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Green bonds: how do green bonds perform when compared with conventional bonds?

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Introduction

This master thesis focuses on a quite recent financial instrument, the so called “green bonds”. The first green bonds were issued by the European Investment Bank in 2007, in order to promote eco-friendly projects and to raise climate awareness. However, we had to wait until 2013 for this new instrument to become famous among both issuers and investors. From this point on, the green bond market has remarkably progressed regarding different aspects and nowadays it represents more than $450 billion over the world.

Among others, the European market has known the most dazzling evolution. More than ever, Europeans are becoming concerned about global warming and ecology. This new trend is reflected in the current market, where 40% of the green bonds issued are in EUR. So far, the European green bond market is the leading one. For this reason, we will focus our research on the green bonds issued in EUR.

Green bonds and conventional bonds are similar instruments and they should share many characteristics. However, in the literature, some scientists and economists believe that there are some differences regarding the performance and the risk. This master thesis aims at comparing the performance and the risk of green and non-green bonds. The problematic is: **“How do green bonds perform when compared with conventional bonds ?”** Is there a difference in the yields to maturity? Are green bonds riskier than ordinary bonds? Do they present a higher liquidity risk?

Moreover, the literature taught us that green bonds were designed differently when they were issued either by corporates or by financial corporates. We will also answer the questions: Are green bonds issued by corporates more performant than the ones issued by financial institutions? Is there a difference in terms of liquidity risk?

This master thesis will be divided in 2 main sections: the literature review and the empirical analysis.

In the literature review section, we will first present the bond market at a glance and define what is a bond and why are they issued.

We will, then, define conventional bonds and their principal characteristics. The different categories of conventional bonds will be mentioned. More, the current situation of the bond market will be stated and the main actors will be presented. We will have a quick look at the

primary versus secondary market as well at the international versus national market. Lastly, the risks faced by bonds will be listed.

The last part of the literature review will focus on the green bonds. We will see what scientists and economists have found regarding their performance and their risks. Before that, we will define the concept and present the poor regulation in place. The situation of the market will also be described.

The second chapter will present the empirical analysis performed in order to answer the problematic.

In the first part, basic and general analysis will be conducted on all the green bonds listed on Eikon.

After, we will create 2 samples of bonds issued in EUR: the first one, composed of green bonds and the second one, composed of similar conventional bonds. Different features such as the coupon rate and the yield to maturity will be examined in order to compare the performance. Additionally, a potential difference in risks will be investigated by comparing the bid/ask spreads.

Last but not least, we will study the divergences between green bonds issued by corporates and green bonds issued by financial institutions. Their yields to maturity and their bid/ask spread will also be compared and the difference will be tested through statistical tests.

Literature review

1. Bonds market at a glance

Prior to 1980, the fixed income securities were basic instruments without any unknown, except the probability of default of the issuer. Indeed, the amount that the investors should expect to receive was known as well as the time they will receive it. Moreover, trading bonds before maturity wasn't that popular. In the 1980s, the bond market has seen an important expansion in the number of instruments available. New instruments such as catastrophe bonds, asset backed securities, etc. made their apparition. (Fabozi, 2006) The transformation of the fixed income market didn't stop there. In fact, the financial crisis of 2008-2009 involved some changes. In order to stimulate their economy, numerous countries had to enlarge their borrowing capacity which resulted in high government debt. Additionally, in order to avoid another financial catastrophe, governments around the world had to put in place a new regulatory environment to control the tradings and the risks taken by financial institutions. The last decades also witnessed important transformation of the bonds return and since then, they are becoming a hedging instrument against the volatility of the stock market. (Veronesi, 2016)

Before providing key numbers about the current bond market, it's important to clearly define what is a bond in order to better understand how the market is working.

A bond is a financial debt obligation of an entity that promises to pay a specified amount of money at specified dates to the bondholder. In this arrangement, the issuer of the bond is the borrower and the purchaser is the lender. (Fabozi, 2006)

The bond market is the environment where all the issuances and trades of bonds occur. The bond market is the major part of the fixed-income securities market. (Fabozi, 2006) Indeed, bonds are commonly called fixed-income instruments because in the beginning, bonds used to pay fixed coupons each year. (Choudry, 2010) It isn't anymore necessarily the case nowadays since financial markets and institutions have been evolving in response to the new technologies and the new constraints and desires of the investors. (Bodie, Kane & Marcus, 2002)

The bond market generally comprises longer-term instruments than the money market. Those ones include Treasury notes and bonds, corporate bonds, municipal bonds, mortgage securities, and federal agency debt. Basically, Treasury notes and bonds are issued by the government to borrow funds. Corporates bonds are a mean for private companies to indirectly borrow money from the public. Municipal bonds are like Treasury notes and bonds in the sense that they are

issued by the state or the local governments, they only differ because they are exempt of federal income taxation. Finally, mortgage securities and federal agency debt are issued to finance farm credit or house mortgages. (Bodie, Kane & Marcus, 2013)

Nowadays, the global bond market represents $100 trillion compared to the global equity market which represents $85 trillion.

Since this research will focus on bonds issued in Euros, we will explore a little bit more this specific market. In 2014, the amount outstanding of international bonds and notes issued in EUR was 37,000 billion of USD, which is more than the 35,000 billion issued in USD. Among these 37,000 billion USD of bonds issued in EUR, 68% were fixed rate bonds. In comparison, the bonds with fixed rates represent 80% of the amount outstanding of international bonds and notes issued in USD. (FRED, 2015) (FRED, 2015[1]) (FRED, 2015[2]) Accordingly, the United States representing 39% of the global fixed income market are the largest market just before the European Union (without the United Kingdom) representing 22% (see *Figure* 1). (SIFMA, 2019)

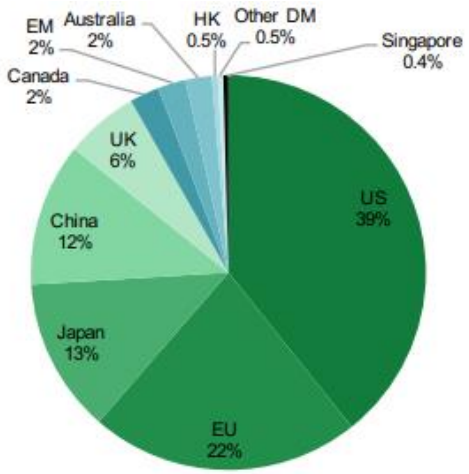

Figure 1: Global Fixed Income Markets Outstanding (SOURCE: SIFMA, 2019)

Up to 2003 and the creation of the Euro, the amount of bonds issued in USD was twice higher than the amount issued in EUR. Indeed, the monetary unification led to an unprecedented rise of the number of issuers and investors. This increase in the European side benefits considerably to all the investors and issuers since it creates competition among the private bonds, in other words the corporate bonds. This infatuation is also present among the European Governments because for them, cutting down basis points of the cost of debt servicing makes considerable difference in terms of taxes reduction to be collected in the future. (Pagagno & von Thadden, 2004)

2. Conventional bonds

2.1. Definition

The fixed-income securities market is made of various instruments and various types of bonds. Among them, the conventional bond, also called plain vanilla, is the most famous one. A conventional bond pays a regular fixed interest payment over a fixed term to the investor. The other types of bonds such as green bonds, convertible bonds, etc. are variations of the conventional bond. (Choudhry, 2010)

In other words, a bond is an agreement between 2 parties: the issuer, which is the borrower, and the investor, which is the lender. Thus, bonds are debts that obligate issuers to bondholders. In this contract, the borrower sells a bond to the lender for some amount of cash and in exchange, the issuer must make specified payments to the bondholder on specified dates.

Quite a few variables are thus specified at the beginning. Indeed, the bond indenture, which is the contract between the issuer and the bondholder, states the coupon rate, the maturity date and the face value of the bond. These variables are the 3 main features of a bond. (Bodie, Marcus & Kane, 2013) The indenture includes the rights of the lender and the promises of the borrower. (Fabozzi, 2006)

2.2. Characteristics

There are thousands of bonds on the market, but all are different. Those differences enable the investors to choose among them according to their needs and their preferences. Each bond has its own characteristics and it is thanks to these characteristics that they differentiate themselves. These characteristics are, for instance, the face value, the maturity date, the coupon, the price at issuance, the type of issuer, etc.

2.2.1. Face Value

The first characteristic of a bond is its face value also called par value. It's the amount the issuer agrees to pay to the bondholder at the end-of-life of the product. As mentioned earlier, this amount is defined in the indenture so that it can't change. Therefore, if the issuer doesn't default, the investor will receive this amount with certainty. (Choudhry, 2010) At maturity, it's a way for the borrower to repay its debt to the lender. (Bodie, Kane & Marcus, 2013)

The value of the par value can be anything, it is completely up to the issuer to determine it. Usually, at least in the United States, the par value is $1,000. (Fabozzi, 2006)

2.2.2. Maturity Date

Another key feature of a bond is its term to maturity commonly called maturity. Choudhry defines the maturity as the number of years over which the bond issuer has promised to meet the conditions of the debt obligation. Typically, at maturity the lender will receive the face value. (Choudhry, 2010)

It's an important information in the investor's decision because it indicates the period during which he can expect to receive the coupon payments as well as the time before he will receive the face value. (Choudhry, 2010)

Conventionally, we can split bonds in 3 categories according to their maturity.

First, the short-term bonds are bonds with maturity from 12 months to 5 years. Usually, if the issuer is the government, the bond will be called treasury note.

The medium-term bonds are bonds with maturity from 5 to 12 years.

Finally, bonds with a maturity of 12 years or more are said to be long-term bonds. (SIFMA, 2011)

We notice that the bond maturities are generally longer than one year. This can be explained by the fact that bonds are loans to government or corporates and they need time to collect benefits from their investments. (Choudhry, 2010)

Short-term bonds are less risky than long-term bonds since the probability of default of the issuer is lower for the short-term bond. Consequently, the longer the maturity, the higher the volatility of its price. (SIFMA, 2011) (Choudhry, 2010)

2.2.3. Coupon Rate

Most of the bonds present in the bond market are coupon bonds. (Choudhry, 2010) It means that they make semiannual or annual interest payments called coupon payments. The coupon is equal to the coupon rate multiplied by the face value. (Bodie, Kane & Marcus, 2013) The coupon rate which is the interest rate the issuer agreed to pay to the bondholder each period until maturity, is specified in the indenture. (Choudhry, 2010)

In the United States, the coupon payments are made semiannually or monthly or quarterly while, in the rest of the world, coupons are annual payments. (Fabozzi, 2006)

There are 3 specific cases:

The most common category of bonds are the **fixed-rate bonds.** The coupon is fixed, meaning that the coupon will stay the same at each payment date. The investor is aware of the coupon rate since it is written in the indenture.

The **floating- rate bonds** are bonds that pay coupons but there is a particularity: these coupons are tied to some measures of the current market rates, the LIBOR for instance. Generally, on top of the reference rate, the issuer adds a quoted margin. In this case, the bond pays always more or less the current market rate. It also means that the coupons will probably differ from one time to the next. (Bodie, Kane & Marcus, 2013)

There also exists a category of bonds that doesn't make coupon payments. They are called **zero-coupon bonds**. In this case, the investor makes profit by buying the zero-coupon bond at a discount rate. (Fabozzi, 2006)

On top of the 3 main characteristics of a bond (i.e. the face value, the maturity date and the coupon rate), there are several yield measures to which investors pay attention. These measures include the current yield, the yield to maturity, the yield to call, … .

2.2.4. Current Yield

The simplest measure of the yield on a bond is the current yield. It measures the annual interest income the bondholder receives as a percentage of the price paid for the bond. It is equal to the annual coupon payment over the bond price. (Bodie, Kane & Marcus, 2002)

For a bond selling at par, the current yield will be equal to the coupon rate. For a bond selling above its face value, in other words selling at a premium, the current yield will be lower than the coupon rate. This measure enables the investor to estimate the profit from holding a bond. (Choudhry, 2001)

It's worth to notice that this measure faces 2 major deficiencies. On one hand, it doesn't take into account the time value of money. On the other hand, the capital gain or loss arisen by the investor from holding or trading a bond are ignored. (Parameswaran, 2007)

2.2.5. Yield to Maturity

The yield to maturity is the most famous yield measure of a bond. It is the interest rate that equates the present value of the cash flows from the bond to the current price of the bond.

$$P_t = \frac{C}{(1+YTM)^1} + \frac{C}{(1+YTM)^2} + \frac{C}{(1+YTM)^3} + \cdots + \frac{C}{(1+YTM)^n} + \frac{FV}{(1+YTM)^n}$$

Where P_t is the bond price at t with t= 0;

C_t is the coupon rate at t;

YTM is the annual yield to maturity;

n is the number of interest periods;

FV_T is the face value at the maturity date T

It depends on the coupon rate, on the maturity and on the face value. Thanks to this measure, the investor can estimate the average rate of return that will be made on a bond if it's bought now and held until maturity. (Bodie, Kane & Marcus, 2002)

The equation of the yield to maturity makes the strong assumption that the coupon payments are reinvested at the yield to maturity itself. (Choudhry, 2001)

Current yield and yield to maturity can't be intermingled. The yield to maturity differs from the current yield in the sense that the yield to maturity takes into account the gain or losses experienced by the investor. (Parameswaran, 2007)

The **yield spread**, also referred to as the credit spread, is the difference between the yields of two bonds having the same maturity and expressed in the same currency. It enables to measure the risk premium which is what the issuer pays to the investor to compensate for the risks associated with the bond. (Chan-Lau & Ivaschencko, 2001)

Financial specialists, such as Wojnilover and Duca, showed decades ago that the yield spread varies according to the expectations of the investors and the economic conditions. (Chan-Lau & Ivaschencko, 2001)

2.2.6. Price at issuance

An important principle in finance is that 1€ today is not equal to 1€ tomorrow. Indeed, money has time value, and this is due to the interest rate.

Applying this principle, it is logical that the price of a bond is not equal to its face value. Actually, the price of a bond is equal to a percentage of the face value of this bond. Equivalently, the price of a bond is the face value discounted at the interest rate. (Choudhry, 2010)

The formula to price a bond is the following:

$$P_B = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} + \frac{FV_T}{(1+r)^T}$$

Where P_B is the bond price;

C is the coupon rate;

r is the interest rate;

T is the number of periods to maturity;

FV is the face value

We observe that the bond value is the sum of the present value of the coupons and the present value of the face value. When the coupon rate is the yield to maturity, the bond price is the face value (the bond sells at par). If the coupon rate is higher than the yield to maturity, the bond price is higher than the face value (the bond sells at a premium). Inversely, if the coupon rate is lower than the yield to maturity, the bond price is lower than the face value (the bond sells at a discount). (Parameswaran, 2007)

The bond value depends on the interest rate, the coupon rate, the face value and the maturity. (Bodie, Kane & Marcus, 2013)

More precisely:

- The higher the interest rate, the lower the present value of the coupons payments the bondholder will receive. (Bodie, Kane & Marcus, 2013)
- The higher the coupon rate, the less the price will change in response to a change in market interest rates. (Fabozzi, 2006)
- The longer the maturity, the more sensitive the bond's price will be to changes in market interest rates. (Bodie, Kane & Marcus, 2013)

Bond prices and yields have an inverse relationship (see *Figure 2*) which explains why the bond curve is convex. This convexity implies that an increase in a bond's yield to maturity leads to a smaller price change than a decrease of equal magnitude of the bond's yield to maturity. (Bodie, Kane & Marcus, 2013)

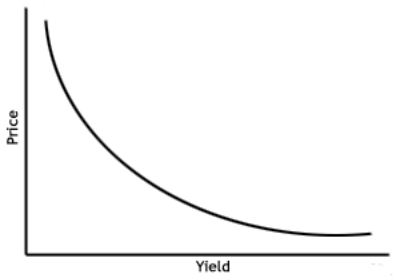

Figure 2: Inverse relationship between bond price and yield (SOURCE: Chen, 2019)

2.2.7. Yield Curve

The yield curve displays the relationship between the yield to maturity (on the y-axis) and the maturity (on the x-axis). This instrument has several uses:

- **Pricing bonds** using the yield curve of the government bonds as a benchmark for yields for the other bonds. The new issued securities in the market are priced thanks to the zero-coupon yield curve.
- **Predicting future yield levels** by analyzing the present shape of the yield curve.
- The yield curve indicates **the returns available at each maturity point** which enables to determine at which maturity point the return will be the most interesting one.
- Comparing the zero-coupon yield curve with other bonds curve with the same maturity **helps to see which bonds should be sold or bought.**

It is important to notice that to be compared, yield curves should represent bonds from the same class of issuers. (Choudhry, 2019)

Figure 3 shows the yield curves of the sovereign and Treasury bonds issued by Belgium (in blue), the United States (in red) and Japan (in purple).

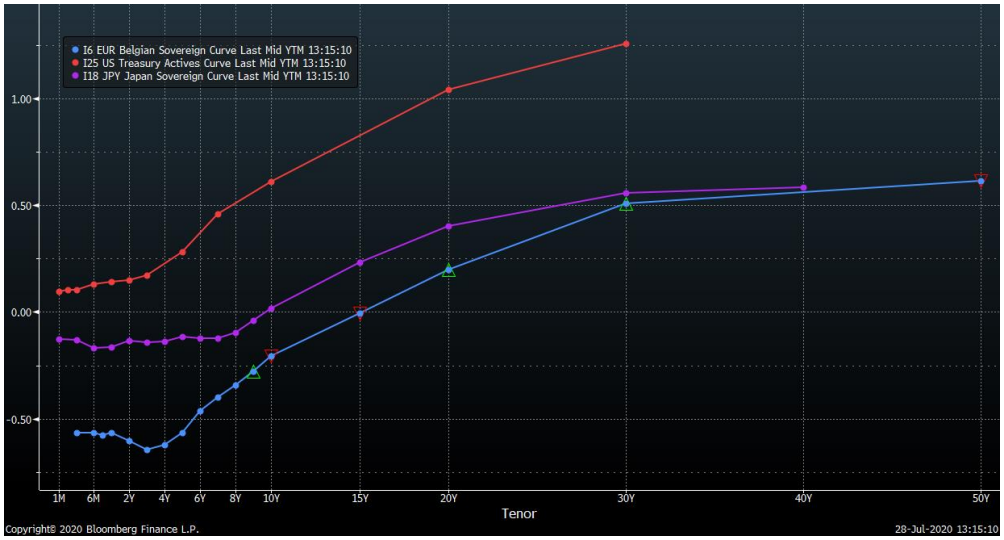

Figure 3: Examples of yield curves. (SOURCE: Bloomberg, 2020)

2.3. Market

As every market, the bond market works according to the supply/demand rule. Indeed, for a market to be effective, 2 things are needed: a demand side which needs something, and a supply side which will provide the demand side.

2.3.1. Issuers

In this case, the bond issuers represent the demand side as they need money. More, the demand curve is downward sloping because the lower the cost of borrowing, the more they will borrow. (See Figure 4*)* (Smith, 2014)

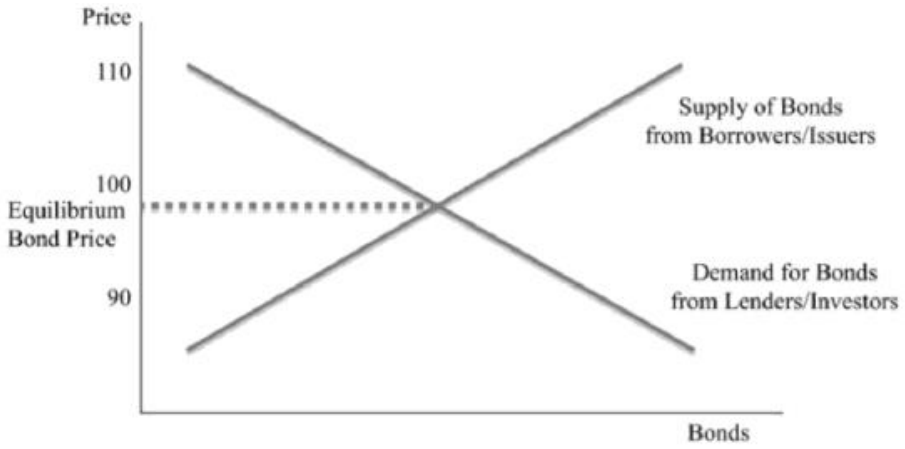

Figure 4: Bond price diagram (SOURCE: Smith, 2014)

There are different categories of issuers, the major ones being:

- The central **governments** are the major issuers of bonds. In the United States, the U.S. Treasury Bonds represent approximately 36% of the total amount of bonds issued. (SIFMA, 2019) Governments fund themselves largely by issuing notes and bonds. Generally, the sovereign bonds are fixed-coupon rate bonds, but they sometimes issue callable bonds. (Bodie, Kane & Marcus, 2002) When issuing a new bond, the company generally refers to the governments bonds to determine the yield. (Redhead,2003)
- Another major issuer category are the **corporates**. This category of issuer is riskier than the government, since they go bankrupt more frequently and more easily. For this reason, the bonds issued by corporates are more diversified and more complex. For instance, a same company may issue bonds with different priority classes if the company goes bankrupt. The senior debts which will be the first to be refund pay a lower rate of coupon yield compared to the subordinated bonds, which are refund only after the senior debts and only if there is still some money left. Corporate bonds don't only differentiate themselves by the riskiness but also by their complexity. Corporates tend to add different features to their bonds and issue more frequently convertible bonds, callable bonds or puttable bonds. (Redhead, 2003)

- Finally, financial institutions such as banks also issue bonds, those ones being pretty like the corporate ones.

All these issuers want to achieve the same goal by issuing bonds; they want to borrow money on the long run. The cost of issuing bonds is low, which is an attractive property for the issuers. (Wang & Zhi, 2016)

Nagano also points out that the probability that a firm with a large funding demand chooses to issue debt securities rather than to borrow a loan is higher namely because it enables a large funding size, the interest rates are lower and there are no collaterals. More, high-valued companies are more likely to issue debt securities than low-valued ones. (Nagano, 2018)

2.3.2. Investors

Investors, on their part, are the supply side, they lend money to the borrowers. But why should they prefer to buy bonds rather than to put their money on a bank deposit? Simply because bonds are, in general, more **profitable** and **liquid** compared with bank deposits, especially nowadays when putting money on a bank account doesn't bring extra money anymore. (Wang & Zhi, 2016)

Besides offering profitability and liquidity, bonds present attractive features for investors:

- Compared to the stock market, the bond market is more **stable**. Particularly during periods of economic difficulties, investors rather buy bonds than stocks, because bonds are less volatile.
- On top of receiving the face value back at maturity, investors also received **interests** in the form of coupons. By paying the coupons, bonds offer a **steady stream of income**. For some bonds, the interests received are even tax-free.
- By selling the bond at a premium, investors can make **additional benefits**.
- Investing in bonds can also be used as a **diversification tool** for investors who want to diversify their portfolio.

(Maeda, 2009)

2.3.3. Credit rating agencies

For investors, the worst scenario would be that the bond issuer became insolvent. If this happens, the investor's chances to receive the face value and the remaining coupons would be low. Fortunately, there exists a tool to know the default risk of each bond or bonds' issuer, could it be the government or a company. This "magic tool" is calculated by taking multiple factors into consideration and it is provided by the so-called credit rating agencies. The most

famous ones are Standard and Poor's, Fitch and Moody's. They all provide a rating to each bond issued or issuer, which reflects the risk of default of the bond or the issuer. The probability of default is very low for high rated issuers, and vice versa. The high rated bonds are called investment grade bonds, while the bad rated bonds are called speculative grade bonds or junk bonds. (Redhead, 2003) *See Annex 1 Credit ratings table*

The main problem with the ratings is that it takes time to update them so that it can't be used as a predictive tool. (Bodie, Kane & Marcus, 2002)

2.3.4. Primary vs. Secondary

Like every financial instrument, bonds are traded on two different markets: the primary and the secondary market.

The primary market is basically the market where all the new bonds issued are traded for the first time. If an investor decides to buy a bond in the primary market, and then to get rid of it before maturity, the investor will have to sell it on the secondary market since it's not a new issued bond anymore. Most of the daily trades are operated on the secondary market.

From the issuer perspective, only the primary market is important in the sense that it's the only place where he can expect to receive money. The passing of the bond from one investor to another doesn't bring money to the issuer. The issuer is absolutely not involved in the secondary market even if he is impacted by what happens there. He has to pay attention because the price of new issued bonds is closely related to the price of one of its bonds traded on the secondary market, all other parameters being similar. It wouldn't be smart from him to issue a new bond at a higher price than the price of a similar old bond traded on the secondary market. No investors would buy it. (Hall & Lieberman, 2008)

2.3.5. International and national markets

Another distinction among bond markets can be made from the perspective of one country: the national and international bond markets.

