Copenhagen Business School

Master Thesis

The Performance of ESG Investing in fixed-income

-A closer look at Recession and Non-Recession Periods-

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Abstract

This thesis studies the effect of screening for Environmental, Social and Governance on corporate bonds returns by looking at their relative performance in periods of market crisis and non-crisis. More specifically, the risk-adjusted financial performance of bonds issued by European companies with high-ESG score is compared with a matched sample of conventional Investment-Grade bonds. By applying well known models in financial theory we find that compared to conventional bond, ESG bonds seem to underperform during the period of market crisis. For periods of financial stability, the picture is quite different with both bond classes showing similar performance. Potential explanations for the asymmetry of returns observed during different market regimes are presented in the end of the paper.

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Contents

1. Introduction

Responsible investing is gaining momentum. In the last decade, Responsible investing approach has been embraced by the mainstream investment community with an increasing number of investors considering not only financial returns but also the impact of their investments on society. The incidents in recent decades have made the social liabilities of the companies more visible, especially with the spotlights turned to their operation's environmental consequences and community engagement. The sustainability issues have been covered in different means of media-which led to a broader access to public as well as the investors. As a result, the sustainable side of corporations have been under the track of both individual and institutional investors.

Different approaches to Responsible Investing (RI) exist. In this thesis, our analysis is focused on ESG investing. The integration of Environmental, Social and Governance criteria is becoming an increasingly important process for investment decisions. More than ever, investors are assessing companies based on their ESG metrics to evaluate corporate behaviour and non-financial risks that might affect investment returns. The increase integration of ESG metrics in investment strategies can be indicated by looking at the assets under management linked to ESG Investing. Although the uptake has been particularly strong in the US, it has gained consistent growth at the European level (GSIA, 2016). The increase awareness of ESG integration is also visible from the supply side. Disclosure of ESG-relevant information by companies is mostly voluntary at this stage but it seems that companies are showing strong appetite on reporting non-financial information (Barclays, 2015).

The increasing integration of ESG factors into investment strategies is undeniable, however the question that is left is whether there is a premium associated with it. Opponents of RI argue that imposing non-financial criteria-such as ESG consideration- restricts the investment universe, limits the opportunity set thereby adversely impacting the risk and return. On the other hand, supporters argue that investing in companies that manage ESG risks more efficiently are less exposed to certain risks such as lawsuits or scandals and that this material benefits more than offsets the loss of efficiency caused by limiting the investment set. An alternative theory is that social and environmental awareness expressed by a firm are sources of financial benefits that are overlooked by mainstream investment

criteria, implying that responsible investors might enjoy an informational advantage (Kurtz, 1997). The question whether there is a premium associated with ESG investing is ultimately an empirical one.

Besides investors, RI has also gathered great attention in the academic world. Several studies have been focused on the performance of these type of investments. Many studies have assessed the financial performance of RI equity investments. The results of these studies are mixed. Remarkably, little attention has been paid to RI performance in respect to fixed-income securities. More specifically, there is little evidence of ESG Investing performance in the fixed income asset class. From our knowledge only two studies have been conducted in this regard, both performed in the US market and with inconsistent results.

This thesis contributes to the literature in various ways. First, there is little evidence in ESG investment bond performance, as mentioned previous studies focused on ESG bond performance provided mixed results. Second, this thesis focus on analysing ESG bond performance of European companies. As most of the past empiric research was focused on the US market there is no evidence of ESG investing performance in the European corporate bond market.

1.2. Problem Statement

In the academic domain of RI, this thesis tries to uncover the risk-adjusted return observed by following an ESG investing strategy. As the market for ESG investing is growing, this is potentially a crucial question for the future of this investment approach. More specifically, this thesis studies the effects on bond returns by incorporating ESG indicators into investment selection. The investigation of a potential effect of ESG screening on bond returns indirectly answers the question of whether ESG metrics are material influence factors for corporate bond returns.

By looking at different market regimes, we investigate whether the performance of ESG bonds relates to a potential risk-reduction effect of ESG Investing. Literature suggests that investors tend to examine firm risks and corporate behaviour more closely when the economy is weak (Hirshleifer, 2008). Therefore, this thesis aims to answer the following fundamental question:

"How do ESG bonds perform compared to conventional ones during recession and non-recession periods?"

1.3. Methodology

To study the financial performance of the ESG bonds we make use of a highly comparable conventional bond sample as benchmark. To do so our approach stems from the CAPM-based Jensen's (1968) alpha measure, which captures the risk-adjusted average abnormal return in excess of a market benchmark. As the market proxy, we chose the Barclays Euro Aggregate Corporate Bond index. Given the criticisms that the 1-factor CAPM framework does not sufficient explain the expected bond returns, we employ multi-factor models as proposed by the finance literature (Fama and French, 1992b; Elton, 1995). More specifically, we employ the Fama-French three factor model and an extended model to capture for any systematic risk affecting corporate bond returns as suggested by Elton (1995). The cross-sectional approach was used instead of the portfolio approach because of interest in the monotonic effect of ESG factor on bond returns. For this purpose, our econometric methodology is based on cross-sectional methodology developed by Fama and Macbeth (1973).

1.4. Delimitations

The main delimitation in this thesis is related to the bond sample. Our dataset for both periods can be considered small and therefore one could argue that this makes our results less applicable for generalization. This delimitation is particularly evident for our sample of the recession-period. The reason is that we only included straight bonds in our analysis since embedded-options entail additional risks, and as we collected the data we observed that during that period most companies issued callable bonds. This trend was already expected for weak economic conditions.

In addition, monthly data is used when analyzing the performance of the two bonds classes. Traditionally transaction data on bonds has been hard to acquire, as great part of the trading is never registered. This would lead to a greater risk of the results becoming data conditional if a shorter period time was chosen (i.e. daily or weekly), as we would be left with zero returns in many of weekly/ daily data points.

Finally, our analyses rely heavily on the ESG-scores provided by Thomsen Reuters. By doing this we assume that these scores reflect how the market participants consider companies when

evaluating them on their ESG behavior and that Thomsen Reuters's ESG rating methodology is the most correct one. If this is not the case, then our analyses lack credibility.

1.5. Thesis Outline

The rest of this thesis is structured in the following way:

Chapter 2 aims to distinguish the two main categories of Responsible Investing and introduces our approach to ESG Investing

Chapter 3 provides a literature review on Responsible investing in the fixed-income asset class

Chapter 4 introduces the risks that influence bond returns

Chapter 5 introduces the models used to study the performance of ESG bonds vis-à-vis with the conventional bond sample

Chapter 6 presents our data cleansing and filtering

Chapter 7 provides the results of the analyses

Chapter 8 presents the conclusion to the research question

2. Responsible Investing

2.1. Definitions

Responsible Investing (RI) can broadly be described as expanding the objectives of an investment process beyond pure financial considerations to reflect investor's values and beliefs that their holdings affect the community and broader eco-system. RI goes by many names and definitions- it is variously referred to as socially responsible investing (SRI), ethical investing (EI), sustainable investing (SI) or ESG investing. In fact, RI is a blanket term intended to encompass the different terms or classes of investing. This is often seen in practice in the existing literature of RI, since scholars do not explicitly make any distinction in investment style or meaning (Bauer et al., 2005).

For the purpose of our study, a clear distinction between the different terms will be made, since there seems to be no consensus on what the term RI exactly means for investors (Berry and Junkus, 2013). In the following sections, we aim to define each of the different investment approaches and highlight the difference between the pure ethical style or SRI and the more mainstream approach to responsible investing: the ESG investing.

2.1.1. Ethical and Socially Responsible Investing

Ethical and Socially Responsible Investing usually refer to the same investment approach and are used interchangeably in the literature. Both types consider the "non-financial" criteria into the investment decision-making process. SRI is defined as "integrating personal values and societal concerns with investment decisions" (Shank et. al, 2005), whereas EI ensures that specific ethical or religious considerations are considered when choosing investments. Both are very similar and generally, in practice, involve excluding controversial industries or firms that sell products to be harmful to society, such as tobacco, alcohol, gambling or weapons (Berry and Junkus, 2013). SRI term has been more widely used in the US, whereas EI is more of a European term (Hancock, 2002).

2.1.2. Sustainable and ESG Investing

According to the European Sustainable Investment Forum (Eurosif, 2016), Sustainable Investing is a long-term oriented investment approach, which integrates ESG criteria to

generate competitive financial return and positive societal impact. It combines fundamental analysis and engagement with an evolution of ESG factors to better capture long-term returns for investors, and to benefit society by influencing the behavior of companies.
Sustainable investing has become synonymous with ESG Investing. ESG investing focuses on different non-financial dimensions, namely on the Environmental, Social and Governance metrics of a company, that investors apply to measure the sustainability of their investments. In sum, SI ensures that an investment will preserve its value over time, where ESG factors serve to highlight exposures to risks that could derail the investment over the long term. Worth note, that unlike the SRI, ESG Investing does not take an industry/ product exclusionary investment approach, but rather takes a broader view by attributing different ESG weights to different industries or countries, in section 1.2. we aim to further discuss the responsible investing strategies.

Overall, SRI and ESG Investing serve very different purposes. SRI uses investment activities to express institutional values or advance the institution's mission. In contract, ESG Investing aims to improve investment performance by integrating ESG factors into fundamental analysis, thereby by making additional resources available for mission support.

2.1.2.1. The ESG metrics

Financial analysts and portfolio managers are expected to be familiar with the financial factors that drive the value of an investment. However, issues that are difficult to measure in monetary terms and that do not form part of the financial metrics also affect the risk and return of investments. The ESG metrics (Environmental, Social and Governance) are a subset of non-financial performance indicators (see Table 1) used by investors to evaluate corporate behavior and to determine the future financial performance of companies, since sustainable companies have a greater likelihood of succeeding in the long-run.
Thus, investors evaluate companies using ESG criteria as a framework to assess risks in investment decision-making since ESG standards provide another level of due diligence.
The three individual elements of ESG differ in nature:

- Environment and Social variables capture the risk and opportunities that are often specific to the industry and the activities of a company. For instance, environmental issues are risks created by business activities with actual or potential negative impact on air, land, water or human health. Social risks refer to the impact that companies

have on society such as how a company treats its workers, health and safety considerations;

- Governance is an indication of how well governed a corporation is and the extent to which the primacy of shareholder interest is ensured. It can be seen as a measure of management quality, since governance positive outcomes avoid unpleasant financial surprises.

Table 1. Examples of ESG Issues

Environmental Issues	Social Issues	Governance Issues
• Carbon emissions	• Customer satisfaction	• Board composition
• Air and water pollution	• Gender and diversity	• Audit committee structure
• Deforestation	• Employee safety	• Corruption
• Energy efficiency	• Human rights	• Executive compensation
• Waste management	• Labor standards	• Lobbying
• Water scarcity	• Advertising ethics	• Political contributions

Note: The list is not exhaustive but includes some of the factors considered to be the most important in the three dimensions

Source: Barclays, 2015

2.2. Responsible Investing Strategies

In practice, there is no standard method of responsible investing, moreover investors can choose which strategy to apply and how they define their investment universe and which companies to invest in. For instance, regarding responsible themed mutual funds, each has its own individual criteria for company selection, generally, the negative screening or exclusionary approach is the most common strategy used by mutual funds, namely the exclusion of tobacco products (Berry and Junkus, 2013). Individual investors can also rely on Responsible Investment Indexes, even the most popular responsible indexes take different approaches when choosing the firms to include (or exclude), and the weighting given to each firm or industry. Either way, different criteria are applicable and different strategies can be applied simultaneously, highlighting the lack of a unique or generally accepted approach.

Overall, according to Eurosif (2016) seven separate strategies for responsible investment can be distinguished: Negative screening, Positive screening/ Best-in-Class, ESG Integration, Norms-based screening, Sustainability themed, Impact investing and Engagement. This thesis will focus on the first three, since those are the ones who take into account ESG metrics

and therefore might be closely related with ESG Investing. Even though Engagement approach also takes ESG factors into account, this is not applicable in the pre-investment stage, rather this strategy relies on active engagement by the investor who advocates for positive change in the companies he invested in.
After reviewing these strategies, we introduce our approach (i.e. which strategy is related with which investment type)

2.2.1. Negative Screening

In compliance with the willingness to limit potential reputational risks, investors may decide to negatively screen companies or sector as part of their value-based approach. Indeed, negative screening or exclusion involves filtering out certain companies of specific industries perceived as controversial business areas from the investment universe when selecting investments for a portfolio regardless of other qualities they might possess. In addition, companies operating in other industries than the ones comprising the negative screen might still derive revenues from them might also be excluded from the universe. According to Eurosif (2016), in Europe, the top exclusions remain for the most traditionally controversial sectors. The Weapon industry it the most prominent negative screen, followed by Tobacco, Nuclear Energy, Gambling and Alcohol.
Some investors take the screening process further by performing a Second-order screening process. This implies that investors exclude companies based on their corporate behavior, in another words, a specific company might be excluded from the investment universe for being involved in violations of labor norms such as child labor or sweatshop conditions. However, giving the difficulty in observing corporate behavior and in quantifying corporate actions, it is not surprising that the relatively narrow, and simple, product exclusion approach is the most used one (Berry and Junkus, 2013).
The negative screening approach is the most often used when engaging in Socially Responsible investing or Ethically investing.

Although, negative screening might reflect investors' values, the approach is criticized for being an unsustainable approach, since it will not generate any change in the company's behavior in a long-term perspective. Furthermore, this approach is considered to be fairly subjective. Different investors may have different concerns on what they regard as unethical, for some alcohol can be seen as immoral while others might not have these objections.

Finally, another consequence of excluding some companies from the investment universe is a smaller investment set.

2.2.2. Integration of ESG factors

Integration is the explicit and systematic inclusion of ESG risks and opportunities by investment managers into traditional financial analysis (Eurosif, 2016). Thus, by following this strategy, all ESG issues are considered *ex-ante* and one can determine how a company is performing or possibly exposed to these criteria. Then an assessment of whether it might be a possible risk or opportunity is made and, alongside with more traditional financial information the investor decides whether or not the company belongs to his investment universe. This strategy is often seen as a building block for constructing positive screening or best-in-class than a strategy itself.

Some investors take this strategy further by focusing on a specific ESG theme. That is, investors focus on a specific factor (either Environmental, Social or Governance) and structure a portfolio around companies or industries that support that theme. This is called Thematic Investing.

2.2.3. Positive Screening/ Best-in-class

A positive screening strategy does not lead to the exclusion of controversial companies or industries, rather it strives to incorporate qualitative, non-financial information into investment decision-making, searching for the companies with desirable characteristics on environmental, social and governance (ESG) criteria. This strategy, in fact includes controversial companies that show engagement for the ESG criteria. For example, an issuer might operate in a controversial sector, such as mining, but demonstrate pro-activeness in managing the risks inherent to that sector (e.g. clean up actions and social development for the community) beyond the standard industry practice will be included in the investment universe under the positive screening approach.

The supporters of positive screening aim to incentivize companies to take specific actions concerning ESG issues in order to improve it rather than restricting the investment universe to companies located in a more "ethical" part of the economy (Michelson et. al, 2004).

A positive screening process starts by defining a universe of strong performing companies on a set of ESG criteria, before evaluating the more traditional financial performance and valuation of the company (Robins and Krosinsky, 2008). Worth of note that disclosure of

ESG-relevant information is mostly voluntary at this stage, however companies that do it so usually come out favorable in a positive screening process.

A Best-in-class approach or best-in-industry belongs to the sub category of positive screening. The Best-in-class investment selection evaluates a company's ESG performance relatively to its industry peers and picks the best performing company based on that measures (Robison et al., 2008). In that way a company, that might not came out on top of a positive screening approach due to any low ESG- performance (for instance low Social due to poor working conditions), it can be included in the universe investment under the best-in-class approach, if the company has taken measures superior to the remaining industry peers.
Under this approach, the portfolio is created with the leading companies within each industry, where the nature of their industry or products are not considered, thus including companies such as tobacco or alcohol producers. The weight attached to the various ESG metrics differs among industries. For example, the risk of pollution and environmental damage is important in the chemical industry, but not very relevant to the financial sector, where social and governance factors may be much more relevant.

2.3. Our Approach

After reviewing some of the Responsible Investment strategies for the purpose of this thesis it is important to define which one is relevant for our study.
In fact, both negative and positive screen take ESG metrics into account. However, in the former, investors on their portfolio construction, start with an exclusion of any company that is involved in non-eligible industries and then screen for company performance on a set of ESG criteria. From the Literature review section, it is clear that all studies focused on SRI performance have as data SRI mutual funds. Berry and Junkus (2012) from their study found evidence that most SRI mutual funds apply a negative screening approach in the selection of their securities. In addiction Henke (2016), found that only 2/3 of the sample funds used on his study do consider ESG criteria after an exclusion of non-eligible industries. With this information in hand, even though ESG factors are considered, the foundation of the negative screening to set its investment universe is the exclusion of controversial industries based on investors' values. Thus, we can conclude that this approach is closely related to Ethical or Socially Responsible Investing.

