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ESG criteria and the credit risk of corporate bond portfolios

A. Höck • T. Bauckloh
• M. Dumrose • C.Klein

centre for financial research
cologne

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Abstract:

Demand for sustainable fixed-income investment solutions is surging but there is hardly research on the impact of sustainability on the risk characteristics of fixed-income portfolios. This study examines the impact of sustainability on the credit risk exposure of U.S. corporate bond portfolios between 2013 and 2020 by analyzing the returns of sustainable and non-sustainable portfolios using two different asset pricing models and environmental, social, and governance (ESG) ratings from different providers. Controlling for a set of portfolio characteristics, our results show that sustainable portfolios are significantly less exposed to credit risk than their non-sustainable peer portfolios. This finding implies that considering ESG criteria in portfolio management is a suitable means to systematically manage credit risk. Being the first study to investigate the relationship between sustainability and credit risk on portfolio level, this study contributes to the understanding of the effects of ESG criteria in portfolio management and provides academics and investment professionals with valuable insights.

Key Takeaways:

- A more sustainable corporate bond portfolio has a lower credit risk exposure compared to a non-sustainable one.
- There is an adverse relation between a corporate bond portfolio's sustainability and its credit risk. Thus, the integration of sustainability can enhance traditional investment processes.
- However, we find no significant performance difference between sustainable and non-sustainable corporate bond portfolios on a risk-adjusted basis.

Keywords: Sustainability, Credit risk management, Corporate bonds

JEL Classification: G12, G32, Q56

INTRODUCTION

Investment solutions considering environmental, social, and governance (ESG) criteria, so-called sustainable investments, have experienced substantial demand and supply side growth in recent years. According to the Global Sustainable Investment Alliance (GSIA), the volume of sustainable investments in Europe, the USA, Canada, Australia/New Zealand, and Japan increased from 22.84 trillion US dollars at the beginning of 2016 to 35.30 trillion US dollars at the beginning of 2020, representing an increase of 65% (GSIA 2021). According to these numbers, sustainable investments account for more than one third of global assets under management (Boston Consulting Group 2020; GSIA 2021).

The growth of sustainable investments is accompanied by a large number of studies that examine the effect of ESG criteria on the risk-return profile of investments (Friede, Busch and Bassen 2015; Wallis and Klein 2015). The vast majority of those studies focus on listed equity, although fixed-income instruments' share is almost 40% of all sustainable investments (GSIA 2019). Furthermore, studies analyzing the impact of ESG criteria on the risk-return profile of fixed-income instruments focus on i) (abnormal) returns of sustainable mutual bond funds (Derwall and Koedijk 2009; Henke 2016) ii) (abnormal) returns of synthetic bond portfolios (Pereira, Cortez and Silva 2019; Polbennikov et al. 2016) or iii) on credit risk at company-level (Graham and Maher 2006; Klock, Mansi and Maxwell 2005; Oikonomou, Brooks and Pavelin 2014; Stellner, Klein and Zwergel 2015). However, to the best of our knowledge, there is no research which systematically investigates the effects of ESG criteria on corporate bond portfolios' credit risk.

This study aspires to fill this research gap by analyzing whether ESG criteria are a means to manage the credit risk of bond portfolios. To do so, we compare the credit risk exposures of sustainable and non-sustainable bond portfolios using the two-factor model by Fama and French (1993) and a four-factor model by Elton, Gruber and Blake (1995). Our analysis covers approximately 5.000 U.S. corporate bonds and the 2013 - 2020 period. We derive the portfolio constituents for the sustainable (non-sustainable) portfolio based on a best-in-class (worst-in-class) approach with varying ESG score percentile thresholds. We control for sector- and country-allocation, option-adjusted duration, and credit rating to minimize the impact of other bond characteristics on the portfolios' credit risk exposure. As proposed by (Chatterji et al. 2016), we conduct our analysis using ESG ratings from two different ESG rating providers to control for differences in ESG ratings across different providers.

We find a significantly adverse relation between the bond portfolios' sustainability and their credit risk. Furthermore, a clear relationship between the level of reduction in credit risk and the severity of the best-in-class (worst-in-class) approach indicates that ESG criteria can be used to systematically manage the credit risk of a bond portfolio. These findings are robust to the use of different asset pricing models and ESG ratings.