On one hand, the national bond market also called the internal bond market can be divided in 2: the domestic bond market and the foreign bond market. The first one includes all the bonds issued and traded in the country itself. The other one includes the bonds issued by a foreign issuer and traded in the country itself. The bonds can be issued in any currency. The foreign bonds are often issued by governments or supra-nationals such as the World Bank. (Fabozzi, 2006)

On the other hand, the international market includes the bonds issued in several countries simultaneously through an international syndicate. They are more commonly called Eurobonds. Eurobonds are named based on the currency in which they are issued. (Stafford Johnson, 2010)

Some bonds can be traded both on the international and the national markets, they are called global bonds. (Stafford Johnson, 2010)

2.4. Risks

Among all the financial instruments, bonds can bring a lot of money for the investors. Nevertheless, bonds are not risk-free so far. There are 6 risks that investors are exposed to when holding bonds. It's interesting to notice that the characteristics of the bond (maturity, coupon rate, …) can affect the risks. Moreover, the potential risks embedded in the bond determine its price.

2.4.1. Interest rate risk

The first risk investors are exposed to is the interest rate risk also called market risk.

Bond prices and interest rates have an inverse relationship. Other things being equal, if the interest rate increases, the price of the bond will fall. Indeed, the issuer can't change the coupon rate nor the maturity as it is stated in the bond indenture. (Ramaswamy,2004) The bad scenario for investors would be that the interest rates rise and thus that the price of the bonds go down. (Fabozzi, 2006) All the investors holding bonds face this risk.

The Macaulay's modified duration enables to see the impact of a variation of the interest rate on the bond price. To compute the modified duration, we first have to compute the duration.

$$\text{Duration} = \sum_{t=1}^{T} t \times w_t \quad \text{with } w_t = \frac{CF_t/(1+y)^t}{P}$$

$$\text{Modified Duration} = \frac{\text{Duration}}{1+y}$$

Where CF_t is the cash flow at time t, P is the bond price, T is the maturity date and y is the yield to maturity.

The percentage of variation in bond price is the product of the duration and the variation in bond's yield to maturity. For instance, if the modified duration equals 1.75%, it means that a change in the interest rate of 1% implies an inverse change of 1.75% in the bond price. (Bodie,

Kane & Marcus, 2002) As mentioned above, the relation between the bond prices and the yields is convex, for this reason, the modified duration measure is only accurate for small changes in bond yields. (Bajo, Barbi & Hillier, 2013)

The features of the bond affect this risk:

- The longer the bond's maturity, the more sensitive the bond's price to changes in interest rates.
- The lower the coupon rate, the more sensitive the bond's price to changes in interest rates.
- The higher the bond's yield to maturity, the less sensitive the bond's price to changes in interest rates.

2.4.2. Default risk

The default risk is the probability that the issuer will not fulfill its obligations stated in the bond indenture. An issuer can default in which case he can't honor his duties with respect to the bondholder. This last one will not receive the face value and may also loose some coupons, which will represent for him a financial loss. (Bielecki, Rutkowski, 2004) The percentage of investor's investment that he can expect to receive if the issuer defaults is called the recovery rate. (Choudhry, 2001)

Fortunately for investors, there already exists a measure of the default risk of each issuer, the famous credit ratings (*cfr 2.3.3 Credit rating agencies*). The default risk increases as the credit rating decreases. (Ramaswamy, 2004) The credit ratings summarize several ratios (coverage ratio, leverage ratio, …), that can also be used by investors to estimate by themselves the default risk. (Bodie, Kane & Marcus, 2002)

This default risk is mainly applicable to bonds issued by corporates. Indeed, it is rare and it would be consequential if a government or a financial institution became insolvent. Sadly famous examples are the restructuring of the Argentine debt and the bankruptcy of Lehman Brothers. (Bodie, Kane & Marcus, 2002)

2.4.3. Reinvestment risk

The third category of risks that bondholders may face is the reinvestment risk. Fabozzi defines the reinvestment risk as "The risk that the proceeds received from the payment of interests and principal that are available for reinvestment must be reinvested at a lower interest rate than the security that generated the proceeds".

The most common example is the callable bond. If the issuer calls the bond back before maturity, he pays the investor. The last one is left with cash that he may not be able to reinvest at a comparable rate. To compensate this additional risk applying only to a certain category of bonds, investors receive a higher yield for such bonds. (Fabozzi, 2006)

Some characteristics of the bond also influence this risk. All things being equal:

- The longer the maturity, the higher the reinvestment risk
- The higher the coupon rate, the higher the investment risk

(Wilson, Fabozzi, 2008)

2.4.4. Inflation risk

Conventional bonds interest payments are fixed so their value can be eroded by inflation. This is called the inflation risk. If there is inflation, the purchasing power of the investors decrease. (Bloomsbury, 2010)

The inflation risk is linked to the interest rate risk since usually when the inflation increases, the interest rate risk also increases. (Fabozzi, 2006)

Some bonds are protected against this risk, the inflation-indexed bonds. Floating rate bonds also limit the exposure of the investors to the inflation risk.

2.4.5. Rating downgrade risk

As we already know, credit rating agencies assign to each issuer a rating which represents the default risk. This rating is reviewed frequently in order to remain accurate.

Experiencing financial difficulties, issuers might see their bonds being downgraded by rating agencies. The downgrade risk can also happen due to rumors and not effective financial issues. This way, the price of a bond can change if the perception of the issuer's ability to pay the promised cash flows changes. The longer the bond maturity, the higher the downgrade risk. (Ramaswamy, 2004)

The downgrade risk together with the default risk constitute the credit risk, which is one of the major risks faced by corporate bonds' investors.

A famous example is the Lehman Brothers rating downgrade due to their bankruptcy in 2008. Before 2008, their Moody's rating was A1, which is the upper medium grade category. Facing difficulties in September 2008, Moody's lowered the rating to B3, which corresponds to highly speculative bonds. A few days later, they announced their bankruptcy and the rating was obviously withdrawn. (Moody's, 2020) *See Annex 1 Credit ratings table*

2.4.6. Liquidity risk

Last but not least, investors may also face the liquidity risk. The trading liquidity risk is the risk that bonds that they hold may only be sold below the current market valuation. For example, an investor having some cash difficulties might not be able to sell his bond at a fair price in a bad economy period. This lack of liquidity will engender a loss for him since he will sell his bond below the market valuation. (Fedelstein & Fabozzi, 2008)

According to Fedelstein and Fabozzi, an investment is said liquid if it can rapidly be converted into cash at a price close to the current market valuation. For investors who plan to hold the bond until maturity, the liquidity risk doesn't constitute a major risk because they won't have to sell the bond. (Fedelstein & Fabozzi, 2008)

However banks may also face liquidity risk, the current regulation about it is very strong. Hopefully, the economic world has learned something from the past. A concrete example is the liquidity crisis of Northern Rock, a British bank, in 2007. The bank used to give mortgages to its customers by borrowing in international markets. During the subprime crisis, the company faced liquidity issues because they weren't able to borrow from the wholesale market which dried up. The bank was short on liquidity and people ran on the bank. (Herecomesthebosscom, 2008)

The main measure of liquidity risk is the bid/ask spread. The bid/ask spread is the spread between the price that investors are willing to sell their bond (the ask price) and the price that investors are willing to pay for the bond (the bid price). The bigger the bid/ask spread, the bigger the liquidity risk. (Fabozzi, 2006)

3. Green bonds

Conventional bonds are the most famous class of bonds but recently, a new type of bonds has made its apparition: the green bonds. These last ones being the subject of this master thesis, it's essential to clearly define this instrument in order to be able, in a second step, to compare them with the conventional ones, described in the previous chapter. Before defining it, we will set the scene to understand the context of its apparition.

3.1. Definition

3.1.1. Historical Context

No one ignores that climate change is becoming a real concern, and everyone needs to adapt to these new climatic conditions. (Voica, Panait & Radulescu, 2015) Since the Copenhagen Conference in 2009, countries have decided to limit the increase in the global warming to 2°C. Nevertheless, no action plan was suggested, and the 193 countries meeting couldn't agree on the practical realization of this international agreement. (United Nations Climate Change, 2009) Fortunately in 2015, the 193 countries joined by 2 others agreed on a practical plan to limit the global warming rise to 2°C, the so-called Paris Climate Agreement. (European Commission, 2019) All the sectors have to take actions to make possible the transition to a low-carbon economy, this includes the financial sector. (Knights, 2015) This last one plays a key role in this transition. Investors' interest for ethical investment has been boosted these last years. Consequently, 2 new investing criteria have been created to help these socially conscious investors, namely the Socially Responsible Investing criteria (SRI) and the Environmental, Social and Governance Investing criteria (ESG). Both methods are quite similar, but still there is a small difference. ESG's investing strategy takes into account the effect of environmental, social and governance criteria on a particular investment. Alternately, SRI determines which companies not to invest in because they don't have a positive impact on environmental and social fields. (Cautero, 2019)

Furthermore, the so called "finance 2°C" includes evolutions such as green bonds. Indeed, green bonds is one of the most promising instruments to finance eco-friendly projects and to raise awareness about the global warming risks. (Fatica, Panzica & Rancan, 2019)

Two years before the global wake-up call of Copenhagen, the European Investment Bank (EIB) issued in 2007 the first green bond that was called the "climate awareness bond". Following the example of the EIB, the World Bank issued in 2008 a first green bond of $400 million. Then, we have to wait until 2013 for other issuers than development banks and supranational institutions to become aware of their major role in the low-carbon economy transition and to take actions by issuing green bonds. It's also worth to notice that the first green sovereign bond was issued by Poland in 2016. (Tang & Zhang, 2018)

From this point, the green bond market has known a transformation in terms of size, number and type of investors as well as issuers, available currencies and geographic base. (Knight, 2015) The transformation of the green bond market was similar for all the continents but since

this master thesis is focusing on the European green bond market only, it's interesting to spot the light on its own evolution. (See Figure 5)

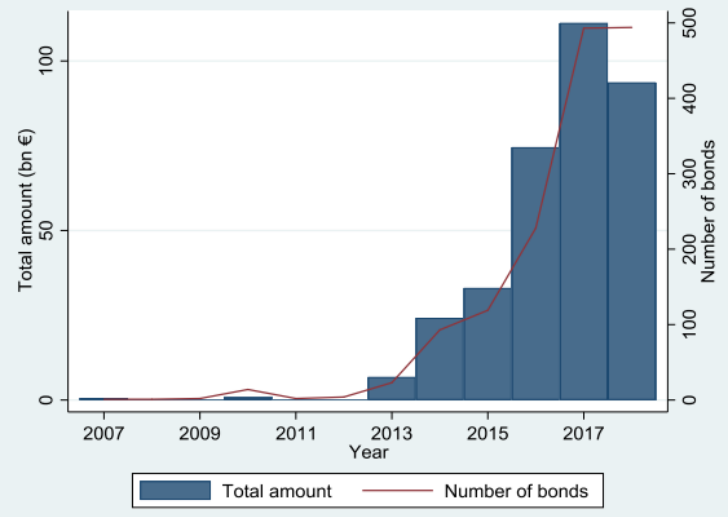

Figure 5: Evolution of the European green bond market (SOURCE: Fatica, 2019)

3.1.2. Definition

The name « green bond » speaks for itself. Bachelet, Beccheti and Manfrediona defined a green bond as "a plain-vanilla fixed-income product which owns the basic characteristics of conventional bonds" (cfr. *2.2 Characteristics*) (Bachelet, Beccheti & Manfredonia, 2019). The unique difference with conventional bonds lays in the use of the proceeds of the bond sales. Green bonds issuers commit themselves to invest the proceeds in a transparent manner in "green" projects. (Wang & Zhi, 2016)

To sum up, green bonds are conventional bonds with the particularity that the proceeds will be invested in projects beneficial to the environment.

To differentiate from conventional bonds, green bonds are mostly labelled as green by their issuer or by external entities, this only after being certified or verified by a second party. (OECD, 2017)

There is still no universal definition of green bonds, indeed there are differences from one part of the world to another. However, there are 2 commonly used green bonds standards: the Green Bonds Principles (GBP) and the Climate Bonds Initiative (CBI). (Tang & Zhang, 2018)

3.1.3. The Green Bonds Principles

The Green Bonds Principles (GBP) were established in 2014 by the International Capital Market Association (ICMA), which gather among others investment banks and securities houses. ICMA defines green bonds as "any type of bond instrument where the proceeds will be

exclusively applied to finance or re-finance, in part or in full, new and/or existing eligible green projects and which are aligned with the four core components of the GBP". (ICMA, 2018)

The GBP are guidelines that specify the issuance process of a green bond and that require transparency and a clear disclosure for issuers. The goal is to enable the investors to clearly understand the characteristics of every green bond issued. (ICMA, 2018) By providing GBP, the ICMA intents to provide a consensus on what classifies a bond as green. (Moid, 2017)

The GBP are made of 4 core components:

- The **Use of Proceeds**: which states that the proceeds of the bond should be invested in green projects. The last ones should be appropriately described and should inform in the bond prospectus about the environmental benefits it will create. The issuer has to choose a green project among a list of recognized categories such as renewable energy, for instance. *See Annex 2 Use of proceeds cash flows*
- The **Process for Evaluation and Selection**: the issuer should clearly set out the decision-making process used in the choice of the green project the proceeds will finance. The potential risks associated with the chosen project should also be communicated, as well as the way they could be managed.
- The **Management of Proceeds**: the proceeds of green bonds should be kept apart from the remaining part of the company or institution's cash, on another account or on a sub-account. It's made in order to be sure that the entire proceeds are used for environmental projects.
- The **Report on the Use of Proceeds**: issuers should publish at least annually, a list of the green projects that have been financed by the proceeds of their green bonds. This report should include details about the projects as well as the amounts allocated and the expected environmental impact. The current environmental impact of the projects should be quantified. (ICMA, 2018)

Transparency is a key to integrity, and it should be applied in the 4 components. (OECD, 2017) Indeed, investors have different views on what is green. Transparency ensures them that green bonds in which they invest have the criteria they value. (SEB, 2017)

The Green Bond Principles also suggest a 2nd party opinion or a 3rd party verification in order to have an external assurance on the compliance with the GBP. Concerning the **2nd party opinion**, it's given by an independent body (such as CICERO, Oekom Research, KPMG, …)

after analyzing if the green bond has been created according to the GBP's 4 components. Nowadays, 62% of the green bonds issued have been externally reviewed. (SEB, 2017)

Each body follows its own methodology to determine the greenness of the bond. Cicero, the world leader (see Figure 6), uses a desk-based review process using documentation available at the bond issuance. They grade bonds as light green, medium green or dark green. (CICERO, 2019) *See Annex 3 CICERO's second opinion process and Annex 4 Shades of green methodology*

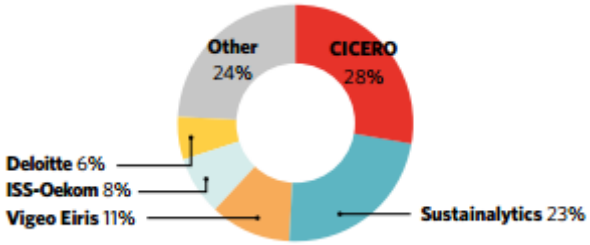

Figure 6: External reviewers market shares (SOURCE : Climate Bonds Initiative, 2018[3])

The **3rd party verification** or certification consists in asking a competent 3rd party to verify consistency with specific criteria mentioned in standards. Standards might be the Climate Bond Standards for instance. (HSBC, 2015) External review is important because it increases investors' trust as well as issuer's reputation. (KPMG, 2015)

The market, especially the European one, recognizes these Green Bond Principles and its four core components detailed above. (Tang & Zhang, 2018)

3.1.4. The Climate Bond Initiative

The Climate Bonds Standard and Certification Scheme (CBSCS) were created in 2010 by the Climate Bond Initiative, an international not-for-profit organization which promotes the growth of the Green bond market in order to find climate change solutions. The goal is to create an effective certification system, which is essential to a sustainable market. (Climate Bonds Initiative, 2019[1])

The CBSCS is made of 2 different parts: the Climate Bonds Standard (CBS) and the Certification Scheme.

- The **Climate Bonds Standard** (also called Climate Bonds Taxonomy) provides specific criteria to verify the actual greenness of the bond and to verify if the proceeds are used to finance projects that are actually helping the transition to a low-carbon economy. (Climate Bonds Initiative, 2017)

- In the **Certification Scheme**, an independent third party verifies, pre- and post-issuance, if the bond meets the Climate Bonds Standard. This operation is supervised by an international board. It also provides frameworks for monitoring and reporting. Obtaining the certification is important for issuers because it proves that they meet the industry standards which will improve among others their reputation.

The Climate Bonds Standard and Certification Scheme (CBS) encompass the Green Bond Principles by specifying sector-specific criteria to assess a green bond compared to GBP that are more general. (Ehlers & Packer, 2017) Additionally, it provides the only international certification scheme for green bonds. (Nairobi Securities exchange, n.d.) Around 25% of the green bonds issued are certified by the Climate Bond Initiative's Certification Scheme, which means that they are also compliant with the Green Bond Principles. (Climate Bonds Initiative, 2018[1])

As previously said, following those 2 standards is not mandatory and many countries have developed their own taxonomies in order to classify bonds as green or not. (Ehlers & Packer, 2017) *See Annex 5 Evolving guidance in the green bond market*

3.1.5. Climate-aligned Bonds, Social Bonds and Sustainability Bonds

In the current literature, we can find expressions similar to green bonds such as climate-aligned bonds or social bonds but it's important to notice that those words aren't synonyms of green bonds.

Indeed, the Climate Bond Initiative defines the **climate-aligned bond** as "a term used to describe the full universe of aligned outstanding bonds, i.e. from fully-aligned issuers, strongly-aligned issuers and green bond issuers". This means that the climate-aligned bonds are a more global concept that encompasses the green bonds. In 2018, the amount of climate-aligned bond outstanding was $1.45tn and the green bonds represented around 32% of this amount (see Figure 7). The European market was the largest one with $509bn of climate-aligned bonds outstanding. (Climate Bonds Initiative, 2018[2])

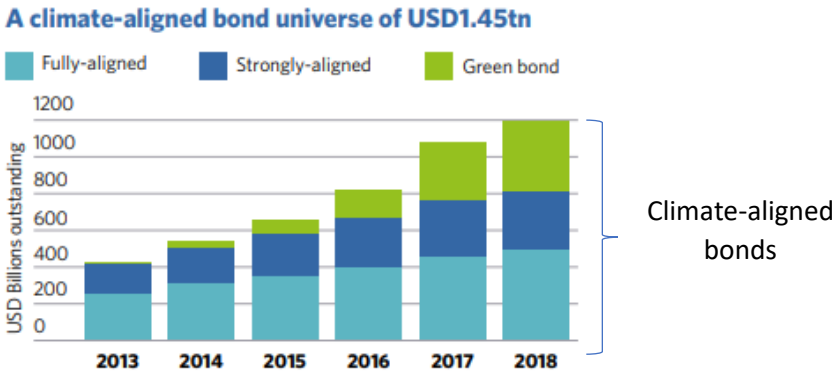

Figure 7: Evolution of the climate-aligned bond market (SOURCE: Climate bonds initiative, 2018[3])

Another concept often associated to green bonds is **social bonds**. Social bonds are defined by the International Capital Market Association (ICMA) as "use of proceeds bonds that raise funds for new and existing projects with positive social outcomes". They differ from green bonds in the type of projects they aim to finance, green projects versus social projects. The standards for this type of bond are the social bond principles, also published by the ICMA. (ICMA, 2019)

In 2018, the Nederlandse Waterschapsbank issued 3 social bonds totaling €2.1 billion. The proceeds of these bonds were used to finance affordable housing for people facing difficulties to find fair living. (NWB bank, 2020)

More rarely, the term **sustainability bond** is also used. This concept is more specific since it concerns the bonds for which the proceeds will be used to finance a combination of both green and social projects (see Figure 8). Once again, specific standards called the sustainability bond guidelines have been created. (ICMA, 2019) In 2019, the Dutch BNG Bank issued a 7-years sustainability bond of €750 million. The proceeds will be used to finance loans to Dutch municipalities with the highest sustainability rates. (Environmental Finance, 2019)

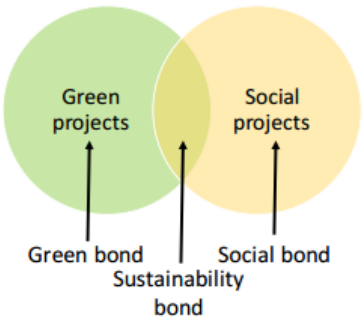

Figure 8: Distinction between green, social and sustainability bonds (SOURCE: HSBC, 2017)

3.2. Characteristics

As mentioned in the definition (see 3.1.2 Definition*)* green bonds have the same characteristics than conventional bonds. Ordinarily, issuers create green bonds to raise capital from investors over a predefined period of time, the maturity. Issuers pay along the way coupons, which are the interests and at the end they pay back the principal or face value. (OECD, 2017)

3.2.1. Maturity Date

Regarding the maturity, both HSBC and Ehlers & Packer agreed to say that on average green bonds' maturity is lower than conventional bonds' maturity. (Ehlers & Packer, 2017) Generally, green bonds are medium-term bonds (see *2.2.2 Maturity Date)* with an average between 5 and 10 years. (Reboredo, 2018) In 2018, 45% of the green bonds were medium-term bonds, as we can observe on Figure 9. (IFC, 2018) On their side, conventional bonds have an average maturity of 9 years. (HSBC, 2016)

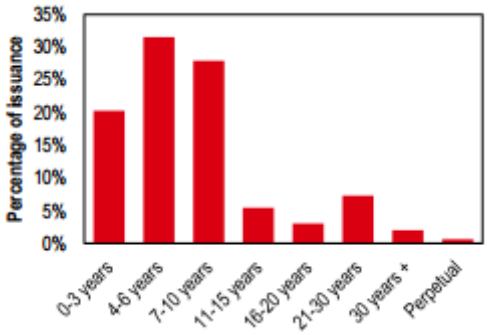

Figure 9: Green bond issuance by tenor (SOURCE: HSBC, 2017)

Another interesting observation Ehlers & Packer made is that in 2017, issuers started to issue green bonds with a longer maturity. (Ehlers & Packer, 2017) The green bonds with the longest maturity was until 2017, the 22-year France Sovereign green bond. (VanEck, 2017) But more recently, European countries such as Poland and Iceland have issued 30-year Sovereign green bonds. (Société Générale, 2019) Last but not least, a 34-year muni US green bond was issued in 2018 by the city of Saint Louis Park, Minnesota. (Climate Bonds Initiative, 2019[2])

3.2.2. Coupon Rate

Comparably to conventional bonds (see *2.2.3 Coupon Rate*), green bonds' investors also receive coupon payments each year or more frequently, in the case of American ones. As for the traditional bonds, the coupon rate can be fixed or floating as well as inexistent. For this reason, there exists fixed-rate green bonds, floating-rate green bonds and zero-rate green bonds. The most common type is the fixed-rate one. (SEB, 2018)

3.2.3. Price at issuance

In the literature, scientists' results diverge on the green bonds' price at issuance.

On one hand, some of them believe that green bonds tend to price in line with conventional bonds. HSBC proved that the new issue premium was the same for green bonds and non-green bonds. They define the new issue premium as "the additional spread that an issuer pays to issue a new bond, versus where its existing bonds trade in the secondary market". Being able to prove that using reconstructed bond curves, they conclude that since the new issue premium was the same, the pricing should also be the same. To sum up, according to their results there is no premium for green bonds trading in the primary market as well as in the secondary market. (HSBC, 2016)

Sharing the same opinion, the Climate Bond Initiative states in an explanatory note on green bonds that the price was flat, meaning that it was the same as for ordinary bonds. Green bonds are *pari passu* to conventional bonds since they are issued by the same issuer and thus the same pricing or credit profile. (Climate Bonds Initiative, 2019[3])

On the other hand, more recent studies have shown that green bonds price at issuance at a premium compared to ordinary bonds.