On the other hand, ESG factors are the primary foundation of building positive screening in defining the investment universe. No industry is excluded from the investment set instead the investment approach favors companies with better ESG policies even if the company operates in a controversial industry. Furthermore, from the literature review, all studies focused on ESG investing made it clear that no industry or company was excluded from the universe. What is more, ESG investing is all about downside risk mitigation, companies that exhibit environment, social and governance responsibility are less likely to suffer large and negative events in ESG areas that strongly impacts their financial performance (Nofsinger and Varma, 2013). Thus, ESG investors seek to invest in companies with high ESG scoring despite the industry companies operate. We can then conclude that the positive screening approach is more closely related with ESG Investing and therefore the one relevant for our analysis.

2.4. Responsible Investing: A Market Overview

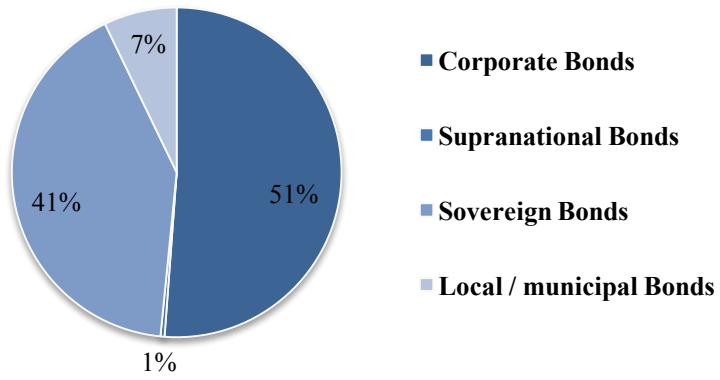
The market of Responsible Investing has grown to a considerable niche of investments due to very high growth rates. According to the Global Sustainable Investment Alliance- GSIA (2016), the global responsible investment market has continued to grow in most of the regions covered by GSIA's member organizations (Europe, United States, Canada, Asia, Japan and Australia and New Zealand). In 2016, there were US$22.89 trillion of assets being professionally managed under responsible investment strategies, an increase of 25% since 2014. In relative terms, RI now stands at 26% of all professionally managed assets globally. In respect to assets, the two largest regions were Europe and the United States. In 2016, Europe accounted for 52,6% of the global RI assets, whereas 38% of the RI assets referred in the report were in the United States. The European market for RI grew according to the EuroSIF European SRI Studies (2006, 2008, 2010, 2012, 2014, 2016) in the years 2005-2015 by a compound annual growth rate of approximately 31%.

The largest responsible investment type globally is the Socially Responsible Investing (or the negative/ exclusionary investment approach), followed by ESG investing (GSIA, 2016). Growth is consistent in the two types of Responsible Investments at the European level; however, Social Responsible investments are still the dominant investment type with over €10 trillion assets under management in 2016, demonstrating a compound annual growth rate of 22% compared to 2013 (EuroSIF, 2016). Worth of note, ESG investing approach

dominates in all the remaining regions covered by the Global Sustainable Investment Alliance review.

In respect to asset allocation, at a European level, according to EuroSIF (2016), equities represented over 30% of the total RI assets in December 2015, showing a significant decrease from the 50% in December 2013. On the other hand, there was a sharp increase of the fixed income in RI, with bonds representing over 64% of the total RI assets in December 2015, compared to the 40% registered in December 2013.
Looking in more detail at all the bond allocation (see Figure 1), Corporate Bonds represented over 51% out of the total European RI bond assets in 2015, showing a significant increase of 142% compared to December 2013. Similarly, sovereign bonds grew from 16.6% in 2013 to 41.6% in 2015 (EuroSIF, 2016). These staggering growths reflect the increasing consideration of fixed income in all types of Responsible Investments and the more prominent role played by bonds in these types of investments.

Figure 1: Breakdown of European RI fixed-income allocation in 2015



Source: EuroSIF, 2016

2.5. ESG and fixed income: Why does it matter?

Most of the discourse on ESG issues has been focused on listed equities, but the practice of considering ESG issues with respect to other asset classes, most notably fixed income, is growing, this is especially true in the European market.

ESG investing is considered to be more important for the fixed-income asset than for the equity asset class, since the risks for fixed income investors of investing in the "wrong" bond is greater than investing in the wrong equity asset. Equities are most commonly traded on an exchange, making them more liquid. In the fixed income, the investment universe is larger, more complex and there is more variation in quality and in the number of investible instruments. This reduces the level of liquidity in the market for some bonds and potentially increases associated transactional costs (My- Linh Ngo, 2016). Indeed, accounting for the non-financial risks is particularly important for the fixed income investors when selecting the securities to invest in.

In addition, given that fixed-income investing is about identifying and mitigating downside risks, when managing investment-grade corporate bonds a big focus is minimizing downside risk. Credit risk is one of the primary risks investors seek to manage, though default may be the worst-case scenario, there are also intervening risks to investors including downgrades in the quality of debt which will impact investors' returns. ESG research serves an important role alongside with traditional investment approach of focusing on "classic" economic factors and credit metrics since ESG factors can be a leading indication for future risks. Poor ESG management damage reputation and can contribute to an increase of the probability of default, credit downgrades, price volatility and widening of the CDS spreads. Several studies back up this point by showing that companies with higher ESG responsibility are less likely to declare bankruptcy and have higher credit ratings (Bauer and Hann, 2010; Stellner et al., 2015). Thus, integrating ESG in the fixed-income world is particularly important to help investors anticipate and avoid investments that may be prone to credit rating downgrades, widening credit spreads and price volatility. According to Klein (2015), the integration of ESG risks into the investment process works as a value-added risk management technique since investors are more able to identify better-managed companies that are less likely to run into credit issues.

Finally, despite the clear rationale for incorporating ESG into fixed income, in practice it can sometimes appear that equity prices react faster and more sharply than bond ones to a negative event. For equities, share prices are often driven by news flow and sentiment about growth prospect (e.g. in earnings, profits), rather than fundamentals. As such, there is more likely to be direct and immediate sensitivity to ESG risks. For fixed income, the emphasis is

focused on fundamentals (e.g. cash flows) with the price of a bond influenced by changes in the creditworthiness of the issuer. This means that the creditworthiness of the issuer can act as a buffer to the ESG risk, potentially delaying the impact. Nonetheless, while the responses may vary in their timings and quantum, and given that both equity and bond prices interact with each other, both prices will react in some way (My- Linh Ngo, 2016).

This can be illustrated by the price performance of BP, following the Deepwater Horizon oil spill in April 2012, which caused huge losses in BP's equity and bond valuations. Prior to the event, BP's five year CDS spreads were trading at about 50 bps, which is normal for an A rated, stable energy company. But after the spill, the CDS spread shot up to more than 600 bps. BP's bond prices rapidly recovered to pre-spill levels because BP's cash flow was so strong that it could afford to pay $50 billion in cleanup costs and fines (Klein, 2015). Few companies in the world could have afforded penalties and costs of this magnitude. However, holding onto BP through the wake of Deepwater certainly had a negative effect on some portfolio performance metrics such as decreased the marketability of portfolios overweighed in BP bonds. Investors who had factored in BP's poor ESG track (specially BP's high environmental risk) would have had a performance advantage.

3. Literature Review

In general, the literature of ESG in fixed income is far less extensive than the one focusing on equities. Much research has been done on the relationship between Environmental, Social and Governance (ESG) investing and performance in equity markets. The market for ESG integration in fixed income, being still in development and gaining attention within the financial markets only lately, explains the few quantity of research in this asset class. In fact, ESG considerations into stocks gained earlier attention compared to ESG integration in bonds.

In this section, we aim to review the existing literature regarding Responsible Investing in the fixed income asset class. It is important to note that in all previous studies a distinction between Socially Responsible Investing and ESG Investing was not made with scholars using both terms interchangeably. In the previous chapter we elaborated on the differences between these two types of responsible investments and on the investment strategy applicable to each approach. In this chapter the terms used by the scholars will be the ones used on the review.

Most of studies of Responsible investing in fixed income are focused in two different topics: mutual funds' performance, spreads and issuer rating. In the following sections, we will elaborate more on the performance related studies, which will be the focus of our thesis.

3.1. Studies on Performance of Responsible investing in the fixed-income

D'antonio et al. (1997) on their study of "Expanding Socially Screened Portfolios: an attribution analysis of bond performance" raised the possibility of the concept of Socially Responsible Investing to be applicable to bonds, however these authors did not perform any study on Socially Responsible Investing in fixed- income performance.

To the best of our knowledge, Goldreyer, Ahmed and Diltz (1999) were the first to evaluate the performance of mutual funds that invest in socially responsible fixed-income securities. The authors studied the performance of a sample of 9 US SRI bond funds, during the period of January 1981 to June 1997. Using the traditional performance evaluation measures of Treynor (1965), Sharpe (1966) and Jensen (1968), Goldreyer et al. (1999) assessed the performance of the SRI-fixed income funds compared to the conventional funds. Although

Treynor ratios favoured SRI funds, Jensen's alpha and Sharpe ratios clearly favour conventional funds. Overall, the average alpha of the SRI fixed-income funds was significantly negative, whereas conventional matched-funds exhibited significantly positive alphas. Indeed, the results of Goldreyer et al. (1999) seem to indicate that US SRI fixed-income funds significantly underperform conventional funds.

Also addressing the US market, Derwall and Koedijk (2009) investigated the performance of two sets of samples: 15 US SRI funds that invest in bonds and 9 US SRI balanced funds which hold both socially responsible debt and equity, labelled by the US Social Investment Forum, over the period 1987-2003. Building their principal model on the four-factor model developed by Elton et al. (1995), Derwall and Koedijk (2009) matched the SRI funds to conventional fixed-income funds. They found that the average SRI bond fund performed similar to conventional funds, while the average SRI balanced fund outperformed its conventional peers by more than 1.3% per year. Another raised questions on their study was whether SRI fixed-income funds have higher expense ratios compared to their conventional peers and whether differences in expense ratio fully account for difference in performance, since Bauer et al. (2005) suggest that SRI equity funds have higher expense ratios than the equity retail market as a whole. They found that the expenses charges by SRI funds match those charged by conventional funds not causing SRI funds to underperform (Derwall and Koedijk, 2009).

Henke (2016) expanded Derwall et al. (2009) research by analyzing the risk-adjusted performance of a considerably larger sample consisting of 103 SRI bond funds in the US and the Eurozone compared with a 309 matched conventional funds during the period of 2001 to 2014. Henke (2016) used a five-factor model based on the four-factor model of Elton et al. (1995) and found an annual outperformance of 0.33% for the US SRI funds over the conventional ones and that the European SRI fixed income funds significantly outperformed conventional funds by 0.49% per year.

To verify if there is a systematic ESG screening-related effect on the variation of SRI mutual fund returns (i.e. if ESG is a driver of performance), Henke (2006) re-estimated the five-factor model with the sample divided into two groups: SRI funds with ESG screening (SRI funds that contain corporate bonds with high ESG ratings from Sustainalytics) matched with conventional funds and SRI funds without ESG screening with the corresponding matched

conventional ones. The study found that the performance difference of SRI *vs*. non-SRI funds is derived from the SRI funds that exclude bond issuers with the highest ESG risks, that is, SRI funds with ESG screening. The US SRI bond funds with ESG screening differed from conventional ones by 0.49%, while this difference reaches 0.70% for EU SRI bond funds.
By looking at different market regimes, Henke (2016) further investigated if the outperformance of SRI bond funds related to the hypothesized risk-mitigation of ESG. The sample time period was divided into crisis and non-crisis period as well as bear and non-bear market periods. The study found that SRI corporate bond funds outperform their peers in all market regimes, with the results being more pronounced for SRI funds with ESG screening and during times of recession.

Leite and Céu Cortez (2016) conducted the first comprehensive investigation on the performance of SRI fixed-income funds only focused on the European market, namely in three leading markets: France, Germany and the UK. Using a sample of 63 SRI fixed-income funds domiciled in France, Germany and in the UK, over the period of 2002 to 2014. Their sample included pure bond funds (SRI bond funds), as well as balanced funds investing predominantly in bonds or in similar proportions of bonds and equities (SRI balanced funds). Following Derwall et al. (2009), their principal model was build on the four-factor model built by Elton et al. (1995) extended to a conditional framework by incorporating conditioning information with both time-varying alphas and betas. Their results showed differences in performance between SRI and conventional funds differ significantly among fund categories and, in the case of bond funds, also among fund markets. Indeed, while German SRI bond funds slightly outperform conventional funds, UK SRI bond funds significantly underperform their peers. French SRI and conventional funds show no statistically significant differences in performance. With regard to balanced funds, SRI and conventional funds exhibit similar performance in all three markets studied (Leite et al., 2016). Thus, Leite et al. (2016) results are consistent with the findings of Derwall et al. (2009) for US funds only within the French market. On the other hand, while Derwall et al. (2009) found that US SRI balanced funds significantly outperform conventional funds, Leite et al. (2016) found no significant differences in performance for European balanced funds.
Furthermore, Leite et al. (2016) also investigated how the European SRI bond funds perform over different market regimes, that is during recession and expansion period, in order to analyse if the more long-term perspective and social characteristics of SRI funds enables

them to provide additional protection in market downturns relative to their conventional peers. The authors found that, during expansions French and German SRI funds significantly outperform conventional funds, whereas UK SRI funds match the performance of their peers. During recessions, only German SRI bond funds significantly outperformed their peers, with UK SRI bond funds slightly underperforming conventional funds and French SRI and conventional bond funds exhibiting similar performance. Thus, only German SRI bond funds seem to provide investors some additional protection during market downturns (Leite et al., 2016).

Inspired by the work of Kempf and Osthoff (2007) that investigated whether integrating ESG ratings into the investment process would affect performance in stock portfolios, Hoepner and Nilsson (2017) extended the former study into the area of fixed income.
Using ESG ratings provided by KLD, they studied how ESG ratings of companies might affect the performance of bonds these companies are issuing. By investigating a sample of 425 US companies and 5240 bonds issued by these companies, for the period January 2001 to December 2014, they constructed value-weighted portfolios based on the ranked ESG ratings.
Three different portfolios were constructed, based on KLD net scores[1] of each company under analysis: a high rated portfolio consisted of all positive KLD scores, a low rated portfolio of all negative scores and a third portfolio consisted of companies with no scores (i.e. with neither strengths or concerns). Using an extension of the Elton et al. (1995) four-factor model, they applied a nine-factor model to measure the financial performance of portfolios. They found that bonds issues by companies with neither strengths or concerns show a significant annualised alpha of 0,89%, outperforming bonds issued by companies with either high or low scores, with these findings being particularly strong in times of market turmoil (i.e. in the post-crisis period).

Finally, Drut (2010) contributed to the existing literature of Responsible investing and fixed income by studying the link between sovereign bond returns and the performance of countries in terms of ESG issues. Drut (2010) constructed portfolios of sovereign bonds with high

[1] KLD assess companies on ESG issues for both strengths and concerns in seven separate categories and sub-categories among the three ESG metrics. In chapter 6 we further analyse the methodology applied by this ESG rating company

sustainability country ratings from Vigeo Sustainable Country Ratings and found no significant under- or outperformance compared to traditional approaches (Drut, 2010).

Besides scholars, banks have also contributed for the existing literature in an attempt to better inform institutional investors in respect to the performance of responsible investments.
Barclays (2015) was the first study only focused on ESG investing performance, it analysed the relationship between ESG scores and US corporate bond portfolio performance, over the period of 2009 to 2015. The study used ESG ratings from either MSCI or Sustainalytics. Two different portfolios were constructed: one that contained only bonds from companies with high ESG scores and another with companies with low ESG scores. To isolate the ESG effect from all other possible sources of risk, the bonds included in the portfolios differed in their ESG scores but their risk profiles were nearly identical across all important dimensions of risk (i.e. yield, maturity or credit quality). Worth of note that the above approach did not exclude any issuer or any industry sector (Barclays, 2015). The high ESG portfolio showed a cumulative outperformance over the low ESG rating portfolio of 2% over the analysed time-period. In respect to the average returns of the two portfolios over the tracked benchmark, the return differences between the high and the low ESG portfolios were small but positive: 0.42% per year in one case and 0.29% in the other.
In addition to pairs of portfolios with the minimum and maximum overall ESG rating, Barclays (2015) also created portfolio pair that accentuate the differences in individual E, S and G scores to try to observe which one of these three pillars is most related to performance. They found that governance had the strongest link with performance and Social the weakest, being even associated with slightly negative returns, and Environment is in between.

