.53	16.6	1.405	1.74
Median	500	10.0	1.149	1.21
Standard Deviation	3.597	18	1.228	2.65
Maximum	27.375	100	5.500	19.22
Minimum	10	5	0.010	0.02
Observations	57	57	57	57

Table 3

France conventional bonds, primary market sample

	AMOUNT ISSUED (M)	*MATURITY (Yr)*	*COUPON (%)*	*ISSUE YIELD (%)*
Mean	680.68	12.6	1.320	1.36
Median	100	10.0	1.200	1.22
Standard Deviation	3.175	8	1.003	1.11
Maximum	49.107	100	7.500	12.90
Minimum	1	1	0.005	-4.36
Observations	1655	1655	1655	1655

Tables 4 & 5 present Germany's green bond and conventional bond market characteristics between 2015 – 2020. Coupon and issue yield have been higher for conventional bonds. In this sample, most of the German green bonds are issued by sovereign entities and financial institutions, therefore this result is expected. The sample shows over 1 % difference in the mean coupon. Also, when comparing France and Germany green bonds,

it seems that French green bonds have clearly higher issue yield and coupon. The mean issued amount is 17 % higher for conventional bonds. However, when compared to French markets, the median issued amount is a lot less for German bonds. Maturity is almost the same for green and conventional bonds. Furthermore, bonds issued in Germany have a shorter maturity than French bonds. Both, conventional and green bonds seem to differ from the characteristics between the countries. However, a noticeable difference between the countries' conventional bond markets, is the sample sizes.

Table 4

Germany green bonds, primary market sample

	AMOUNT ISSUED (M)	*MATURITY (Yr)*	*COUPON (%)*	*ISSUE YIELD (%)*
Mean	156.1	7.7	0.416	0.43
Median	50	7.0	0.355	0.37
Standard Deviation	207	3	0.311	0.33
Maximum	500	20	1.600	1.64
Minimum	5	3	0.010	-0.23
Observations	88	88	88	88

Table 5

Germany conventional bonds, primary market sample

	AMOUNT ISSUED (M)	*MATURITY (Yr)*	*COUPON (%)*	*ISSUE YIELD (%)*
Mean	183.4	7.9	1.4558	1.43
Median	30	7.0	0.7500	0.75
Standard Deviation	1208	5	2.0850	2.14
Maximum	30500	100	21.0000	21.00
Minimum	0	1	0.0010	-1.68
Observations	5522	5522	5522	5522

3.1.1 Primary market research methodology

When investigating if a green bond premium exists, it would be optimal to compare bonds that have same attributes and that have been issued during the same day, but the only difference would be the green label. This way it would be easy to conclude the effect

of the green label. However, this method is not very realistic since bonds are issued on different periods with different characteristics and they rarely match enough. Therefore, this study follows the same method as Kapraun and Scheins (2019) used in their research on primary green bond markets. They conducted a fixed OLS regression where different bond characteristics are controlled. Fixed effects regression can mitigate the omitted variable bias. Moreover, in that case, relevant variables related to the regression might be excluded, resulting in inefficient estimation. This thesis initial primary market regression is as follows:

$$IssueYield_i = \beta Green_i + FE_i + \epsilon_i \quad (2)$$

The equation shows fixed effects regression where bond i issue yield is estimated by using green label variable and set of fixed variables. The dependent variable is the bond's yield at issuance. First independent variable $Green$ is a dummy variable that indicates 1 if a bond is green and 0 otherwise. Fixed effects include many other variables that can affect bond's yield. These characteristics such as seniority, maturity, Moody's rating is bond specific, and they can impact the yield. Issuer is included as a fixed variable since different companies and entities have different factors that can have an impact on bonds yield.

Table 6

Primary market variables legend

VARIABLE	DESCRIPTION
Issue Yield	A quantitative variable for the bond's yield at issuance
Green	An indicator variable equaling 1 if the bond is labeled as green and 0 otherwise
Rating	A qualitative variable based on Moody's bond ratings

Seniority	A qualitative variable for the bond risk
Maturity	A qualitative variable that has been categorized to three different categories based on bond's maturity. Variable equals 1 if bond's maturity is less than 5 years, 2 if maturity is between 5 and 10 years and 3 if maturity is more than 10 years
Month and Year	A qualitative variable for the issue month and year
Issue Amount	A quantitative variable for the amount issued

3.2 Secondary market data

The secondary market analysis tries to continue answering the first and second hypotheses. Thus, the analysis research if a green bond premium exists in the secondary marketplace for French or German green bonds. In the secondary market, investors can buy and sell the security after the company has issued its first at the primary market. The market price of a security fluctuates depending on the demand.

The data set collection is similar to the primary market data collection part with few differences. The data is downloaded from Thompson Reuters Eikon. The euro conventional and green bonds listed between 2015 and the 2nd of December are obtained. The sample consists of 13,947 conventional bonds and 145 green bonds for both countries. Zero-coupon bonds and floating-rate bonds are excluded. In the next step, bonds are matched to pairs with certain criteria. In the matching method, conventional and green bonds need to be as similar as possible to improve the quality of analysis since the goal is to study the yield difference between conventional and green bonds. Matching criteria

for the pairs are presented in table 7. In this method, green bonds are treated units and conventional bonds non-treated units.

Table 7

Matching criteria

Bond characteristics	*Criteria*
Amount issued	+/- 400 %
Coupon rate	+/- 0.25 %
Maturity date	+/- 2 Years
Issuance date	+/- 4 Years
Currency	Same
Issuer	Same
Moody's rating	Same
Coupon type	Same
Interest frequency	Same
Seniority	Same

Each green bond is being matched with a conventional bond that fills the requirements mentioned above. The amount issued can be 400 % more or less between the bonds according to Zerbib (2017) study. The coupon rate is a maximum of 25bps bigger or smaller. A trade-off with the accuracy of the maturity is made since a more optimal method would be to create a synthetical bond out of two conventional bonds as Zerbib (2019) presented. However, this method could have decreased the sample size too much. Therefore, not creating a synthetical bond may introduce a maturity bias since bonds that have higher maturity also have a higher yield. Currency, issuer, Moody's rating, coupon type, interest frequency and seniority are the same. As a result, 20 pairs of French and 71 pairs of German bond pairs are created.