Ehlers and Packer (2017) explain this by taking into account the investor's perspective. Indeed, a sufficient number of investors value the green label and are consequently ready to pay more for it. Nevertheless, investors still want their bonds to financially perform. There is a limit to what they are ready to pay as an extra. They conclude that in the primary market, there is a negative spread of -18 basis points (bps). Regarding the secondary market, the performances of both green and non-green bonds seem similar. (Ehlers & Packer, 2017)

This spread between the green bonds and the conventional bonds is called the green bond premium or the greenium. Zerbib (2018) defines it as "the yield differential between a green bond and an otherwise identical conventional bond". The formula is the following:

$$\Delta\overline{y_{i,t}} = y_{i,t}^{GB} - y_{i,t}^{CB}$$

Where, $y_{i,t}^{GB}$ is the green bond i's yield on day t and $y_{i,t}^{CB}$ is the conventional bond i's yield on day t. This formula slightly differs from the one he used in his first study in 2016, in which there was a denominator: the absolute value of the conventional bond's yield. (Zerbib, 2018)

In the secondary market, Zerbib demonstrated in 2018 that there was a significant negative green bond premium of -2bps. This means that the yield of a green bond is lower than the one

of an ordinary bond. He combined a green bond and a conventional bond with identical characteristics to constitute pairs. Then, he proceeded to a panel regression on these pairs to see if there was green premia and a cross-sectional regression to identify the features of the bonds that could explain this green premium. He found out that the sector and the rating were drivers for the premium; financial bonds and low-rated bonds have a more negative premium than others. (Zerbib, 2018)

In 2019, he made a complementary study on the effect of pro-environmental preferences on bond prices. From his researches it appears that investors' pro-environmental motivations have a low impact on the bond prices. This result shows that investor value green investments and that there is no reason for them to go against the development of the green bond market. (Zerbib, 2019)

In 2015, Barclays (2015) demonstrated that investors were paying a premium of -17bps to buy green bonds in the secondary market. To do so, they ran a linear regression (OLS) on the Global Credit Index. More than observing that there was a negative greenium, they also found out that the green bond investor premium has increased over time, as the market has grown. This observation is showed in Figure 10, where the x-axis are basis points. Barclays suggests several potential explanations for the negative premium. (Barclays, 2015)

It could be explained by the unbalance between the supply and the demand. Investors' demand for eco-friendly funds exceed issuers' supply of green bonds. Prices are higher and thus the yields and the returns are lower. The European Commission stated that green bonds were issued at a lower yield relative to traditional bonds. (Fatica, Panzica, Rancan, 2019) Wulandari, Schafer, Stephan & Sun agreed on that and they even showed that the yield spread was lower for green bonds relative to ordinary bonds. (Wulandari, Schafer, Stephan & Sun, 2017) (Wulandari, Schafer, Stephan & Sun, 2018)

Externalities through the projects they finance, such as mitigating the climate change, are hard to quantify and thus to price. (Barclays, 2015)

Last but not least, green bonds could be less risky and less volatile than traditional ones which could also explain the presence of the green premium. (Barclays, 2015)

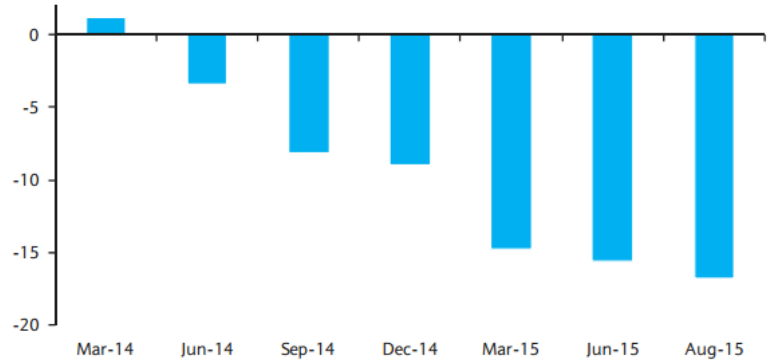

Figure 10: Green bond premium has increased over time (SOURCE: Barclays, 2015)

Finally, another study has shown that green bonds are traded at lower prices than conventional bonds.

Karpf and Mandel (2017) demonstrated using the yield term structure that the market expects lower returns for green bonds relative to non-green bond. The spread is even bigger for longer maturities. Furthermore, by applying an Oaxaca-Blinder Regression, it appears that the market values less favorably green bonds against traditional bonds. The result of the study shows that in the secondary market, there is a positive greenium of +7.8 bps. (Karpf & Mandel, 2017)

As we observe, the results and opinions are very divergent as well on the secondary market as on the primary market. Through this master thesis, the goal is to compare the returns on the primary market in order to see on which scientist's theory we agree.

3.3. Categories

So far, the International Capital Market Association (2018) dissociates 4 different types of green bonds: the standard green use of proceeds bonds, the green revenue bonds, the green bond projects and the green securitized bonds. With the expected green bond market's growth, new categories of green bonds might emerge.

3.3.1. The standard green use of proceeds bonds

In this first category, the proceeds of the green bonds are allocated to green projects. The issuer has the obligation to repay its debt, comparably to conventional bonds. The bonds are secured by assets. Examples are the bonds issued and backed by the European Investment Bank, called "Climate Awareness Bonds".

3.3.2. The green revenue bonds

The recourse to the issuer debt obligation is not possible. The debt is not secured by issuer's assets but by issuer's revenue streams such as fees, taxes, … The green revenue bond's proceeds

are used to finance or refinance green projects. In 2014, the Hawaii State Department of Business, Economic Development and Tourism issued a green revenue bond backed by fees on the electricity bills of the Hawaiian state utilities. (Kidney, 2014[1])

3.3.3. The green project bonds

The proceeds are used to finance a specific single or multiple green project(s). By investing in this category, the investor has a direct risk exposure and he can't recourse to the issuer debt obligation. The securities are the project's assets and balance sheet. A real example is the green project bond issued by MidAmerican Energy to finance the construction of 2 wind farms. The recourse there are the Wind X and XI projects. (Gilbert + Tolbin, 2018)

3.3.4. The green securitized bonds

Finally, the proceeds of the green securitized bonds are used to finance or refinance green projects. Investors can make recourse to a group of projects pooled together. Usually, the first sources of repayment are the assets' cash flows. In 2014, the Canadian Northland Power issued a green securitized bond backed by solar projects. Investors recourse to the solar projects instead of to Northland Power. (Kidney, 2014[2])

All these categories required the bond to be aligned with the Green Bond Principles. (cfr 3.1.3) (ICMA, 2018) (Climate Bonds Initiative, 2019[3])

3.4. Market

3.4.1. Issuers

As for non-green bonds, different types of issuers may issue green bonds: financial institutions, government, corporates, … Moreover, every type of conventional bonds' issuers may potentially issue green bonds since they all can benefit from it.

The firsts green bonds were issued by supranational entities such as the European Investment Bank and the World Bank. (Reboredo, 2018) Then, financial and non-financial corporates and later governments also started issuing green bonds. With the development of the green market, the amount and the categories of issuers keeps multiplying. (Tang & Zhang, 2018)

The diversity of issuers comes from the fact that green bonds issuers don't have to be green themselves, they just have to use the proceeds to finance green projects. (HSBC, 2016)

In 2017, the category that has been issuing the biggest part of all the green bonds available on the market was the financial sector with almost 30% of green bonds outstanding (see Figure 11). The second one with 24% was the non-financial corporates. (HSBC, 2017)

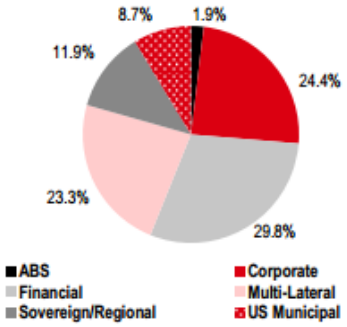

Figure 11: Green bonds outstanding by issuer in 2017 (SOURCE: HSBC, 2017)

In 2018, financial corporates were still leaders but this time, the second ones were asset-backed securities issuers (ABS) (see Figure 12). (Climate Bonds Initiative, 2018[3])

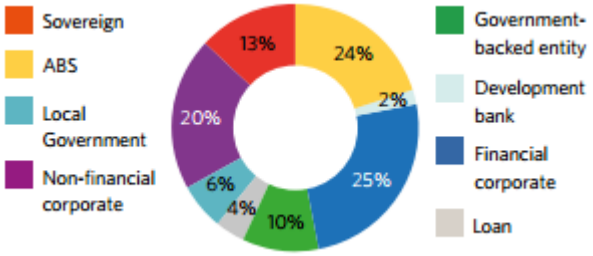

Figure 12: Green bonds outstanding by issuer in 2018 (SOURCE: Climate bonds initiative, 2018[3])

On Figure 12, we also observe that financial institutions and corporates are the main green bonds' issuers, combining almost half of the market.

Nevertheless, the green bonds they issue are designed differently. On one hand, corporates issue green bonds to finance their own green projects. On the other hand, financial institutions use their green bonds' proceeds to invest in and to give loan to other firms' green projects. (Tang & Zhang, 2018) *See Annex 6 Example of Renewi's green bond prospectus*

Regarding the ratings attributed by credit rating agencies to green bonds issuers, we observe on Figure 13 that only a few of them are rated as speculative grade bonds. (Ehlers & Packer, 2017) *See Annex 7 Green bond market segmentation*

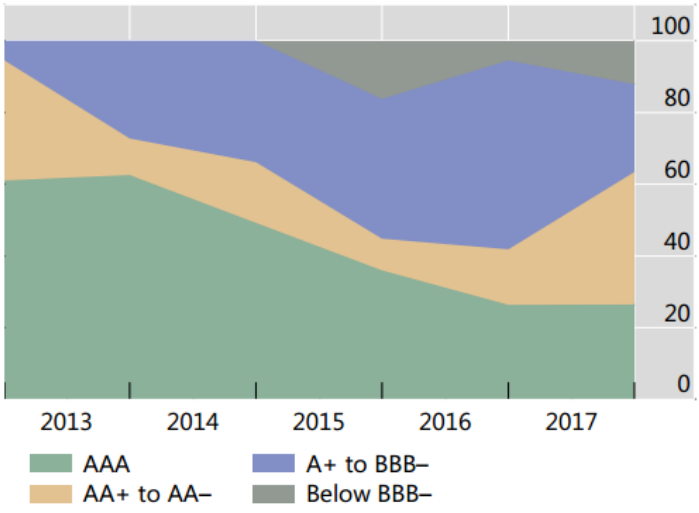

Figure 13: The share of credit ratings in % (SOURCE: Ehlers & Packer, 2017)

One question remains unanswered so far: Why issuers may rather issue green bonds than ordinary bonds? What are the advantages?

The main advantage, mentioned frequently in the literature, is that investors' demand for yield is low and thus the yields at issuance are lower, which enables issuers to decrease the cost of capital. At issuance, green bonds **cost less** for issuers than conventional bonds. (Wang & Zhi, 2016)

Moreover, so far there is a mismatch between the supply and the demand of green bonds. Indeed, the demand for these financial products exceeds their supply. (Gianfrate & Peri, 2019) As a consequence of the law of supply and demand, green bonds enjoy **better pricing**. (Moid, 2017)

Zerbib (2018) and Tang & Zhang (2018) also proved that a company's stock reacts positively to green bonds issue's announcement. Moreover, the **announcement returns** are bigger for the first-time issuers and when the issuer being a corporate and not a financial institution. (Fatica, Panzica & Rancan, 2019)

Additionally, it's a **long-term source of debt financing** that enables issuers to enlarge and **diversify their investors' base**. In fact, issuing green bonds increase media exposure and thus visibility, which will catch the investors' attention. (KPMG, 2015)

Last but not least, it **enhances issuer's reputation**. Indeed, issuing green bonds is a signal of good governance, it shows issuer's expertise and taste for innovation. (Berger, 2017) It also supports company's sustainable strategy. (OECD, 2015) Moreover, it might be appealing for employees and customers preoccupied by the global warming. (Bachelet, 2019)

However, there aren't only advantages of issuing green bonds.

One of the biggest inconvenients are the **additional costs** that it brings. Undoubtedly, green label benefits to issuer but it incurs extra-costs (paying the external reviewers, …) to obtain the green certification. (Gianfrate & Peri, 2019) Nevertheless, issuer may benefit from economies of scales since the main part of the costs comes from the processes' setting up. It explains why for first-time issuers, issuing green bonds can be expensive. (OECD, 2015)

Wulandari, Schafer, Stephan & Sun (2017) also point out the **lack of fiscal incentive** as well as the **high level of information disclosure** required which according to them are non-negligible disadvantages for green bond issuers.

Furthermore, it increases the **reputational risk** because issuer may face accusation of greenwashing. Issuer may be accused of greenwashing if the proceeds are used to finance non-green or not green enough projects or if the management of proceeds is not transparent enough. Globally, issuer may be accused of greenwashing if there is a lack of transparency in their process and if they don't correctly apply the Green Bonds Principles (see 3.1.3). (KPMG, 2015)

3.4.2. Investors

As we have understood, investors play a key role in the green bond market. It's thanks to their high interest for this financial product that the green bond market has known this remarkable growth.

There are, for them, several advantages to invest in green bonds rather than conventional bonds.

Obviously, the most important one is the **ecological and ethical aspect** of this investment. Ecology is more and more a preoccupation for millennials and young investors, in this perspective they want to **improve their Environmental, Social and Governance (ESG) Score**. By doing that, they prove their social responsibility in the climate change. (Voica, Panait & Radulescu, 2015)

Similarly to issuers, investing in green bonds might also improve **investor's reputation**. Especially, for public investors such as corporates and financial institutions for which investments are closely watched. (Voica, Panait & Radulescu, 2015) Recently, coalitions of investors, who commit to decarbonize their portfolios, were born. They also urge themselves to measure the carbon footprint of their investments and to publish it. (Zerbib, 2018)

Beyond extra-financial motivations, investors also have financial incentives. Investing in green bonds enables them to **diversify their portfolios**. This way, they hedge their portfolio against climate change risk which they consider as a threat to wealth in the long run. (Zerbib, 2018)

Furthermore, investing in green bonds represents **lower risks** namely because the disclosure requirements are stricter, like the Green Bonds Principles. (Wang & Zhi, 2016) Moreover, thanks to the requirements of the Green Bonds Principles, investors can more correctly assess their investment's risks. (OECD, 2015)

Despite these advantages, investors also face drawbacks.

The **absence of a universal and official definition** of green bonds may lead to confusion and uncertainty among investors. Furthermore, investors may encounter difficulties in comparing different green bonds since there is no international system to assess the greenness. (Cochu & Al. , 2016)

It's also important to notice that investors are generally not environmental experts. They have **limited tools** to exercise a critical analysis and to make sure that the proceeds of green bonds are allocated to eco-friendly projects. It is very important for them because their reputation is also at stake. Investors depend, mainly, on the information voluntary disclosed by the issuers. (Tang & Zhang, 2018) Fortunately, they can also rely on the results and comments of the second-party reviews and the third-party verifications. (Moid, 2017)

Gianfrate and Peri (2019) mentioned that green bonds offer **lower returns** for investors than traditional ones. As explained previously (cfr. 3.2.3) scientists have different results on the topic. For instance, Bachelet, Becchetti and Manfredonia (2019) proved that green bonds have higher returns, are more liquid and less volatile than ordinary bonds.

3.4.3. Credit rating agencies

Following the green bonds' trend, rating agencies have developed instruments to judge the greenness of financial products like green bonds. Basically, they analyze green bond's compliance with the Green Bond Principles (GBP) (cfr. 3.1.3 The Green Bonds Principles) (Climate Bonds Initiative, 2019[4])

Moody's has created an instrument called "Green Bond Assessment". This tool enables to assess the alignment level with the GBP, it provides a relative ranking which is in any case a credit rating. They evaluate 5 broad factors: the use of proceeds, the ongoing reporting, the

organization, the management of proceeds and finally, the disclosure on use of proceeds. Based on these evaluations, they attribute a grade from GB1 to GB5. GB1 means it's excellent, the green bond is aligned with the GBP; on the opposite, GB5 means the green bond is poorly aligned with the GBP. (Moody's, 2018) *See Annex 8 Moody's GBA process*

Similarly, S&P has generated a tool called "Green Evaluation", which is based on the analysis of 3 parts: the transparency, the governance and the mitigation or adaption. They attribute a score from E1 to E4, E1 being the strongest Green Evaluation score. This global score is a weighted aggregation of each task's grade. (S&P, 2019) *See Annex 9 S&P Green evaluation*

Both tools, Moody's Green Bond Assessment and S&P's Green Evaluation, assess the relative greenness of the bonds. (HSBC, 2017)

3.4.4. Current market situation

Since the introduction of the first green bond in 2007 by the European Investment Bank, the green bond market has steadily increased and expanded over the world. The database of issuers keeps enlarging as well as the number of green bonds issued.

End 2018, the amount outstanding of green bonds issued since 2007 represented $521 billion. (Climate Bonds Initiative, 2018[3]) Currently, the green bond market still constitutes less than 1% of the total bond market, which is valued around $100 trillion. (SIFMA, 2019) (Hupart, 2019)

Regarding the amount of green bonds issued each year, we also notice a dazzling evolution going from $3bn in 2012 to $167.6bn in 2018 (see Figure 14). Compared to 2017, the green bond market has increased by 3.40% and it targets to reach $1 trillion issuance for 2021. (Climate Bonds Initiative, 2018[3])

Moreover, Tang & Zhang (2018), highlight the first hike in 2014 as the consequence of the apparition of new issuers such as commercial banks and corporations. (Tang & Zhang, 2018) Nevertheless, the potential of the green bond market to enlarge further remains high. (Fatica, Panzica, Rancan, 2019)

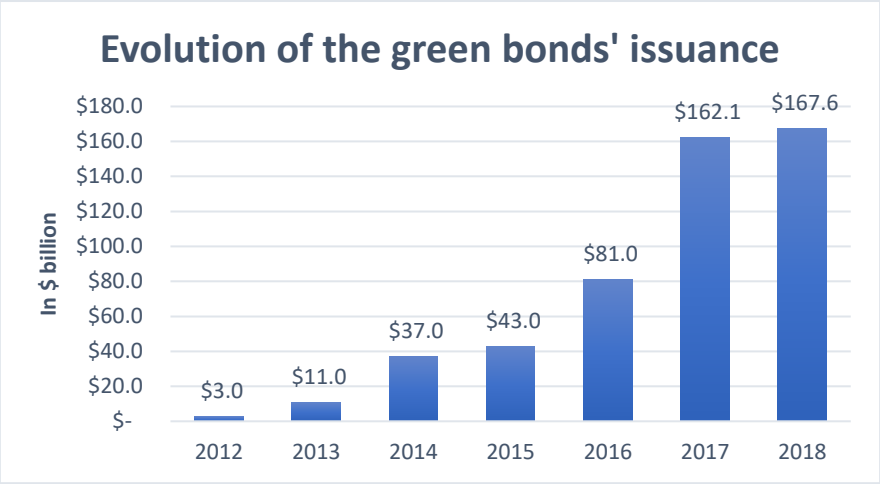

Figure 14: Evolution of green bonds' issuance (SOURCE: Reboredo, 2018)

Concerning the issuers, the top 5 of countries issuers are in the following order: The United States, China, France, Germany and The Netherlands. Together they represent more than the half of the total amount of green bonds issued in 2018. Belgium comes at the 6th place. (Climate Bonds Initiative, 2018[3])

Therefore, the majority of green bonds are issued either in USD or in EUR. In 2018, Euro was the leading currency with 40% of the green bonds issued that year (see Figure 15).

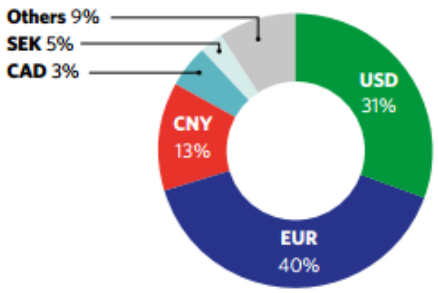

Figure 15: Currency split of green bond issuance in 2018 (SOURCE: Climate Bonds Initiative, 2018[3])

The Chinese Yuan remains the 3rd most popular currency which is the result of the continued growth of the Chinese green bond market. (Climate Bonds Initiative, 2018[3]) Despite a late arrival and a lack of issuers' diversification, China has been able to develop a robust development strategy of its green bond market. (HSBC, 2017)

Notwithstanding the currency diversification, the green bond market remains driven by the European market. (Natixis, 2018)

3.5. Risks

Since green bonds are bonds before being green, they face the same risks as conventional ones, namely the interest rate risk, the default risk, the reinvestment risk, the inflation risk, the rating downgrade risk and the liquidity risk (cfr. 2.4 Risks). Bonds, green and non-green ones, issued by a same company are exposed to the same risks. (Zerbib, 2019)

3.5.1. Liquidity risk

Among these risks, the liquidity risk is the most discussed one in the green bond literature. (Zerbib, 2018)

In their studies, both Bachelet (2019) and Febi (2018) agreed to say that green bonds are more liquid than traditional ones. Therefore, the liquidity risk is smaller for green bonds.

3.5.2. Greenwashing

Green bonds issuers also face a reputational risk, called greenwashing. Bachelet, Beccheti and Manfredonia (2019) defines greenwashing as « including companies that declare a commitment to environmental responsibility that is greater than in reality ». When the public observe greenwashing, the reputation of the company as well as the price of its bonds drop down.

To protect their credibility and decrease the risk of being accused of greenwashing, issuers should: (KPMG, 2015)

- Be transparent with regard to their investors
- Clearly state the green bond criteria used
- Put control processes
- Measure and report on the use of proceeds as stated in the Green Bond Principles
- Operate an external review

Empirical analysis

The previous section has shown that scientists' results diverge regarding the existence of a greenium. In other words, some of them believe that green bonds don't perform better than conventional bonds, while the others do. In order to find who is right and who is wrong and to be able to build our own opinion, this section will focus on an empirical analysis of this matter. The goal of this master thesis is to **analyze if green bonds perform better than conventional bonds.** Put differently, is there a positive difference in yields between green bonds and similar conventional bonds? Are green bonds riskier than conventional bonds?

First, based on the information gathered in the literature review, some hypothesis will be formulated and later be tested on a recent data set. Then, the construction of the data set will be explained, and the methodology will be stated. Subsequently, the hypothesis will be tested and the results and findings will be presented, as well as the limitations of this empirical analysis.

1. Methodology

We will follow different steps in order to answer the problematic. The first section consists in a basic descriptive analysis conducted on the 2234 green bonds listed on Eikon by Refinitiv. Basic features such as the coupon rate, the maturity, the duration and the yield to maturity will be studied.

In the second section, we will compare the performance (through the yield to maturity) and the liquidity of 2 samples: the first sample containing 82 green bonds and the second one containing 82 similar conventional bonds.

Last but not least, the last section aims at comparing green bonds issued by corporates and financial institutions. The performance and the liquidity of 2 other samples (financial green bonds versus corporate green bonds) will be compared.

2. Hypothesis

Several institutions such as the Climate Bonds Initiative and HSBC believe that green bonds and conventional bonds' prices at issuance are similar, as long as they are issued by the same emitter. Other scientists found out that green bonds price at a premium compared to equivalent conventional bonds. This divergence leads us to the first hypothesis:

Hypothesis 1: Green bonds are priced similarly to conventional bonds.

There are several factors influencing the price of a bond, among them the interest rate (or yield) and the coupon rate. Regarding the price of green and traditional bonds, two sub-hypothesis can be developed:

Sub hypothesis 1 (H1): The yields of a conventional and an identical green bond are the same.

Sub hypothesis 2 (H2): For similar bonds issued by the same issuer, the coupons of non-green bonds and green bonds are equivalent.

If one of the two sub hypothesis does not hold, it will mean that the *Hypothesis 1* does not hold neither. If there are no significant results proving that the two hypothesis hold, the main hypothesis will also have to be rejected. If *Hypothesis 1* holds, we will be able to conclude that green bonds do not perform better or worse than conventional bonds.

To compare the performance of green bonds and traditional bonds, we also should look at the risk and particularly at the liquidity risk. Indeed, the literature review has taught us that green bonds and conventional bonds were exposed to the same risks except the liquidity risk. This information leads us to the second hypothesis which will be:

Hypothesis 2: Green and conventional bonds face the same liquidity risk.

If *Hypothesis 2* holds, we will conclude that investors don't invest in green bonds for their safer or riskier nature and that they don't expect higher or lower return.

Finally, if both *Hypothesis 1* and *Hypothesis 2* hold, it will mean that investors buy green bonds simply for the greenness and not especially for profit.

We will also look for a potential difference in yields and bid/ask spread between green bonds issued by corporates and green bonds issued by financial institutions. We will thus have a third hypothesis.

Hypothesis 3: Green bonds issued by corporates and by financial institutions perform equivalently.

3. Data set

Data has been collected on Eikon developed by Refinitiv beginning June 2020. Since Eikon listed all the government and corporate bonds, we had to put a filter in order to only select green bonds. We obtained the 2334 green bonds listed on Eikon.