The contributions of this study are threefold. First, it is the first study which systematically investigates the effect of ESG criteria on the credit risk of corporate bond portfolios. Hence, this study adds a new perspective to the risk-return debate inherent to sustainable investments. It clearly shows that the consideration of ESG criteria in the portfolio allocation of bonds can significantly reduce a portfolio's systematic default risk. Second, it also provides important insights into the usability of ESG ratings. While a large body of literature indicates that (some) ESG ratings are subject to various biases, such as the sustainability rating agencies' understanding of sustainability (Berg, Koelbl and Rigobon 2019; Chatterji et al. 2016; Dimson, Marsh and Staunton 2020; Dorfleitner, Halbritter and Nguyen 2015) or the size (Drempetic,

Klein and Zwergel 2020), the rewriting history (Berg, Koelbl and Rigobon 2019), a mean reverse (Gidwani 2020), and a quantity bias (Chen, Behren and Mussalli 2021), the results of this study suggest that ESG ratings are still a suitable means for managing bond portfolios' credit risk. Third, the findings of this study support investment professionals in finding an efficient solution to effectively manage credit risks in their corporate bond portfolios by integrating ESG criteria into their investment process.

The remainder of this study is structured as follows: The next section briefly reviews the related literature. The section is followed by the description of the data and methodology of the empirical analysis. We than present the results and highlight the main findings of the analysis, followed by a confirmation of the results using different robustness checks. Finally, this paper concludes with a summary of the key findings and gives an outlook of further research needs.

LITERATURE REVIEW

Research that assumes a link between sustainability and default risk usually argues with one of the two following theories. First, the risk mitigation view (Goss and Roberts 2011) states that companies with a superior sustainability performance are less risky, since they are, e.g., less prone to reputational losses induced by negative incidents. Second, the overinvestment view (Goss and Roberts 2011) regards investments in sustainability as a waste of scarce resources, which increase fixed costs and earnings' volatility and thus companies' default risk (e.g., Frooman, Zietsma and McKnight 2008). Literature that deals with the effect of ESG criteria on the risk-return profile of fixed-income instruments primarily focuses on i) (abnormal) returns of sustainable mutual bond funds, ii) (abnormal) returns of synthetic bond portfolios or iii) on credit risk at company-level. Thus, there is no literature that systematically analyzes the effect of ESG criteria on the risk characteristics of bond portfolios.

Concerning returns of sustainable mutual bond, Derwall and Koedijk (2009) measure the performance of ESG fixed income funds in the U.S. for the 1987 to 2003 period by using multi-index performance evaluation models. They find that the performance of average ESG bond funds does not differ compared to conventional bond funds. Henke (2016) uses a five-factor model to explain returns of bond funds, showing that ESG bond funds in the U.S. and the Eurozone outperform conventional funds during the 2001 to 2014 period. This finding especially occurs during recessions or bear market periods. He attributes the outperformance to a systematic effect of social screening on financial performance caused by the hypothesized lower risk of high-ESG firms in combination with ESG bond funds' exclusion of irresponsible corporate bond issuers. Leite and Cortez (2018) investigate the performance of ESG bond funds domiciled in France and Germany from 2002 to 2014 using conditional multi-factor models that allow for both time-varying risk and performance. They find that ESG bond funds significantly outperform their conventional counterparts, which might be attributable to the government bonds and not to the corporate bonds in the portfolios. Madhavan and Sobczyk (2020) find a strong negative relation between a fund's total return and its holdings based ESG score for an active US bond fund sample in the 2015 to 2020 period. The authors explain this observation by the fact that funds with higher ESG scores have an exposure to high quality bonds, which are less volatile.