In the next part, daily price data is downloaded for each bond starting from 2015 till December 2nd, 2020. Daily data consist of ask price, bid price, and redemption yield. The used yield in the analysis is the ask yield. Since the previous green bond literature has used ask yield as a measurement for yield, it is used in this study as well. Thus, ask yield is calculated from the daily ask price. As the yield can be affected by the liquidity of a bond, the bid-ask spread is calculated from the daily data as a liquidity proxy. Each

pair has an equal amount of data points, starting from the issue date of the latest bond in the pair. Bonds that had missing daily data, were removed from the set. The final data set has 16 French and 37 German bond pairs. Tables 8 & 9 display the descriptive statistics for the French secondary market. Since bonds were matched according to their characteristics, the descriptive statistics are fairly similar between green and conventional bonds. The data contains in total 14,990 daily observations for French conventional and green bonds. The amount issued and maturity are slightly higher for green bonds. Besides, both of these characteristics have relatively high variation. The longest maturity bonds issued are 30 and 31 years from Societe du Grand Paris. Coupon and bid-ask spread are almost identical further demonstrating that the matching method has decreased the possibility for biases. However, bid-ask spread varies greatly for conventional and green bonds, indicating that liquidity bias can be controlled better by adding the bid-ask variable.

Table 8

Secondary market conventional bonds, France

	Bid	***Ask***	***Bid-ask***	**Coupon %**	**Amount issued (M)**	***Maturity***
Mean	104.01	104.53	0.52	0.98	617.70	10.72
Median	102.30	102.72	0.35	0.88	650	9
Std Dev	5.27	5.55	0.43	0.57	245.46	4.76
Maximum	121.21	123.13	3.08	1.88	1500	30
Minimum	83.37	83.99	0.05	0.01	10	6
Observations	7495	7495	7495	7495	7495	7495

Table 9

Secondary market green bonds, France

	Bid	***Ask***	***Bid-ask***	**Coupon %**	**Amount issued (M)**	***Maturity***
Mean	104.14	104.65	0.51	0.98	683.26	11.30
Median	102.50	102.84	0.35	0.88	600	10
Std Dev	6.21	6.44	0.40	0.60	374.71	4.77
Maximum	133.54	134.84	3.12	2.13	2500	31
Minimum	87.00	88.00	0.05	0.01	25	5
Observations	7495	7495	7495	7495	7495	7495

Furthermore, tables 10 & 11 show the same descriptive tables for German conventional and green bonds. From these tables can be seen that French and German markets data differ noticeably. The data set has 9629 trading days for both bond classes and 19,258 days in total. The average coupon is 0.47 % for both bond types which is almost twice less than for French bonds. The reason for this is the issuer type. Almost every issuer in the data for Germany is a financial institution or an agency whereas France has corporate issuers offering bigger coupons. Issuances by sector will be presented later in the study. Thus, characteristics seem to be close between the bonds due to the matching method. The main difference is in the amount issued, where conventional bonds have a higher average of EUR 622 million and green bonds EUR 434 million. Nevertheless, variation for conventional bonds in the amount issued is also greater. Maturity in years is about 7.5 years which is less than for French bonds. Bid-ask spread is also smaller for German bonds over French bonds. In addition, the bid-ask variable is smaller for the German bonds.

Table 10

Secondary market conventional bonds, Germany

	Bid	***Ask***	***Bid-ask***	***Coupon %***	**Amount issued (M)**	***Maturity***
Mean	101.48	101.77	0.30	0.47	622.79	7.68
Median	101.14	101.34	0.22	0.38	500.00	8.00
Std Dev	2.02	1.98	0.27	0.39	314.60	2.04
Maximum	107.76	108.32	3.55	1.5	1000.00	15
Minimum	96.45	97.50	-0.10	0.01	5.00	1
Observations	9629	9629	9629	9629	9629	9629

Table 11

Secondary market green bonds, Germany

	Bid	***Ask***	***Bid-ask***	***Coupon %***	***Amount issued (M)***	***Maturity***
Mean	101.55	101.87	0.32	0.47	434.69	7.41
Median	101.25	101.51	0.25	0.375	500.00	6
Std Dev	2.86	2.83	0.26	0.35	161.52	2.38
Maximum	110.5	111.2	3	1.25	500.00	14
Minimum	86.7	87.6	-0.1	0.03	10.00	3
Observations	9629	9629	9629	9629	9629	9629

Tables 12 & 13 present the yields, yield difference and bid-ask difference for both countries. French bonds have yielded more during the period over German bonds. Moreover, for both countries, ask yield difference is positive, meaning that green bonds have offered better yield during 2015-2020. Positive yield difference is 3bps for French green bonds and 9bps for German green bonds. However, the average daily ask yield for German conventional bonds is only 0.04 % which is extremely low. Besides, the ask yield difference has varied more for German bonds, ranging from -1.04 to 1.69. The bid-ask difference is slightly negative but closer to zero for French bonds over German bonds, which indicates somewhat better liquidity in the France bond markets.

Table 12

Secondary market yield comparison, France

	Daily ask yield, conventional bonds (%)	*Daily ask yield, green bonds (%)*	*Ask yield difference*	*Bid-ask difference*
Mean	0.46	0.49	0.03	-0.01
Median	0.31	0.37	-0.01	0.03
Std Dev	0.56	0.57	0.17	0.35
Maximum	2.21	2.25	0.41	2.28
Minimum	-0.49	-0.42	-0.41	-2.35
Observations	7495	7495	7495	7495

Table 13

Secondary market yield comparison, Germany

	Daily ask yield, conventional bonds (%)	*Daily ask yield, green bonds (%)*	*Ask yield difference*	*Bid-ask difference*
Mean	0.04	0.13	0.09	0.08
Median	0.03	0.09	0.07	0.05
Std Dev	0.43	0.51	0.25	0.33
Maximum	2.54	3.12	1.69	2.65
Minimum	-1.19	-0.71	-1.04	-2.90
Observations	9629	9629	9629	9629

Figure 8 demonstrates bonds issued by their type. Between these two countries, there are significant differences as the data shows that France has a lot wider issuer type by having most of the bonds issued by financial institutions and corporates whereas Germany has almost 90 % of the bonds issued by financial institutions. A French multinational electricity company Engie SA accounts for all issuances in the corporation category. For France and Germany, financial institutions contain different banks and agency refers to a government-owned organization. Moreover, the sub-sovereign category is also a government-owned entity, such as the city of Paris. As previously stated, the descriptive statistics had noteworthy differences between the countries. This can be the possible explanation for the lower bond coupons and therefore lower bond yields for German bonds.