In order to be able to compare green bonds with conventional bonds, 2 samples were needed: a sample of green bonds and a sample of traditional bonds. On the 2334 green bonds list, we added again some filters in order to focus our research on a certain type of green bonds for which all the needed information were available. Indeed, after the literature review it appeared that the European bond market was flourishing and even rivaling with the American one. Moreover, in 2018, 40% of green bonds were issued in EUR. For these reasons, this master thesis will focus on green bonds issued in **EUR currency**. Additionally, corporates and financial corporates are the main issuers of green bonds but they design them differently. On the one hand, corporates use the proceeds to finance their own project while on the other hand, financial institutions use them to finance the green project of their clients. 26 green bonds issued by **corporates and** 56 by **financial corporates** will be selected in our data sample. Afterwards, we will also compare their performance and liquidity.

Our first data set was composed of 82 green bonds (see Annex 10 Green bonds sample), issued in EUR by corporates and financial corporates only and with a fixed coupon from 20th August 2013 to 13th May 2020. For the comparison to be as accurate as possible, we selected manually similar non-green bonds (see Annex 11 Conventional bonds sample). By similar we mean: issued by the same issuer, with a fixed coupon, with a difference of coupon of max -0.13 and +0.13 and with a difference of maturity of max -2 years or +2 years. Moreover, our green bonds sample and our non-green bonds sample both present similar ratings' distribution. We are now sure to compare comparable instruments. On theFigure 16: Density distribution of ratings for the green bonds and conventional bonds samples. (SOURCE: Eikon, 2020) Figure 16, HG stands for High Grade, LMG= Lower Medium Grade, P= Prime and UMG= Upper Medium Grade.

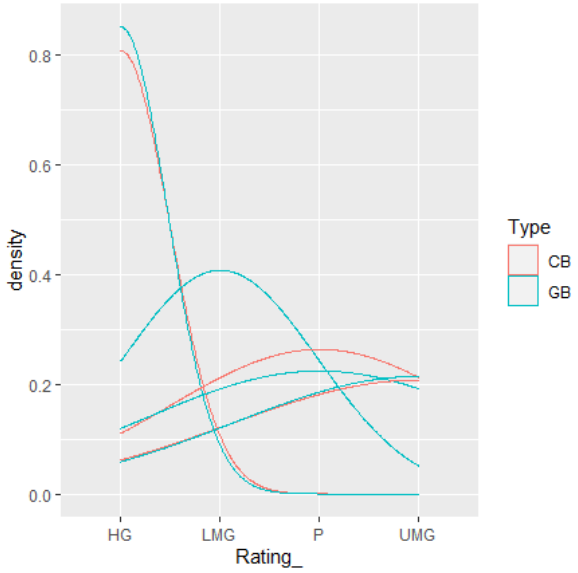

Figure 16: Density distribution of ratings for the green bonds and conventional bonds samples. (SOURCE: Eikon, 2020)

Green bonds being a quite recent instrument, it's unintentionally that our data set only include active bonds, which means that none of them has reached maturity yet.

For each bond, the following information has been collected

- Issuer
- Coupon
- Maturity
- Issue date
- Country of issue
- Amount issued
- Bond grade
- Moody's Rating
- Yield to maturity
- Modified duration
- Issue price
- Issuer sector

4. Results

4.1. Basic analysis on all the green bonds listed

On the 2334 green bonds listed on Eikon by Refinitiv, we are going to conduct a basic descriptive analysis to analyze some features such as the coupon rate, the yield to maturity, …

The results are presented in Table 1 below.

	Min	Max	Average	Median	Variance
Coupon	-0.41	15.50	1.26	2.00	5.82
Maturity (in years)	0.04	1,000.66	8.21	5.01	329112.39
Amount issued (in USD)	10,000.00	28,434,450,859.00	295,700,474.91	93,161,915.00	5.86287E+17
Yield to maturity	-367.35	602.81	4.80	1.18	1186.94
Modified duration	0.00	55.51	4.31	3.37	23.95
Price at issuance	35.60	137.65	99.69	100.00	11.28

Table 1: Descriptive analysis on all the green bonds. (SOURCE: Eikon by Refinitiv, 2020)

The average maturity for green bonds is 8 years, which is coherent with what scientists say. However, some bonds have a very long maturity, the longest one being 1000 years. It was issued in 2017 by Orsted A/S, a Danish energy company, and the bond will mature in 3017.

On average, issuers tend to increase the maturity of their green bonds with the years (see Figure 17). In 2012, the average maturity was 5 years and in 2020, it was 9 years. It means that issuers look for longer-term investment and this way, investors benefit from higher interest rates. Indeed, interest rates being lower and lower, investors look for longer maturity investment. This maturity evolution is a global tendency observable on the general bond market since a decade.

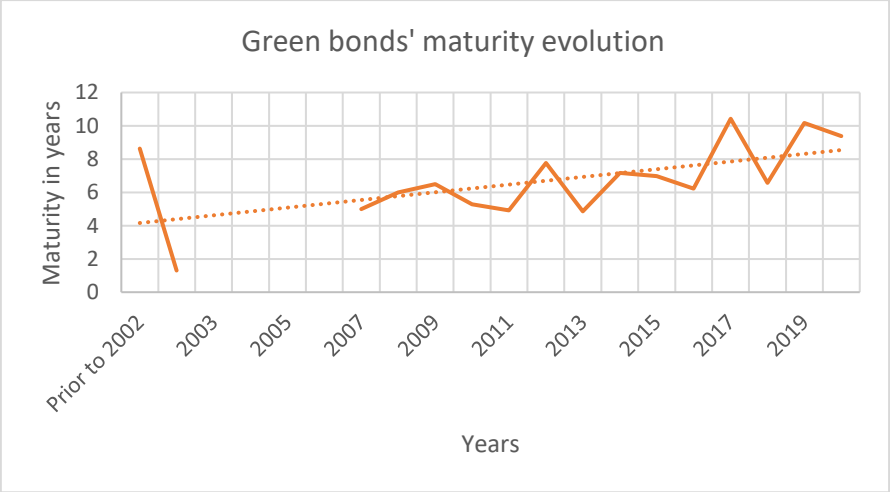

Figure 17: Green bonds' maturity evolution. (SOURCE: Eikon, 2020)

Table 1 shows that the average coupon rate is 1.26% while the average yield to maturity is 4.80%. The average modified duration is 4.31 which means that for every 1% movement in interest rates, green bonds will on average inversely move in price by 4.31%. Moreover, the average price at issuance is 99.69, which means that on average green bonds price at a discount. The amount issued is rather high, with an average of $295 million.

From the green bonds list, we are also able to analyze the type of issuers represented on Figure 18 . Almost 70% of green bonds issuer are corporates (financial and non-financial ones). On

the other hand, government bonds only represent 1% of the total amount outstanding of green bonds.

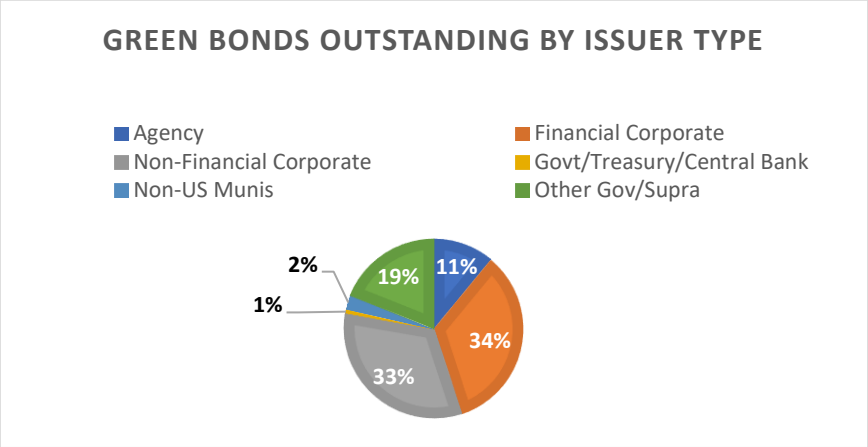

Figure 18: Green bonds outstanding by issuer type. (SOURCE: Eikon, 2020)

Regarding the ratings of green bonds issued, the majority of them are investment grade bonds as shown on Figure 19. Only a few are high yield bonds. This finding is coherent with what was found in the literature. It's worth to notice that the information wasn't available for most of the green bonds.

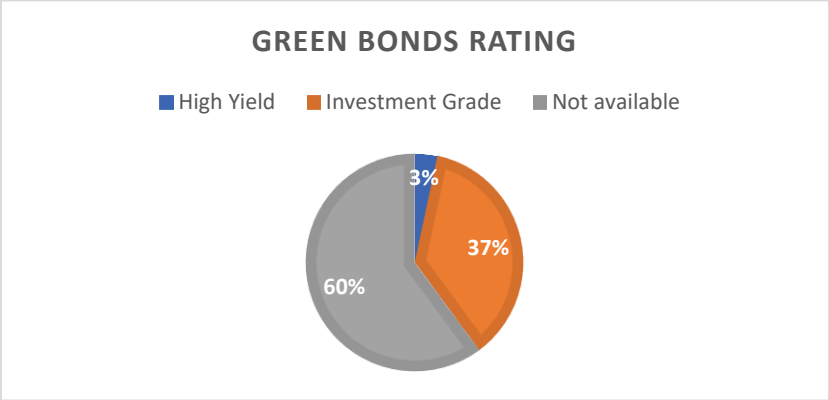

Figure 19: Green bonds rating. (SOURCE: Eikon, 2020)

4.2. Hypothesis 1

4.2.1. Sub-hypothesis 1

Sub hypothesis 1 (H1): The yields of a conventional and an identical green bond are the same.

The research is going to focus now on the comparison between the green bonds sample and the conventional bonds sample, and more precisely on the performance over the other one. The first part will focus on the price of the bonds and should enable us to reject or not the first hypothesis.

The first measure we can compare is the average yield to maturity of green bonds versus non green bonds. The average yield to maturity of our green bonds' sample is 0.43% while the average yield to maturity of the traditional sample is 0.48%. So far, the difference of yield to maturity is in favor of the non-green bonds.

However, we ran a t-test to see if the difference in yield to maturity between the samples was significant. The null hypothesis (H_0) and the alternative hypothesis (H_1) are the following:

$$H_0: YTM_{Green\ Bonds} - YTM_{conventional\ Bonds} = 0$$

$$H_1: YTM_{Green\ Bonds} - YTM_{conventional\ Bonds} \neq 0$$

From the results obtained on R Studio and presented on Figure 20, we cannot say that the difference between the yield to maturity of both samples is significant. Indeed, the p-value (0.6136) being above 0.05, we cannot reject the null hypothesis.

```
        Welch Two Sample t-test

data:  GB_yields$`Yield to Maturity` and CB_yields$`Yield to Maturity`
t = -0.50603, df = 153.74, p-value = 0.6136
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.2310770  0.1368352
sample estimates:
mean of x mean of y
0.4334130 0.4805338
```

Figure 20: YTM t-test results. (SOURCE: R Studio, 2020)

Nevertheless, the analysis should go deeper. We will analyze the difference of yield to maturity by sector between green and conventional bonds. The data has been collected on Bloomberg on a monthly basis and then, has been averaged by sector. It is thus the averages by sector that are presented on the graphs.

For green bonds, it appears on Figure 21 that the category 'Utility Other' was the most profitable one with yield to maturity going around 1.5% from December 2017 until March 2019. Since then, the 'Others' category including telecommunications, home builders, etc. presents the highest yield. On the other hand, the 'Mortgage Banking' sector is the sector with the lowest yield to maturity, always close to 0% and since March 2019, even negative. We notice that all the yields to maturity decreased in March 2019. Moreover, all sectors have seen that their yield to maturity increased sharply in March 2020 because of the Coronavirus crisis. Nevertheless, for the 'Agency' and 'Mortgage Banking' sectors, the increase was way lower.

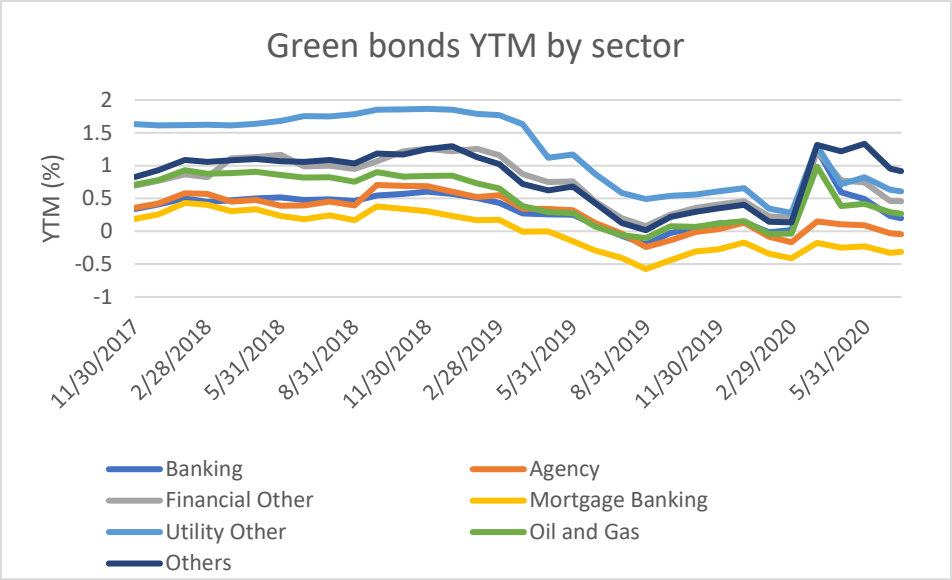

Figure 21: Green bonds YTM by sector. (SOURCE: Bloomberg, 2020)

Regarding the conventional bonds, Figure 22 shows that the sector 'Financial Other' was the most profitable one in our sample until January 2020. But since then, the 'Others' sector shows the highest yield to maturity. And once again, the 'Mortgage Banking' sector is the less profitable one with YTM always averaging 0%.

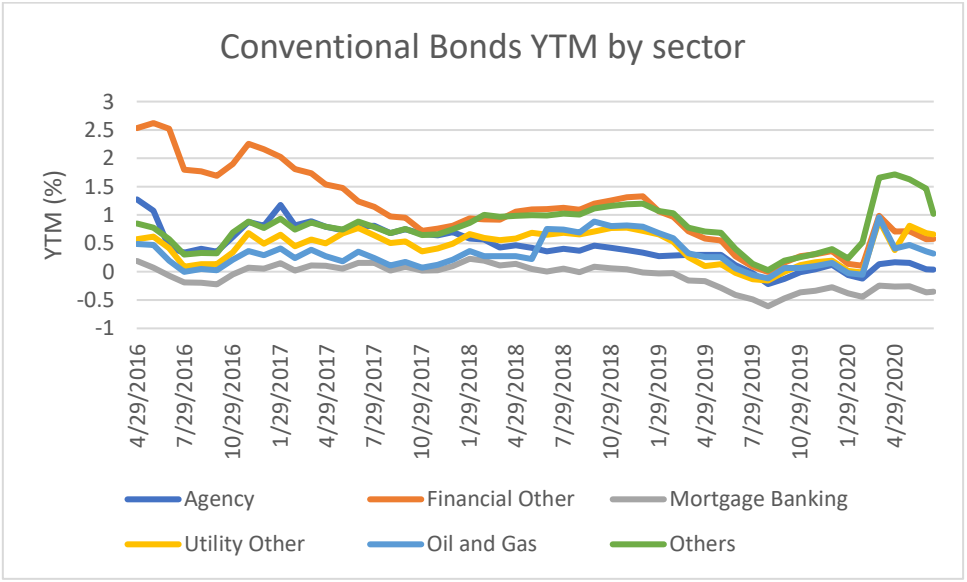

Figure 22: Conventional bonds YTM by sector. (SOURCE: Bloomberg, 2020)

The yield to maturity has been compared sector by sector and the results are presented from Figure 23 to Figure 29. For the 'Banking', 'Agency' and 'Financial Other' sectors, the conventional bonds used to have higher yield to maturity than their peer green ones until end 2017. This difference was of more than 1% for the 'Agency' sector. For these 3 sectors, from 2018 green bonds started to be slightly more performant. Regarding the 'Mortgage Banking',

'Utility Other' and 'Oil and Gas' sectors, green bonds have always performed better. The difference in yield to maturity is sometimes quite high such as for the 'Utility Other' sector until 2019, where the difference was of 1%. However, for each sector, the difference in yield to maturity seems to vanish with time. For instance, the difference of yield to maturity for the 'Financial Other' sector decreases from 1.2 % in April 2016 to 0.11% in June 2020.

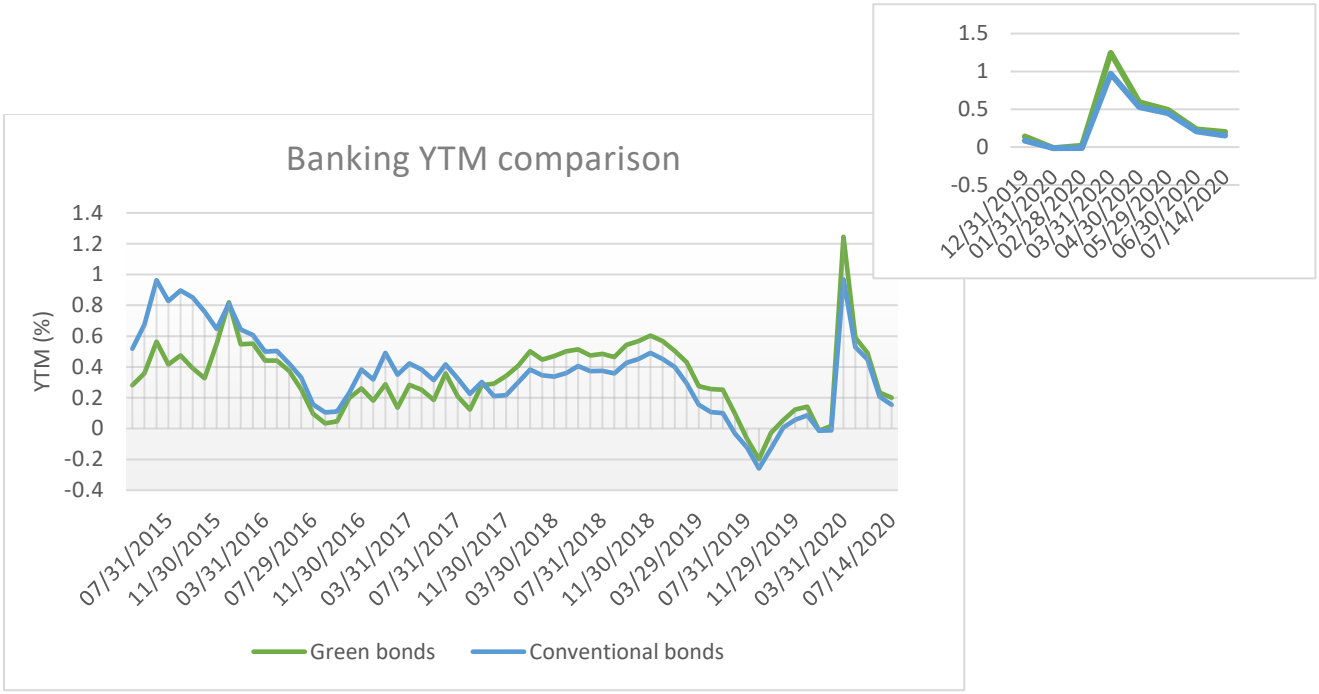

Figure 23: Banking YTM comparison. (SOURCE: Bloomberg, 2020)

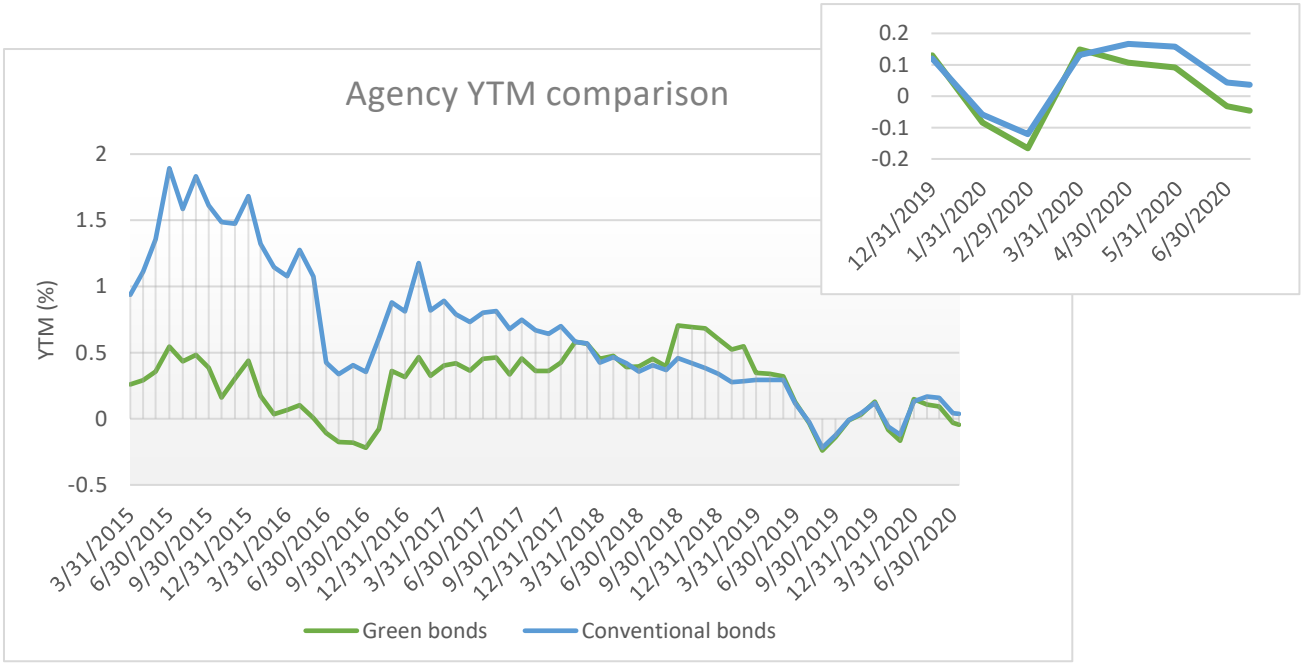

Figure 24: Agency YTM comparison. (SOURCE: Bloomberg, 2020)

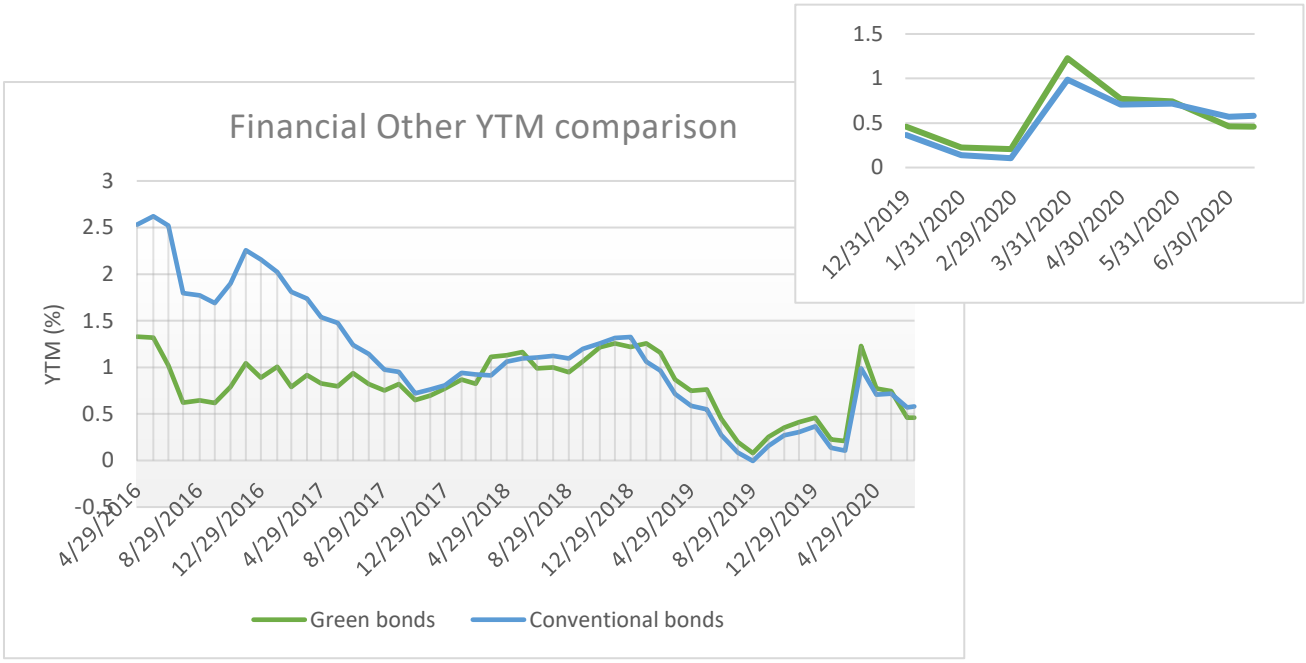

Figure 25: Financial Other YTM comparison. (SOURCE: Bloomberg, 2020)