Considering the return patterns of synthetic bond portfolios, Polbennikov et al. (2016) show that portfolios consisting of high-ESG bonds have a slightly higher performance than their low-ESG counterparts after controlling for systematic risk factors such as duration, spread, and

DTS[1] by sector. Moreover, high-ESG bond portfolios have lower credit spreads on average. The first finding indicates the existence of a sustainability premium, which can explain a certain fraction of bond portfolio returns beyond the used systematic risk factors. Their second finding adds to the current academic discussion regarding the impact of sustainability on credit spreads. However, even though Polbennikov et al. (2016) account for systematic risk factors in their return attribution, they don't analyze possible differences in the exposure to systematic factors. Pereira, Cortez and Silva (2019) investigate the performance of high- and low- ESG bond portfolios of 189 Eurozone companies between 2003 and 2016 using a conditional multifactor model. They conclude that high-ESG bond portfolios outperformed at an early stage, with the outperformance disappearing over time. Moreover, their regression results indicate that high-ESG bond portfolios are significantly more exposed to default risk than low-ESG bond portfolios. Pereira, Cortez and Silva (2019) try to explain their finding by arguing that since low credit rated bonds present high yields, issuers of speculative grade bonds can benefit the most in absolute terms from reductions in the cost of debt that may result from considering ESG criteria in business practices. Building active investment grade, high-yield, and emerging market bond portfolios, Bahra and Thukral (2020) conclude that ESG scores can be used to enhance portfolio outcomes via lower drawdowns, reduced portfolio volatility, and, in some cases, even marginally increased risk-adjusted returns.

Finally, there is a large body of literature investigating the potential effects of the integration of ESG criteria in business activities on credit ratings, default risk premiums, and the costs of debt of firms. The results are ambiguous. Some studies suggest better credit ratings, i.e., lower risks and costs of debt, for high-ESG firms (Bauer and Hann 2010; Bhojraj and Sengupta 2003; Chiesa, McEwen and Barua 2021; Oikonomou, Brooks and Pavelin 2014; Stellner, Klein and Zwergel 2015). In contrast, other investigations point in the opposite direction (Izzo and Magnanelli 2012; Menz 2010).

METHODOLOGY

We investigate the impact of ESG criteria on the credit risk exposure of corporate bond portfolios using the following two-factor approach introduced by Fama and French (1993):

$$r_{P,t} = \alpha + \beta_1 * TERM_t + \beta_2 * DEF_t + \varepsilon_t \quad (1)$$

This model explains excess returns ($r_{P,t}$) of, in our case, a bond portfolio P with a term ($TERM_t$) and a default (DEF_t) factor in month t. $TERM_t$ represents the return resulting from price changes and the carry of treasury bonds, hence, capturing interest-rate risk. The factor return is calculated using the monthly return of a long-term US treasury index[2] in excess of the one-month USD-LIBOR rate. The monthly USD-LIBOR proxies for a risk-free investment opportunity. DEF_t explains the part of the return that is attributable to credit spreads, i.e., DEF_t captures default risk. The monthly factor return is calculated by subtracting the long-term US treasury index from long-term US corporate bond index[3]. $\varepsilon_{P,t}$denotes the error term. Despite

[1] Duration Times Spread (DTS) is used to measure the credit volatility of bond portfolios and is calculated by multiplying the spread duration and the credit spread, see Ben Dor et al. (2007) for more details.

2 The long-term US treasury index is the "Bloomberg Barclays U.S. Treasury: 7-10 Year TR Index" (Bloomberg ticker: "LT09TRUU Index")

3 The long-term US corporate bond index is the "Bloomberg Barclays U.S. Corporate Bond: 7-10 Year TR Index" (Bloomberg ticker: "I13283US Index").

being a rather simple model, Fama and French (1993) demonstrate the strong explanatory power of these two factors in the variation of US investment-grade corporate bond portfolio returns. Hence, we use this straightforward approach due to its simplicity to analyze the differences in the systematic default risk of sustainable and non-sustainable corporate bond portfolios by regressing the time series of different portfolios returns as well as the long-short portfolio returns for each level of sustainability. We test the robustness of our results by using i) ESG scores from two different data providers and ii) a more sophisticated four-factor model to explain the portfolio returns.

PORTFOLIO CONSTRUCTION

We derive our initial bond universe using the yearly constituents from the "Bloomberg Barclays US Agg Corporate Bond Index"[4], during the analyzed period from 2013 to 2020 covering 12.592 corporate bonds in total. The index comprises U.S. companies' corporate bonds denominated in US-Dollar. Bonds included in the index are restricted to a time to maturity of at least one year and a credit rating equal to investment grade. The index provides an excellent foundation due to its broad coverage and its representativeness of the US bond market. We consider all bonds with a sustainability rating from MSCI ESG Research[5].