Furthermore, figure 9 compares the difference between the bond ratings. As before, there are significant differences when it comes to bond ratings. The figure shows that the data sample has more similarly distributed ratings for France. Indeed, over 50 % of the German bond pairs do not have a rating while France has about 19 % of the bonds without a rating. For French bonds, 37.5 % has a Baa1 rating which only accounts for a French electric utility company Engie SA. Besides, Germany has three bond rating categories with only one observation.

Figure 8

Types of issuers

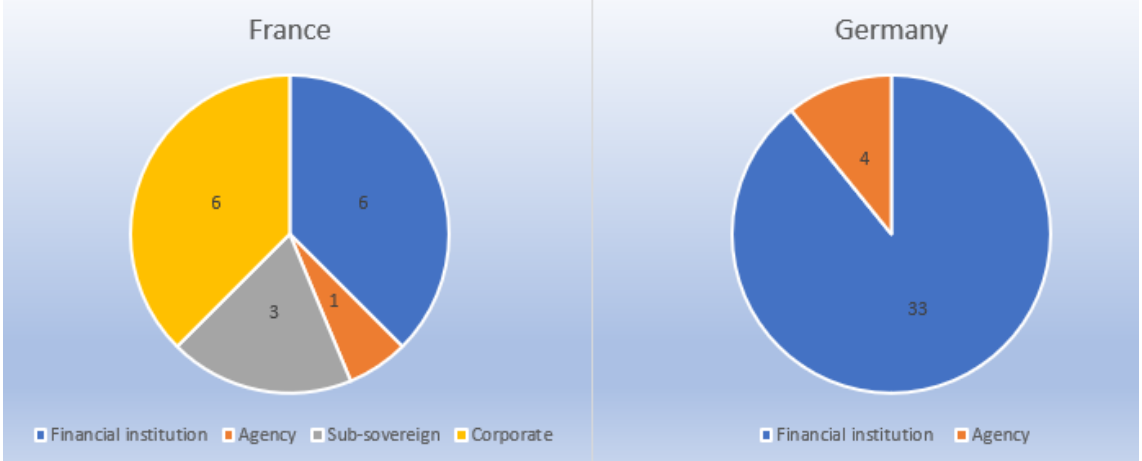
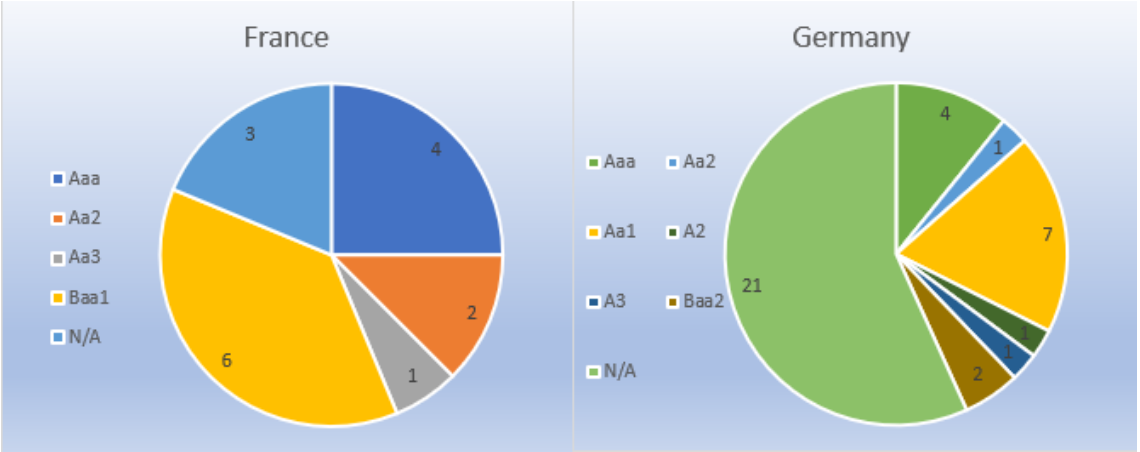


Figure 9

Bond pair rating comparison



3.2.1 Secondary market research methodology

In order to examine whether green bonds are priced differently from the conventional ones in the secondary market, this study follows Zerbib's (2019) two-step regression procedure. As was done in the previous chapter, bonds are matched in pairs according to their characteristics. Then the first step of the regression procedure is to estimate a green bond premium by using a fixed-effects regression model. In the second step, the idea is to identify the determinants that can affect the estimated green bond premium. The estimation of the green bond premium goes according to the next fixed effects regression model:

$$\Delta Yield_{i,t} = \alpha_i + \beta \Delta BidAsk_{i,t} + \varepsilon_{i,t} \quad (3)$$

Here the $\Delta Yield_{i,t}$ is the dependent variable and it represents the ask yield spread for green and conventional bond on day t. Whereas α_i is the estimated green bond premium for each pair and it is representing all the unobserved effects in the panel regression. And lastly, $\varepsilon_{i,t}$ is the error term.