In addition to the above studies, there has also been a strand of literature exploring fixed income and ESG from a corporate finance perspective investigating corporate social performance and cost of debt, cost of bank loans, and on capital constraint (Bauer and Hann, 2010; Goss and Roberts, 2011; Cheng et. al, 2014)

3.2. Literature Review Summary

In Table 2 we summarize the existing research described above and their results. From the table, we conclude that the results differ somewhat. Overall, it seems that SRI show no outperformance in comparison to conventional funds. The only study where positive results

in this RI type were obtained was the one from Henke (2016), with the outperformance being attributed to funds where ESG criteria are considered.

In all remaining SRI studies, it is not clear which investment strategies are taken by the SRI bond mutual funds and whether ESG factors are or not taken into account. It is the type of assets included or excluded from an SRI fund that determines its investment strategy. Berry and Junkus (2012) analysed the approach taken by the most prominent SRI mutual fund companies and found that the exclusion of tobacco and gambling products are the most common factors used by mutual funds, therefore it can be assumed that most of the SRI bond mutual funds used in the studies take an exclusionary approach.

The studies focused on the ESG investing show inconclusive results, however both studies mentioned that no industry considered as controversy is excluded from the study (Barclays, 2015; Hoepner et. al, 2017).

The overall take away seems to be that during recession periods, SRI investments outperform conventional ones and therefore offering protection to investors. In respect to ESG investing no performance analysis was conducted in different market regimes in the reviewed studies.

Table 2: Overview of the studies examined

Study	Time-period	Region	Data	Methodology	RI dimension	Result
Goldreyer, Ahmed & Diltz (1999)	1981-1997	US	9 US SRI bond funds	Traditional portfolio performance measures: Treynor, Sharpe and Jensen	SRI	Negativ
Derwall and Koedijk (2009)	1987-2003	US	15 SRI bonds & 9 SRI balanced funds	Four-factor model/ Fama-MacBeth regressions	SRI	Neutra
Barclays (2015)	2009-2015	US	4,366 US corporate bonds	Cumulative returns of ESG portfolios compared to the benchmark (Barclays US Corporate index)	ESG	Positiv
Henke (2016)	2001-2014	US & EU	412 funds (thereof 103 SRI)	Five-factor regression with an ESG screening-related return factor	SRI with ESG	Positiv
Leite & Céu Cortez (2016)	2002-2014	France, Germany, UK	63 SRI funds	Four-factor performance attribution analysis	SRI	Mixed
Hoepner & Nilsson (2017)	2001-2014	US	5,240 US corporate bonds	Nine-factor model	ESG	Negativ

From the above table, it is also clear that the majority of studies use SRI fixed income mutual funds to study the financial impact of responsible investing in this asset class. Derwall et. al (2009) mentioned that an alternative approach to study the financial impact of responsible investing would be the portfolio construction based on Environmental, Social and Governance rating data of the individual fixed-income securities, however, at that time these types of data were underdeveloped. The ESG ratings of individual companies is done by third-party providers. Several ESG service providers have emerged in the past two decades, this relatively new industry is still fragmented but it is experiencing consolidation (Barclays, 2015). This explains why only in the recent years scholars started using the later approach (i.e. using corporate bonds under analysis).

In this thesis, we aim to study the financial performance of an ESG bond, for this purpose our benchmark is a comparable conventional corporate bond. This thesis distinguishes itself from previous research mentioned above, as our analyses are conducted in the whole

European market. So far, all the studies focused on ESG Investing in the fixed-income asset class were either performed in the US market or by studying their performance on a portfolio approach. Also, our ESG scores are provided by Thomson Reuters database, while the previous research relies on ESG scores from other sources such as KLD or Sustainalytics. Worth of note that, while there are similarities, each provider of independent ESG research and rating has its own methodology to assess ESG risks and opportunities, thus the way the data are processed, analysed and presented can lead to very different scores, we will further develop the different methodologies in chapter 6.

Similar to Henke (2016) and Leite et al. (2016), a separation between different market regimes will be made. Their studies showed significant outperformance of SRI mutual funds during market crisis periods. In our study, we aim to investigate the performance of an ESG bond relatively to their conventional peers in the different market regimes as there is a gap in this regard for the ESG investing.

4. Bonds

Before proceeding to a further understanding of the bond market it is important to define what we understand for an ESG bond. Given the definition of ESG Investing, an ESG bond is a bond issued by companies that are compliant with the ESG metrics. Thus, ESG bonds have the same structure, risk and return as the traditional bonds. Because of this structure, the overview of the bond market is highly relevant when it comes to ESG bonds.
Indeed, in this chapter we start with a sketch of corporate bonds. For the purpose of our analysis, we make an overview of the risks associated when investing in this asset class.

4.1. Bond Characteristics: Corporate Bonds

There are a wide range of bond types in the bond market, in this thesis our focus are the corporate bonds. The degree of riskiness of these bonds is evaluated by three major bond-rating agencies: Moody's, Standard & Poor's and Fitch. In general, the safer the bond is the stronger the capacity to pay interest and repay principal.
In a typical corporate bond, there are options embedded in the issue. An embedded option is part of the structure of a bond, as opposed to a "bare option", which trades separately from any underlying security. The presence of embedded options affects the value of a bond (Fabiozzi, 1996).

4.2. Bond risks

An investment in corporate bonds works the same way as any other investment in risky assets, that is, the return of the investment is subject to risk. Within corporate bonds the two main components of risk among others, are credit risk and interest rate risk. Other sources of risk can also affect bond's returns and therefore are further explored in this section.

4.2.1. Credit Risk

Some of the risk associated with investment in corporate bonds is connected to the issuers' ability to pay the promised coupon as well as getting the predetermined principal at maturity. The investment is not riskless unless the investor can be sure that the issuer will not default on the obligation. While some high-quality government bonds, such as the U.S. and Germany government bonds, may be treated as free of default risk, this is not true for corporate bonds.

To determine the creditworthiness of the issuer of a bond, corporations frequently pay for external companies to have their debt rated. The lower the creditworthiness of a company the higher the probability of default on the obligation and thus the less safe the bonds issued by the corporation are. As mentioned before, the three leading rating companies Moody's, Standard & Poor's and Fitch measure the creditworthiness of the companies. Each rating assigns letter grades to the bonds to reflect their assessment of the safety of the bond issue. The top rating is AAA or Aaa bonds with gradations of A ratings are safer than those with B rating or below. Those rated BBB or above (S&P, Fitch) or Baa and above (Moody's) are considered Investment-grade bonds, whereas lower rated or unrated bonds are classified as High-yield corporate bonds or junk bonds. Even if highly rated bonds rarely default, these bonds are not free of credit risk or from a rating downgrade (Bodie et al., 2014).

4.2.2. Interest Rate Risk

Interest rate fluctuations present the main risk in the fixed-income market. In the secondary market, option-free bond prices fluctuate inversely with the market interest rate. The inverse relationship between price and yield is a central feature of fixed-income securities, as interest rates can fluctuate substantially. For instance, consider a bond that was bought with a price of an 8% coupon bond, if market yields rise then the bondholder suffer a capital loss on the bond reflected as a fall in its market price and thus in order to sell it, it has to sell the bond at discount.

There are several factors that determine the sensitivity of the bond prices to market yields such as bond's maturity, coupon rate and yield to maturity. However, maturity is the major determinant of interest rate risk since prices of long-term bonds are more sensitive to interest rate movements than prices of short-term bonds (Bodie et al., 2014).

This sensitivity is measured by the duration of the bond. According to Macaulay (1938), the duration of a bond is its effective maturity and it is of great importance since it allows to quantify the proportional price change to changes in yields. Duration and modified duration will be further explored in the next chapter, as they will be considered in our portfolio performance analysis.

4.2.3. Liquidity Risk

When bond returns become more complex, such as in corporate bonds, liquidity risk is another risk component to take into account. Liquidity risk refers to the risk caused by the

lack of marketability of a security that cannot be bought or sold quickly enough to prevent or minimize a loss. As the market for an asset becomes less liquid, traders are more likely to take losses because they face bigger bid-offer spreads (Hull, 2015). Corporate bonds are known to have relatively large bid-offer spreads compared to stocks, thus liquidity should be taken into consideration while interpreting returns. Lesmond, Long and Wei (2007) confirm this in their study, they find that different measures of liquidity can explain roughly half of the variation in the yield spreads.

4.2.4. Volatility Risk

Volatility risk is a risk that involves bonds with embedded options, since expected volatility affects the option price within a callable or puttable bond. Campbell and Takser (2003) studied the impact of firm specific equity volatility as well as systematic volatility as an explanatory factor for corporate bond returns. They argue that increased idiosyncratic or systematic volatility will hurt the bondholder given an expected profit level. As volatility increases, the value of the put option increases which implies a larger expected claim on the bondholder from the equity holder. They further conclude that firm specific equity volatility can capture as much as bond ratings when it comes to variations in yields, since recent information may not yet be reflected in a bond's credit rating (Campbell and Takser, 2003). Similarly, Geske and Delianedis (2001) found that residual spread decreases when stock market volatility increases.

Among the risks mentioned above, there are other risks involved when investing in corporate bonds such as call risk and tax attributes.

5. Theory

The following section deals with the theoretical explanation of the performance measures that will be used in our study. We start by explaining the basics of bond returns. Next, the Capital Asset Pricing Model (CAPM) is elaborated upon. Third, two traditional performance measures that correspond to the CAPM are explained. The fourth section deals with the Arbitrage Pricing Theory and with multifactor versions of APT to accommodate the multiple sources of risk that affect bond returns.

5.1. Return Basics

The first step in analysing security's performance is investigating its return. The return on a security is the sum of the change in price of the security between two different dates, and the income received by the holder of the security in that time-period. Such return is known as the Holding Period return (HPR). For a corporate bond, excluding zero-coupon bonds, the HPR can be calculated as follows:

$$R_t = \left[\frac{P_t + RC_t}{P_{t-1}}\right]^{\frac{1}{t}} - 1$$

Where,
R_t = Holding period return of the security over the period between *t*-1 and *t*
t = holding period
P_t, P_{t-1}= bond price at time t and t-1 respectively
RC_t = Reinvested Coupons at rate i*

Holding Period return is the rate of return over a particular investment period and depends on the market price of the bond at the end of that holding period (Bodie et al., 2014). As the market price of a bond in Bloomberg import can be either the mid-price or the last price, we choose to retrieve the last price. The reason is that the last price represents the price at which the last trade occurred, and for the average investor this is usually the price displayed.

When calculating the returns on short time intervals, we use simple returns instead of logarithmic returns. There are pros and cons with both sorts of returns, in fact using

logarithmic returns are quite popular in finance, however, similar to Fama and French (1992b) we apply simple return calculation, which we also have used for our factor models.

In our thesis we are working with monthly returns, but when reporting the returns we annualize them. The concept of compounding is explained with the following equation:

$$R_{annual} = \left[1 + R_{period}\right]^{number\ of\ periods} - 1$$

5.2. CAPM

The Capital Asset Pricing Model (CAPM) was developed by Sharpe (1964), Lintner (1965) and Mossin (1966) and is based on the risk-return fundamentals of modern portfolio theory by Markowitz (1952). The CAPM is a single factor equilibrium model for expected return on risky assets. The model assumes that the expected return that investors require on their investments should be linearly related to the assets covariance with the market portfolio. That is, the model allows the calculation of the hypothetical expected rate of return of an asset given the sensitivity of that asset to non-diversifiable, market risk. According to Bodie et al. (2014) the model has two prime functions. First, it provides a benchmark of rate of return for evaluating possible investments. This is so because it estimates a return that is standardized for risk, thereby allowing the investor to determine whether the return for the respective asset is "fair" given its level of risk. Second, it assists in guessing prices for assets that are not trading on the marketplace as it provides an estimation regarding to the return that can be expected given its risk.

The expected risk-adjusted return based on the CAPM, also known as Sharpe-Lintner CAPM equation, is computed in the following way:

$$E\left[R_{ij}\right] = R_{ft} + \beta_i\left(E[R_{Mt}] - R_{ft}\right)$$

Where,
R_{it}= Return of security i at time t
R_{Mt}= Expected return on the market portfolio at time t
R_{ft} = Risk free rate at time t
β_i= Beta of security i; sensitivity factor of security i's return to returns on the market

The model is widely used because of the insights it offers, however it has also met a lot of scepticism in the academic environment. The reason is that, CAPM is built upon many simplifying assumptions making the empirical record of the model rather poor (Fama and

French, 2004). Several papers studied the implications of the above equation (Reinganum, 1981; Stambaugh, 1982). Fama and French (1992) confirm the evidence that the relation between average return and beta for common stocks was flatter after the sample periods used in the early empirical work on the CAPM. Other empirical studies found that much of the variation in expected return is unrelated to market beta, with other variables contributing to the returns of the security (Basu, 1977; Banz, 1981; Frama and French, 1996).

5.2.1. Practical Application of CAPM

For statistical purposes it is common to use the excess return form of the CAPM:

$$Z_{it} = \alpha_{im} + \beta_{im} Z_{mt} + e_{it}$$

Where,
Z_{it} = Excess return of asset i in period t
α_{im} = Intercept of asset i with market m
β_{im} = Beta of asset i with the market m
Z_{mt} = Excess return of the market portfolio in period t
e_{it} = Error term of asset i in period t

The implication is that in equilibrium, (alpha) of all assets should be equal to zero and thus all variation in returns should be explained by the beta. The asset's total risk is the sum of the variance of the market risk component $\beta_{im} Z_{mt}$, and the variance of the firm-specific risk ε_{it}. The firm-specific residual ε_{it} is assumed uncorrelated across assets and with the market portfolio, since it can be eliminated by diversifying the investments across different securities.

In previous research CAPM has mostly been applied to stocks, whereas applying CAPM to corporate bonds is rather an unexplored area. One possible reason for this is the availability of data for stocks. A large fraction of bond trading is performed over the counter and never registered. Stocks trades are registered at a stock exchange and the trading has therefore been more transparent than bond trading (Thorsell, 2008). Indeed, due to the insights it offers, for our analysis, to capture ESG and conventional bonds portfolio returns we will use the practical application of the CAPM.

5.3. Performance Measures

In order to assess the market performance of ESG bonds and conventional ones, we start by studying their performance referred to the traditional measures performance. These include

the Sharpe Ratio, Treynor Ratio and Jensen's alpha and are fundamentally based on Modern Portfolio Theory and the CAPM. The measures provide risk-adjusted returns, however the difference lies in the proxy for risk. The following section further explains the separate indicators and how they are applied. Treynor ratio is not included in our explanation because is more suitable to measure the performance of a portfolio instead of individual securities (Bodie et al., 2014)

5.3.1. Sharpe Ratio

The Sharpe ratio is a measurement of risk-adjusted return of a financial portfolio. Originally called "reward-to-variability" ratio, it was first introduced by Sharpe (1996) to measure the performance of mutual funds. The Sharpe ratio measures how much excess return an investor receives for the extra volatility that he endures for holding a riskier portfolio. In the Sharpe ratio the total risk is defined as the standard deviation of returns of the portfolio.

The ratio can be expressed as ex-ante, by using the expected return and standard deviation, but it can also, as it is most common, be expressed as ex-post by using the realized return and standard deviation over a specific time (Sharpe, 1996). The ex-post Sharpe ratio, as used in this thesis, is given by:

$$S_p = \frac{R_p - R_f}{\sigma_p}$$

Where,
S_i= Sharpe ratio of security i
$R_i - R_f$= Excess return of security i
σ_i= Estimated return volatility of securities

The Sharpe ratio is one of the most commonly applied performance measures as it takes into account total risk, is easily computed and highly comparable across securities. It is useful not only to evaluate risk-adjusted returns of individual securities but also portfolios. Even though it is widely used, it has several shortcomings. The ratio does not incorporate the correlation between current assets held and the asset being evaluated. To overcome this Sharpe (1994) states that the ratio must be supplemented with other measures.

5.3.2. Jensen's alpha

Jensen (1968) in his study of "*The performance of mutual funds in the period 1945-1964*", was interest not only in the return of the mutual funds but also on the risk, since there was

little understanding on the nature and on how to measure risk. The study result in what is now known as Jensen's alpha, which is a measure of risk-adjusted performance.
The foundation for this measurement is the CAPM model. Jensen's alpha will be the intercept of this model, which is the excess return on a portfolio after controlling for its exposure to the market (Bodie et al., 2014). The formula to calculate alpha is as following:

$$\alpha_i = R_i - (R_f + \beta_i(R_M - R_f))$$

Jensen's alpha is considered a more thorough performance measure than the Sharpe ratio or Treynor ratio as it not only adjusts returns for market risk, as it also indicates the extent at which it outperforms the market. If alpha of the portfolio equals zero no abnormal return is earned. Securities or portfolios that show positive alpha have performed better than the market.