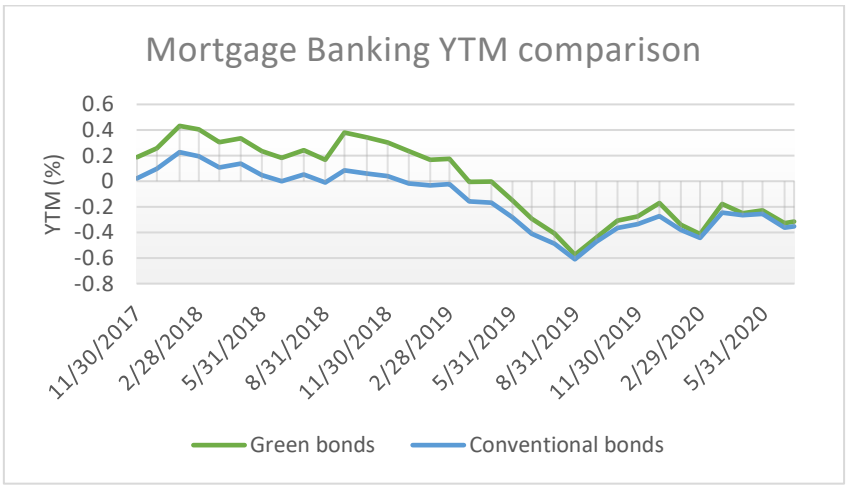

Figure 26: Mortgage Banking YTM comparison. (SOURCE: Bloomberg, 2020)

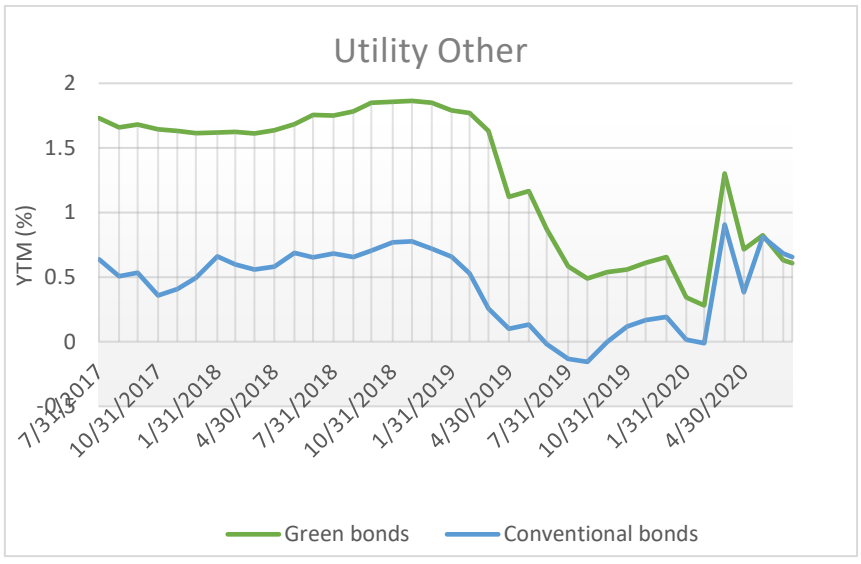

Figure 27: Utility Other YTM comparison. (SOURCE: Bloomberg, 2020)

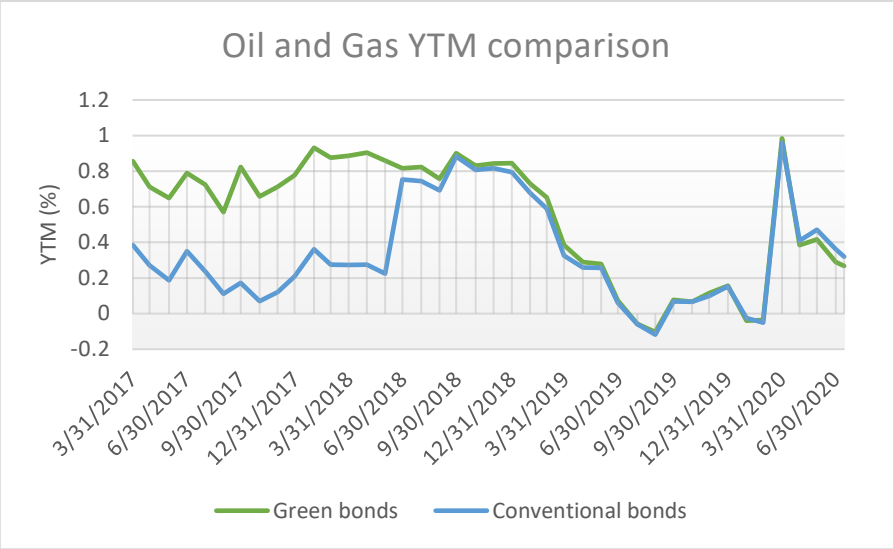

Figure 28: Oil and Gas YTM comparison. (SOURCE: Bloomberg, 2020)

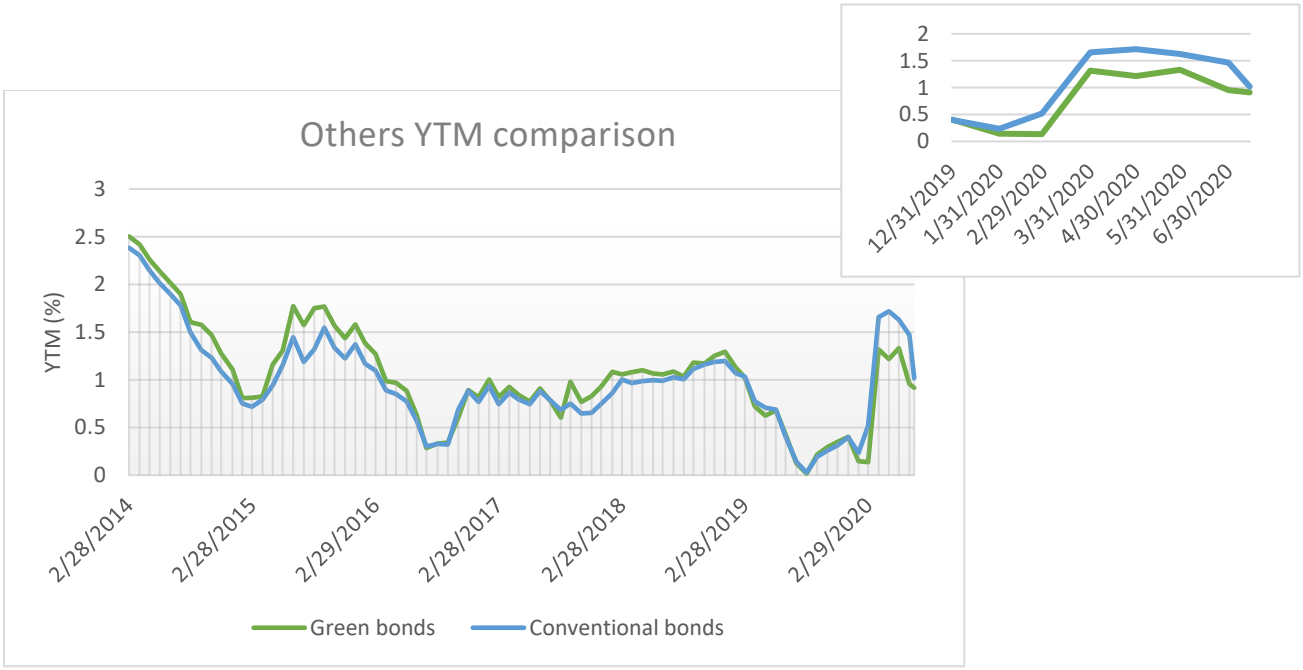

Figure 29: Others YTM comparison. (SOURCE: Bloomberg, 2020)

Zooming on the Covid-19 period, the yields to maturity first decrease end 2019 and only start re-increasing around March 2020. This Covid-19 period corresponds to the start of the epidemic in Asia and its spread to other continents. Every sector has been impacted by this crisis and consequently, all the yields to maturity too. There was a second wave of decrease in the yields to maturity end of May 2020. The decrease of yields to maturity corresponds to a decrease in interest rates due to this global crisis impacting the economic world. Some sectors such as 'Others' or the 'Banking' sectors have seen their yields more impacted by this crisis compared to the others.

Coming back to the global situation, if we compute the average spread between the yields of the green bonds and the conventional ones for each sector by using the formula:

$$\Delta\overline{y_{i,t}} = y_{i,t}^{GB} - y_{i,t}^{CB}$$

we obtain the results presented in Table 2.

We have also looked at the average spread between our 2 samples for all sectors together. This spread is equal to 0.08%, which means that there is a positive premium for green bonds of +8bps.

	Banking	*Agency*	*Financial Other*	*Mortgage Banking*	*Utility Other*	*Oil and Gas*	*Others*	***Total average***
spread	-0.0219	-0.3674	-0.28850	0,1378	0,8393	0.2108	0.0595	**0.0814**

Table 2: YTM spread by sector. (SOURCE: Bloomberg, 2020)

Furthermore, we have verified if the difference in YTM between the green bonds sample and the non-green bonds sample was significant by conducting a t-test for each sector.

	Banking	*Agency*	*Financial Other*	*Mortgage Banking*	*Utility Other*	*Oil and Gas*	*Others*	*Total*
p-value	0.6187	**1.553e-06**	**0.0062**	**0.0414**	**3.333e-11**	**0.0032**	0.467	**0.0254**

Table 3: T-test results by sector for the YTM comparison. (SOURCE: Bloomberg, 2020)

The difference in yield to maturity between our green bonds and our non-green bonds is not significant for every sector, as shown in Table 3. It is significant for the 'Agency', the 'Financial Other', the 'Utility Other', and the 'Oil and Gas' sectors (where the p-values are below 0.05), while for the 'Banking' and 'Others' sectors it is not significant. For the 'Mortgage Banking' sector, the p-value is very close to 0.05.

If we consider all sectors together, we can conclude that on average, there is a significant difference in yields to maturity between green and traditional bonds. Consequently, we can reject the sub-hypothesis 1. We can say so far that the yields of conventional and green bonds are not the same. More, the difference is positive for the green bonds, in other words, there is a premium for green bonds also called "greenium".

However, on the graphs (see Figure 23 to Figure 29), we observe that the spread between the yield to maturity was higher before 2018. Therefore, we have conducted 2 separate t-tests: one for the period before 2018 (see Table 4) and one from 2018 to today (see Table 5).

	Banking	*Agency*	*Financial Other*	*Mortgage Banking*	*Utility Other*	*Oil and Gas*	*Others*	*Total*
p-value	**0.01**	**4.252e-12**	**7.199e-06**	0.08	**4.493e-08**	**5.855e-10**	0.247	**0.0336**

Table 4: T-test results by sector for the period before 2018. (SOURCE: Bloomberg, 2020)

	Banking	*Agency*	*Financial Other*	*Mortgage Banking*	*Utility Other*	*Oil and Gas*	*Others*	*Total*
p-value	0.1542	0.4608	0.6582	0.0527	**2.888e-08**	0.2032	0.7185	**0.0416**

Table 5: T-test results by sector for the period after 2018. (SOURCE: Bloomberg, 2020)

After 2018, the difference in spread is only significant for one sector: 'Utility Other'. On the opposite, for the period prior to 2018, the difference in yield to maturity is significant for all sectors except the 'Mortgage Banking' and 'Others' sectors. In both cases, when we consider all sectors together, the p-values are very close to 0.05.

4.2.2. Sub-hypothesis 2

The second component of a bond price that we are going to analyze is the average coupon rate.

The coupon rates in function of the issue prices have been compared and the results are presented on Figure 30. One can observe that coupon rates of green bonds are pretty similar to traditional bonds' ones.

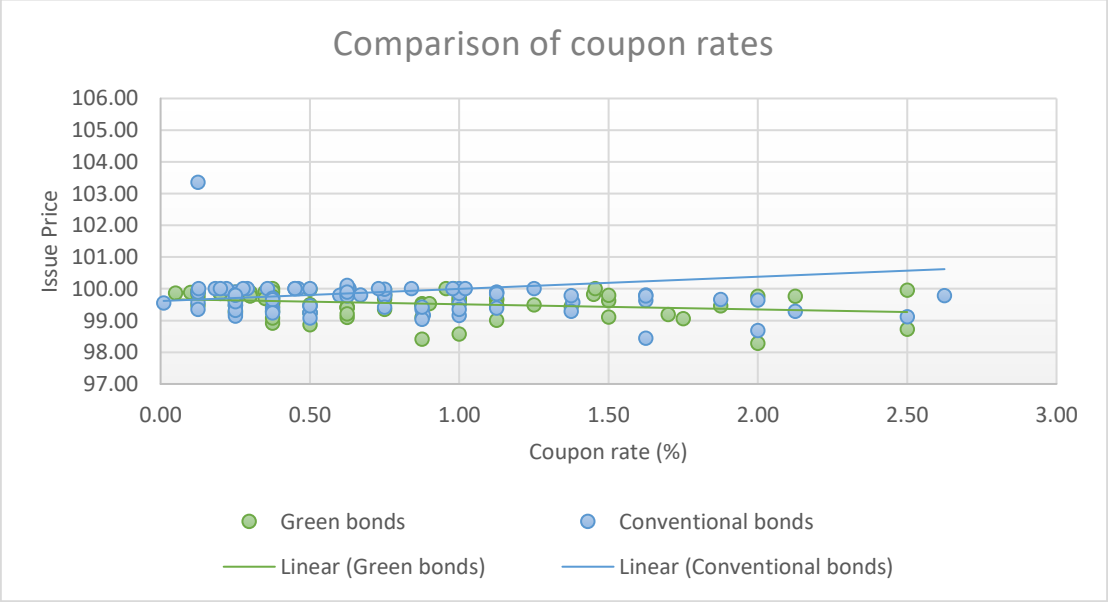

Figure 30: Comparison of coupon rates. (SOURCE: Eikon, 2020)

Moreover, the average coupon rate of both samples are identical as shown in Table 6. The average issue prices are quite similar too, both of them below par. For both samples, every bond

trades at par or below par, except for one traditional bond which trades above par at 103.36. It is a bond issued by the Dutch Rabobank in December 2019.

	Green bonds		Conventional bonds	
	Coupon rate	Issue price	Coupon rate	Issue Price
Average	0.77	99.55	0.77	99.91
Min	0.05	98.28	0.01	98.44
Max	2.50	100.00	2.63	117.49
Median	0.63	99.63	0.63	99.78

Table 6: Coupon rate and issue price comparison. (SOURCE: Eikon, 2020)

We can conclude that for similar bonds issued by the same issuer, the coupons of non-green bonds and green bonds are equivalent. Therefore, we have sufficient evidence to not reject the sub-hypothesis 2.

However, coupon rates being fixed and pre-determined in the bond agreement, they don't represent the best measure to compare the returns.

They are not an as good measure as yields to maturity to compare the returns. If we combine the results obtained for sub-hypothesis 1 and sub-hypothesis 2, we have sufficient and significant proof to reject the Hypothesis 1. We can thus affirm that green bonds and conventional bonds are not priced similarly

4.3. Hypothesis 2

Hypothesis 2: Green and conventional bonds face the same liquidity risk.

The liquidity risk can be measured using the bid/ask spread. The higher the bid/ask spread, the more illiquid is the bond. On our green bond sample, the average bid/ask spread is 0.29 (see Table 7). This value was computed from the average bid/ask spread for each green bond from their issue date to the 26th of June 2020. On our conventional bond sample, the average is 0.34. Green bonds are slightly more liquid than the traditional ones. This is actually the case for 53% of the green bonds.

	Green bonds	**Conventional bonds**
Bid price	101.6157683	101.4896543
Ask price	101.9085	101.8402963
Bid/ask spread	0.292731707	0.346365854

Table 7: Average bid/ask spread comparison. (SOURCE: Eikon, 2020)

In order to see if this difference between the bid/ask spread (BAS) of the 2 samples is significant, we ran a t-test using the software R Studio. The null hypothesis (H_0) and the alternative hypothesis (H_1) are the following:

$$H_0: BAS_{Green\ Bonds} - BAS_{conventional\ Bonds} = 0$$

$$H_1: BAS_{Green\ Bonds} - BAS_{conventional\ Bonds} \neq 0$$

The results of this t-test are presented in Figure 31.

```
        Welch Two Sample t-test

data:  GB$`Bid/ask spread average` and CB$`Bid/ask spread average`
t = -1.4677, df = 125.76, p-value = 0.1447
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.12595166  0.01868336
sample estimates:
mean of x mean of y
0.2927317 0.3463659
```

Figure 31: Bid/ask spread t-test results. (SOURCE: R Studio, 2020)

Because the p-value (0.1447) is higher than 0.05, we cannot reject the null hypothesis. It means that we cannot say that there is a significant difference between the bid/ask spread of green bonds versus conventional bonds. In other words, we can't affirm that green bonds are significantly more liquid than the non-green ones.

An analysis of the bid/ask spread by sector has been conducted. For this purpose, the monthly bid/ask spreads of each green and non-green bonds have been collected on Bloomberg, from their issuance date to June 2020. The averages of the bid/ask spread for each sector have been computed and plotted for both green (see Figure 32) and conventional bonds (see Figure 33).

Regarding the green bonds (see Figure 32), the sector with the highest bid/ask spread and thus the most illiquid one was the 'Oil and Gas' sector until end 2019. From end 2019 until today, the 'Utility Other' sector presents the highest bid/ask spreads. The most liquid one is the 'Mortgage Banking' sector, which averages 0.2%. On average, the bid/ask spreads go between 0.1% and 0.65% and they are slightly increasing for every sector with time.

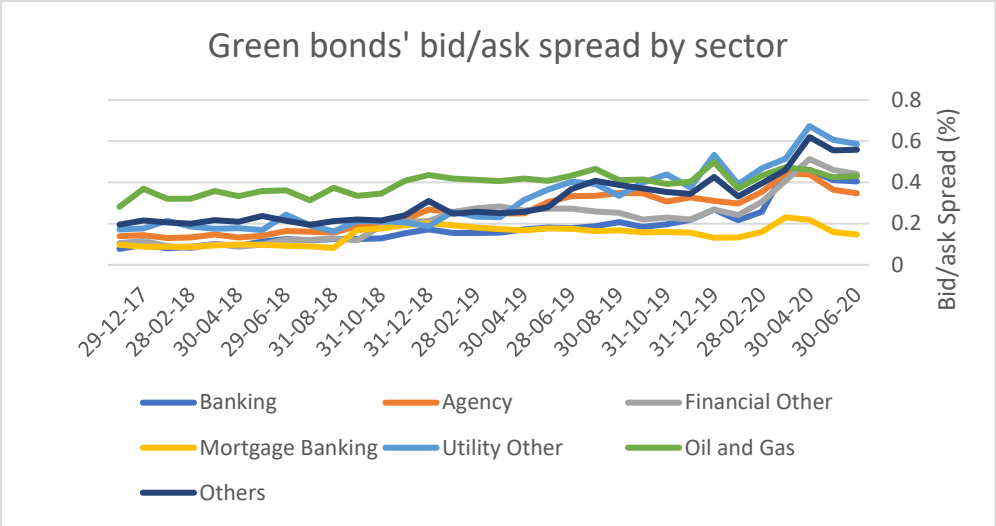

Figure 32: Green bonds' bid/ask spread by sector. (SOURCE: Bloomberg, 2020)

Observing the bid/ask spreads of the conventional bonds (see Figure 33), the sectors 'Others' is the less liquid one and thus presenting the highest liquidity risk. Until 2017, the most liquid sector was the 'Banking' sector. Between, 2017 and 2018, it was the 'Oil and gas' sector. Like for the green bonds, since the end of 2019, the 'Mortgage Banking' sector is the most liquid one. The values are comprised between 0% and 0.8%.

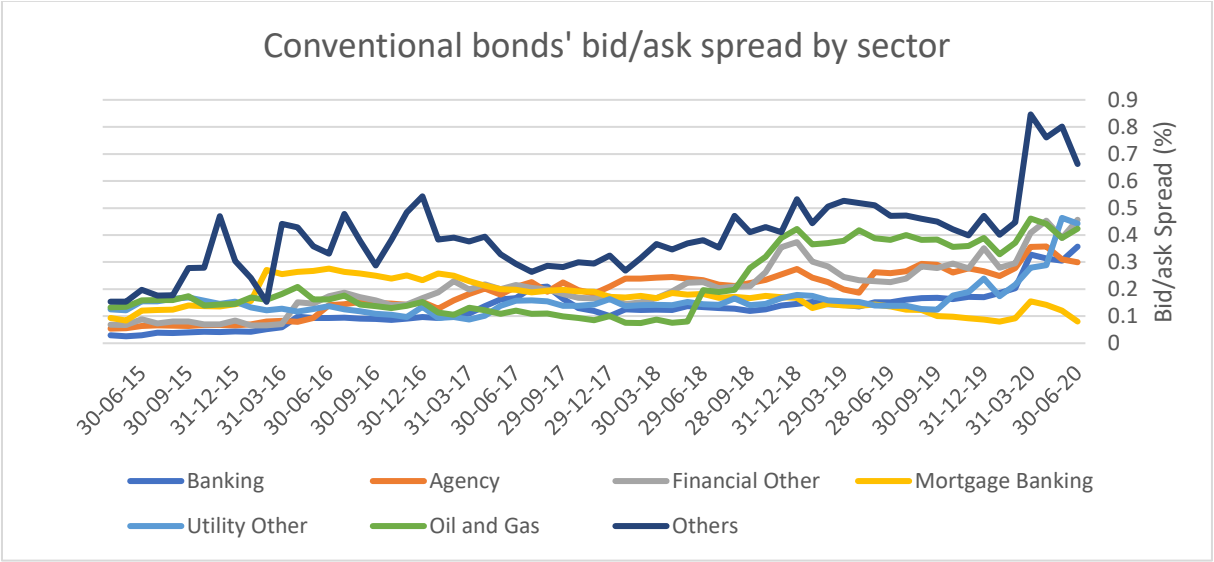

Figure 33: Conventional bonds' bid/ask spread by sector. (SOURCE: Bloomberg, 2020)

On Figure 34 , the average bid/ask spreads of green and conventional bonds issued by the 'Banking' sector are compared. Until end 2018, conventional bonds presented higher bid/ask spreads. If we zoom on the Covid-19 period, we observe unexpected movements on the curve. End 2019, the difference of bid/ask spreads between green bonds and non-green ones decreased

from 0.1% to 0.03%. 3 months later, when the majority of European countries were locked down, the difference of spreads increased to 0.14%. In June 2020 with the economy starting to recover, the difference decreased again to 0.05%.

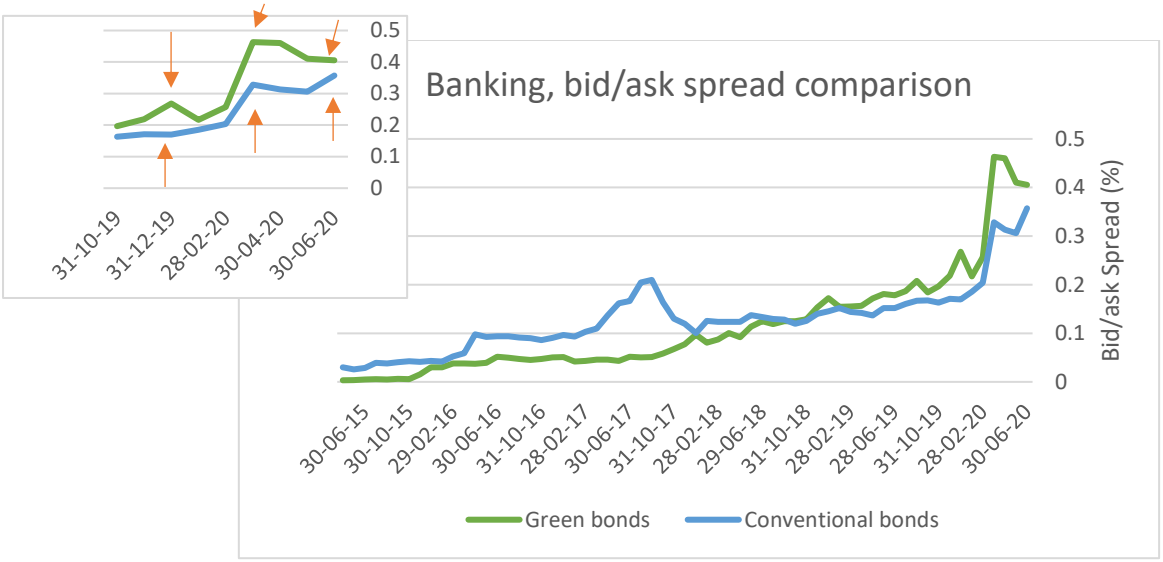

Figure 34: Banking, bid/ask spread comparison. (SOURCE: Bloomberg, 2020)

Regarding the 'Agency' sector (see Figure 35), green bonds were more illiquid in 2014 than traditional bonds. Quickly, this tendency reversed and conventional bonds were more illiquid than green bonds. It was the case until end 2019, when again the tendency reversed. On average, the difference in spreads is 0.05%. Zooming on the Covid-19 period, the difference in spreads is lower than for the 'Banking' sector.