The yield spread between a green bond (GB) and a conventional bond (CB) is calculated the following way:

$$\Delta Yield_{i,t} = Yield_{\mathrm{i,t}}^{GB} - Yield_{\mathrm{i,t}}^{CB} \quad (4)$$

In the equation 4, the yield difference is defined as a difference between ask yield of the green bond *i* and the conventional bond *i* on day *t.* Moreover, equation 5 shows the calculation for the bid-ask spread. Bid-ask difference is defined as a bid-ask difference of a green bond *i* and bid-ask of conventional bond on a day *t.* The reasoning behind adding the liquidity control is to eliminate the effect of a bond's liquidity to the price that could otherwise give biased results. Furthermore, the bid-ask liquidity proxy can help to alleviate the potential liquidity bias when dealing with low frequency data (Zerbib, 2019). Thus, bid-ask difference is an ideal liquidity estimate when dealing with low frequency data, like used in this thesis, and when the data set does not include daily trading volumes.

$$\Delta BidAsk_{i,t} = BidAsk_{\mathrm{i,t}}^{GB} - BidAsk_{\mathrm{i,t}}^{CB} \quad (5)$$

3.2.1.1 Determinants of the green bond premium

The second step of the procedure tries to identify which bond characteristics have an effect on the premium and in what extent. The following OLS-regression is run to identify the factors:

$$\widehat{\alpha_\iota} = \beta_0 + \beta_1 Maturity_i + \beta_2 Rating_i + \beta_3 LogAmountIssued_i + \beta_4 Sector_i + \varepsilon_i \quad (6)$$

Here the $\widehat{\alpha_\iota}$ is the estimated green bond premium for pair *I,* whereas other variables are explained in the table 14.

Table 14

Secondary market variables legend

VARIABLE	DESCRIPTION
Maturity	A qualitative variable that has been categorized to three different categories based on bond's maturity. Variable equals 1 if bond's maturity is less than 5 years, 2 if maturity is between 5 and 10 years and 3 if maturity is more than 10 years
Rating	A qualitative variable based on Moody's bond ratings.
Issue Amount	A logarithmic quantitative variable for the amount issued
Sector	A qualitative scale variable based on the Thompson Reuters Eikon database definitions.

4 Empirical Results

This chapter presents the results for the hypotheses testing. In the first part, the primary market analysis results are presented and examined. Primary market analysis studies if the yield at issuance is different between green bonds and conventional bonds. In the secondary market analysis, regression analysis is implemented based on the matching method. In the last part, a cross sectional regression tries to identify bond characteristics that might have an effect on the estimated premium.

4.1 Primary market analysis

A fixed-effects regression model is applied to capture the potential green bond premium. Thus, the first hypothesis states that green bond premium does not exist. The regression model presented in equation 2 is applied to further test the hypothesis. Firstly, to test for heteroskedasticity in the models, Modified Wald test is utilized. The null hypothesis is rejected with a p-value 0.00, further indicating that heteroscedasticity is found for both countries. Therefore, White robust estimators are applied to the models.

Table 15 shows the fixed effects regression results for France. Different variables are a green bond indicator, Moody's rating, debt seniority, the maturity of a bond, log issue amount, and a year dummy. The table presents four different models. In the first model, only rating and seniority are explanatory variables with the green bond indicator. The coefficient for the green variable is -0.341 and it is statistically significant at a 1 % level. This indicates that there is a 34 bps credit spread between green bonds and conventional bonds. However, the R^2 is 9.9 % which is relatively small and only few variables have been taken into account. Furthermore, when adding maturity as a fixed effect, the green estimate decreases to -20.8 bps, but it is still significant at a 10 % level. In addition, R^2 increases notably to 28 %. In the next step, the logarithmic amount issued was added to the model. As a result, the green estimator decreases and becomes insignificant. The R-squared increases only by 1 %, indicating that this fixed variable might not be

appropriate for the model. The last model takes the year variable into accounts. By adding this, the R^2 increases to 43 %, and the coefficient for the green indicator further decreases to – 12 bps but it still remains insignificant. Out of these four models, the last model has the highest R^2 but not a significant green indicator. According to model one and two, there is a green bond premium in the French markets. However, when taking enough factors into account is seems that the green indicator is not statistically significant. Next, Germany's primary market will be analyzed the same way.

Table 15

France primary market regression analysis

Dependent Variable:				
Issue Yield				
	(1)	(2)	(3)	(4)
Green	-0.341***	-0.208*	-0.167	-0.120
	(0.117)	(0.118)	(0.118)	(0.103)
Constant	1.533***	0.243 ***	1.114***	1.397***
	(0.261)	(0.222)	(0.352)	(0.317)
Fixed effects				
Rating	Yes	Yes	Yes	Yes
Seniority	Yes	Yes	Yes	Yes
Maturity	No	Yes	Yes	Yes
Issue Amount	No	No	Yes	Yes
Year	No	No	No	Yes
Observations	1465	1465	1465	1465
R^2	0.099	0.281	0.295	0.436

Note: Robust standard errors are reported in parentheses.
*p < 0.1; **p < 0.05; ***p < 0.01.

Table 16 present the primary markets regression results for Germany. First, this sample has 5608 observations which is considerably more than in French sample. Also, it is good to notice that France has a lot of higher standard deviation for its green indicator. This can be also seen from the table 2 and figure 7. Thus, In the first model, significant -25 bps green bond premium is documented with a small R^2 of 12 %. The variable maturity

increases R-squared to 19% and the green indicator is significant at a 5 % level. After adding logarithmic amount issued variable, the green indicator and R-squared stay almost the same compared to the second model. In the last model, the green variable is not statistically significant while it greatly decreased. Also, R-squared is higher of 25 %. It seems that both France and Germany have an insignificant green bond premium. This can be seen when more variables are added into the models and the green indicator becomes insignificant.

Table 16

Germany primary market regression analysis

Dependent Variable:				
Issue Yield				
	(1)	(2)	(3)	(4)
Green	-0.258***	-0.208**	-0.204**	-0.056
	(0.084)	(0.081)	(0.081)	(0.078)
Constant	0.855***	1.104***	1.419***	2.001***
	(0.061)	(0.064)	(0.118)	(0.119)
Fixed effects				
Rating	Yes	Yes	Yes	Yes
Seniority	Yes	Yes	Yes	Yes
Maturity	No	Yes	Yes	Yes
Issue Amount	No	No	Yes	Yes
Year	No	No	No	Yes
Observations	5608	5608	5608	5608
R^2	0.129	0.194	0.195	0.25

Note: Robust standard errors are reported in parentheses.
*p < 0.1; **p < 0.05; ***p < 0.01.