In many cases performance evaluation assumes a multifactor market. Jensen's alpha can be applied to multi-factor models. It therefore measures performance after controlling for the three or four factors (Bodie et al., 2014). In this thesis we apply the Jensen's alpha as a risk-adjusted return measure in our factor models. Thus, the "alphas" in our models are referring to Jensen's alpha.

5.4. Arbitrage Pricing Theory and Multi-Factor Models

The arbitrage pricing theory (APT) developed by Stephen Ross in 1976, like the CAPM, predicts the relationship between risk and return, however there are some differences. Ross's APT relies on three key propositions (Bodie et al., 2014):

- Security returns can be described by a factor model
- There are sufficient securities to diversify away idiosyncratic risk
- Well-functioning security markets do not allow for the persistence of arbitrage opportunities

5.4.1. Factor Models

A factor model is a model that explains the return on an asset given the risks that might affect its returns. Considering a basic example of the single-factor model: the uncertainty in the asset return has two sources, a macroeconomic or common factor and firm-specific events.

The common factor (F) is constructed to have zero expected value, because it is used to measure the *new* information concerning the macroeconomy, which by definition has zero expected value. Thus, the single-factor model of excess return on the security *i* is described as follows:

$$R_i = E(R_i) + \beta_i F + e_i$$

Where,
$E(R_i)$ = expected excess return on asset i
β_i= sensitivity of firm I to that factor or factor beta
F= deviation of the common factor from its expected value
e_i= firm-specific disturbance

Therefore, from the above equation, the factor model states that the actual excess return of a security *i* will equal its initially expected value plus a (zero expected value) random amount attributable to unanticipated economywide events, plus another (zero expected) random amount attributable to firm-specific events. The non-systematic components of return, the *e*is, are assumed to be uncorrelated across stocks and with the factor F (Bodie et al., 2014).
Above, we gave an example of a single-factor model, which is a factor model with a single factor of systematic risk, however, extra market sources of risk may arise from a number of sources such as uncertainty about interest rates, inflation and so on. A more refinement of the systematic risk allows for a better understanding of the sensitivity of the asset returns to the various components. Models that allow for several factors are called multifactor models. As in the single-factor model, each factor has a coefficient (β_is) that measure the sensitivity of the asset returns to that factor. These coefficients are called factor loadings or factor betas (Bodie et al., 2014).

5.4.2. Diversification

In the second proposition, Ross states that a sufficient number of securities has to exist, such that firm-specific risk is diversifiable. The idea behind this proposition is that diversification can eliminate the non-systematic risk if the investment universe is large enough. This is because the investor can hold a portfolio with different securities that are less than perfectly correlated, that is correlation coefficient less than 1, which enables the holder to eliminate the firm-specific risk or each security. For instance, if one security experiences negative firm specific shocks, while other a negative one, in the overall portfolio these shocks will average out and be insignificant on a portfolio level, if well diversified. Therefore, if a portfolio is

well diversified its firm specific or nonfactor risk becomes negligible (i.e. $e_i = 0$), so that only factor (or systematic) risk remains.

5.4.3. No Arbitrage

The exploitation of security mispricing in such a way that risk-free profits can be earned is called arbitrage. It involves the simultaneous purchase and sale of equivalent securities in order to profit from discrepancies in their prices. An example of arbitrage could be that the same security is traded in two different market places, but at different prices. An investor could long the cheap security and short the expensive one thereby making a risk-free profit without actually committing wealth. The law of one price states that two assets that are similar in all relevant economic aspects, should be priced equally. Conversely, the violation of the Law of One Price gives rise to an arbitrage opportunity (Bodie et al., 2014).

Suppose a single-factor market, where the well-diversified portfolio, M, represents the market factor F. The excess return of a well-diversified portfolio, P, is given by:

$$R_p = \alpha_p + \beta_p R_M$$

$$E(R_p) = \alpha_p + \beta_p E(R_M)$$

As mentioned in the previous section, in a well-diversified portfolio, the non-systematic risk is diversified away. Thus, the only risk to the returns of the two portfolios M and P is the systematic. One can eliminate all risk of P by creating a zero-beta portfolio Z by selecting weights w_P and $w_M = 1 - w_P$. Therefore, portfolio Z is riskless. Since the beta of Z is zero, its risk-premium is just its alpha, thus the alpha must be zero, as otherwise arbitrage profits can be made. This implies that the alpha of any well-diversified portfolio must also be zero (Bodie et al., 2014). Indeed, from this argument, the expected excess return of a well-diversified portfolio, P, is:

$$E(R_p) = \beta_p E(R_M)$$

The above equation shows that under the "no arbitrage" and diversification conditions, in a single factor model where there are no extra-market risk factors, APT leads to a mean return-beta equation identical to that of the CAPM.

Both APT and CAPM are theories about the relationship between risk and return used in capital markets but based on different arguments or assumptions. Neither model however is free of limitations; still despite of their shortcomings both models are valuable and widely use due to the insights they offer.

5.4.4. The Multifactor APT

As mentioned, APT states that expected returns can be driven by multiple factors rather than the single model considering only systematic risk. There are several factors driven by the business cycle that might affect security returns. Presumably exposure to any of these factors will affect a security's risk and hence its expected return. To accommodate for these multiple sources of risk we use the multifactor version of the APT. The logic applied in the single-factor model applies also for the multifactor model (Bodie et al., 2014).

The consideration of a more refinement risks that affect the security's return has given rise to academics testing factors that could explain the cross section of expected returns and led to the development of multi-factor models. Among others, the most heralded multi-factor models are those developed by Fama and French (1993).

Table 2 from the literature review chapter of this thesis shows that researchers made use of factors to explain bond returns to assess the performance of the SRI bond mutual funds and portfolios. As mentioned, this thesis follows the literature of bond performance and also applies multi-factor models to study the performance of the bond portfolios under analysis. In the following sections we introduce the multi-factor models that will used in our analysis.

5.4.5. Fama-French Three-Factor Model

Fama and French (1992a) found that a simple CAPM model proved to be poor at explaining the returns of securities. Building upon APT, Fama and French (1992b) on their study of "*Common risk factors in the returns on stocks and bonds*" identified five common risk factors that explain average returns on stocks and bonds. According to Fama Jr. (2006), CAPM seems to explain approximately 70% of the variability in returns, while the Fama-French three-factor model explains approximately 95% of the variability in returns.

The common risk factors of Fama and French (1992b) consist of three factors for the stock market (stock market factors) and two for the bond market (bond market factors). The stock market factors are an overall market factor and two firm-characteristic factors, namely a firm

size factor (SMB) and a factor of book-to-market value of equity (HML). The bond market factors consist of one interest rate change risk factor (TERM) and a default risk factor (DEF). Fama and French (1992b) evaluated seven bond portfolios: two government bond portfolios and 5 corporate bond portfolios containing different rating groups. The authors concluded that the factor for default risk and the factor for interest rate change risk could explain almost all the variability in returns. Explanatory power of stock-market factors disappeared for all but the low-grade corporate bonds when the two bond-market factors were included in the bond regressions. It would therefore be a natural step to exclude the stock-market factors when using the Fama and French (1992b) model on corporate bond returns. However, subsequent research has argued for systematic risk factors affecting corporate bond prices (e.g. Elton et al. (1995)). As such, we include the market risk factor in our Fama and French (1992b) model. For this purpose, we use a bond market index, namely the Barclays Euro Aggregate Corporate Bond index as market proxy in the model.
Thus, our application of the Fama-French Three-Factor model is specified as follows:

$$R_{it} - R_{ft} = \alpha_i + \beta_1\left(R_{Mt} - R_{ft}\right) + \beta_2 TERM_t + \beta_3 DEF_t + e_{it}$$

Where,
$R_{it} - R_{ft}$=Excess return on security *i* at time *t*; excess yield return in our case
α_i= Intercept term of security *i*; Jensen's alpha
$R_{Mt} - R_{ft}$= Excess return on the bond market index at time *t*
$TERM_t \; and \; DEF_t$= Return on the TERM and DEF factor respectively in period *t*
β_k= Loadings of the respective factors, where k=1,2 and 3
e_{it}= Error-term, which incorporates the non-systematic risk of security *i* in period *t*

The specifications of the different factors used in our regression analysis will be explained in detail in the next chapter.

Some studies have concluded that the Fama French model performs poorly when applied to less developed markets, such as emerging markets (Foye, Mramor and Pahor, 2013). This critique has no implication for our research as our focus is on the European market.

5.4.6. The Four-Factor Model

Subsequent research to Fama and French has appeared to argue for systematic risk factors affecting security prices. In this section we shortly review previous research of these factors that might affect bond returns in order to formulate our four-factor model.

Titman and Jagadeesh (1993) on their study showed the momentum anomaly by showing that stocks that had performed well in the past outperform stocks that have performed poor in the past. As such, Carhart (1997) extended the Fama-French three-factor model that explains stock market returns and included a momentum factor. Carhart found that much of the returns of the mutual funds could be explained by their exposure to momentum stocks. The research of the momentum anomaly was further extended to the bond market. Gebhardt et al. (2004) examined the interaction between momentum in the returns of equities and corporate bonds. They found that investment grade corporate bonds do not exhibit momentum, instead the evidence suggests that they exhibit reversals. However, they found significant evidence of a momentum spillover from equities to low-grade corporate bonds (or high-yield corporate bonds) that hold even after controlling for past earning surprises. Similarly, Jostova et al. (2013) studied the momentum effect in the US corporate bonds, they found that the momentum is driven by low-grade corporate bonds and that bond momentum is not just a manifestation of equity momentum. These studies show clearly evidence of momentum anomaly in high-yield corporate bonds but no evidence in investment-grade corporate bonds. The focus of our work is on investment-grade corporate bonds therefore the momentum factor is not suitable for our analysis.

As the literature review shows, several researchers made use of Elton et al (1995) multi-factor model to explain bond returns in order to estimate the performance of responsible investments. Elton et al (1995) studied the relationship between bond fund returns and seven possible explanatory variables: aggregate bond return index, an aggregate stock index, default, term, option effects and two observable expectational variables namely, unexpected change in inflation and in a measure of economic performance. The scholars created different models containing the different variables and found that a four-index model employing an aggregate bond index (BOND), an aggregate stock index (EQUITY), default (DEFAULT) and option effects (OPTION) better explained bond returns. Elton et al (1995) multi-factor model is expressed as follow:

$$R_{it} - R_{ft} = \alpha_i + \beta_1 BOND_t + \beta_2 DEFAULT_t + \beta_3 OPTION_t + \beta_4 EQUITY_t + e_{it}$$

The first variable intends to capture exposure to the market index of bond returns, as mentioned on Elton et al. (1995) study "*if one were looking for a single factor that best explains individual bond returns, the single factor that would probably do the best job is a market index of bond returns"*. For this reason, this thesis applies bond market indices as a proxy to the market portfolio in all regressions. This issue is further explored in the next section. The second variable like the Fama and French (1992b) three-factor model captures default risk compensation. In our study, option-embedded bonds are excluded from our data set and therefore the third variable is not suitable for our analysis. The fourth variable EQUITY allows for the possibility that performance to be explained by variation in equity returns and to account for convertible bonds. Elton et al. (2001) provided further empirical support for systematic risk affecting corporate bond returns. They argue that as compensation for risk changes over time in capital markets, both the equity and bond markets will be affected, which in turn introduces a systematic influence on corporate bond returns. Subsequent studies have come to the same conclusion (Huang and Huang, 2002: Geske and Delianedis, 2001).

Thus our four-factor model is an extension of Fama and French (1992b) three-factor model by accounting for equity effects on bond returns as proved by Elton et al. (1995):

$$R_{it} - R_{ft} = \alpha_i + \beta_1\left(R_{Mt} - R_{ft}\right) + \beta_2 TERM_t + \beta_3 DEF_t + \beta_4 EQUITY_t + e_{it}$$

Where,
$EQUITY_t$= Return on EQUITY factor in period *t*
β_4= Securities' sensitivity on the equity factor at time t
The remaining components are as in the Fama-French three-factor model

Even though, Elton et al. (1995) considered the TERM variable on their study, they found no statistical significance in the relationship between fund returns and the TERM variable. However, and as proven by Fama and French (1992b) interest rate risk is the major risk that affects bond returns and for this reason is considered in our four-factor model in order to evaluate the performance of the analysed portfolios.

5.5. The Fama-MacBeth Procedure

For the regression methodology, this thesis follows the Fama and French (1992a) in applying the cross-sectional methodology developed by Fama and MacBeth (1973).

The Fama-MacBeth procedure is commonly known as "two-pass cross sectional regression" and is a practical way of testing how the factors included in our models affect asset returns. The procedure consists of first using time-series regressions of individual securities to estimate betas against the corresponding risk factor and then run the cross-sectional regression to test the hypotheses derived from the used model (Sylvain, 2013).

We start with a formation period of four years during which we run the time series regression for each security's excess monthly return, against the returns of the different considered risk factors. These regressions are performed using the Ordinary Least Squares (OLS) regression:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i \mathcal{F}_t + e_{i,t}$$

Where,
$R_{i,t}$= return of bond I at time t
$R_{f,t}$= risk-free rate at time t
$\mathcal{F}_t$= explanatory variable at time t
β_i= coefficient of over time

In the second step, we run cross-sectional regressions of the excess returns (using the above equation) of each bond for each month against the estimates which are the outcomes of the first step to estimate the risk premium for each factor. We obtained coefficients estimates for every observed risk factor in every month of the considered period. We then average the coefficients over the time-period to estimate the risk premium.

6. Data

After defining the models to study the performance of the portfolios, in this section we discuss the data used for that purpose. We start by explaining the different approaches followed by the different ESG rating providers, specially those used on the literature review and the one used on our analysis. Next, we show how we proceeded to the screening process to form our bond data set. Finally, we set up the data for the models presented in the previous section to perform the analysis.

6.1. ESG Data

To quantify the performance impact of ESG-motivated investment decisions, we need to rely on independent providers of ESG scores and ratings in order to select the companies that follow better ESG practices. The ratings are of extremely importance when engaging in ESG investment. As formulated from our approach, ESG investing takes a positive screening approach, which means investing in high-rated companies regardless of the industry they operate. Several ESG service providers have emerged in the past two decades and each provider has its own methodology, for this reason we find important to analyse some of them so we can choose the one most suitable for our analysis.

According to an annual industry survey by Independent Research of Responsible Investment, the two top providers of independent ESG research and rankings are MSCI ESG Research and Sustainalytics (Barclays, 2015).

MSCI counts with 140 research analysts to assess and collect data of company's exposure to and management of ESG risks and opportunities. The analysts assess 37 ESG key issues within each of the three pillars. The scoring for each company is focused on the intersection between a company's core business and the industry issues that can create significant risks and opportunities for the company. (MSCI ESG Research, 2017). Companies are then scored to a rating between best (AAA) and worst (CCC), and at the end of each calendar year each score is reviewed. The more refined scores provided by MSCI is clearly a good feature since it allows to better differentiate between companies. However, MSCI ratings are not freely available.

Sustainalytics provides ESG rating for more than 8,400 companies in a global scale. The analysts assess more than 100 ESG key issues within each of the three pillars. Similar to MSCI, a weighted average corresponding to the industry is applied and companies are scored from 0 (lowest score) to 100 (best score). A special feature of Sustainalytics is the ESG report provided for each company. In the report, one can find the overall performance score of the company and the respective score of each ESG factor, the company's performance relative to its industry peers as well as a full description of the highest controversies the company faces. In our opinion, the more refined the ESG KPIs issues are the more "realistic" is the rating. However, similar to MSCI, these rating are hard to obtain.

KLD ratings have been widely used in the literature of ESG investing. While it follows a similar approach of the providers mentioned above, KLD does not provide the investor an aggregated ESG score for each company. To be able to compare the ESG performance of the companies, the investor needs to net the strength and concern scores for each company. Another limitation is that KLD measures corporate governance considerably differently from the general corporate governance literature (Kemp and Osthoff, 2007).

We ended up with Thomson Reuters. Since this is an important part of our analysis, we elaborate further on Thomson Reuters ESG Scores below.