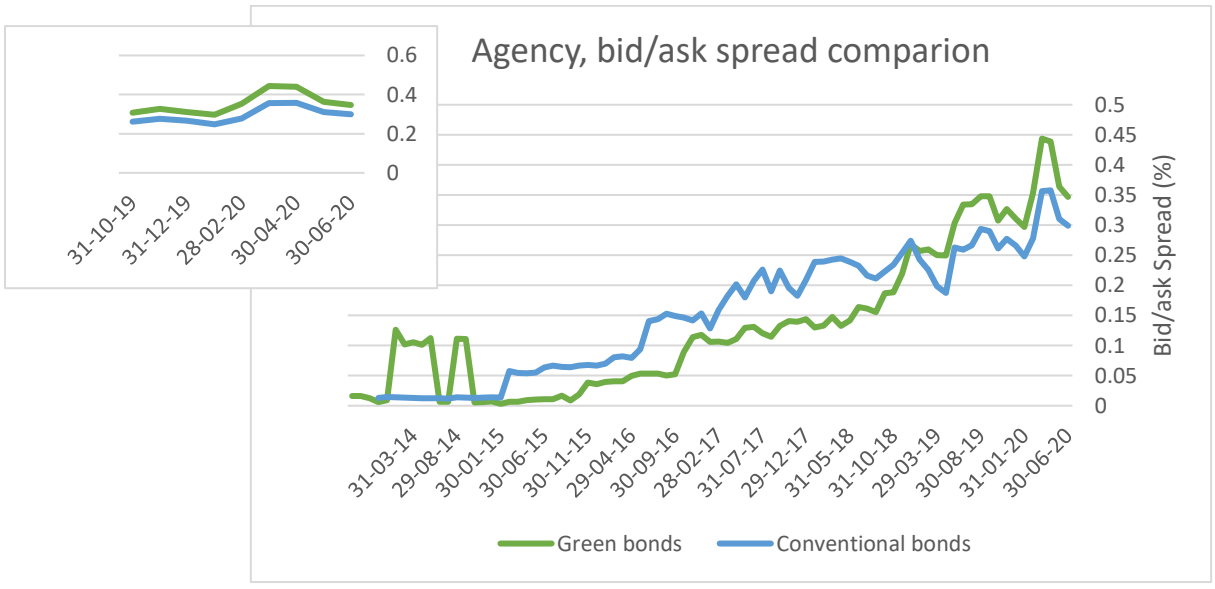

Figure 35: Agency, bid/ask spread comparison. (SOURCE: Bloomberg, 2020)

For the 'Financial Other' sector (see Figure 36), the conventional bonds are on average the most illiquid ones. However, during the Coronavirus crisis, the green bonds were the most

illiquid ones. The curve has also presented a sudden increase of 0.2% since the beginning of the crisis.

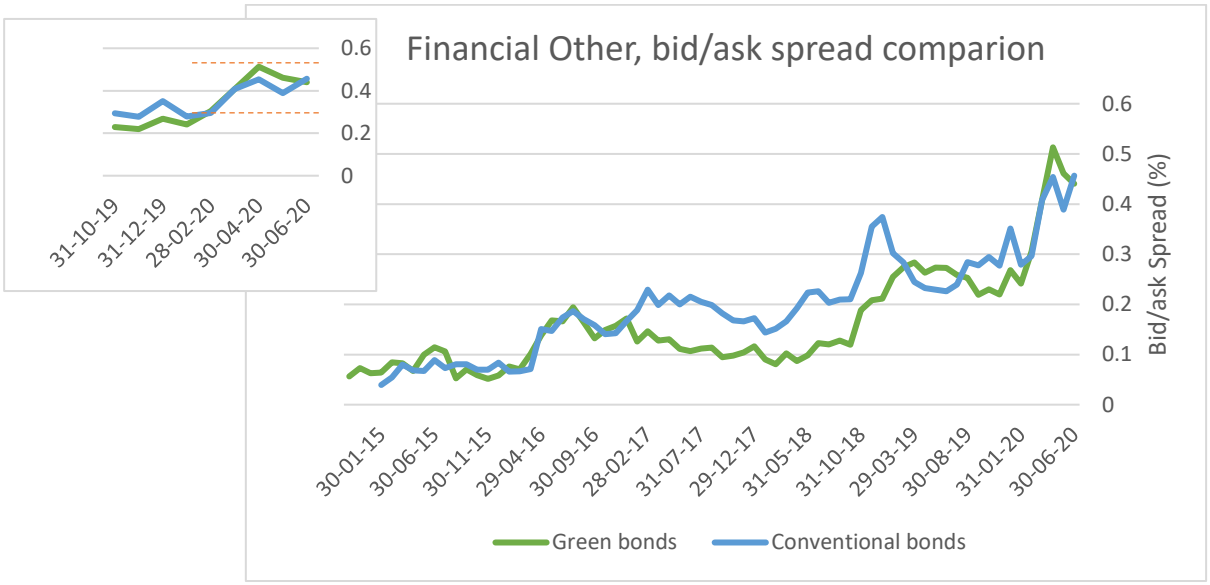

Figure 36: Financial Other, bid/ask spread comparison. (SOURCE: Bloomberg, 2020)

Concerning the 'Mortgage Banking' sector (see Figure 37), the same tendency as for the 'Banking' and 'Agency' sectors is observable. We can also make the same observations as for the other sectors during the Coronavirus crisis.

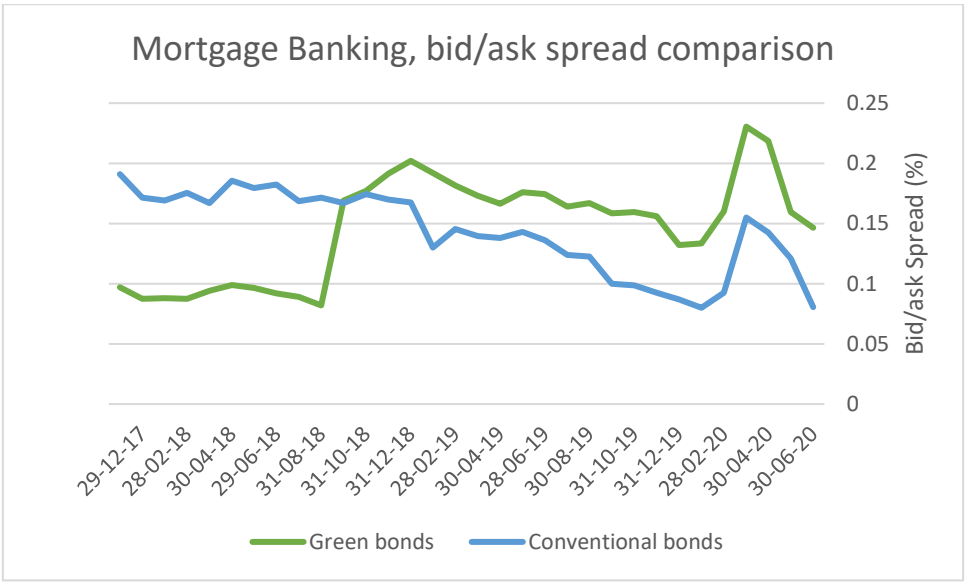

Figure 37: Mortgage Banking, bid/ask spread comparison. (SOURCE: Bloomberg, 2020)

For the 'Utility Other' (see Figure 38) and the ''Oil and Gas' (see Figure 39) sector, green bonds have always been more illiquid compared to the non-green ones. The same tendency is observable during the crisis as for the other sectors. Nevertheless, the difference in bid/ask

spreads is almost null for the 'Oil and Gas' sector since 2019 while it's more or less 0.2% for the 'Utility Other' sector since May 2019.

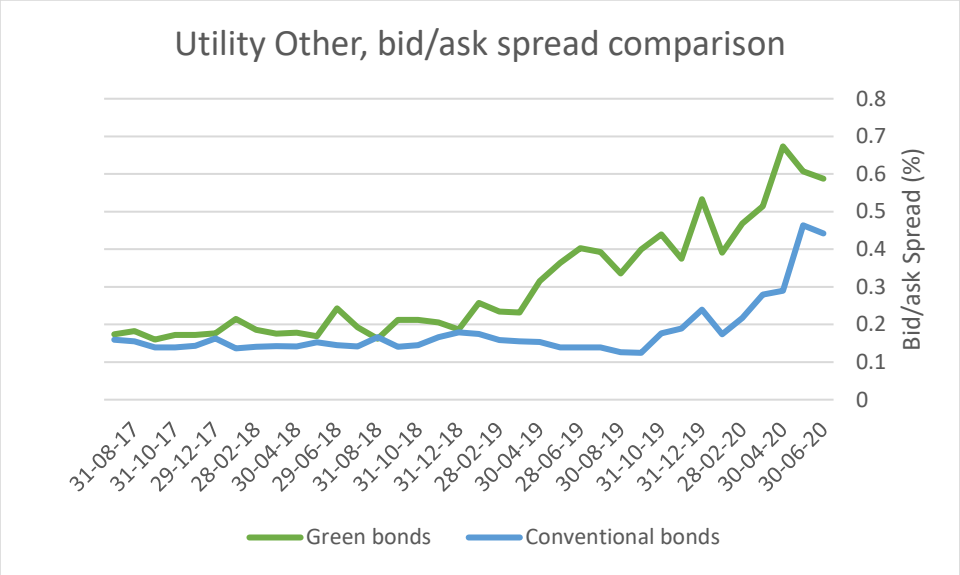

Figure 38: Utility Other, bid/ask spread comparison. (SOURCE: Bloomberg, 2020)

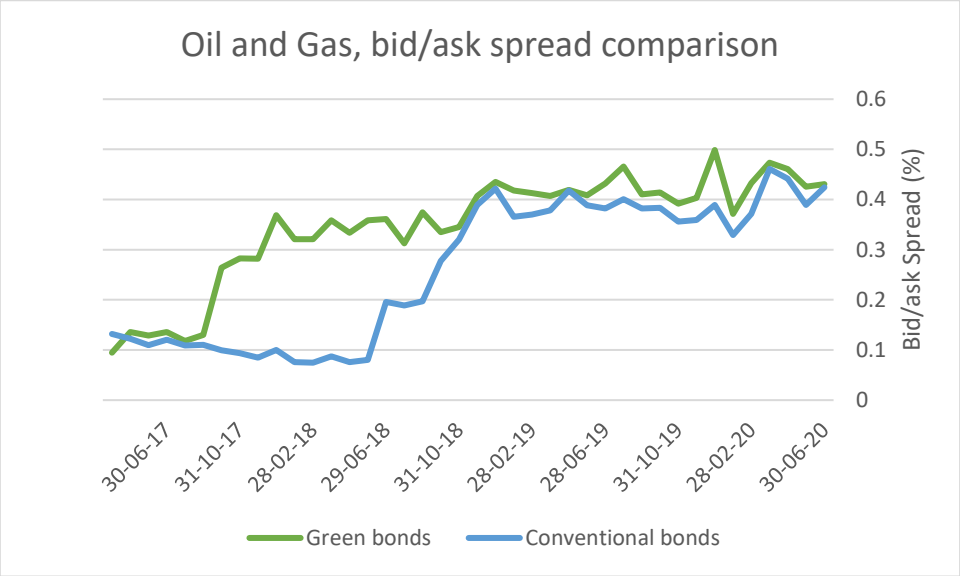

Figure 39: Oil and Gas, Bid/ask spread comparison. (SOURCE: Bloomberg, 2020)

Lastly, the comparison of bid/ask spreads for the 'Others' category including telecommunications, home builders, etc is shown on Figure 40. It's the only sector for which the green bonds haven't been more illiquid than the non-green ones during the Covid-19 crisis. Indeed, conventional bonds have on average presented higher bid/ask spread since 2014.

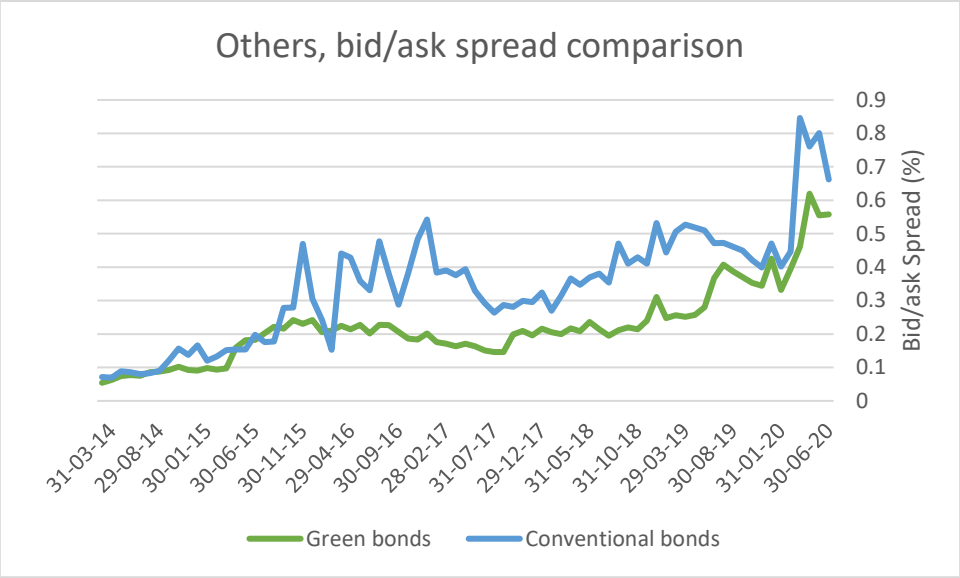

Figure 40: Others, bid/ask spread comparison. (SOURCE: Bloomberg, 2020)

As we see on Table 8, the results obtained regarding the liquidity diverge depending on the sector. Using the formula : $\Delta\overline{BAS_{\iota,t}} = BAS_{i,t}^{GB} - BAS_{i,t}^{CB}$, the bid/ask spread is positive for 3 sectors: 'Mortgage Banking', 'Utility Other' and 'Oil and Gas'. It means that for these sectors green bonds are less liquid than conventional bonds and thus the liquidity risk is higher. More, on average, green bonds present a lower liquidity than non-green ones.

	Banking	*Agency*	*Financial Other*	*Mortgage Banking*	*Utility Other*	*Oil and Gas*	*Others*	***Total Average***
spread	-0.0154	-0.0151	-0.0318	0.0041	0.1227	0.0856	-0.1105	**0.0057**

Table 8: Bid/ask spread by sector.(SOURCE: Bloomberg, 2020)

We conducted a t-test in order to determine if the differences were significant or not.

	Banking	*Agency*	*Financial Other*	*Mortgage Banking*	*Utility Other*	*Oil and Gas*	*Others*	*Total*
p-value	0.3024	0.5867	0.2637	**0.0214**	**0.00088**	0.7415	**1.872e-06**	0.6483

Table 9: t-test results by sector for the bid/ask spread comparison. (SOURCE: Bloomberg, 2020)

As shown in Table 9, there is a significant difference in bid/ask spreads for only 3 sectors: 'Mortgage Banking', 'Utility Other' and 'Others'. However, depending on the sector, green bonds are either more liquid or less liquid than traditional bonds. For instance, green bonds issued by the 'Mortgage Banking' or the 'Utility Other' sectors are less liquid than non-green bonds. It is coherent with what was found in the literature. Contrariwise, green bonds issued by

telecommunications and home builders are significantly more liquid than the conventional ones they also issue.

On the whole sample, the difference in bid/ask spread is not significant. Consequently, we don't have enough proof to reject the Hypothesis 2, which was 'Green and conventional bonds face the same liquidity risk'.

4.4. Hypothesis 3

Hypothesis 3: Green bonds issued by corporates and by financial institutions perform equivalently.

Firstly, we will compare the performance of 26 green bonds issued by corporates versus 56 green bonds issued by financial corporates. We use the average yield to maturity of each sample monthly since November 2017.

Looking at Figure 41, financial and corporate green bonds move very similarly and the difference between the yields to maturity is tiny. However, this difference started to increase in March 2020 due to the Covid-19 crisis. At that time, investing in corporate green bonds was less profitable than investing in green bonds issued by financial institutions.

After running a t-test, we confirm that there is no significant difference between the 2 samples' yields to maturity. Indeed, the p-value obtained is 0.5211 which is far superior than 0.05.

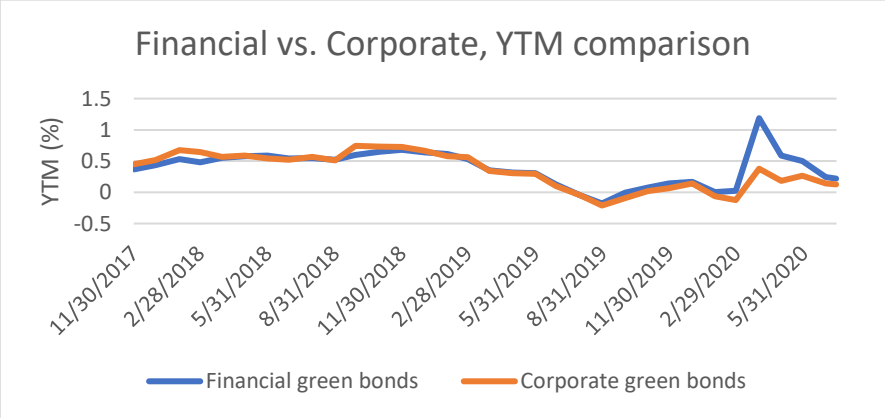

Figure 41: YTM comparison between financial and corporate green bonds. (SOURCE: Bloomberg, 2020)

In order to compare the liquidity of both samples, we use the monthly average bid/ask spread for each green bond. As shown on Figure 42, green bonds issued by corporates are more illiquid than the ones issued by financial corporates. This trend continued during the Coronavirus crisis. The t-test confirms what we observe on the graph: there is a significant difference between the bid/ask spread of our 2 samples. In other words, corporate green bonds are less liquid than

financial green bonds. Consequently, green bonds issued by financial corporates present a lower liquidity risk than the ones issued by corporates.

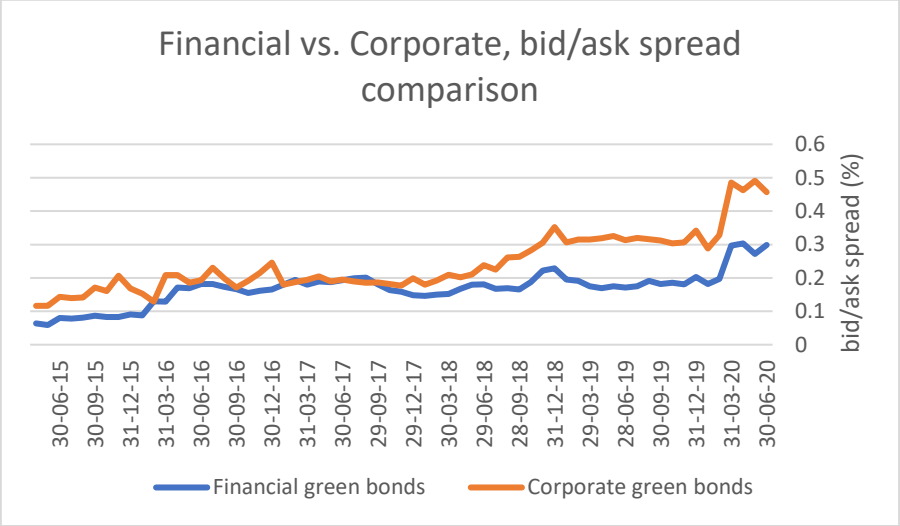

Figure 42: Bid/ask spread comparison between financial and corporate green bonds. (SOURCE: Bloomberg, 2020)

Focusing on the recent period, it clearly appears that the financial sector has been more impacted by the Coronavirus crisis. Indeed, the yield to maturity of the bonds they issued were twice higher in March 2020 compared to the corporates' ones. Some businesses have been shut down temporarily or at least have been slowed down for a few weeks. The financial sector granted loans to these indebted corporates. Additionally, financial markets including the bond market has known a financial turmoil and the prices of the major benchmark has suddenly dropped down. Indeed, in March 2020 we observe a decrease in the prices of the indexes presented on Figure 43. The prices started to go up again rapidly to come back close to their original level except for China, which has known a second Coronavirus wave end June 2020 and consequently a second drop down in the price of the government bond benchmark.

Figure 43: Major Bond Indexes during Covid-19 period. (SOURCE: Eikon, 2020)

The cloud of uncertainty has expanded globally among both investors and issuers. In this period of market stress, investors are becoming more risk averse and rather like to keep their money in cash instead of investing it. As the cash demanded by both the financial and non-financial sectors increased, the bid/ask spread increased. Indeed, the demand for bonds went down while the supply for it went up. Consequently, both sectors became less liquid and the liquidity risk thus increased.

5. Limitations

The empirical analysis realized above has been carried out with rigor and neutrality. Nonetheless, the analysis faces some limitations.

The first limitation comes from the availability of the data. From the 2334 green bonds listed on Eikon, only 10% have simultaneously the EUR as currency of issuance, a fixed coupon rate and complete data for all information needed. From these, we selected manually the green bonds for which we could find an equivalent traditional bond to create our 2 sample groups.

Furthermore, green bonds being new financial instruments, data was not available before 2013. For some sectors, the green bonds selected in the sample were even more recent and this explains why for some of them the analysis only begins in 2017.

As we observed in the literature review part, there is no legal context concerning the green bonds. There are some recommendations published either by the Climate Bonds Initiative or by the International Capital Market Association, but issuers are in no case obliged to fully comply

with them to issue green bonds. More, from one country to another, the recommendations change. This is an additional reason why we choose to only focus on the European market. However, there is no certitude that the green bonds of our sample fully comply with all the recommendations.

Lastly, it is worth to remember that this master thesis only investigates the green bonds issued in EUR. The results found are consequently only valid for the European green bond market.

Conclusion

In a world where the awareness for environmental matters is increasing day by day, with visible impacts of the global warming, people are more and more selecting ecofriendly alternatives to standard products. This is also the case for financial instruments, which has led to the creation of green bonds. But from a purely economical point of view, how are these new instruments performing compared to conventional ones? To answer this question, this master thesis aims at investigating this new product and its characteristics.

In the literature review, it appears that there is still no universal definition for green bonds. Nevertheless, all authors agree to define green bonds as conventional bonds with the particularity that the proceeds are invested in green projects. Besides the lack of a clear definition, the green bonds market also suffers from a lack of regulation. Indeed, there are only recommendations on this instrument, and they vary from one country to the other.

Scientists and economists compare green bonds to traditional ones because according to them, they share many characteristics. They work the same way: investors are paid coupons along the way and they receive back the face value at maturity. The only apparent major difference is in the use of proceeds.

However, some of them made interesting observations regarding the maturity. According to them, green bonds are issued at a smaller maturity than conventional bonds. Indeed, we have calculated that the average maturity of all green bonds listed is 8 years while the average maturity for conventional bonds is 9 years.

For the other features of green bonds compared to non-green ones (coupon, price, risk, …), there is less consensus in the literature about a possible advantage to invest in green bonds. Therefore, in the empirical part of this master thesis, we have conducted a deep statistical analysis on real financial data to try to provide an answer to the question: “How do green bonds perform when compared with conventional bonds?”.

The first divergence among the authors is about the price at issuance. Some of them believe that there is no premium while others think that green bonds price at issuance at a premium compared to ordinary bonds. This led us to the first hypothesis: ***Green bonds are priced similarly to conventional bonds.*** In order to compare the prices, we analyzed 2 components of the price: the coupon rate and the yields to maturity.

We began by this last one and we computed the spread between the yield to maturity of green bonds and the yield to maturity of conventional bonds. On average, we observe a positive green bond premium of +8bps and the statistical test conducted taught us that this difference is significant in general. The spread varies strongly depending on the sectors. However, we can reject in general the sub-hypothesis 1. We have sufficient proof to deny that the yields of a green bonds and an identical green bond are the same. However, if we split the analysis into 2 periods: before 2018 and after 2018, it clearly appears that the spread in yield to maturity was significant for almost every sector before 2018 while it's only significant for one sector after 2018.