The results above identified an insignificant green bond premium for both countries. Between the countries there is variation differences in the green indicator and R-squared. The rest of the chapter focuses on the investigation of the green bond premium in the secondary markets.

4.2 Secondary market analysis

In this subchapter, the results of the green bond premium in the secondary markets are presented. The first part focuses on the potential green bond premium and its size, while the second part tries to identify the characteristics that affect the premium. Lastly, the chapter concludes with a discussion about the findings and limitations of the analysis.

The green bond premium estimation begins by implementing the fixed effects regression presented in equation 3. However, to run the regression, some assumptions need to hold so that the results are interpretable. Therefore, different tests are run for both countries. The tests are run for heteroskedasticity, serial correlation, and whether the model should be fixed effects or random effects. Firstly, the Hausman test shows that fixed effects regression is suitable for the France market data set, but random effects should be run for Germany's analysis. For both countries, the Breusch-Pagan test found heteroskedasticity in errors, the Wooldridge tests showed serial correlation, and lastly, augmented Dickey-Fuller test reported stationarity. The results can be found in Appendix 1.

Since heteroskedasticity and serial correlation exists, Beck-Katz and Newey-West robust standard errors are implemented to tackle these problems. Tables 17 & 18 present the estimations for all three models. The ΔBid-Ask variable is -8.87 bps for France and –5.22bps for Germany. Both of these estimates are statistically significant at a 1 % level. Thus, these results indicate that one basis point increase in the bid-ask spread will decrease the yield spread between a green bond and its conventional counter bond by 0.0887 (FR) percentage points and 0.0522 (DE) percentage points. The R^2 values for the countries are 9 % and 0.4 %, indicating weak explanatory power for the ΔBid-Ask variable. However, as the interest of the analysis is the green bond premium, table 19 illustrates the results for both countries.

Table 17

France secondary market analysis

Dependent Variable:			
$\Delta Yield_{i,t}$			
	Within	Beck-Katz	Newey-West
Δ Bid-Ask	-0.0887***	-0.0887***	-0.0887***
	(0.0032)	(0.0032)	(0.0028)
Observations	7495		
R^2	0.0928		
Adjusted R^2	0.0907		

Note: Standard errors are reported in parentheses.
*p < 0.1; **p < 0.05; ***p < 0.01.

Table 18

Germany secondary market analysis, random effects

Dependent Variable:			
$\Delta Yield_{i,t}$			
	Within	Beck-Katz	Newey-West
Δ Bid-Ask	-0.0522***	-0.0522***	-0.0522***
	(0.0077)	(0.0077)	(0.0064)
Observations	9629		
R^2	0.0047		
Adjusted R^2	0.0009		

Note: Standard errors are reported in parentheses.
*p < 0.1; **p < 0.05; ***p < 0.01.

The green bond premium estimation can be seen in table 19. For French bonds, the average estimate is slightly negative whereas the German average estimate is positive. France has a -0.42 bps negative green bond premium. However, there is some variation between the pairs. French bond pairs premium varies from -19 bps to 27 bps. In fact, 62 %

of the green bond premium estimations are negative. In addition, 14 out of 16 pairs have a significant estimation at a 1 % level, one bond pair at a 10 % level, and one insignificant bond pair estimation.

German bond pairs have an average green bond premium of 3.8 bps. The variation between the pairs is a lot higher compared to French pairs. The green bond premium estimate varies between -53bps to 36 bps. Only 35 % of the estimations were negative, indicating that the distribution is skewed left and not normally distributed. Thus, 21 pairs out of 37 are significant at a 1 % level, 6 pairs at a 5 % level, and 10 pairs are insignificant. These results indicate that green bonds have offered better returns compared to their matching conventional bonds. However, in French markets premium was slightly negative and close to zero, indicating that investors pay a small premium for green bonds.

Table 19

Green bond premium

Green bond premium: $\widehat{\alpha_i}$

Country	*Min*	*1st Quartile*	*Median*	*Mean*	*3rd Quartile*	*Max*	*N*
France	-0.1925	-0.0865	-0.0307	-0.0042	0.1091	0.2727	16
Germany	-0.5319	-0.0319	0.0162	0.0380	0.0956	0.3683	37

Next, subsamples are formed based on the bond characteristics such as rating and sector, to see if the green bond premium of these samples is different from zero. Shapiro-Wilk test is run for the subcategories with at least three bond pairs. For both countries, the test found normality for each sector, except for Germany's financial sector where the null hypothesis was rejected with a p-value of 0.002. Besides, the Shapiro-Wilk test shows normality for every rating group except bonds without rating in France. In the next step, a t-test is run for the sub-samples. The null hypothesis states that the mean green bond estimations are equal to zero. Tables 20 & 21 show the French and German subsamples and their average green bond premium. The t-test displayed that, for both countries, the full sample estimates are not statistically different from zero. Furthermore, the

null hypothesis cannot be rejected to any of the subcategories in France. When analyzing the industry category for the French market, 3 out of 4 categories have a negative average premium while sub-sovereign is the only issuer type with a positive average of 10.8 bps. The rating category shows a negative premium for Aaa, Aa3 and Baa1 ratings whereas the Aa2 and bonds without rating have a positive average premium. As mentioned before, these subcategories' green premia means are not statistically different from zero.

Table 20

Green bond premium sub-sample, France

Category	***Subcategory***	***Mean***	$\widehat{\alpha_i} \neq 0$	***No.Pairs***
Industry				
	Agency	-0.1926		1
	Corporate	-0.0200		6
	Financial	-0.0135		6
	Sub-Sovereign	0.1085		3
Rating				
	Aaa	-0.0112		4
	Aa2	0.0400		2
	Aa3	-0.1714		1
	Baa1	-0.0200		6
	N/A	0.0628		3

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

German market sample differs completely from French markets, as table 21 demonstrates this. The industry category has two issuer types. First, is the issuer type Agency, which includes the state development bank NRW, which has a statistically significant 12.19 bps positive average green bond premium at a 10 % level. The second issuer group is the financial issuer that has a positive average premium of 2.7 bps while not statistically different from zero. For the most rating subcategories the null hypothesis cannot be rejected except Aa1 that has 10 bps average premia that is statistically significant at a 10 % level. However, most of the demonstrated sub-samples green bond premium does not differ statistically from zero.