6.1.1. Thomson Reuters ESG Scores

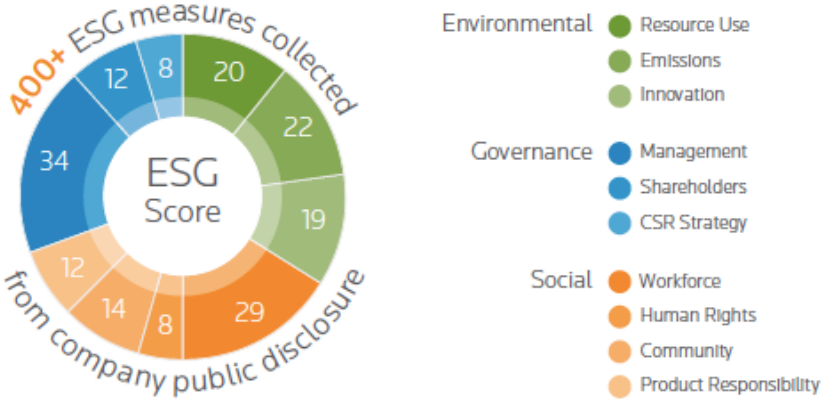
Thomson Reuters ESG scores are enhancement and replacement for the existing equally weighted Asset4 ratings. The ratings provided by Asset4 do not reflect the "true" ESG score, the reason is that the scores are the result of an equally weighted average, and as mentioned each industry requires different ESG weights.

Thomson Reuters counts with more than 140 analysts to assess ESG data from different public sources such as company's annual report, website and CSR reports. Currently they have ESG Scores calculated for more than 6,500 public companies globally.

A combination of the ten categories makes up the ESG Scores (see Figure 2). The underlying measures are based on considerations around comparability, data availability and industry relevance. On contrary to Asset4, Thomson Reuters scores take into consideration the different ESG weights for each industry. When there are ESG controversies, these are discounted from the ESG Scores to calculate the ESG Combined Score. When there were no

controversies for a particular period, the ESG Combined Score and ESG Score have the same value. Companies are rated to a rating between best (100) and worst (0), and the scores are reviewed every six months. These scores are available on Thomson Reuters Datastream with the codes "TRESGS" for the ESG Score and "TRESGCS" for the ESG Combined Score. For the purpose of our analysis we consider the ESG Combined Scores since these scores take into account controversies that happened during the fiscal period. If a scandal occurs, companies involved are penalized, affecting their overall ESG Combined Score (Thomson Reuters, 2017).

Figure 2: Thomson Reuters ESG metrics



Source: Thomson Reuters ESG Scores, 2017

Even though the analysis done by each provider is based on publicly accessible data sources, as mentioned, different providers apply different methodologies. The differences in the way data are processed, analysed and presented can lead to very different ratings for the same company. This presents a limitation as it can potentially suggest different portfolio management decisions.

6.2. ESG Companies Selection

To acquire the companies covered by the Thomson Reuters in Europe we used the DataStream code "LA4RGNEU". In order to have the Thomson Reuters scores instead of the ones provided by Asset4 we had to further filter the research using the code "TRESGCS". We collected ESG scores of companies for the two data periods: from 2008 to 2012 and from 2013 to 2017. For the first time-period we obtained a list of 900 companies whereas for the

second period a list of 1087 companies. We decided a minimum of years of ESG coverage in order to be applicable for the dataset. The cut-off point we sat was at least two years of coverage for each of the data period samples.

Companies that lacked a score in some periods were given the score they had in the closest time-period. Also, some companies had not yet received their score for 2017 when we collected our data. Such companies were given the score they had in 2016 in this period. A weighted average of the ESG scores for each company during the time-period was applicable to make up the "final" ESG score of the company. The 35% highest ESG scores companies were selected.

6.2.1. ESG Bonds Selection

For each of the companies selected in each period, we retrieved bonds issued by the respective company. As one could expect, not all the companies in our selected sample issued bonds during the periods of analysis. The reason is that companies have various sources of funding (bank finance, bonds or equity), and even though the conditions attached to borrowing in the bond market are less strict than those demanded by banks, generally companies that issue bonds are those that aim to borrow large sums of money. Indeed, from the selected companies only those that issued bonds during the particular market regime were included in our sample. Furthermore, because we exclude callable or puttable bonds those companies who did not issued straight bonds ended up being excluded. For the recession period only 47 highest ESG score companies issued bonds, however only 35 companies issued straight bonds. For the non-crisis period, out of the 369 highest ESG score companies only 130 companies had active bonds during the period, however 44 only issued callable bonds and thus those were excluded from analysis.

To limit eventual distorting price influences that issuance or maturity may have on the price of a corporate bond, the search was limited to straight corporate bonds issued before our initial period and maturing after the end of each of the periods under analysis.

Table 3: Bloomberg Filter Search Criteria

Recession Period Search Criteria
Issues type: Corporate Bonds
Bond Type: Straight
Currency: EUR
Issue Date Before: 2007/12/01
Maturity Date After: 2012/12/31

Non- crisis Period Search Criteria
Issues type: Corporate Bonds
Bond Type: Straight
Currency: EUR
Issue Date Before: 2012/12/01
Maturity Date After: 2017/12/31

6.2.1.1. Adjusting for patterns of illiquidity and bad data points

A problem when considering data from the corporate bond market is that corporate bond market in general is less liquid than the equity market. Thus, when using corporate bond data one needs to adjust for patterns of illiquidity and bad data points.

Monthly returns were calculated for each corporate bond for the given period (hence, 60 data points for each listed corporate bonds was available). Corporate bonds were excluded for having insufficient amount of data points if out of the 60 data points it had less than 55 data points (or less than 55 closing price data). Furthermore, a corporate bond was deemed to show a pattern of illiquidity if showed no price movement over five or more months of both periods of analysis and hence excluded from the data set.

Table 5: Adjusting for patterns of illiquidity and bad data points

Recession Period
Number of bonds initial set: 35
Number of bonds excluded due to illiquidity risk: 2
Number of bonds excluded due to insufficient data points: 5
Final data-set: 28

Non- crisis Period
Number of bonds initial set: 86
Number of bonds excluded due to illiquidity risk: 3
Number of bonds excluded due to insufficient data points: 12
Final data-set: 71

6.2.2. Conventional Bonds selection

To evaluate the performance of the ESG bonds we make use of comparable conventional bonds, that is, bonds issued by companies that neither have an ESG score or whose scores are not the 35% highest. The conventional bonds sample is selected from the global bond universe provided by the Bloomberg database. Only corporate bonds with a straight interest rate were included for the data import. Including floating interest rate bonds or bonds with embedded options would decrease the comparability between the bonds included in our study. To eliminate distorting effects based on currency movements we limited the screening criteria to a single currency. EUR was chosen since our study is focused in Europe.

In order to increase comparability, high-yield corporate bonds are excluded from our sample. The reason is that high ESG scores are positively correlated with higher credit ratings (Barclays, 2015). We therefore used the rating from S&P and filtered the ratings between (AAA to B+). To avoid bias of our results we excluded all bonds issued by companies that belonged to our ESG highest score company list (section 6.2.). Duplicate conventional bonds were also eliminated.

Once again, bonds included in our conventional data sample were those issued before the specified dates and maturing after the dates of analysis (see table 3 above). After setting all the filters, we ended up with 66 conventional bonds for the recession period and with 170 for the non-crisis period. The reason for such a small sample during the recession period is that we observed that a great majority of the bonds issued at the time were callable bonds. What is more, one should also note that the euro bond market is smaller than the US bond market. Since our study is strictly focused in Europe, and to increase comparability between conventional and ESG bonds[2], we further screened our conventional bond sample by excluding all bonds issued by non-European companies.

6.2.2.1. Adjusting for patterns of illiquidity and bad data points

The process of screening the data through excluding corporate bonds that showed signs of illiquidity and excluding corporate bonds that had insufficient data points was the same as explained in section 6.2.1.1.

[2] The ESG scored companies obtained from Thomsen Reuters are only European companies

Table 6.: Adjusting for patterns of illiquidity and bad data points

Recession Period	Non- crisis Period
Number of bonds initial set: 66	Number of bonds initial set: 120
Number of bonds excluded due to illiquidity risk: 9	Number of bonds excluded due to illiquidity risk: 9
Number of bonds excluded due to insufficient data points: 20	Number of bonds excluded due to insufficient data points: 8
Final data-set: 38	**Final data-set:103**

6.4. Risk-free Rate

This thesis follows the approach of Fama and French (1993) and considers the one-month Treasury-Bill in the particular market. As our study is focused on Europe, we use the one-month T-Bill rate of Germany as risk-free. This is coherent with the EUR data for the bonds sample. The rates are downloaded on a monthly basis from the "Investing" platform.

6.5. Fama-French and Four-factor model Factors

To perform the Fama-French three-factor and our Four-factor models we needed the returns for each of the factors DEF, TERM and EQUITY. Fama and French (1992b) used global factors to conduct their analysis, since we focus in Europe, to account for potential distortions we use European factor indexes. By doing so we follow Henke (2016) approach to estimate our factors. Relying on the argument that changes in interest rates is a common risk in bond returns, Fama and French (1992b) introduced a proxy for this factor which they name TERM. In line with Henke (2016) approach the TERM factor is the difference between the long- and short-term investment-grade government bond indices. As a proxy for the LT and ST IG government bond indices we chose the *FTSE highest rated Eurozone government bond 10-15 years* and the *FTSE highest rated Eurozone government bond index 1-3 years'* indexes. The DEF factor aims to capture the risk of default and is based on the excess total returns of the Eurozone high-yield corporate bond index (*Bloomberg Barclays European High Yield* index) in excess of the investment grade government bond index (*FTSE MTS Highest-Rated Eurozone Government Bonds* index). Finally, the EQUITY factor is generated from the

excess returns of the *Eurotoxx600 Total Return Equity* index over the one-month German government bond yields.

6.6. Implications of Data Set

Since we follow a positive screening approach, our ESG sample is restricted to the highest-ESG score bonds. As literature suggests high ESG scores are positively associated with high credit ratings. In order to increase comparability among samples, our conventional sample only includes European Investment-Grade bonds. This selection was done to ensure a high comparability between samples, such that the difference in alpha (the amount of return that is not explained by the exposure to the factors), of the two bond asset classes can be justified by the ESG component and therefore an unbiased picture of their relative vis-à-vis performance is given.

By restricting our universe to high quality bonds one should expect these bonds to be less exposed to the risk factors suggested by the literature of bond returns. This will result in the respective factor loadings to be very close to zero, as we will see in the following sections. This will also impact the explanatory power of our models, since low exposure to the factors prevents them to explain much of the cross-sectional variation of the average returns (Fama and French, 1992b). Therefore, as expected the R square's obtained are very close to zero.

7. Results and Analysis

The following section provides a discussion of the results of the analyses conducted to study the performance of ESG bonds and conventional counterparts. This section is divided in two general parts, one regarding the recession period performance and the second part deals with the results obtained from the non-recession period.

7.1. Recession Period

7.1.1. Descriptive Statistics and Performance Measures

Our analysis starts with a summary of the descriptive statistics. Table 7, describes the annual monthly return and standard deviation of returns for the sample of ESG and conventional bonds respectively.

Table 7: Descriptive Statistics and Performance Measures, Recession period

Bond Class	Mean Return	Standard Deviation	Minimum	Maximum	Median	Sharpe Ratio
ESG	4,36%	0,52%	-0,94%	6,86%	4,63%	6,50
Conventional	4,32%	0,57%	-1,01%	9,44%	4,49%	5,84

Where:
Mean return is the annualized mean of the returns of each company
Standard Deviation is the annualized standard deviation of the returns
Minimum and Maximum are the annualized minimum and maximum returns in the sample
Median is the annualized median of the returns
Sharpe Ratio is the ratio explained in section 5.3.1.
The period analysed is from January 1st, 2008 and December 31st, 2012

The above table provides the summary statistics of the ESG and conventional bond samples. Over the considered time-period between January 1st, 2008 and December 31st, 2012, the average return on an ESG bond amounts to 4,36%. The descriptive statistics suggests that the ESG bond sample seems to outperform the conventional bond sample, with a yearly outperformance of 0.04%-points. The ESG bonds also have had less variability in returns and therefore have a lower standard deviation than a conventional bond. Moreover, the ESG bonds also have had higher Sharpe ratio in the recession period than their conventional

counterparts. In another words, ESG companies outperform its conventional peers in terms of excess returns per unit of total risk.

7.1.2. CAPM

From our unconditional analysis, ESG bonds, even though by a small difference, seem to outperform its conventional counterparts. Financial Theory says that the exposure to certain factors can drive investment return, therefore our unconditional analysis is not enough to draw conclusions. For this reason, to determine the true financial performance of the ESG and conventional bonds we apply different models that incorporate different risk factors that influence bond returns. The out- or underperformance will be captured by Jensen's alpha, and we start with CAPM model, which assumes exposure to the market factor as the only source of risk.

The CAPM parameters are estimated by the use of a Fama-MacBeth regression analysis using the OLS estimation. Table 8 shows the results of the regressions with respect to the CAPM.

Table 8: CAPM Regression Results, Recession period

Bond Class	Alpha	Yearly Alpha	β MKT	R squared
ESG	0,00065	0,00782	-0,00016	0,00003
Conventional	0,00219	0,02628	-0,00225	0,00612

Where:
Alpha is the monthly return that cannot be explained by the exposure to the market factor (Beta)
Yearly alpha is the annualized monthly alpha
β MKT is the average exposure to the market factor
R- squared is how much of the variability in the returns is explained by the model
**** indicates significance on a 1% confidence level*
*** indicates significance on a 5% confidence level*
** indicates significance on a 10% confidence level*
The period analysed is from January 1st, 2008 to December 31st, 2012

By applying the CAPM model to explain the return of the different bond asset classes, one can see that both the ESG bonds and Conventional bonds exhibit positive alphas. The conventional bonds show a yearly outperformance compared to the corporate bond market of about 2.63%-points, whereas on average for the ESG bond this abnormal annual return was lower than 1%-points.

On contrary to our findings in the unconditional analysis, when both bond classes are adjusted for market risk the conventional bond seems to have better performance than the ESG bond. A vis-à-vis comparison shows that on a yearly basis, this outperformance amounts 1.85%-points. This implies that ESG bond returns adjusted for market risk have a worst performance when compared with its conventional peers during the recession period. However, the results are to be interpreted with caution due to the statistical insignificance of the parameter estimates. Therefore, a refined conclusion in respect to the risk-adjusted returns cannot be drawn due to the statistical insignificance.

In terms of market risk, both type of bonds show negative exposure to the market effect. This means, that returns of both bond classes are negatively correlated with the general European corporate bond market. That is, if the average market return increases, both bond returns decrease. A strict comparison among the two in respect to market exposure, suggests that conventional bonds have slightly higher exposure than the ESG bonds, which means that on average an ESG bond is less volatile than the market when compared with a conventional bond, though none of the beta estimates are statistically significant and therefore such robust conclusion cannot be made.

In respect to the model fitness, as expected the model is poor in explaining the cross-section bond returns and a great part of the variability of returns remains unexplained.

7.1.3. Fama-French Three Factor Model

We move to the Fama-French Three Factor model analysis, where we incorporate more two risk factors in the model that drives performance, namely TERM and DEF factor to capture interest and default effects.

Table 9 displays the results of the Fama-Macbeth cross-section regression analyses applied to the respective model.

Table 9: Fama-French Three Factor Model Regression Results, Recession period

Bond Class	Alpha	Yearly Alpha	β MKT	β DEF	β TERM	R squared
ESG	-0,00066	-0,00790	-0,00013	-0,00297	0,00339	0,00676
Conventional	0,00103	0,01236	-0,00119	-0,00097	0,00015	0,00521

Where:
Alpha is the monthly return that cannot be explained by the exposure to the factors
Yearly alpha is the annualized monthly alpha
β MKT is the average exposure to the market factor
β DEF is the average exposure to the DEF factor
β TERM is the average exposure to the TERM factor
R- squared is how much of the variability in the returns is explained by the model
**** indicates significance on a 1% confidence level*
*** indicates significance on a 5% confidence level*
** indicates significance on a 10% confidence level*
The period analysed is from January 1st, 2008 to December 31st, 2012

By applying the Fama-French Three factor model, both alphas are reduced compared to the ones obtained in the CAPM model. The alpha for an ESG bond is now negative, while the alpha of the conventional bond is still positive. These results suggest that when accounting for market, interest rate and default effects, ESG bonds shows underperformance with an annual abnormal return of -0,79%. On the other hand, a conventional bond shows outperformance with a yearly abnormal return of 1,24%-points. These results imply that, during the period of January 2008 to December 2012, on average a conventional bond had a better performance compared with the average ESG bond. However, the intercept estimates are not statistically significant in any of the confidence levels, therefore limiting the interpretation of our results.

With respect to the beta loadings, comparing with the results from the CAPM model, ESG and conventional bonds continue to show a negative relationship with the corporate bond market. Regarding exposure to default probability/ risk, both bonds classes excess returns are negatively correlated with this effect, this result was already expected as an increase in de default probability decreases bond returns. However, as we focus on investment-grade bonds it makes sense that exposure to this effect to be so small. Indeed, from these beta estimates it seems that this effect has a higher negative impact on ESG bond returns.