Concerning the coupon rates, we quickly observe that the coupon rates of non-green bonds and green bonds were equivalent, both averages being 0.77%. The sub-hypothesis 2 stating that for similar bonds issued by the same issuer, the coupons of non-green bonds and green bonds are equivalent, was also not rejected. However, coupon rates being fixed and pre-determined in the bond agreement, they don't represent an as good measure as yield to maturity to compare the returns.

After testing the 2 sub-hypothesis and combining the results, we have sufficient and significant proof to reject Hypothesis 1. There is enough evidence to affirm that green bonds and conventional bonds of our samples are not priced similarly. Therefore, we can agree with the authors saying that there exists a premium for green bonds called "greenium". We can conclude that investors invest in green bonds for their green feature and are prepared to accept a slightly lower financial performance.

However, the literature also mentioned a potential advantage in investing in green bonds, since they should present lower liquidity risks. We have thus tested a second Hypothesis: ***Green and conventional bonds face the same liquidity risk.*** We measured the liquidity of the bonds by using the bid/ask spread measure. The results were not significant for all the sectors, but only for 3 of them ('Mortgage Banking', 'Utility Other' and 'Others'). Nevertheless, if we take a general look, the spread is not significant. Therefore we cannot reject Hypothesis 2 because we don't have evidence proving that green and conventional bonds don't face the same liquidity risk.

Last but not least, the last hypothesis focused on the issuer type. Financial corporates and non-financial corporates are the main green bonds issuers. Nonetheless, the bonds they are issuing are designed differently. Corporates use the proceeds to finance their own green projects while

financial institutions use them to finance people's projects. The hypothesis 3 tested if: ***Green bonds issued by corporates and by financial institutions perform equivalently.*** The results of the empirical analysis indicate that there is no significant difference between the yield to maturity, whether the green bonds are issued by a financial institution or by a non-financial corporate. Although the results weren't conclusive for the yield to maturity, they were significant for the liquidity analysis. Corporate green bonds are less liquid than financial green bonds, and they present a higher liquidity risk.

Regarding the Covid-19 period, all sectors were impacted on the European market. The yields to maturity first decreased end of 2019 and only started re-increasing around March 2020. Concerning the bid/ask spread, the spread first lowered end 2019, then raised during the lockdown. Since the deconfinement, the bid/ask spreads has reduced again. Even though all sectors were concerned, some were more impacted than others. It's the case for the 'Banking' and 'Others' sectors. In general, financial institutions were more hurt by this crisis than corporates.

As said previously, this master thesis faces some limitations and the analysis was only focused on green bonds issued at a fixed rate on the European market by corporates and financial institutions. The analysis conducted in this master thesis could go further and expand its scope. Other markets could be studied such as emerging markets or the other market leaders (the United States and China). More, instead of only focusing on financial and corporates issuers, the study could take into account other issuers such as governments. Actually, governments, particularly the European ones, are more and more issuing green bonds.

Another path that could be further explored is the analysis of the factors influencing the "greenium". And how much financial performance are the people prepared to loose in supporting projects for a greener planet?

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List of annexes

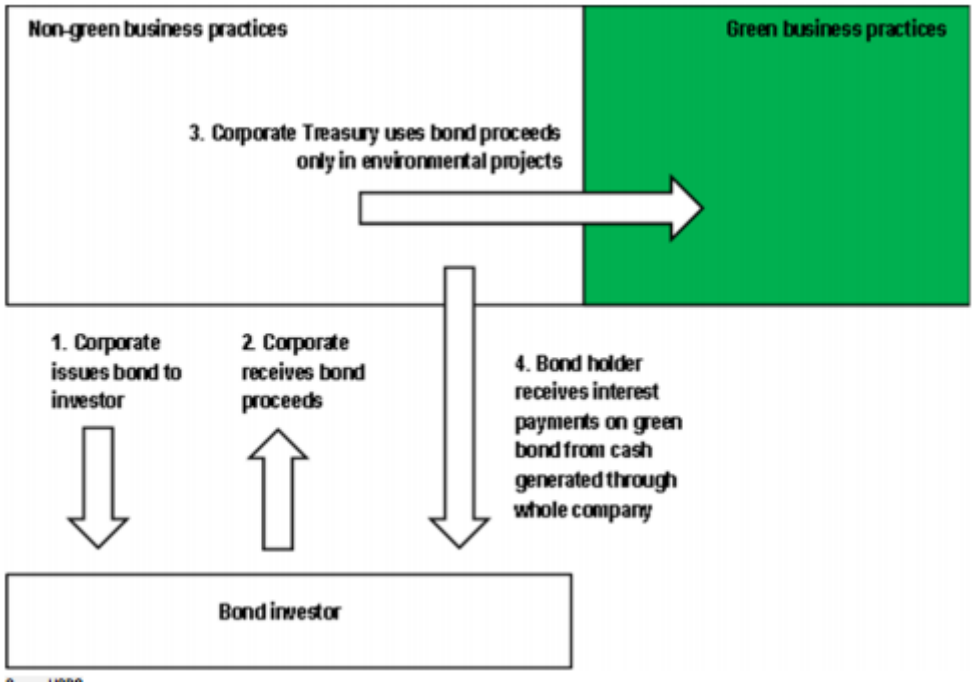
Annexes

1. Credit ratings table

	Moody's	S&P	Fitch	Meaning
Investment Grade	Aaa	AAA	AAA	Prime
	Aa1	AA+	AA+	High Grade
	Aa2	AA	AA	
	Aa3	AA-	AA-	
	A1	A+	A+	Upper Medium Grade
	A2	A	A	
	A3	A-	A-	
	Baa1	BBB+	BBB+	Lower Medium Grade
	Baa2	BBB	BBB	
	Baa3	BBB-	BBB-	
Junk	Ba1	BB+	BB+	Non Investment Grade Speculative
	Ba2	BB	BB	
	Ba3	BB-	BB-	
	B1	B+	B+	Highly Speculative
	B2	B	B	
	B3	B-	B-	
	Caa1	CCC+	CCC+	Substantial Risks
	Caa2	CCC	CCC	Extremely Speculative
	Caa3	CCC-	CCC-	
	Ca	CC	CC+	In Default w/ Little Prospect for Recovery
		C	CC	In Default
			CC-	
	D	D	DDD	

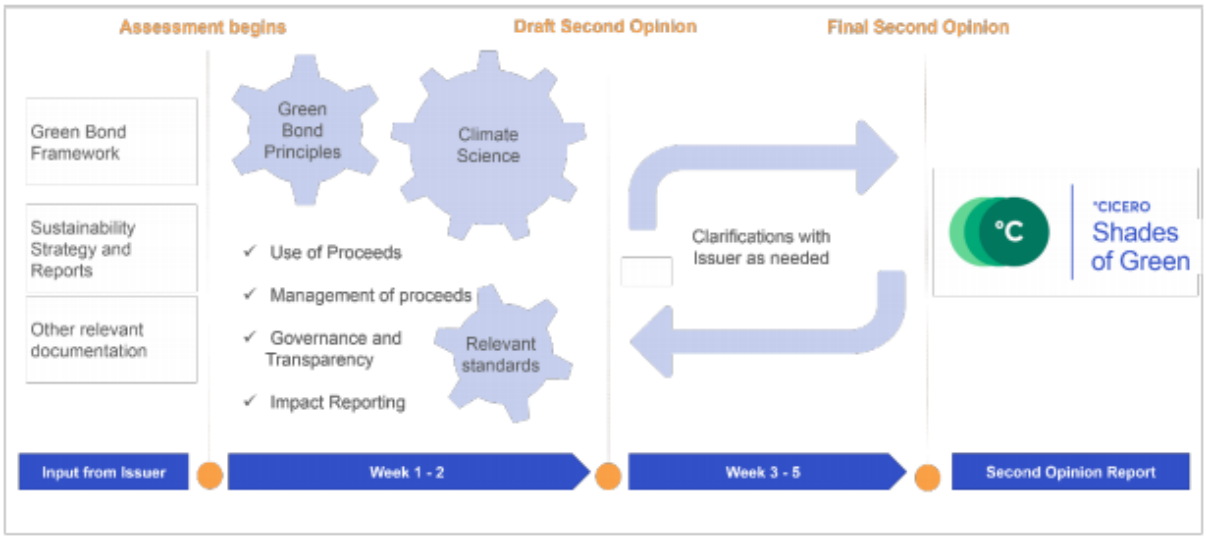
SOURCE: WARING, 2012

2. Use of proceeds cash flows



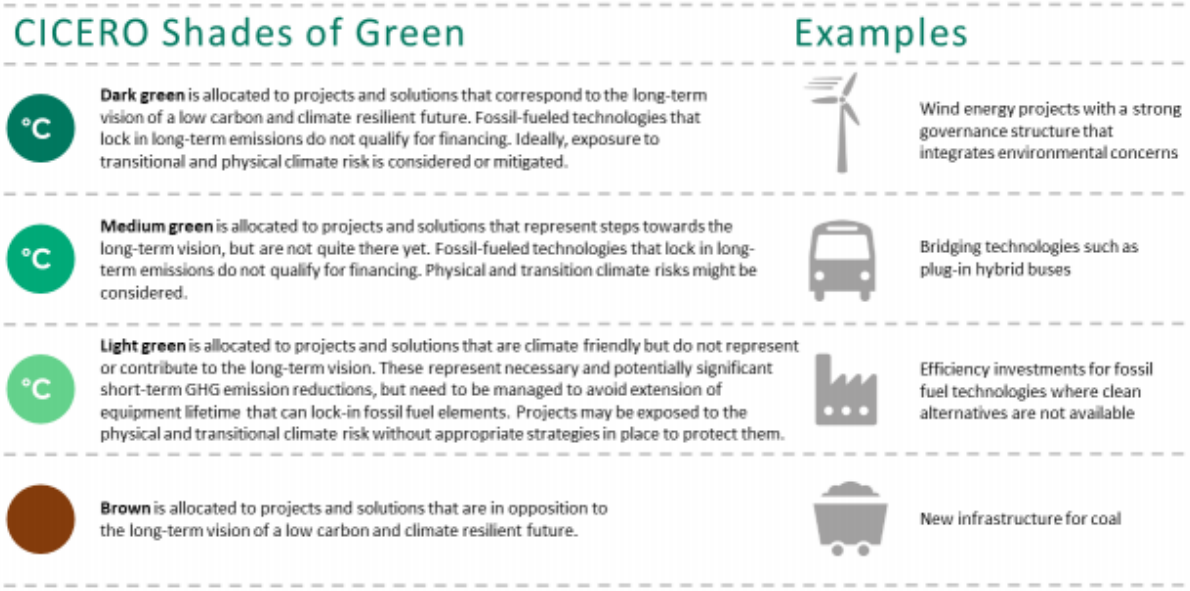
SOURCE: HSBC, 2015

3. CICERO's second opinion process



SOURCE: CICERO, 2019

4. Shades of green methodology



SOURCE: CICERO, 2019

5. Evolving guidance in the green bond market

Evolving guidance in the green bond market

	Green Bond Principles	Climate Bonds Standard	Green bond indices
Who developed it?	A group of over 50 large financial institutions.	The Climate Bonds Initiative, an international investor-focused not-for-profit organization.	Each index is run by a bank or credit rating agency, sometimes in collaboration with another party (e.g. a research organization).
What is it?	A set of principles that outlines good practice for the process of issuing a green bond, including: **Use of proceeds**: the principles recommend issuers define and disclose their criteria for what is considered 'green' i.e. what projects, assets or activities will be considered 'eligible' and what funds will be spent on. **Project evaluation and selection**: what process will be used to apply 'green' criteria to select specific projects or activities. **Management of proceeds**: what processes and controls are in place to ensure funds are used only for the specified 'green' projects. **Reporting**: how projects will be evaluated and progress reported against both environmental and financing criteria.	A standard that issuers can have their green bond certified to. The standards define what is considered 'green' and the technology specifications for certain types of climate-related projects. Currently standards are available only for wind and solar energy generation projects. Standards for green buildings, transport, biomass, water and agriculture/forestry projects are being developed.	A growing number of green bond indices launched by investment banks or credit rating agencies including: • Barclays/MSCI • Standard & Poor's/Dow Jones • Bank of America Merrill Lynch The indices are designed to help investors benchmark green bond performance. Inclusion on a green bond index could improve issuers' reputation, credibility and visibility to investors. Each index has different requirements for eligible green bonds. For example Barclays/MSCI excludes large-scale hydro projects and corporate energy efficiency projects, despite these being labeled green by some issuers and considered green by some investors.[14]
Is it voluntary?	Yes	Yes	Yes
Is third-party assurance required?	Recommended	Yes	Varies due to different listing requirements of each index

SOURCE: KPMG, 2015

6. Example of Renewi's green bond prospectus

FINAL VERSION FOR SUBMISSION TO FCA

Prospectus dated 2 July 2019

RENEWI PLC

Public offer in Belgium and admission to trading on a regulated market

3.00 per cent. fixed rate notes due 2024 for a maximum amount of €75,000,000
Denomination: €1,000
Issue Price: 101.875 per cent.
Gross actuarial yield at Issue Price: 2.595% per cent. (on an annual basis)
Net actuarial yield at Issue Price: 1.706% per cent. (on an annual basis)
Minimum subscription amount: €1,000
ISIN Code: XS2022227222 – Common Code: 202222722
(the "**Notes**")

Guaranteed by

A&G Holding B.V.
ATM B.V.
Coolrec Belgium NV
Coolrec Nederland B.V.
Mineralz ES Treatment NV
Orgaworld Nederland B.V.
Renewi Belgium NV
Renewi Canada Ltd.
Renewi Commercial B.V.
Renewi Europe B.V.
Renewi Hazardous Waste B.V.
Renewi Icopower B.V.
Renewi Monostreams B.V.
Renewi Nederland B.V.
Renewi Netherlands Holdings B.V.
Renewi NV
Renewi Overheidsdiensten B.V.
Renewi PFI Investments Limited
Renewi Smink B.V.
Renewi Support B.V.
Renewi UK Services Limited
Renewi Valorisation & Quarry NV
Reym B.V.
Robesta Vastgoed B.V.
Shanks B.V.
Verwerking Bedrijfsafvalstoffen Maasvlakte (V.B.M.) C.V.

*The yield is calculated on the basis of the issue of the Notes on the Issue Date, the Issue Price, the original rate of interest of 3.00 per cent. per year and is based on the assumption that the Notes will be held until 19 July 2024 (the "**Maturity Date**") when they will be repaid at 100% of their principal amount in accordance with the Terms and Conditions of the Notes. It is not an indication of future yield if the Notes are not held until the Maturity Date. The net yield reflects a deduction of Belgian withholding tax at the current rate of 30% (Investors should consult Section 5 (Taxation) of this Prospectus for further information about Belgian taxation).*

The global aggregate maximum nominal amount of the Notes amounts to €75,000,000.

Issue Date: 19 July 2019
Offer Period: between 9.00 a.m. (CET) on 5 July 2019 and 5.30 p.m. (CET) on 12 July 2019
(subject to early closing).

Application will be made for the Notes to be admitted to listing on the Official List of the FCA and admitted to trading on the regulated market of the London Stock Exchange.

The Notes are being issued as green bonds.

AN INVESTMENT IN THE NOTES INVOLVES CERTAIN RISKS. YOU SHOULD HAVE REGARD TO THE FACTORS DESCRIBED IN SECTION 2 (RISK FACTORS) OF THIS PROSPECTUS. YOU SHOULD ALSO READ CAREFULLY SECTION 11 (IMPORTANT LEGAL INFORMATION).

Manager

ING

SOURCE: RENEWI, 2019

7. Green bond market segmentation

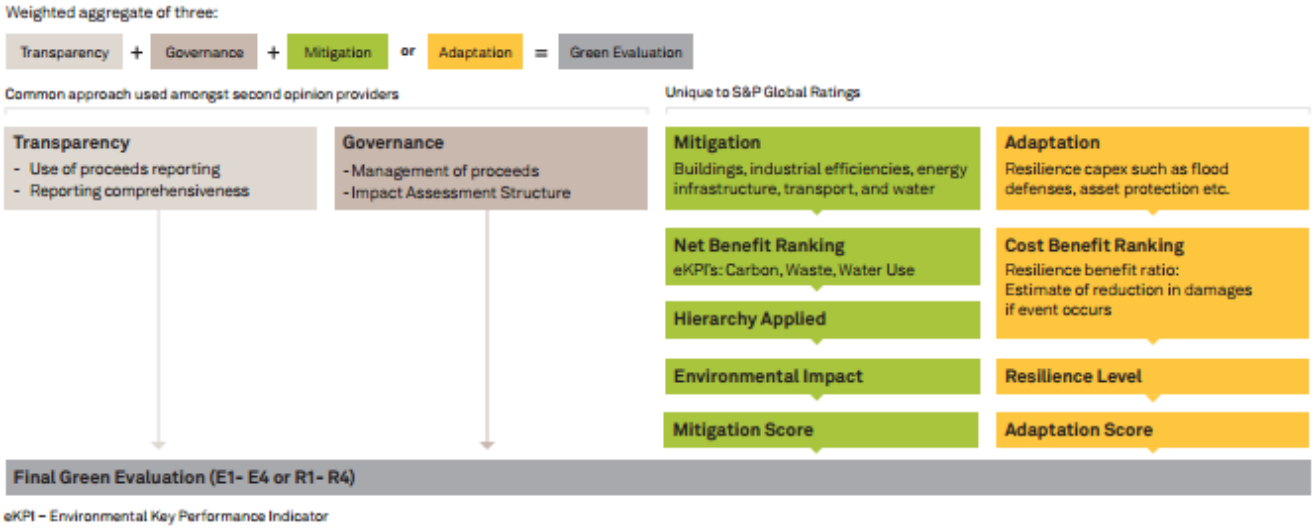
Type	Green Attributes	Credit Quality	Definition
Sovereigns, quasi-sovereigns	Labeled	High investment-grade	Bonds issued by country governments or entities that are fully owned by governments, e.g., KEXIM, EDC, KfW
Supranationals	Labeled	High investment-grade	Bonds issued by multilateral development banks and other international organizations, e.g., IFC, EIB, IBRD, Africa Development Bank
Subnationals including regional, state, municipalities and city governments	Labeled	Investment-grade	Bonds issued by regional, local or cities, e.g., Johannesburg, Massachusetts, Gothenburg
Corporates	Labeled	Investment-grade/ Subinvestment-grade	Bonds issued by corporates, including banks, e.g., Bank of America, GdF Suez, Arise, Unibail Radamco, EdF
Asset-backed securities (ABS)	Labeled	Low investment-grade	Asset-backed securities whose cashflows come from a portfolio of loans, receivables leases or PPAs, which are indirectly associated with renewable energy and energy efficiency projects e.g., Toyota ABS
Asset-backed securities (ABS)	Unlabeled	Low investment-grade	Asset-backed securities whose cashflows come from a portfolio of loans, receivables leases or PPAs, which are associated with renewable energy and energy efficiency projects, e.g., Hannon Armstrong, SolarCity
Project bonds/loans	Unlabeled	Low investment-grade/ Subinvestment-grade	Cashflows to repay come from specific assets created by the green bond proceeds, e.g., Topaz Solar Farms, Breeze, CSolar
Corporate – pure play green or renewable	Unlabeled	Low investment-grade/ Subinvestment-grade	Corporates with portfolio of renewable energy and energy efficiency, assets issuing debt at the corporate level, e.g., Terraform

SOURCE 1: S&P DOW JONES INDICES, 2014

8. Moody's GBA process

SOURCE: MOODY'S, 2018

9. S&P Green evaluation



SOURCE: S&P, 2019

10. Green bonds sample

Issuer	Coupon	Maturity	Issue Date	Country of Issue	Amount Issued (USD)	Bond Grade	Rating	Yield to	Mac. Du	Issue Pri	Sector
ABN Amro Bank NV	0.63	5/31/2022	5/31/2016	Eurobond Market	566,797,029.00	Investment Grade	A1	0.05	1.97	99.87	Banking
ABN Amro Bank NV	0.50	4/15/2026	4/15/2019	Eurobond Market	850,195,544.00	Investment Grade	A1	0.21	5.78	99.24	Banking
Banco Bilbao Vizcaya Argentaria	1.00	6/21/2026	6/21/2019	Eurobond Market	1,133,594,059.00	Investment Grade	Baa2	1.12	5.83	99.74	Banking
Banco Santander SA	0.30	10/4/2026	10/4/2019	Eurobond Market	1,133,594,059.00	Investment Grade	A2	0.43	6.26	99.78	Banking
Berlin Hyp AG	0.13	5/5/2022	5/5/2015	Germany	566,797,029.00	Investment Grade	Aaa	-0.25	1.91	99.71	Banking
Berlin Hyp AG	0.38	6/28/2023	4/28/2020	Germany	39,675,792.00	Investment Grade	Aa2	0.33	3.04	100.00	Banking
Berlin Hyp AG	1.13	10/25/2027	10/24/2017	Germany	566,797,029.00	Investment Grade	A2	0.47	7.09	99.01	Banking
BNP Paribas SA	1.00	4/17/2024	4/17/2018	Eurobond Market	566,797,029.00	Investment Grade	Baa1	0.54	3.80	99.62	Banking
BNP Paribas SA	1.13	8/28/2024	2/28/2019	France	850,195,544.00	Investment Grade	Baa1	0.59	4.11	99.64	Banking
Bpce SA	1.13	12/14/2022	12/14/2015	France	340,078,217.00	Investment Grade	A1	0.27	2.48	99.68	Banking
Caisse Francaise de Financeme	0.10	11/13/2029	11/13/2019	France	850,195,544.00	Investment Grade	Aaa	0.02	9.38	99.88	Banking
Cassa Depositi e Prestiti SpA	2.13	9/27/2023	9/27/2018	Eurobond Market	566,797,029.00	Investment Grade	Baa3	0.78	3.18	99.77	Agency
China Development Bank	0.38	11/16/2021	11/16/2017	Eurobond Market	1,133,594,059.00	Investment Grade	A1	0.24	1.44	99.57	Agency
Commerzbank AG	1.25	10/23/2023	10/23/2018	Germany	566,797,029.00	Investment Grade	Baa2	1.24	3.30	99.49	Banking
Cooperatieve Rabobank UA	0.13	10/11/2021	10/11/2016	Eurobond Market	566,797,029.00	Investment Grade	Aa3	-0.05	1.34	99.90	Banking
Cooperatieve Rabobank UA	0.25	10/30/2026	10/30/2019	Eurobond Market	850,195,544.00	Investment Grade	A3	0.56	6.34	99.64	Banking
CPPIB Capital Inc	0.25	4/6/2027	4/6/2020	Eurobond Market	1,133,594,059.00	Investment Grade	Aaa	0.25	6.78	99.58	Financial - Other
Credit Agricole SA	0.38	10/21/2025	10/21/2019	Eurobond Market	1,133,594,059.00	Investment Grade	Baa1	0.65	5.31	99.90	Banking
Deutsche Hypothekenbank AG	0.13	11/23/2023	11/23/2017	Germany	566,797,029.00	Investment Grade	Aa1	-0.20	3.45	99.48	Mortgage Banking
Deutsche Hypothekenbank AG	0.25	12/10/2024	9/10/2018	Germany	566,797,029.00	Investment Grade	Aa1	-0.17	4.48	99.26	Mortgage Banking
Deutsche Kreditbank AG	0.75	9/26/2024	9/26/2017	Germany	566,797,029.00	Investment Grade	A2	0.84	4.23	99.35	Banking
Digital Euro Finco LLC	2.50	1/16/2026	1/16/2019	Eurobond Market	1,218,613,614.00	Investment Grade	Baa2	1.15	5.27	99.96	Financial - Other
DNB Boligkreditt AS	0.63	6/19/2025	6/19/2018	Norway	1,700,391,089.00	Investment Grade	Aaa	-0.13	4.94	99.41	Financial - Other
DZ BANK AG Deutsche Zentral Ge	0.50	10/2/2023	10/2/2018	Germany	283,398,514.00	Investment Grade	Aa1	0.38	3.29	99.99	Banking
E.ON SE	1.00	10/7/2025	4/7/2020	Eurobond Market	850,195,544.00	Investment Grade	Baa2	0.39	5.21	99.55	Utility - Other
E.ON SE	0.38	9/29/2027	1/16/2020	Eurobond Market	1,133,594,059.00	Investment Grade	Baa2	0.48	7.21	98.92	Utility - Other
EDP Finance BV	1.88	10/13/2025	10/12/2018	Eurobond Market	680,156,435.00	Investment Grade	Baa3	0.61	5.09	99.46	Financial - Other
Engie SA	0.38	2/28/2023	9/28/2017	France	566,797,029.00	Investment Grade	A3	0.24	2.72	99.55	Oil and Gas
Engie SA	0.88	3/27/2024	3/27/2017	France	793,515,841.00	Investment Grade	A3	0.23	3.75	99.10	Oil and Gas
Engie SA	1.38	2/28/2029	9/28/2017	France	850,195,544.00	Investment Grade	A3	0.66	8.27	99.44	Oil and Gas
Hera SpA	0.88	7/5/2027	7/5/2019	Eurobond Market	566,797,029.00	Investment Grade	Baa2	0.86	6.84	98.41	Gas Utility - Local Distrib
HSBC France SA	0.63	12/3/2020	12/3/2015	France	566,797,029.00	Investment Grade	Aa3	-0.06	0.49	99.43	Banking
Hypo Vorarlberg Bank AG	0.63	9/19/2022	9/19/2017	Austria	340,078,217.00	Investment Grade	A3	0.79	2.26	99.40	Banking
Iberdrola International BV	1.13	4/21/2026	4/21/2016	Eurobond Market	1,133,594,059.00	Investment Grade	Baa1	0.33	5.71	99.49	Financial - Other
Icade SA	1.50	9/13/2027	9/13/2017	France	680,156,435.00	Investment Grade	Baa1	1.81	6.86	99.11	Home Builders
Ignitis Grupe UAB	2.00	7/14/2027	7/14/2017	Eurobond Market	340,078,217.00	Investment Grade	Baa1	1.56	6.58	98.28	Utility - Other
ING Bank NV	0.75	11/24/2020	11/24/2015	Eurobond Market	566,797,029.00	Investment Grade	Aa3	0.00	0.46	99.77	Banking
Instituto de Credito Oficial	0.20	1/31/2024	4/9/2019	Eurobond Market	566,797,029.00	Investment Grade	Baa1	-0.11	3.64	99.86	Agency
Intesa Sanpaolo SpA	0.88	6/27/2022	6/27/2017	Eurobond Market	566,797,029.00	Investment Grade	Baa1	1.08	2.03	99.53	Banking
Intesa Sanpaolo SpA	0.75	12/4/2024	12/4/2019	Eurobond Market	850,195,544.00	Investment Grade	Baa1	1.29	4.41	99.97	Banking
KBC Groep NV	0.88	6/27/2023	6/27/2018	Eurobond Market	566,797,029.00	Investment Grade	Baa1	0.39	3.00	99.49	Banking
KfW	0.13	10/27/2020	10/27/2015	Eurobond Market	1,700,391,089.00	Investment Grade	Aaa	-0.47	0.39	99.94	Agency
KfW	0.25	6/30/2025	5/16/2017	Eurobond Market	2,267,188,119.00	Investment Grade	Aaa	-0.37	5.02	99.29	Agency
La Poste SA	1.45	11/30/2028	11/30/2018	France	566,797,029.00	Investment Grade	A1	0.75	7.99	99.82	Agency