Table 21

Green bond premium sub-sample, Germany

Category	*Subcategory*	*Mean*	$\widehat{\alpha_i} \neq 0$	*No.Pairs*
Industry				
	Agency	0.1219	*	4
	Financial	0.0278		33
Rating				
	Aaa	-0.0734		4
	Aa1	0.1009	*	7
	Aa2	0.0595		1
	A2	0.3039		1
	A3	-0.0068		1
	Baa2	0.3683		1
	N/A	0.0122		22

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

4.2.1 Green bond premium determinants

In the second stage of the analysis procedure, the factors that might affect the estimated green bond premium are investigated. Investigation of the determinants happens by running a cross-sectional OLS-regression presented in equation 6. The equation's dependent variable is the estimated green bond premium. To avoid artificially high R^2 only variables that have at least two observation are included. Therefore, the final sample for France consists of 13 observations and 33 for Germany. The procedure continues by running different tests for heteroskedasticity and multicollinearity. The Breusch-Pagan test confirms that error variances are equal and homoskedasticity is confirmed. However, model three in Germany's analysis found heteroskedasticity in the errors. Next, independent variables multicollinearity is tested with Variance Inflation Factors (VIF). Multicollinearity is not present in the models except for model three in Germany's analysis that has high levels of multicollinearity between the explanatory variables. The results of the test are presented in appendices 2 & 3.

Table 22 shows the results for the green bond premium determinants analysis for France. Three different models are run that include industry, bond rating, maturity, and logarithmic issued amount. Most of the explanatory variables in different models do not have statistically significant meaning. Across all the models, rating and industry dummies are mostly positive but statistically insignificant, while the maturity variable is also positive but significant at a 10 % level. The amount issued is negative and not significant. The low R^2 is aligned with the previous green bond premium literature i.e., Zerbib (2019). The R^2 varies from 10.81 % to 38.56 %. This indicates that these models explain little of variations in the green bond premium. In addition, the adjusted R-squared is noticeably lower, varying from -0.0703 to 0.0784.

Table 22

France secondary market green bond premium determinants

Dependent Variable:			
$\hat{\alpha}_i$			
	(1)	(2)	(3)
Industry	0.01930	0.0187	-0.0096
	(0.0392)	(0.0397)	(0.0437)
Rating	0.0292	0.0564	0.0206
	(0.0392)	(0.0374)	(0.0512)
Maturity		0.0784 *	0.0969*
		(0.0425)	(0.0518)
Log(Amount Issued)			-0.0532
			(0.0310)
Constant	-0.0870	-0.1866	0.9916
	(0.0975)	(0.1112)	(0.7295)
Observations	13	13	13
R^2	0.1081	0.2533	0.3856
$Adjusted\ R^2$	-0.0703	0.0043	0.0784

Note: Robust standard errors are reported in parentheses.
*p < 0.1; **p < 0.05; ***p < 0.01.

Table 23 presents the regression results for Germany's data. As can be seen from the results, there are some major differences between the countries. The industry variable is negative in all three models as well as the rating variable. However, neither of these

variables is statistically significant. Maturity coefficients and log(amount issued) coefficients are also negative, suggesting that an increase in the maturity of the bond and amount issue leads to a smaller premium. Nevertheless, both of these variables are statistically insignificant. The results indicate that increase in all of the variables, have a negative effect on the estimated green premium. In addition, the R^2 is clearly smaller than in France's analysis. The R-squared varies from 6.75 % to 10.56%, while the adjusted R-squared turns negative when more variables are added.

Table 23

Germany secondary market green bond premium determinants

Dependent Variable:			
$\hat{\alpha}_i$			
	(1)	(2)	(3)
Industry	-0.1051	-0.1032	-0.0874
	(0.1177)	(0.1211)	(0.1237)
Rating	-0.0061	-0.0109	-0.1027
	(0.0546)	(0.0552)	(0.1633)
Maturity		-0.0017	-0.0030
		(0.0094)	(0.0101)
Log(Amount Issued)			-0.0573
			(0.1003)
Constant	0.2331	0.2567	1.4898
	(0.0966)	(0.1679)	(2.1989)
Observations	33	33	33
R^2	0.0675	0.0681	0.1056
$Adjusted\ R^2$	0.0053	-0.0282	-0.0221

Note: Robust standard errors are reported in parentheses.
*p < 0.1; **p < 0.05; ***p < 0.01.

4.3 Discussion

The following section discusses and interpretates the results from the primary market and secondary market analysis while at the same time analyzing the limitations of the study. Thus, the hypotheses state: 1) *In both markets, there is no green bond premium* 2) *French green bonds have more demand compared to German green bonds.*

4.3.1 Primary market

The primary market analysis found a negative but statistically insignificant coefficient for the green dummy in the fixed effects regression model for both countries. French green bonds had an estimated issue yield premium of -12 bps whereas German green bonds had an issue premium of -5.6 bps. Also, the analysis revealed a fairly noticeable difference in the R^2 between the countries. The R^2 levels were 10 – 15 % bigger for French bonds. Consequently, this implies that the factors that affect in French and German markets differ.

The negative premium is consistent with the previous green bond primary market literature (Ehlers & Packer, 2017; Kapraun & Scheins, 2019). Even though the first hypothesis of the study cannot be rejected, and the estimations are not significant, the negative premium across all the models could indicate that investors are willing to accept lower yields for green bonds in both countries. As the demand for green investing has risen over the years and investors are looking to diversify their portfolios to more ESG-friendly assets, green bonds offer a great option for that. Fama & French (2007) have stated that when investors as a group have a preference towards some asset class, the equilibrium prices tend to change and thus the capital asset pricing model (CAPM) does not manage to explain the asset returns. Therefore, this can be an explanation of why a green bond premium could exist in the markets. As Zerbib (2019) studied, investors with pro-environmental preferences in the bond market are willing to accept lower returns on green bonds.