Finally, both bond classes have low exposure to changes in the levels of interest rates, with an ESG bond return to have more exposure compared with a conventional bond. Once again,

since all the obtained results are not statistically different from zero results should be interpreted with caution, thereby disqualifying the ability of drawing robust conclusions.

Overall, even though our results are not statistically significant the results obtained allow us to see that, when applying the Fama-French multi factor model, on average an ESG bond underperformed the market during the period. On the other hand, the conventional bonds had an outperformance. Carefully generalizing the results, investors during the period should refrain from investing in ESG bonds due to their underperformance.
Looking at the R-squared, one can see that this later model is better able to explain the variation of the cross-sectional returns than the CAPM-model. Nevertheless, as explained in section 6.6, there is still a large variance unexplained by the model.

7.1.4. Four-Factor Model

Our last factor model is the Four-Factor Model, which incorporates a fourth factor- the equity factor, as suggested by Elton (1995).
Table 10 displays the results of the Fama-MacBeth regression analysis applied to the respective model.

Table 10: Four-Factor Model Regression Results, Recession period

Bond Class	Alpha	Yearly Alpha	β MKT	β DEF	β TERM	β EQU	R squared
ESG	-0,00096	-0,01151	0,00040	-0,00426	0,00414	-0,00758	0,00964
Conventional	0,00170	0,02040	-0,00206	-0,00149	-0,00110	-0,00556	0,01020

Where:
Alpha is the monthly return that cannot be explained by the exposure to the factors)
Yearly alpha is the annualized monthly alpha
β MKT is the average exposure to the market factor
β DEF is the average exposure to the DEF factor
β TERM is the average exposure to the TERM factor
β EQU is the average exposure to the EQUITY factor
R- squared is how much of the variability in the returns is explained by the model
**** indicates significance on a 1% confidence level*
*** indicates significance on a 5% confidence level*
** indicates significance on a 10% confidence level*
The period analysed is from January 1st, 2008 to December 31st, 2012

Analysing the results of our extended model when adjusting for the equity effect, the ESG bond show an insignificant negative annual alpha of -1.15%-points. On the other hand, an average conventional bond yields an insignificant alpha of 2.04%-points annually. Interestingly, compared to the results obtained in the Fama-French model, on average a conventional bond now shows a higher alpha, whereas the ESG bond reveals worst performance. The results obtained amplify the Fama-French model conclusion that ESG bonds underperformed the market whereas its conventional peers outperformed. This implies that the ESG sample continues to show an underperformance compared to its conventional peers, though the results obtained are statistical insignificant.

With respect to the dependent variables, changes occur in the exposure to the market risk vis-à-vis with the Fama-French model. The average ESG bond now seems to be positively correlated with the corporate bond market effect, while the conventional bond return is still negatively affected by this effect. The exposure to default risk is similar to the ones obtained in the previous model. Additionally, it seems that, even by a small amount, both bond classes' returns are negatively correlated with the European equity market. However, once again none of the parameters are statistically significant.

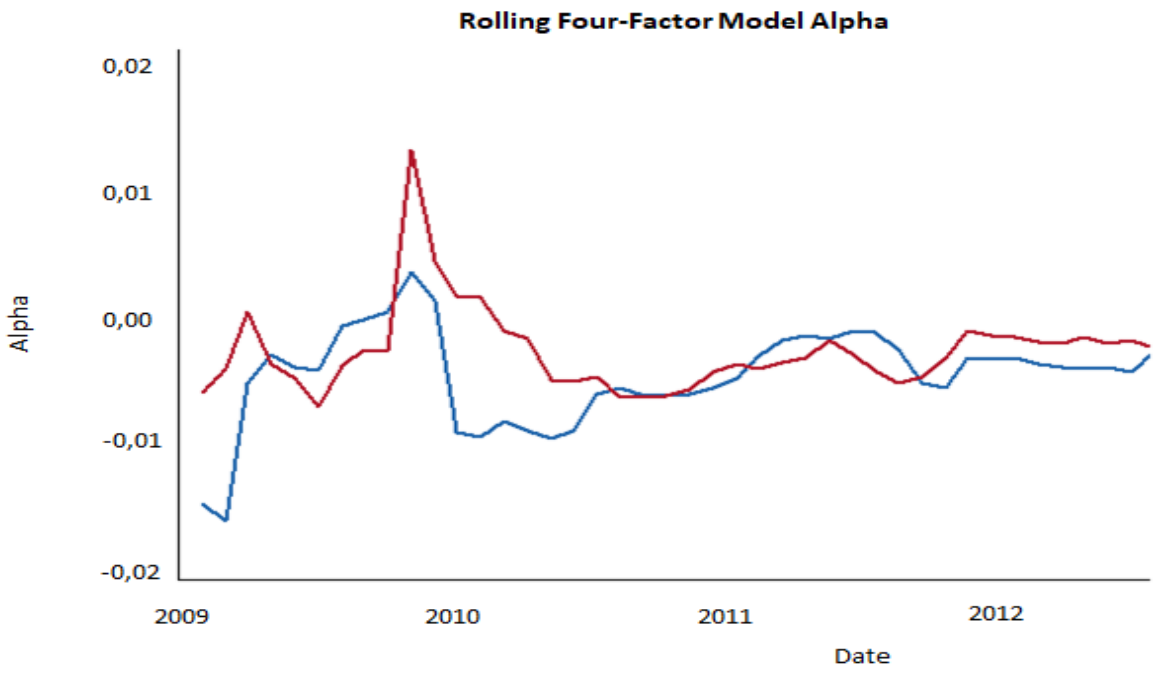
Considering the model fitness, R squared estimates slightly improved in this model. Implying that this is the most appropriate model to explain the cross-sectional average bond returns. As expected, there still a significant part that is not explained by the model.

7.1.5. Rolling Regressions

The overall takeaway from our conditional analysis is that, over the interval studied, conventional bonds had outperformed ESG bonds, though not statistically significant. In order to analyse if this was the case throughout the period, rolling regressions were performed. The reason is that, under the conditional models, time-varying exposures do occur. By performing rolling regressions, we allow the factor exposures to change throughout time providing a time-varying performance outlook (Gregory et al., 2007).

Regressions were run for successive over-lapping 12 months periods, starting in January 2008. Because the results from all the three models were very similar we only present for the Four-factor model since it is the most comprehensive model. Figure 1, shows the evolution of alphas for both bond classes for the respective period of analysis.

Figure 3: Rolling regressions, Recession period



Where:

The red line illustrates the average of alphas of the conventional bonds

The blue line illustrates the average of alphas of the ESG bonds

As we can see from Figure 3, the alphas of the different bond classes are not stationary over time. This indicates that assuming the factor loadings constant over time is an assumption that does not hold in practise. The red line indicates that for the first half period conventional bonds outperformed the ESG sample on a risk-adjusted basis. The window analysed initiates at the very beginning of the sub-prime crisis in the US, when Investment-Grade European corporate bonds could be seen by investors as safe haven assets. This could explain the increasing in performance of both asset classes that we observe in the beginning of the graph. However, in the second half the relative performance of the ESG bonds is starting to catch up. Overall, while there was considerable variation in the performance of the two bond classes for the first half period, in the second half such difference in performances is not noticeable. In fact, both bonds seem to underperform, given their negative alphas. This

underperformance of both bond classes coincides with the period where sovereign debt crisis triggered Europe.
Worth note that there is no statistical significance in this graph avoiding any possibility of draw conclusions on performance differences.

7.1.6. Sub-conclusion: Recession- Period

As mentioned throughout the analysis, none of the results obtained in the three models are statistically significant. This disqualifies the ability of making any robust conclusion about our results. Nonetheless, even though from our unconditional analysis an ESG bond had an insignificant higher average return than a conventional bond, when controlling for corporate bond market effects the CAPM-model unveils different results, showing an underperformance of the ESG bonds when compared with the performance of its conventional peers. While in the CAPM-model the ESG bond had a positive performance with an average annual abnormal return of 0.78%-points, the alphas obtained in the Fama-French and Four- Factor models showed that in fact, an ESG bond underperformed the market, with annual abnormal returns of -0.79% and -1.15% respectively.
Allowing for variation of the factor loadings, by running rolling regressions, we saw that in fact throughout the period it seems that on average a conventional bond had a better risk-adjusted performance than an ESG bond.

The consistent underperformance of the ESG bonds during the recession period, might be justified by a premium paid by investors for this type of bonds. This is in line with the risk mitigation view. Shefrin and Statman (1993) and Heirshleifer (2008) found that investors examine firm risks and corporate behavior more closely when the economy is weak. If this is the case, then investors are willing to pay more for bonds issued by companies with high ESG scores as they manage those risks more effectively. Therefore, the underperformance of the ESG bonds might be related with investors' willingness to pay a premium for the "ESG" label during recession periods. Another possible justification in line with the overpricing logic, could be that during periods of recession the likelihood of a "worst-case scenario" to happen is higher and thus risk-averse investors are willing to pay more for bonds that mitigate the downside risk. Therefore, investors are paying for a compensation for low non-financial risks.

7.2. Non- Recession Period

The next section is dedicated to study the performance of the ESG bonds and make a comparison with the respective conventional peers during the Non-recession period.

7.2.1. Descriptive Statistics and Performance Measures

Similar to what was done for the recession period, our analysis starts with a summary of the descriptive statistics. Table 11, describes the annual monthly return and standard deviation of returns for the sample of ESG and conventional bonds respectively.

Table 11: Descriptive Statistics and Performance Measures, Non- recession period

Bond Class	Mean Return	Standard Deviation	Minimum	Maximum	Median	Sharpe Ratio
ESG	0,35%	0,42%	-2,40%	5,54%	0,31%	1,71
Conventional	0,74%	0,35%	-1,79%	6,38%	0,54%	2,86

Where:
Mean return is the annualized mean of the returns of each company
Standard Deviation is the annualized standard deviation of the returns
Minimum and Maximum are the annualized minimum and maximum returns in the sample
Median is the annualized median of the returns
Sharpe Ratio is the ratio explained in section 5.3.1.
The period analysed is from January 1st, 2013 and December 31st, 2017

As we can see from the above table the average return of an ESG bond amounts to 0.35%. The descriptive statistics suggests that the conventional bond sample, with an average return of 0,74% seems to outperform the ESG bond sample, with a yearly outperformance of 0.39%-points. The conventional bonds also have had less volatility in returns and therefore have a lower standard deviation than an ESG bond. This implies that the performance variability is higher for the average ESG bond.

The conventional bonds also have had higher Sharpe ratio in the period of research. The average ESG bond has an annual Sharpe ratio of 1.71, while the conventional sample has an annual Sharpe ratio of 2.86. In other words, conventional companies outperform ESG ones in terms of excess returns per unit of total risk.

7.2.2. CAPM

We then move to our conditional analysis, starting with the CAPM model, which assumes exposure to the market factor as the only source of risk. Table 12 displays the results of the Fama-MacBeth regression analysis applied to the CAPM model.

Table 12: CAPM Regression Results, Non- recession period

Bond Class	Alpha	Yearly Alpha	β MKT	R squared
ESG	0,00475***	0,0570***	-0,00003	0,000003
Conventional	0,00499***	0,0599***	-0,00014	0,000110

Where:
Alpha is the monthly return that cannot be explained by the exposure to the market factor (Beta)
Yearly alpha is the annualized monthly alpha
β MKT is the average exposure to the market factor
R- squared is how much of the variability in the returns is explained by the model
**** indicates significance on a 1% confidence level*
*** indicates significance on a 5% confidence level*
** indicates significance on a 10% confidence level*
The period analysed is from January 1st, 2013 to December 31st, 2017

When applying the CAPM model to explain the returns of the different bond classes, we can see that both types of bonds have positive alphas. This indicates that both bonds, when adjusted for market risk, outperformed the corporate bond market. The ESG bonds show an outperformance with an annual abnormal return of 5.7%-points, whereas on average a conventional bond has an annual abnormal return of 5.99%-points during the period of analysis. Overall, it seems that ESG bonds and their comparable peers have performed rather comparable, however due to the small difference between the two alphas one could argue that on average an ESG bond slightly underperformed conventional bonds. Additionally, the estimates of alpha are highly significant at a 1% level.

We can also observe that, similar to what we found for the recession period, both asset classes are negatively exposed to the general European corporate bond market, with the average ESG bond showing less exposure than its conventional peer. However, none of the factor loading are statistically significant on common confidence levels and therefore a conclusion cannot be made.

It is also worth to have a more thorough look at the model fitness test. The R squared obtained for both bond classes demonstrates that the market risk solely does not explain the cross

section of returns. This latter finding is in line with the Arbitrage Pricing Theory. Indeed, this suggests that there are other factors that explain the cross section of returns to a higher degree.

7.2.3. Fama-French Three Factor Model

Table 13 shows the outputs of the Fama-MacBeth regression analysis applied to the Fama-French Three Factor model.

Table 13: Fama-French Three Factor Model Regression Results, Non-recession period

Bond Class	Alpha	Yearly Alpha	β MKT	β DEF	β TERM	R squared
ESG	0,00476***	0,05712***	0,00010	-0,00390	0,00198	0,0111
Conventional	0,00482***	0,05784***	-0,00008	-0,00198	-0,00062	0,0089

Where:
Alpha is the monthly return that cannot be explained by the exposure to the factors
Yearly alpha is the annualized monthly alpha
β MKT is the average exposure to the market factor
β DEF is the average exposure to the DEF factor
β TERM is the average exposure to the TERM factor
R- squared is how much of the variability in the returns is explained by the model
**** indicates significance on a 1% confidence level*
*** indicates significance on a 5% confidence level*
** indicates significance on a 10% confidence level*
The period analysed is from January 1st, 2013 to December 31st, 2017

Analyzing the results of the Fama-French Three Factor model for the non-recession period, we can see that the alpha for the ESG bonds had, even by a small amount, increased when compared with the alpha of the CAPM-model. The same cannot be said for the conventional bond sample, with the alpha decreasing from one model to another. Nonetheless, both bond asset classes show positive abnormal returns when adjusted for market, interest and default effects. On average, the ESG bond shows an abnormal annual return of 5.71%-points and conventional bonds a yearly abnormal return of 5.78%-points. With both alphas showing statistical significance at 1% level. These results imply that during the period of January 1st, 2013 to December 31st, 2017, even by a small difference, on average a conventional bond had a better performance when compared with an ESG bond.

In respect to the exposure to the factors, the ESG bond now shows a positive correlation with the corporate bond market, whereas the conventional bond return is still negatively affected by this effect. In terms of changes in interest rate levels, conventional bonds seem to be less

sensitive to this effect. What is more, as expected both have almost no exposure to default, however, conventional bonds returns seem to be less exposed to default effects than ESG bond returns. Indeed, such robust conclusion cannot be taken as a finding as such parameters are not statistically different from zero.

Summarizing, the Fama-French regressions allows the conclusion to be drawn that both bond classes has positive performances over the period. However, given that conventional bonds had a slightly outperformance when compared with the ESG sample, investors would have been wise to take on a trading strategy by going long on conventional bonds and short on ESG bonds.
The R squared estimates improved for both bond classes compared to the ones obtained in our CAPM-model. This implies, on one hand that the Fama-French Three factor model is better able in explaining the variance in individual bond returns than the CAPM, while on the other hand there is still a great majority of the variance in cross sectional returns unexplained.

7.2.4. Four-Factor Model

Finally, we apply the Four-Factor Model to analyse the performance of both ESG and conventional bonds adjusting for the equity effect. Table 14 provides the results of the Fama-MacBeth regression analysis applied to our Four-Factor model.

Table 14: Four-Factor Model Regression Results, Non-recession period

Bond Class	Alpha	Yearly Alpha	β MKT	β DEF	β TERM	β EQU	R squared
ESG	0,00492***	0,0590***	-0,00016	-0,00375	0,00301	-0,003960	0,0116
Conventional	0,00490***	0,0588***	-0,00011	-0,00163	-0,00040	0,00072	0,0092

Where:
Alpha is the monthly return that cannot be explained by the exposure to the factors
Yearly alpha is the annualized monthly alpha
β MKT is the average exposure to the market factor
β DEF is the average exposure to the DEF factor
β TERM is the average exposure to the TERM factor
β EQU is the average exposure to the EQUITY factor
R- squared is how much of the variability in the returns is explained by the model
**** indicates significance on a 1% confidence level*
*** indicates significance on a 5% confidence level*
** indicates significance on a 10% confidence level*
The period analysed is from January 1st, 2013 to December 31st, 2017

When accounting for the equity effect we obtain different results from the ones obtained so far. Compared with the previous multi-factor model, both alphas increased. Indeed, this regression yields evidence of a slightly better performance of an ESG bond when compared to a conventional peer. In fact, both bonds are still showing outperformance in relation to the market, however on average an ESG bond had an abnormal annual return of 5.9%- points, while on average a conventional bond had 5.88%- points. Even though, the difference of both returns might be insignificant, there is statistical significance on the results obtained and therefore there is evidence of outperformance of ESG bonds compared to their conventional peers for this period.