We group the bonds according to their industry sector, region of risk, credit rating[6] and duration using Bloomberg data. The grouping procedure enables us to minimize the influence from differences in exposure to systematic risk factors. Table 1 describes the variables and the possible characteristics used in the grouping procedure:

Exhibit 1: Description of the Grouping Systematics for the Matching Procedure

Factor	Description	Characteristics
Industry sector	According to the Bloomberg Industry Sector Classification System (BICS).	Basic Materials, Communication, Consumer cyclical, Consumer non-cyclical, Energy, Financial, Industrial, Technology, Utility
Region of risk	The region of the country to which the company has the biggest business risk exposure (country of risk).	Africa/ Middle East, Asia Pacific, North America, South and Central America, Western Europe
Credit rating	The worst credit rating for the bond from S&P, Moody's and Fitch.	Better than AA-, from A+ to A-, worse than BBB+
Duration	The option-adjusted duration (OAD) of a bond.	Below 3%, 3%-5%, 5%-7%, 7%-10%, 10%-15%, 15%-20%, above 20%

Note: This exhibit describes the variables that are used for the grouping procedure. Column 1 displays the name of each characteristic, column 2 contains a short description and column 3 lists the possible characteristics for each variable. The grouping procedure aims to minimize differences between the sustainable and the unsustainable bond portfolio that are related to default risk.

4 Bloomberg ticker: "LUACTRUU Index".

5 For a discussion of the properties and behavior of the MSCI ESG scores see Polbennikov et al. (2016).

6 Since we have multiple credit ratings available, a bond's worst credit rating is used for the matching process.

We built sustainable (High ESG) and unsustainable (Low ESG) portfolios using three different ESG score percentile thresholds. We first rank the bonds within each of the resulting 1050 groups with respect to their MSCI ESG score. Bonds with an ESG score equal to or higher than the 12.5% percentile (25% and 50% percentile respectively) within each group are assigned to the High ESG portfolio, and conversely, bonds with ratings equal to or lower than the 87.5% percentile (75% and 50% percentile respectively) are assigned to the Low ESG portfolio. This procedure yields three pairs of portfolios with each pair consisting of one sustainable and one unsustainable portfolio.[7] We account for changes in a bond's option-adjusted duration, companies' credit rating and their sustainability performance (proxied by the ESG score) by revising the constituents of each portfolio in December of each year. All bonds within a portfolio are assigned an equal weighting.

Systematically investigating the impact of ESG criteria on credit risk using a portfolio approach rather than focusing on individual bonds comes with several advantages. First, the portfolio approach reduces bond specific idiosyncratic factors. Thus, it allows to gain more precise estimations of the exposure to the default risk factor and, ultimately, the impact of ESG criteria and credit risk. Second, it enables us to differentiate between different levels of sustainability. And third, the findings are better tailored to investors.

DESCRIPTIVE STATISTICS

Exhibit 2 provides statistics on High (Low) ESG portfolios' yearly credit ratings and their option adjusted duration based on the 12.5% ESG score percentile threshold for which the likelihood of significant differences in these characteristics is the highest. However, we expect differences in both characteristics to disappear with respect to our grouping procedure which allows us to assign differences in the High and Low ESG portfolios' exposure directly to the differences in their ESG criteria. The descriptive analysis of the two characteristics at the portfolio level supports our expectation. We find consistently small, if any, differences between the High and Low ESG portfolios' credit ratings (Panel A) and the option-adjusted duration (Panel B) with respect to their yearly median (column 3) and mean (column 4). Using a non-parametric Wilcoxon test (column 7) and a two-sided t-test (column 8), we can confirm that those small differences are not statistically significant. We conclude that High and Low ESG portfolios do not differ with respect to their average credit rating (Panel A) and to the average option adjusted duration (Panel B) in any of the given years. Thus, the grouping process is successful and differences in the portfolios' credit risk can be attributed to differences in the degree of sustainability.