Since other currencies were excluded from the study and Euro was the only accepted currency, sub-sample analysis could not be carried on. However, Kapraun & Scheins (2019) captured heterogeneity in green premia among different currencies. Especially EUR and USD denominated green bonds were traded at a discount compared to other currency denominated green bonds such as e.g., CNY. Between EUR and USD denominated bonds, EUR green bonds had a slightly larger premia over USD green bonds. Moreover, this could indicate that green bonds which are following the European or recognized international green bond principles (GBP), might be more known amongst investors and thus priced differently (Kapraun & Scheins, 2019).

A bond's green label in the sample is not revealing if the bond has received an external verification from a third party. As it would have been a possibility to try to verify green bond's "greenness", it could have had reduced the data tremendously. As mentioned earlier in the study, greenwashing is a growing problem, especially in times when ESG investing is growing more than ever. Companies can claim that the proceeds gained from the issuance of the green bonds are used in environmentally friendly projects but after all, they are used elsewhere. Moreover, Kapraun & Scheins (2019) found that corporate green bonds which have received a certification from third party, have around -22 bps yield spread to green bonds that have not received certification. In fact, green bonds that did not have a certification, traded at a significant 12 bps discount.

The biggest limitation for primary and secondary market analysis is the amount of data available. Even if France and Germany have one of the biggest green bond markets in the world, the overall market is fairly young, and therefore the data is limited. One of the biggest limitations of this study is the lack of corporate green bonds. Thus, for both countries, most of the issuers were financial institutions and public entities, and Germany did not have a single corporate issue in the data set. Kapraun & Scheins (2019) documented 31 bps negative premia in the primary market for the supranational and sovereign issuer. Corporate green bonds premium did not differ statistically from zero.

Thus, this implies that primary market investors are not willing to accept lower yields from green bonds compared to conventional bonds.

4.3.2 Secondary market

The secondary market model revealed an insignificant negative premium for French green bonds and a positive premium for German bonds. However, the mean premia for French bonds is close to zero. Hence, the analysis discloses a small -0.042 bps premium, while the distribution is skewed to the right. Moreover, about 50 % of the pairs have a positive premium. This means that 50 percent of the green bonds trade at higher levels compared to their conventional counter bonds. Consequently, this could indicate that investors do not value or trust the green label, or they are not interested in green bonds and therefore the demand is smaller. For German bonds, the mean premium is positive of 3.8 bps, whereas the premium distribution is more spread with few outliers. Over 65 % of the estimated premiums are positive. Thus, indicating that the demand for green bonds is not as high compared to French markets. Since financial institutions represent the biggest issuer group, it is possible that investor's trust in these institutions green bond label is not so high. Besides, the results are not consistent with the previous secondary market green bond literature (Zerbib, 2019). The spread in the green premia between the countries can be to a large extend explained by differences in their mean characteristics.

The bid-ask spread was added into the model to control liquidity. This variable turned to be negative and statistically significant for both countries. A negative coefficient means that an increase in the bid-ask variable will further decrease the yield spread between a green and a conventional bond. This result is aligned with Zerbib (2019), who found a -9.88-bps bid-ask differential. Although the regressions had low R^2 levels, and the bid-ask spread differential could not explain much of the variance, it should not be bypass as it still has significant explanatory power, besides controlling for liquidity differences.

The study continued by analyzing different sub-samples and their premium. Most of the sub-categories' premium did not differ significantly from zero. One explanation for this can be the sample size which was relatively small for both countries. For French data, both corporate and financial institutions have a negative premium whereas the premium for German financial institutions is positive. This difference could indicate that in these countries, the market prices green bonds differently. Another difference occurs in a sub-category "Agency". This group includes sovereign entities and for French markets, the coefficient is negative whereas the German markets coefficient is positive. However, another sub-category in the French sample is called "Sub-sovereign" and this coefficient turned out to be positive.

The rating sub-categories were mainly statistically insignificant except for German bonds with an Aa1 rating, which differs from zero at a 10 % level. The average premium for this category is 10.1 bps, implying that green bonds with Aa1 rating, face lower demand or the secondary market does not see the bonds as credible enough. For example, both countries had a negative premium for bonds with an Aaa rating. Nevertheless, since the sub-sample category sizes are small and mainly statistically insignificant, it is hard to conclude the final effect.

The analysis of green bond premium determinants showed that the chosen bond characteristics could not explain very well the estimated premium. The R^2 remained small in all the models and almost all the explanatory variables were insignificant. Again, the sample size is one factor that can explain this. Maturity turned out to be the only significant variable for French bonds at a 10 % level. Industry, rating, and log(amount issued) were all insignificant. It is possible that with a bigger sample size some of these estimates could have affected the premia.

The secondary market analysis also faces numerous limitations. Like mentioned earlier in the study, the biggest limitation is the amount of data available. As the purpose of the study is to compare French and German green bond markets, the German sample was a

lot bigger, thus making the comparison harder. Also, the German sample did not have any corporate green bonds. It would have been interesting to compare corporate green bond markets between these two countries and see what the pricing mechanism is. Next, since the analysis required a matching procedure, this could have introduced some errors and a green bond might have had an even closer conventional bond pair. However, the procedure was done carefully and following the matching criteria. Moreover, the used yield measurement was the daily ask yield. The actual yield of a bond could have been a better measurement but as this was not available and some of the bonds do not trade frequently, it could have had decreased the sample size even more. Thus, the use of ask yield is consistent with the study from Zerbib (2019).

The difference in the green premia in the primary and secondary market can possibly be explained either by different sample characteristics or differences in the primary and secondary market. Thus, investor's demand towards green bonds in the primary and secondary markets can be noticeably different. Furthermore, this study is written during the COVID-19 pandemic. Hence, it is probable that bond pricing and the green premia are affected to some extent due to the radical changes in the economic environment.