Regarding the dependent variables, there are some differences in respect to the exposure of each ESG and conventional bonds to the factors analysed. Similar to the CAPM-model results, ESG bonds are now negatively correlated with the market affect, however, conventional bonds show now higher sensitivity to this factor compared with the ESG sample. While both types of bonds are kept with no exposure to default or credit downgrading's. Regarding the default exposure, no significant differences was observed from the previous model. In respect to the TERM factor, now an ESG bond shows slightly higher exposure to the change of interest rates, whereas conventional ones continue to exhibit negative correlation.

Elaborating upon the equity effect, conventional sample shows an insignificant effect of 0.001, while the ESG displays an equity effect of -0.004, suggesting that the cross section of excess returns of ESG bonds is negatively affected by the equity effect. In terms of equity risk conventional bonds seem to be less sensitive to this effect than the average ESG bond. However, we cannot make any robust conclusion about these results due to the statistically insignificance of the parameters.

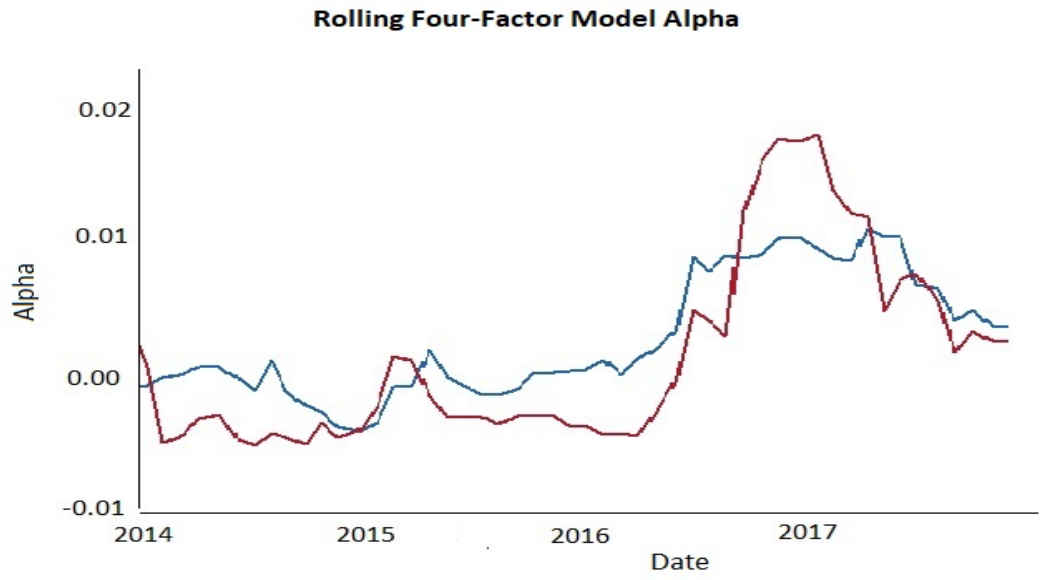
Looking to the fit of the model, one can see that the R squared slightly increased compared to the previous models. Even though R square is still small we can conclude that our Four-factor model is the most appropriate to explain the cross section of excess bond returns. Anyhow, the relatively low R square continues to imply that part of the variance in the returns is not explained by the models.

7.2.5. Rolling Regressions

The overall conclusion from the previous analysis is contradicting among the different models applied. While there seems to be a slightly underperformance of ESG bonds in the first two models, the picture is changes in the fourth model where an average ESG bond slightly outperformed its conventional peer. Due to the different results obtained we feel the urge to analyse their respective performance throughout the period. Similar to the recession period, one-year rolling regressions were performed. Regressions were run for successive over-lapping 12 months-periods, starting in January 2013.

Only the rolling regressions for the Four-factor model are presented, first because it is the model that better explain the cross-section excess returns, second because is the most comprehensive model. Figure 2, shows the evolution of alphas for both bond classes for the respective period of analysis.

Figure 4: Rolling regressions, Non- recession period



Where:

The red line illustrates the average of alphas of the ESG bonds

The blue line illustrates the average of alphas of the conventional bonds

As we can see from figure 4, there was some variation in the performance of both ESG and conventional bonds. Overall for the first half of the period it seems that both bond classes display similar patterns on performance. However, a vis-à-vis comparison suggests that ESG bonds had a lower performance than its conventional peers from 2014 to 2016. From 2016 onwards, both bond classes showed an increase in their respective monthly alphas, with ESG bonds significantly increasing their performance. The plot also suggests that during a specific time interval (end of 2016 to mid of 2017), ESG bonds significantly outperformed their conventional peers on a risk-adjusted basis. Overall, it seems like there were periods of out- and underperformance of the ESG bonds throughout the interval and it could therefore be beneficial to perform the previous study on sub-samples of the non-recession period interval.

7.2.6. Study of sub-samples

As the results from the rolling regression indicated, the performance of the ESG bonds and conventional ones have not been stationary during the period. There is evidence of periods where conventional bonds outperformed ESG bonds and periods where the opposite happens. To perform a robustness check, we performed the previous analysis for the first and second half of our interval. Table 15, presents the results of the models for each of the sub-samples.

Table 15: Non-Recession period: sub-samples

Panel A	Bond Class	Alpha	β MKT	β DEF	β TERM	β EQU
CAPM	**ESG**	0,0013	0,0028***			
	Conventional	0,0015***	0,0021***			
Fama-French	**ESG**	0,0017***	0,0024***	-0,0027	0,0088***	
	Conventional	0,0019***	0,0012***	-0,0045	0,0041*	
Four-Factor Model	**ESG**	0,0020***	0,002***	-0,0037	0,0092***	-0,0018
	Conventional	0,0022***	0,001**	-0,0049	0,0042**	-0,0059

Panel B	Bond Class	Alpha	β MKT	β DEF	β TERM	β EQU
CAPM	**ESG**	0,0056***	-0,0011			
	Conventional	0,0058***	-0,0006			
Fama-French	**ESG**	0,0053***	-0,0003	-0,0059	-0,0002	
	Conventional	0,0054***	0,0001	-0,0005	-0,0025	
Four-Factor Model	**ESG**	0,0055***	-0,0007	-0,0056	0,002	-0,0047
	Conventional	0,0054***	0,0002	-0,0002	-0,0018	0,0042

Where:
Alpha is the monthly return that cannot be explained by the exposure to the factors
β MKT is the average exposure to the market factor
β DEF is the average exposure to the DEF factor
β TERM is the average exposure to the TERM factor
β EQU is the average exposure to the EQUITY factor
****; **; * indicates significance on a 1%, 5 and, 10% confidence level respectively*
Panel A is from January 1st, 2013 to December 31st, 2015
Panel B is from January 1st, 2016 to December 31st, 2017

As we can see from the above results, during the first half, a vis-à-vis comparison suggests that ESG bonds underperformed conventional ones. For the second half, we obtain similar results from the previous analysis, with ESG bonds outperforming, even by an insignificant amount, its conventional peers in the Four-Factor Model.

The underperformance in the first half of the ESG bonds, might be a post crisis-effect. Financial crisis tends to have a long-lasting impact on investors' attitudes towards risk

leading to cautious investment decisions. Therefore, in periods right after crisis, investors seem to still take into consideration the "ESG" label and willingness to pay a premium for it.

Worth of note that now for the first period we obtained significant factor loadings for the market and interest rate changes effect. In general, ESG bonds seem to be more exposed to the general European corporate bond market when compared with the conventional bonds during this period, even though the exposure is close to zero. The same can be said in respect to the term effect.

7.2.7. Sub-conclusion: Non-recession period

We started our analysis with the descriptive statistics that revealed that the average conventional bond had a higher average annual return than a ESG bond with difference in annual returns accounting for 0.39%-points. When adjusting for the corporate bond market effect, both bond classes outperformed the market, still a vis-à-vis comparison shows that conventional bonds continued to show a higher performance. However, the performance difference was much lower than the one observed in our unconditional analysis. By applying the Fama-French Three factor model this difference in performance was even more insignificant, yet conventional bonds continued to have a higher performance compared to the ESG sample. Finally, by extending the previous multi-factor model to control for equity effect, as suggested by Elton (1995), the difference in performances continued to be very small, but with the ESG bonds showing a better performance than its conventional peers.

The application of several asset pricing models yields contradicting results. Therefrom, by allowing the factor exposures to vary throughout time we performed rolling regressions. The evolution of both bond classes performance displayed periods where ESG bonds outperformed the conventional sample. As a robust check, the study of sub-samples, demonstrated that in first half of the non-recession period on average an ESG bond was still outperforming a conventional bond. This can be attributed to the post-crisis effect, where investors are still more cautious on their investment decisions and might still, in line with the risk mitigation view, track more closely firms' risks and behaviours and therefore prone to pay for the ESG label. However, the small difference suggests a shift in the investors' attitude towards the risk perception in their investment decision making. Nevertheless, in the second

half-period the difference in performance is less evident, with ESG bonds outperforming by a modest amount the conventional sample.

Overall, there seems to be no significant difference in performance during the non-recession period and we can conclude that the performance of the both bond classes is rather comparable.

8. Robustness Tests

In order to investigate the validity of the reported findings several robustness tests are conducted. We start by analysing whether there is a possible selection bias by investigating the respective sample, namely in respect to industry effects. We then conduct some econometric tests to test the nature and quality of the data.

8.1. Selection Bias

Stock (2015) defines sample selection bias as "the bias in an estimator of a regression coefficient that arises when a selection process influences the availability of data and that process is related to the dependent variable". In other words, it implies that the statistical analysis could be biased as the result of the sample selection methodology.

In our case, a sample selection bias could arise based on industry categorization of samples. While we could not control for industry effects for the ESG bond sample, we tried to control for industry over-representation when cleaning and filtering for the respective conventional peers. In fact, the financial services sector was over-represented in our initial conventional sample, especially for the non-recession period. The elimination of those companies was done in a random-selection manner.

Table 16 contains the frequency of the industry categorizations in our ESG and conventional sample for the recession period. Overall, it seems that all industries, for this period, are equally represented. In table 17, we can see that Financial Services are still over-represented in the conventional sample, however by a small amount. The same can be said for the manufacturing industry.

Table 16: Industry Frequency Analysis, Recession period

Industry	**Percentage**	
	ESG companies	*Conventional companies*
Automotive	3,57%	3%
Construction	7,14%	7,89%
Technology	3,57%	2,63%
Telecommunications	14,29%	15,79%
Financial Services	53,57%	42,11%
Utilities	14,29%	18,42%
Oil & Gas	3,57%	5,26%
Consumer Goods	-	5,26%

Table 17: Industry Frequency Analysis, Non- recession period

Industry	**Percentage**	
	ESG companies	*Conventional companies*
Automotive	11,27%	-
Construction	2,82%	9,86%
Technology	1,41%	1,41%
Telecommunications	9,86%	1,41%
Financial Services	28,17%	36,62%
Utilities	9,86%	9,86%
Oil & Gas	9,86%	4,23%
Consumer Goods	7,04%	2,82%
Real State	1,41%	5,63%
Transportation	4,23%	4,23%
Health	4,23%	2,82%
Mining	1,41%	-
Manufacturing	8,45%	21,13%

8.2. Econometric Robustness Tests

In addiction to check if our results produced unbiased and consistent estimators, several econometric tests are conducted. The econometric method applied to conduct regression analysis is the Ordinary Least Squares (OLS), that only leads to unbiased results under specific assumptions known as "The Least Squares Assumptions" (Stock, 2015). Thus, we devote this part to test whether our data is in conflict with the most critical econometric assumptions.

8.2.1. Serial Correlation

Serial Correlation, or autocorrelation, means that the error terms across observations are correlated. In another words, it means that the value of residuals depends on previous values of the residuals. For simplicity we make use of Autocorrelation plots to analyse if there is autocorrelation in our models. In the appendix, we provide the Autocorrelation plots performed for the whole sample. As we can see our factors contain serial correlation.

Even though we found statistical evidence of autocorrelation within the explanatory variables, this does not cause our estimators to be biased. The only impact is that it will increase their variance, thus making more difficult to derive statistically significant results.

For further research, we would recommend that some corrective procedure should be applied on the series to control for this issue.

8.2.1. Multicollinearity

Multicollinearity arises when two or more explanatory variables in the regression are highly correlated. That is, when exists a linear relationship between the explanatory or independent variables (Stock, 2015). The absence of multicollinearity is one of the Least Squares fundamental assumptions. If multicollinearity exists then the estimates of one variable's impact on our dependent variable will be less precise than if no correlation with one another existed. Therefore, this would imply that our parameters estimates (i.e. factor loadings) of the explanatory variables are incorrect as well as the fitness of the model. In our research, we are applying widely used models by the academic world and it is therefore expected that these models do not contain multicollinearity. Anyway, to test for multicollinearity we run the Variance Inflation Factor (VIF)- test. As a rule of thumb, the critical value for VIF is 10, if that is the case then multicollinearity exists (Stock, 2015).

Table 18: VIF values, Multicollinearity test

Model	Sample Period	Bond Class	MKT	DEF	TERM	EQU
Four-factor	2008-2012	Conventional	3,231	3,981	3,561	2,067
		ESG	2,447	3,369	2,764	2,670
	2013-2015	Conventional	2,234	3,010	2,708	2,537
		ESG	2,258	3,235	3,142	2,387
	2016-2017	Conventional	1,833	3,577	3,909	1,580
		ESG	2,560	2,256	2,769	2,440
Fama-French	2008-2012	Conventional	3,036	2,699	3,558	
		ESG	2,422	2,981	2,938	
	2013-2015	Conventional	1,874	1,652	2,628	
		ESG	1,947	2,178	2,881	
	2016-2017	Conventional	1,376	2,534	2,968	
		ESG	1,189	1,801	1,906	
CAPM	2008-2012	Conventional	1,000			
		ESG	1,000			
	2013-2015	Conventional	1,000			
		ESG	1,000			
	2016-2017	Conventional	1,000			
		ESG	1,000			

As we can see from Table 18, none of our explanatory variables is close to 10 and therefore we can conclude the absence of multicollinearity in our models.

8.2.3. Heteroscedasticity

Homoscedasticity exists when the conditional variances of variables' error terms in the regression models are equal. On the other hand, if the variance of the residuals in our regressions varies then heteroscedasticity exists. The existence of heteroscedasticity would not cause unbiased estimated of model parameters, but cause the variance of the parameters to be biased and no longer t-distributed (Yamano, 2009). In this thesis, to control for heteroscedasticity robust standard errors were used when running our regressions.

9. Conclusion

The market of ESG Investing has seen significant growth in the last decade. The great exposure of sustainable issues faced by companies had led investors to track social liabilities of companies more closely. As a result, incorporation of ESG metrics to evaluate exposure to companies' non-financial risks in the investment process is increasing.

The boost integration of ESG factors into investment strategies is undeniable, however the question that remains is whether investors pay or not a premium for the ESG label. This thesis contributes to the literature of ESG investing by studying the performance of ESG in the fixed-income asset class. More specifically, we study the risk-adjusted return of European ESG bonds.

To study the performance of ESG Investing, we follow a positive-screening approach. By doing so only the 35% highest ESG companies that issued bonds are included in our ESG sample. We made use of a highly comparable conventional bond sample, so that after controlling for the risk factors that influence bond returns, the difference in performance can be justified by the ESG component. To test the ESG effect, the cross-sectional approach was used instead of the portfolio approach because of interest in the monotonic effect of the ESG label on bond returns. The cross-sectional regressions were performed in several well-known financial models in order to compare the risk-adjusted performance of ESG bonds and conventional peers.

Given the great attention academic literature has given on RI performance during periods of crisis and non-crisis, this thesis also contributes for the existing literature by analyzing ESG bond performance during different market regimes. Evidence exists that when the economy is weak investors tend to pay greater attention to firm risks and corporate behavior. If that is the case then ESG Investing is of greater importance during recession periods compared with non-recession periods.

Our results for the recession period showed that ESG bonds underperformed its conventional peers. Although our descriptive statistics show higher average annual return for the ESG bond than the conventional one and a slightly higher Sharpe ratio, after controlling for the corporate bond market effect both bond classes outperformed the market. However, a vis-à-vis comparison showed a different picture from the one obtained in the unconditional

analysis, with an average ESG bond underperforming its conventional peer. This underperformance of ESG bonds was consistent in the remaining factor-models applied when adjusting for market, default, interest rate and equity effects.
Regressions were run for successive 12-months periods, starting in January 2008. Our rolling regressions indicated that on average throughout the period ESG bonds had underperformed conventional ones and that this underperformance has been rather stationary over time. Despite of no statistical inference for the recession period results, on average an ESG bond showed an abnormal annual return of -1.15%-points, underperforming conventional bonds.