Landesbank Baden Wuerttembe	0.20	12/13/2021	12/13/2017	Eurobond Market	850,195,544.00	Investment Grade	A2	0.55	1.51	99.85	Banking
Landesbank Baden Wuerttembe	0.13	6/27/2023	6/27/2018	Germany	566,797,029.00	Investment Grade	Aaa	-0.25	3.05	99.83	Banking
Landesbank Baden Wuerttembe	0.38	7/29/2026	7/29/2019	Eurobond Market	566,797,029.00	Investment Grade	A2	0.62	6.06	99.68	Banking
Landwirtschaftliche Rentenban	1.46	8/20/2020	8/20/2013	Eurobond Market	56,679,702.00	Investment Grade	Aaa	-0.31	0.20	100.00	Agency
Mitsubishi UFJ Financial Group I	0.98	10/9/2023	10/9/2018	Eurobond Market	566,797,029.00	Investment Grade	A1	0.55	3.28	100.00	Banking
Mizuho Financial Group Inc	0.96	10/16/2024	10/16/2017	Eurobond Market	566,797,029.00	Investment Grade	A1	0.80	4.26	100.00	Banking
Muenchener Hypothekenbank e	0.25	12/13/2023	11/8/2018	Germany	566,797,029.00	Investment Grade	Aaa	-0.24	3.50	99.84	Banking
National Australia Bank Ltd	0.35	9/7/2022	3/7/2017	Eurobond Market	566,797,029.00	Investment Grade	Aa3	-0.04	2.24	99.91	Banking
National Australia Bank Ltd	0.63	8/30/2023	8/30/2018	Eurobond Market	850,195,544.00	Investment Grade	Aa3	0.02	3.19	100.00	Banking
NORD LB Luxembourg Covered B	0.05	1/28/2025	1/28/2020	Eurobond Market	340,078,217.00	Investment Grade	Aa2	0.04	4.63	99.87	Banking
Nordea Bank Abp	0.30	6/30/2022	6/30/2017	Eurobond Market	566,797,029.00	Investment Grade	Aa3	0.00	2.05	99.89	Banking
Nordea Bank Abp	0.38	5/28/2026	5/28/2019	Eurobond Market	850,195,544.00	Investment Grade	Aa3	0.17	5.92	99.29	Banking
NRW Bank	0.88	11/10/2025	11/10/2015	Germany	566,797,029.00	Investment Grade	Aa1	-0.17	5.30	99.49	Agency
NRW Bank	0.38	11/17/2026	11/17/2016	Germany	566,797,029.00	Investment Grade	Aa1	-0.12	6.37	99.07	Agency
NRW Bank	0.50	9/13/2027	9/13/2017	Germany	566,797,029.00	Investment Grade	Aa1	-0.09	7.13	98.87	Agency
NRW Bank	0.75	6/30/2028	7/2/2018	Germany	566,797,029.00	Investment Grade	Aa1	-0.04	7.81	99.83	Agency
NRW Bank	0.63	2/2/2029	2/4/2019	Germany	566,797,029.00	Investment Grade	Aa1	0.02	8.44	99.10	Agency
OP Yrityspankki Oyj	0.38	2/26/2024	2/26/2019	Eurobond Market	566,797,029.00	Investment Grade	Aa3	0.13	3.69	99.56	Banking
Prologis Euro Finance LLC	0.38	2/6/2028	2/6/2020	Eurobond Market	623,476,732.00	Investment Grade	A3	0.95	7.55	99.75	Financial - Other
Prologis International Funding I	1.75	3/15/2028	3/15/2018	Eurobond Market	340,078,217.00	Investment Grade	A3	1.00	7.32	99.06	Financial - Other
Raiffeisen Bank International AG	0.25	7/5/2021	7/5/2018	Eurobond Market	566,797,029.00	Investment Grade	A3	0.45	1.07	99.67	Banking
Regie Autonome des Transports	0.35	6/20/2029	6/20/2019	France	566,797,029.00	Investment Grade	Aa2	0.31	8.88	99.70	Agency
Royal Bank of Canada	0.25	5/2/2024	5/2/2019	Eurobond Market	566,797,029.00	Investment Grade	A2	0.31	3.89	99.48	Banking
Royal Schiphol Group NV	2.00	4/6/2029	4/6/2020	Eurobond Market	850,195,544.00	Investment Grade	A1	1.05	8.18	99.76	Transportation - Other
SBAB Bank AB (publ)	0.50	5/13/2025	5/13/2020	Eurobond Market	566,797,029.00	Investment Grade	A1	0.29	4.88	99.50	Banking
Skandinaviska Enskilda Banken	0.30	2/17/2022	2/17/2017	Eurobond Market	566,797,029.00	Investment Grade	Aa2	0.08	1.69	99.78	Banking
SNCF Reseau	1.00	11/9/2031	11/9/2016	Eurobond Market	1,020,234,653.00	Investment Grade	Aa2	0.41	10.81	98.57	Agency
Societe du Grand Paris	1.70	5/25/2050	6/3/2019	France	2,833,985,149.00	Investment Grade	Aa2	1.04	24.27	99.19	Agency
Societe Generale SA	0.75	11/25/2020	11/25/2015	Eurobond Market	566,797,029.00	Investment Grade	A1	0.12	0.46	99.67	Banking
Stockland Trust Management Lt	1.50	11/3/2021	11/3/2014	Eurobond Market	340,078,217.00	Investment Grade	A3	1.27	1.39	99.62	Financial - Other
Svenska Handelsbanken AB	0.38	7/3/2023	7/3/2018	Eurobond Market	566,797,029.00	Investment Grade	Aa2	0.05	3.05	99.44	Banking
Swedbank AB	0.25	11/7/2022	11/7/2017	Eurobond Market	566,797,029.00	Investment Grade	Aa3	0.26	2.41	99.89	Banking
Terna Rete Elettrica Nazionale S	1.00	4/10/2026	4/10/2019	Eurobond Market	566,797,029.00	Investment Grade	Baa2	0.76	5.69	99.89	Utility - Other
Unibail-Rodamco-Westfield SE	2.50	2/26/2024	2/26/2014	Eurobond Market	850,195,544.00	Investment Grade	A3	1.49	3.58	98.72	Real Estate Investment Trust
Unibail-Rodamco-Westfield SE	1.00	3/14/2025	4/15/2015	Eurobond Market	566,797,029.00	Investment Grade	A3	1.63	4.67	99.67	Real Estate Investment Trust
Unione di Banche Italiane SpA	1.50	4/10/2024	4/10/2019	Eurobond Market	566,797,029.00	Investment Grade	Baa3	1.70	3.75	99.79	Banking
Vodafone Group PLC	0.90	11/24/2026	5/24/2019	Eurobond Market	850,195,544.00	Investment Grade	Baa2	0.73	6.28	99.53	Telecommunications
Westpac Banking Corp	0.63	11/22/2024	11/22/2017	Eurobond Market	566,797,029.00	Investment Grade	Aa3	0.19	4.39	99.21	Banking

11. Conventional bonds sample

Issuer	Coupon	Maturity	Issue Date	Country of Issue	Amount Issued (USD)	Bond Grade	Rating	Yield to	Mac. Du	Issue Price	Sector
ABN Amro Bank NV	0.60	1/15/2027	1/15/2020	Eurobond Market	1,416,992,574.00	Investment Grade	Baa2	0.91	6.48	99.80	Banking
ABN Amro Bank NV	0.46	11/22/2024	11/22/2018	Eurobond Market	2,267,188,119.00	Investment Grade	Aaa	-0.27	4.41	100.00	Banking
Banco Bilbao Vizcaya Argentaria	1.00	1/20/2021	1/20/2016	Eurobond Market	1,133,594,059.00	Investment Grade	A3	0.04	0.62	99.52	Banking
Banco Santander SA	0.45	12/20/2021	12/20/2016	Spain	283,398,514.00	Investment Grade	Aa1	0.09	1.53	100.00	Banking
Berlin Hyp AG	0.13	1/5/2024	9/5/2017	Germany	566,797,029.00	Investment Grade	Aaa	-0.22	3.57	99.57	Banking
Berlin Hyp AG	0.45	6/28/2023	4/30/2020	Germany	28,339,851.00	Investment Grade	Aa2	0.40	3.04	100.00	Banking
Berlin Hyp AG	1.00	12/27/2023	12/23/2014	Germany	11,335,940.00	Investment Grade	A1	0.22	3.49	99.95	Banking
BNP Paribas SA	1.00	5/12/2023	5/12/2015	Eurobond Market	17,003,910.00	Investment Grade	Aa3	1.42	2.90	100.00	Banking
BNP Paribas SA	1.13	11/22/2023	5/22/2018	Eurobond Market	991,894,802.00	Investment Grade	Baa1	0.52	3.39	99.89	Banking
Bpce SA	1.13	1/18/2023	1/18/2017	France	1,133,594,059.00	Investment Grade	Baa2	0.57	2.58	99.88	Banking
Caisse Francaise de Financeme	0.18	7/24/2029	7/24/2019	France	56,679,702.00	Investment Grade	Aaa	0.05	9.05	100.00	Banking
Cassa Depositi e Prestiti SpA	2.13	3/21/2026	3/21/2019	Eurobond Market	850,195,544.00	Investment Grade	Baa3	1.26	5.49	99.29	Agency
China Development Bank	0.50	6/1/2021	6/1/2016	Eurobond Market	1,133,594,059.00	Investment Grade	A1	0.25	0.98	99.45	Agency
Commerzbank AG	1.25	9/11/2024	3/11/2019	Germany	56,679,702.00	Investment Grade	Baa2	1.80	4.13	100.00	Banking
Cooperatieve Rabobank UA	0.13	9/12/2024	9/12/2019	Netherlands	5,667,970,299.00	Investment Grade	Aaa	-0.37	4.25	103.36	Banking
Cooperatieve Rabobank UA	0.25	5/31/2024	5/31/2017	Netherlands	1,700,391,089.00	Investment Grade	Aaa	-0.27	3.96	99.21	Banking
CPPIB Capital Inc	0.38	6/20/2024	6/20/2017	United States	2,267,188,119.00	Investment Grade	Aaa	0.05	4.00	99.38	Financial - Other
Credit Agricole SA	0.36	1/20/2027	1/20/2020	France	566,797,029.00	Investment Grade	Aa3	1.26	6.54	100.00	Banking
Deutsche Hypothekenbank AG	0.13	4/20/2022	4/20/2015	Germany	850,195,544.00	Investment Grade	Aa1	-0.22	1.87	99.35	Mortgage Banking
Deutsche Hypothekenbank AG	0.25	2/22/2023	2/22/2016	Germany	850,195,544.00	Investment Grade	Aa1	-0.23	2.70	99.48	Mortgage Banking
Deutsche Kreditbank AG	0.75	6/26/2023	12/3/2014	Germany	11,335,940.00	Investment Grade	Aaa	-0.06	3.01	99.84	Banking
Digital Euro Finco LLC	2.63	4/15/2024	4/15/2016	Eurobond Market	680,156,435.00	Investment Grade	Baa2	1.05	3.71	99.79	Financial - Other
DNB Boligkreditt AS	0.63	1/14/2026	1/14/2019	Norway	1,700,391,089.00	Investment Grade	Aaa	-0.07	5.51	99.83	Financial - Other
DZ BANK AG Deutsche Zentral G	0.50	2/18/2027	2/18/2020	Germany	56,679,702.00	Investment Grade	A3	0.50	6.59	100.00	Banking
E.ON SE	0.88	5/22/2024	5/22/2017	Eurobond Market	556,699,883.00	Investment Grade	Baa2	0.37	3.92	99.35	Utility - Other
E.ON SE	0.25	10/24/2026	10/24/2019	Eurobond Market	835,049,824.00	Investment Grade	Baa2	0.46	6.34	99.14	Utility - Other
EDP Finance BV	1.88	9/29/2023	1/30/2017	Eurobond Market	680,156,435.00	Investment Grade	Baa3	0.47	3.20	99.66	Financial - Other
Engie SA	0.5	3/13/22	3/13/2015	France	835,049,824.00	Investment Grade	A3	0.32	1.77	99.26	Oil and Gas
Engie SA	0.88	9/19/2025	9/19/2018	France	556,699,883.00	Investment Grade	A3	0.4	5.17	99.17	Oil and Gas
Engie SA	1.38	6/22/2028	6/22/2018	France	835,049,824.00	Investment Grade	A3	0.73	7.59	99.57	Oil and Gas
Hera SpA	0.88	10/14/2026	10/14/2016	Eurobond Market	445,359,906.00	Investment Grade	Baa2	0.81	6.18	99.03	Gas Utility - Local Distrib
HSBC France SA	0.63	3/15/2022	3/15/2017	France	340,078,217.00	Investment Grade	Aa3	0.55	1.76	100.00	Banking
Hypo Vorarlberg Bank AG	0.67	5/16/2022	5/16/2017	Eurobond Market	22,671,881.00	Investment Grade	A3	0.89	1.93	99.80	Banking
Iberdrola International BV	1.13	1/27/2023	1/27/2015	Eurobond Market	680,156,435.00	Investment Grade	Baa1	0.26	2.60	99.39	Financial - Other
Icade SA	1.63	2/28/2028	2/28/2018	France	680,156,435.00	Investment Grade	Baa1	1.82	7.28	98.44	Home Builders
Ignitis Grupe UAB	2.00	5/21/2030	5/21/2020	Eurobond Market	340,078,217.00	Investment Grade	Baa1	1.82	9.12	98.68	Utility - Other
ING Bank NV	0.75	2/22/2021	2/22/2016	Eurobond Market	1,416,992,574.00	Investment Grade	Aa3	0.03	0.71	99.79	Banking
Instituto de Credito Oficial	0.25	4/30/2022	9/15/2017	Eurobond Market	1,246,953,465.00	Investment Grade	Baa1	-0.22	1.89	99.89	Agency
Intesa Sanpaolo SpA	1.00	7/4/2024	7/4/2019	Eurobond Market	1,416,992,574.00	Investment Grade	Baa1	1.31	3.97	99.86	Banking
Intesa Sanpaolo SpA	0.63	12/22/2022	12/22/2017	Eurobond Market	1,360,312,871.00	Investment Grade	Baa3	0.83	2.52	100.00	Banking
KBC Groep NV	0.75	3/1/2022	3/1/2017	Belgium	1,416,992,574.00	Investment Grade	Baa1	0.36	1.72	99.99	Banking
KfW	0.13	11/7/2023	11/5/2018	Germany	5,667,970,299.00	Investment Grade	Aaa	-0.44	3.41	99.90	Agency
KfW	0.22	10/13/2024	10/13/2017	Eurobond Market	170,039,108.00	Investment Grade	Aaa	-0.41	4.33	100.00	Agency
La Poste SA	1.38	4/21/2032	4/21/2020	France	1,303,633,168.00	Investment Grade	A1	1.11	11.03	99.78	Agency

La Poste SA	1.38	4/21/2032	4/21/2020	France	1,303,633,168.00	Investment Grade	A1	1.11	11.03	99.78	Agency
Landesbank Baden Wuerttembe	0.20	6/9/2025	6/9/2020	Germany	27,206,257.00	Investment Grade	A3	0.40	4.98	100.00	Banking
Landesbank Baden Wuerttembe	0.13	5/28/2024	5/28/2020	Germany	113,359,405.00	Investment Grade	A3	0.49	3.96	100.00	Banking
Landesbank Baden Wuerttembe	0.38	1/14/2026	1/14/2019	Germany	850,195,544.00	Investment Grade	Aaa	-0.16	5.55	99.29	Banking
Landwirtschaftliche Rentenban	1.38	11/19/2020	11/19/2013	Eurobond Market	1,473,672,277.00	Investment Grade	Aaa	-0.26	0.45	99.29	Agency
Mitsubishi UFJ Financial Group I	0.98	6/9/2024	6/9/2020	Eurobond Market	566,797,029.00	Investment Grade	A1	0.64	3.94	100.00	Banking
Mizuho Financial Group Inc	1.02	10/11/2023	10/11/2018	Eurobond Market	566,797,029.00	Investment Grade	A1	0.68	3.28	100.00	Banking
Muenchener Hypothekenbank e	0.25	10/14/2020	8/5/2015	Germany	991,894,802.00	Investment Grade	Aaa	-0.30	0.35	99.79	Banking
National Australia Bank Ltd	0.25	3/28/2022	3/28/2017	Eurobond Market	1,416,992,574.00	Investment Grade	Aaa	-0.20	1.80	99.66	Banking
National Australia Bank Ltd	0.63	11/10/2023	11/10/2016	Eurobond Market	566,797,029.00	Investment Grade	Aaa	0.04	3.39	99.78	Banking
NORD LB Luxembourg Covered B	0.01	6/10/2027	6/10/2020	Eurobond Market	566,797,029.00	Investment Grade	Aa2	0.12	7.00	99.55	Banking
Nordea Bank Abp	0.29	11/30/2021	5/31/2017	Eurobond Market	11,335,940.00	Investment Grade	Aa2	1.01	1.47	100.00	Banking
Nordea Bank Abp	0.50	5/14/2027	5/14/2020	Eurobond Market	1,416,992,574.00	Investment Grade	Aa2	0.32	6.83	99.24	Banking
NRW Bank	0.84	11/27/2028	11/27/2018	Germany	5,667,970.00	Investment Grade	Aa1	0.77	8.18	100.00	Agency
NRW Bank	0.38	5/16/2029	5/16/2019	Germany	1,133,594,059.00	Investment Grade	Aa1	0.03	8.81	99.71	Agency
NRW Bank	0.50	6/7/2027	6/7/2017	Germany	566,797,029.00	Investment Grade	Aa1	-0.10	6.90	99.08	Agency
NRW Bank	0.73	2/16/2027	2/16/2017	Germany	11,335,940.00	Investment Grade	Aa1	0.04	6.54	100.00	Agency
NRW Bank	0.63	2/23/2027	2/23/2017	Germany	566,797,029.00	Investment Grade	Aa1	-0.10	6.58	100.11	Agency
OP Yrityspankki Oyj	0.38	6/19/2024	6/19/2019	Eurobond Market	566,797,029.00	Investment Grade	Baa1	0.73	3.99	99.66	Banking
Prologis Euro Finance LLC	0.25	9/10/2027	9/10/2019	Eurobond Market	680,156,435.00	Investment Grade	A3	0.85	7.18	99.82	Financial - Other
Prologis International Funding I	1.63	6/17/2032	6/17/2020	Eurobond Market	566,797,029.00	Investment Grade	A3	1.47	11.01	99.63	Financial - Other
Raiffeisen Bank International AG	0.28	1/17/2021	1/17/2018	Austria	373,179,164.00	Investment Grade	A3	0.75	0.61	100.00	Banking
Regie Autonome des Transports	0.38	6/15/2024	6/15/2016	France	566,797,029.00	Investment Grade	Aa2	-0.15	3.98	99.24	Agency
Royal Bank of Canada	0.25	1/29/2024	1/29/2019	Eurobond Market	1,983,789,604.00	Investment Grade	Aaa	-0.11	3.63	99.49	Banking
Royal Schiphol Group NV	2.00	10/5/2026	10/5/2015	Eurobond Market	453,437,623.00	Investment Grade	A1	1.02	5.94	99.64	Transportation - Other
SBAB Bank AB (publ)	0.50	5/11/2021	4/11/2016	Eurobond Market	566,797,029.00	Investment Grade	A1	0.22	0.93	99.46	Banking
Skandinaviska Enskilda Banken	0.25	6/20/2024	6/20/2017	Sweden	1,133,594,059.00	Investment Grade	Aaa	-0.14	4.01	99.32	Banking
SNCF Reseau	1.13	5/25/2030	2/12/2015	Eurobond Market	2,210,508,416.00	Investment Grade	Aa2	0.36	9.50	99.84	Agency
Societe du Grand Paris	1.70	5/25/2050	5/7/2020	France	1,700,391,089.00	Investment Grade	Aa2	1.04	24.27	100.00	Agency
Societe Generale SA	0.75	2/19/2021	2/19/2016	Eurobond Market	850,195,544.00	Investment Grade	A1	0.04	0.70	99.42	Banking
Stockland Trust Management Lt	1.63	4/27/2026	4/27/2018	Eurobond Market	340,078,217.00	Investment Grade	A3	1.98	5.65	99.81	Financial - Other
Svenska Handelsbanken AB	0.25	2/28/2022	2/28/2017	Eurobond Market	1,133,594,059.00	Investment Grade	Aa2	0.03	1.72	99.59	Banking
Swedbank AB	0.25	10/9/2024	10/9/2019	Eurobond Market	850,195,544.00	Investment Grade	Baa1	0.75	4.31	99.80	Banking
Terna Rete Elettrica Nazionale S	0.88	2/2/2022	2/2/2015	Eurobond Market	1,113,399,766.00	Investment Grade	Baa2	0.67	1.65	99.42	Utility - Other
Unibail-Rodamco-Westfield SE	2.50	6/12/2023	6/12/2013	Eurobond Market	793,515,841.00	Investment Grade	A3	1.50	2.87	99.11	Real Estate Investment Trust
Unibail-Rodamco-Westfield SE	1.00	2/27/2027	2/27/2019	France	850,195,544.00	Investment Grade	A3	1.88	6.51	99.16	Real Estate Investment Trust
Unione di Banche Italiane SpA	1.63	4/21/2025	10/21/2019	Eurobond Market	566,797,029.00	High Yield	Ba3	2.85	4.71	99.77	Banking
Vodafone Group PLC	1.00	9/11/2020	9/11/2014	Eurobond Market	1,948,449,590.00	Investment Grade	Baa2	0.27	0.04	99.35	Telecommunications
Westpac Banking Corp	0.63	1/14/2022	1/14/2015	Eurobond Market	1,416,992,574.00	Investment Grade	Aaa	-0.18	1.59	99.89	Banking