5 Conclusions

As climate change poses a significant challenge for the global economy, different sectors have begun to develop solutions to tackle these issues. The demand for SRI is growing more and more, and as a result, a green bond was introduced in 2007 to allocate funds for environmentally friendly projects. This study focuses on the French and German markets as these countries are one of the main participants in the green bond market. In theory, a green bond and conventional bond should not differ in terms of yield, if the only differentiating factor is the green label. For this reason, the yield difference is a widely studied subject. In addition, the existing research has mainly focused on the secondary market while the primary market has not received so much consideration.

The objective of the study is to find out how green bonds are priced compared to conventional bonds in the primary and secondary markets. The primary market analysis is done by using a fixed-effects regression, where the fixed effects include different bond characteristics that might affect the yield. The variable of interest is a dummy variable that indicates if a bond is green or not. In the secondary market analysis, matching method procedure is applied, in which a green bond and conventional bond are matched to a pair according to a certain criterion. And lastly, a regression analysis is run based on these pairs in order to compare yields. Hence, both of the methods are widely used in the research vis-à-vis green bond premium.

This thesis finds a negative insignificant issue yield premium for both countries in the primary market. Based on the results, the first hypothesis cannot be rejected, which states that there is no green bond premium. The same applies to the second hypothesis claiming that French green bonds face more demand compared to German green bonds. However, the results might indicate that primary market investors may be willing to accept lower yields for obtaining green bonds. A rational explanation for this might be the issuer type. Investors may be less fearful concerning greenwashing from financial institutions as this group represents the largest portion in the sample. Thus, green bonds issued by these institutions might face higher demand. Sustainability reputation of the

issuers has been found to be important to investors. Consequently, financial institutions might have better ESG ratings and third-party verifications that might improve the trust of the investors. Based on the previous literature, it seems that in the primary market, investors are more skeptical towards corporate issuers.

The secondary market analysis finds insignificant negative yield differences in French markets and positive differences in German markets. The German green bond premium has turned positive compared to primary market analysis and this raises questions. An explanation can be that the investor base is different from the primary market. Another reason could be the marketplace where bonds are trading. Exchanges that include a dedicated green bond market segment have been found to have bigger green bond premia over non-green market segments. Furthermore, an analysis of subsamples reveals a significant positive green bond premium for German agencies (i.e., state development bank) as well as bonds with Aa1 rating. Lastly, different bond characteristics and their effect on the estimated green premia are investigated. Thus, industry, rating, maturity, and issue amount cannot statistically explain the estimated premium.

As mentioned before, this study has multiple limitations. Firstly, the availability of data for each analysis limits the quality of the results. In addition, the sample has noticeably more issuances from German issuers. The analysis concerning German bonds does not include any corporate issuer, thus, the results apply only to financial institutions and sovereign issuers. Therefore, it is hard to draw conclusions regarding the whole green bond market in Germany. The initial sample is decreased even further due to some missing data and adjustments on data requirements. It is possible that some of the coefficients could turn statistically significant with a higher number of observations. Especially the secondary market sub-sample analysis and the investigation of the green bond premium determinants suffer from a small number of observations and therefore the results can be limited. Lastly, the use of actual yield instead of ask yield would be more optimal regarding the analysis. However, by using actual yield the sample size could have reduced even further. The author, however, expects different results with larger sample size.

Despite the limitations, this thesis can provide some implications for French and German green bond markets. First of all, there are noticeable differences between the countries and also between the primary and secondary market pricing. It seems that investors in the primary and secondary market value green bonds differently. In the primary market, investors pay a premium for green bonds, thus, indicating their preferences towards SRI. In the secondary markets, investors are not willing to pay a premium for green bonds. Some explanation might be a fear of greenwashing. Kapraun & Scheins (2019) found that the issuer's credibility has an important role in decreasing investor's suspicion towards greenwashing. However, investors rely more on the green label from public entities.

Even though the study did not find green bond premia, the green bond market is most likely going to grow in the future. As literature has shown, issuers, investors, and the environment benefit from the existence of green bonds. Investors can expand their portfolios and participate in green project funding. Issuers can improve their environmental reputation; they can have a wider investor base and possibly lower cost of debt. In future research, it would be interesting to see an extended investigation on French and German green bonds with German corporate bonds included. Besides, the COVID-19 pandemic has influenced the global economy in multiple ways. The debt markets have presumably been affected and this might have had some effect on green bond markets equilibrium. The effect of COVID-19 on the green bond market could also be a topic of interest in future research.

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Appendices

Appendix 1. France & Germany secondary market, regression model tests

France	*Test*	*P-value*	*Result*
Fixed effects vs Random effects	Hausman	0.0011	Fixed effects
Heteroskedasticity	Breusch-Pagan	0.0000	Heteroskedasticity
Serial correlation	Wooldridge	0.0000	Serial correlation
Unit root test	Augmented Dickey-Fuller	0.0000	Stationarity
Germany			
Fixed effects vs Random effects	Hausman	0.2915	Random effects
Heteroskedasticity	Breusch-Pagan	0.0000	Heteroskedasticity
Serial correlation	Wooldridge	0.0006	Serial correlation
Unit root test	Augmented Dickey-Fuller	0.0000	Stationarity

Appendix 2. Heteroskedasticity and multicollinearity tests, France

Dependent Variable: $\hat{\alpha}_i$				
		Model:		
	P-value	(1)	(2)	(3)
Homoskedasticity Breusch-Pagan		0.2995	0.4170	0.8137
Multicollinearity				
VIF	Industry	1.07	1.43	1.50
	Rating	1.07	1.07	2.13
	Maturity		1.36	1.45
	Amount Issued			2.78

Appendix 3. Heteroskedasticity and multicollinearity tests, Germany

Dependent Variable: $\hat{\alpha}_i$				
		Model:		
	P-value	(1)	(2)	(3)
Homoskedasticity Breusch-Pagan		0.4524	0.6157	0.0026
Multicollinearity				
VIF	Industry	1.77	2.28	2.37
	Rating	1.77	1.94	10.15
	Maturity		1.30	1.31
	Amount Issued			8.18