During non-recession periods, we obtained different results from the previous one. During periods of stability in financial markets ESG and conventional bonds seem to perform rather comparable. Our unconditional analysis showed that during the time-period, ESG bonds had lower average returns and Sharpe ratio than conventional ones. By controlling for market risk, the underperformance was less significant. This small difference in performance between ESG bond and its conventional peers was even smaller when adjusted for interest and default effects. After adjusting for the equity effect, the difference in performances continued to be very small, but now with ESG bonds showing a slightly better performance than its conventional peers. Identical to what was done for the recession period, rolling regressions were run for successive 12 months-period starting in January 2013. Our rolling regressions indicated that for the second half period there was a specific time interval where ESG bonds significantly outperformed their peers. Our robustness check uncovered that during that first half of our time-period ESG bonds continued to underperform relatively to their conventional peers. Whereas in the second half there was evidence of a marginally outperformance. Whether this can be an indication of future outperformance of ESG bonds is hard to conclude.

Discussion

Our results showed that ESG bonds' performance differs in the two market regimes. Corporates with high ESG ratings manage ESG risks more effectively and consequently are less exposed to those risks. Thus, the risk mitigation effect of ESG is expected to be greater in high-score ESG companies. During recession periods, investors track corporate behaviour and risks more carefully. This might imply that investors are willing to pay more for bonds of companies that provide them fully information regarding those behaviours and risks.

Following this rationality, the underperformance of the ESG bonds during the period can be justified by a premium paid by investors for the ESG label. Bonds are priced on perception of their risk, and the ESG label appears to play a role in the investment decision making as these companies are perceived to be less risky by investors during recession periods.

However, it seems that the ESG risk reduction effect is perceived rather differently in periods of financial stability. The comparable performance obtained for the non-recession period could be that investors might underestimate the risk-mitigation view of incorporating ESG considerations into their investment strategies. Opposed to tendency observed in recession periods, investors during stable market scenarios seem to be less risk averse and the costs[3] of ESG investing might outweigh their benefits. Leading investors to be indifferent regarding the ESG label of securities.

Future Research

Our results raise the question of whether the benefits of ESG investing are losing track in the European corporate bond market. Future research can be done in order to understand the root of this tendency. For this purpose, using a larger data set and extending the ESG universe to the general ESG European companies could be suggested. Additionally, our study was restricted to Europe, further research needs to be done in this market in respect to ESG performance in the fixed-income asset class. The nonexistence of studies in this market prevent us to compare our results and therefore further research is suggested.

Finally, another suggestion could be to study each ESG attributes in explaining bond returns, instead of the overall aggregate score. Similar studies were conducted for the equity asset class (see Manescu, 2011). For this purpose, another ESG rating methodology should be used, since Thomsen Reuters does not provide individual scores for each dimension. In general, there are still plenty research to be done in respect to ESG performance in the fixed-income as most studies have been focused in the equity class.

[3] ESG Investing costs are costs related with collecting ESG companies' information

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Appendix

Appendix A: List of 35% highest ESG companies, Recession period

The following list presents the companies that are included in our ESG bond sample. These are the companies that had the highest ESG scores during the analysed period 2008-2012 and that issued bonds that were active during the same period.

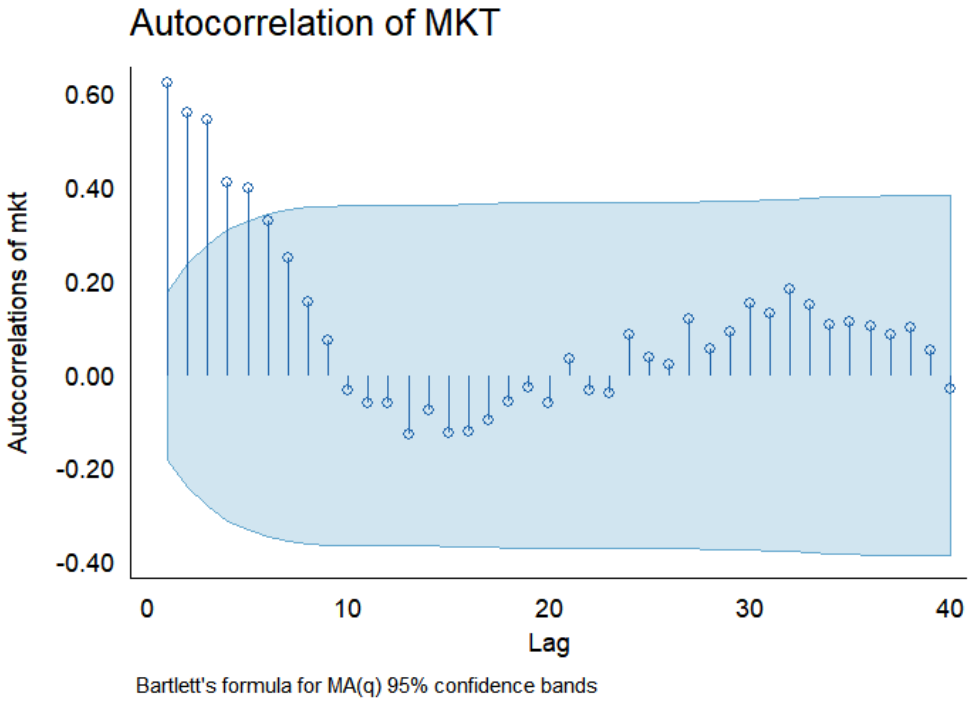
Company	Ticker
Siemens NV	SIEGR
Vodafone Group PLC	VOD
Intesa Sanpaolo SpA	ISPIM
UBS AG	UBS
UniCredit Bank AG	HVB
Banco Santander SA	SANTAN
Banco Bilbao Vizcaya Argentaria SA	BBVASM
BNP Paribas SA	BNP
Deutsche Bank AG	DB
Royal Bank of Scotland PLC/The	RBS
CaixaBank SA	CABKSM
Orange SA	ORAFP
Commerzbank AG	CMZB
Engie SA	ENGIFP
Electricite de France SA	EDF
National Grid Gas PLC	NGGLN
Abertis Infraestructuras SA	ABESM
KBC IFIMA SA	KBC
Iberdrola Finanzas SA	IBESM
Bankia SA	BKIASM
EDP - Energias de Portugal SA	EDP
Dexia Kommunalbank Deutschland GmbH	DEXGRP
ING Bank NV	INTNED
Barclays Bank PLC	BACR
Credit Agricole SA	ACAFP
HSBC France SA	HSBC
Eni Finance International SA	ENIIM
Deutsche Telekom International Finance BV	DT

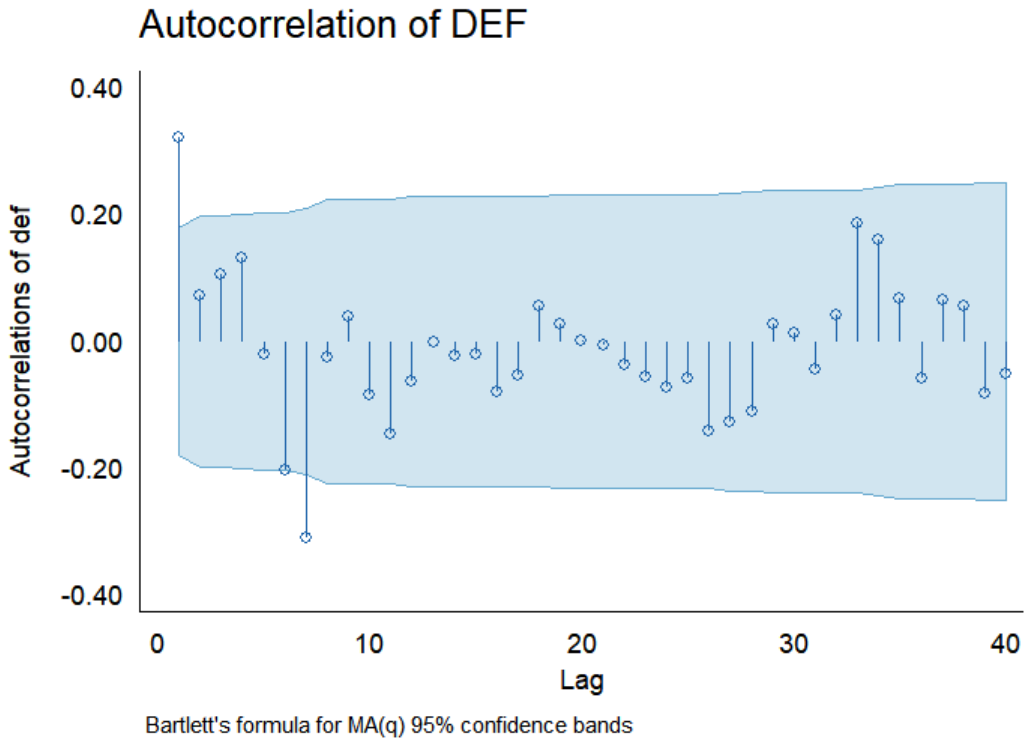
Appendix B: List of 35% highest ESG companies, Non-recession period

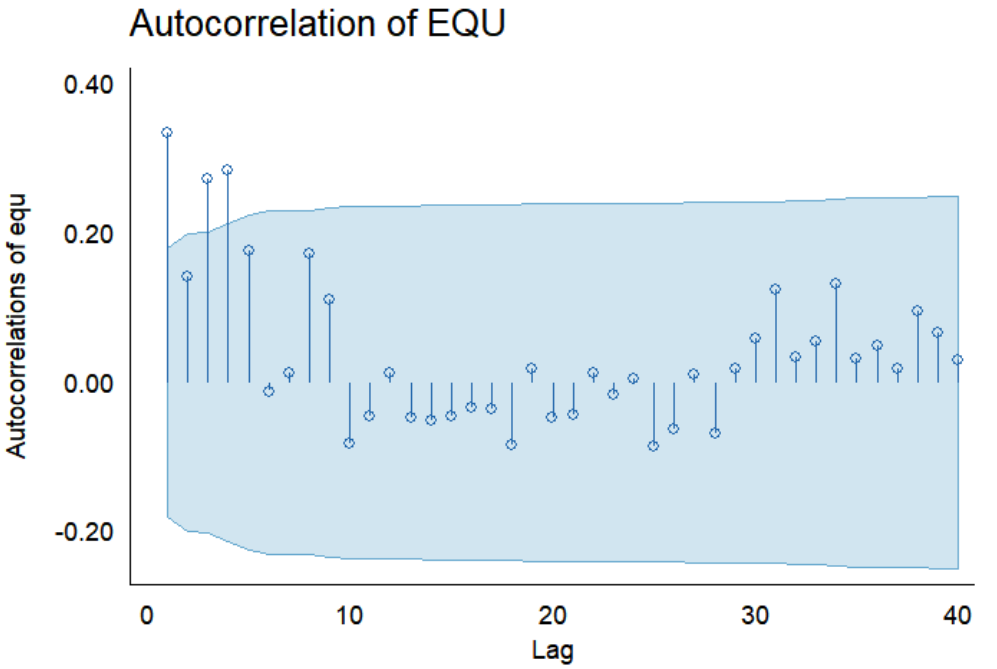
The following list presents the companies that are included in our ESG bond sample. These are the companies that had the highest ESG scores during the analysed period 2003-2017 and that issued bonds that were active during the same period.

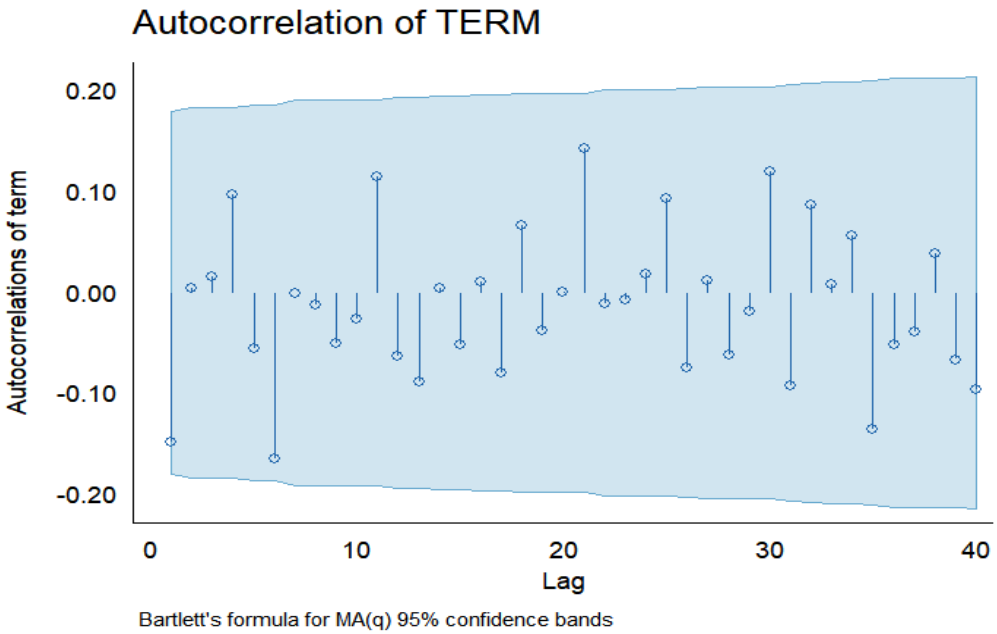
Company	Ticker	Company	Ticker
Statoil ASA	STLNO	WPP	WPPLN
BASF SE	BASF	Glencore Europe Ltd	GLELN
Linde AG	LINGR	Rolls-Royce PLC	ROLLS
Deutsche Bank AG	DB	Air Liquide SA	AIFP
Total Capital AS	TOTAL	Hera SpA	HERIM
Telecom Italia SpA	TITIM	ABN AMRO Bank NV	ABNANV
Bankinter SA	BKTSM	Phoenix PIB Dutch BV	PHARGR
HeidelbergCement AS	HEIGR	Telenor ASA	TELNO
Danone SA	BNFP	Credit Agricole AS	ACAFP
Snam SpA	SRGIM	KBC IFIMA SA	KBC
HSBC France SA	HSBC	Red Electrica Financiaciones SAU	REESM
Fiat Chrysler AS	FCAIM	Carrefour SA	CAFP
Intesa Sanpaolo SpA	ISPIM	Orange AS	ORAFP
Lloyds Bank PLC	LLOYDS	Gas Natural Fenosa BV	GASSM
BMW NV	BMW	DNB Bank ASA	DNBNO
EDP - Energias de Portugal SA	EDP	Fonciere Des Regions	FDRFP
Nestle Ltd	NESNVX	Accor AS	ACFP
Deutsche Telekom International Finance BV	DT	Svenska Handelsbanken AB	SHBASS
SKF AB	SKFBSS	LafargeHolcim Ltd	LHNVX
Cie de Saint-Gobain	SGOFP	Telekom Finanzmanagement GmbH	TKAAV
Atlas Copco AB	ATCOA	Raiffeisen Bank AG	RBIAV
Anglo American Capital PLC	AALLN	Smurfit Kappa Acquisitions ULC	SKGID
Iberdrola BV	IBESM	AP Moller - Maersk A/S	MAERSK
Fresenius SE & Co KGaA	FREGR	Assa Abloy AB	ASSABS
Renault AS	RENAUL	Unilever NV	UNANA
SSE PLC	SSELN	BNP Paribas SA	BNP
Commerzbank AG	CMZB	Banco Bilbao Vizcaya Argentaria SA	BBVASM
Volvo AB	VLVY	Daimler AG	DAIGR
Schneider Electric SE	SUFP	Allianz BV	ALVRG
Volkswagen NV	VW	Unibail-Rodamco SE	ULFP
Repsol BV	REPSM	Eni SpA	ENIIM
Telefonica Emisiones SAU	TELEFO	Siemens NV	SIEGR
Kering AS	KERFP	BP PLC	BPLN
Ferrovie dello Stato Italiane SpA	FERROV	Banco Santander AS	SANTAN
Swisscom AG	SCMNVX	CRH Finance dac	CRHID

Appendix C: Autocorrelation Test






Autocorrelation of EQU
Autocorrelations of equ
0.40
0.20
0.00
-0.20
0
10
20
30
40
Lag
Bartlett's formula for MA(q) 95% confidence bands


Autocorrelation of TERM
Autocorrelations of term
0.20
0.10
0.00
-0.10
-0.20
0
10
20
30
40
Lag
Bartlett's formula for MA(q) 95% confidence bands