Exhibit 2: Descriptive Portfolio Statistics

Panel A: Credit Ratings

	(1) Min	(2) 25%	(3) Median	(4) Mean	(5) 75%	(6) Max	(7) Wilcoxon	(8) T-test
High ESG 2013	4	7	8	8.01	9	11	0.78	0.76
Low ESG 2013	4	7	8	7.97	9	11		
High ESG 2014	4	7	8	7.89	9	11	0.98	0.98
Low ESG 2014	4	7	8	7.89	9	11		
High ESG 2015	2	7	8	7.89	9	11	1	0.99

7 To increase the readability, we will refer to those three pairs using the terms 12.5% ESG score percentile (25% and 50% ESG score percentile threshold, respectively) in this manuscript.

Low ESG 2015	2	7	8	7.89	9	11		
High ESG 2016	2	7	8	7.88	9	11	0.92	0.93
Low ESG 2016	2	7	8	7.87	9	11		
High ESG 2017	2	7	8	7.91	9	11	0.98	0.98
Low ESG 2017	2	7	8	7.91	9	11		
High ESG 2018	2	7	8	8.01	9	11	0.99	1
Low ESG 2018	2	7	8	8.01	9	11		
High ESG 2019	2	7	8	8.05	9	11	0.84	0.81
Low ESG 2019	2	7	8	8.02	9	11		
High ESG 2020	2	7	8	8.01	9	11	1	1
Low ESG 2020	2	7	8	8.01	9	11		

Panel B: Option-Adjusted Duration

	Min	**25%**	**Me-dian**	**Mean**	**75%**	**Max**	**Wilcoxon**	**t-test**
High ESG 2013	0.92	3.37	5.33	6.55	8.08	17.33	0.43	0.65
Low ESG 2013	0.94	2.94	4.94	6.4	8.04	17.09		
High ESG 2014	0.81	3.36	5.56	6.92	7.98	17.75	0.46	0.67
Low ESG 2014	0.9	2.97	5.4	6.78	8.82	17.76		
High ESG 2015	-3.54	3.33	5.63	6.85	9.05	17.37	0.32	0.57
Low ESG 2015	0.9	2.89	5.41	6.68	8.64	17.68		
High ESG 2016	0.9	3.41	5.53	6.94	9.75	17.35	0.26	0.54
Low ESG 2016	0.93	2.76	5.19	6.75	9.02	17.57		
High ESG 2017	0.33	3.32	5.37	6.85	8.08	18	0.44	0.73
Low ESG 2017	0.97	2.86	4.93	6.74	8.16	18.03		
High ESG 2018	0.92	2.92	5.31	6.71	10.44	17.35	0.96	0.95
Low ESG 2018	0.88	3.16	5.22	6.69	9.64	17.69		
High ESG 2019	0.91	3.04	5.15	6.96	10.9	19.66	0.75	0.86
Low ESG 2019	0.76	2.81	5.34	6.91	10.41	19.31		
High ESG 2020	0.77	3.74	6.25	7.94	11.73	21.79	0.93	0.94
Low ESG 2020	0.61	3.76	6.13	7.92	11.58	21.24		

Note: This exhibit provides the minimum (Min). the 25% percentile (25%). the median. the mean. the 75% percentile (75%) and the maximum (Max) value of the credit rating (Panel A) and the Option-Adjusted Duration (Panel B) for the portfolios built on the MSCI 12.5% ESG score percentile threshold. Credit ratings are translated into numeric values range from 2 (lowest credit rating) to 11 (highest credit rating). To test for potential differences between the sustainable (High ESG) and the unsustainable (Low ESG) portfolio. we apply a Wilcoxon Rank Sum Test and a two-sided t-test on the yearly mean values. P-values of both tests are presented in column 7 and 8.

RESULTS

Exhibit 3 presents the results of the Fama and French (1993) two-factor model regressions for the High and Low ESG corporate bond portfolios. In addition to the regression results for the return time-series of the respective portfolios, return and risk factor differences between both portfolios are analyzed by means of a difference portfolio, going long in the Low and short in the High ESG portfolio ("Low-High").

Exhibit 3: Fama and French two Factor (1993) Model using MSCI ESG Data

	50% Cut-Off Value			**25% Cut-Off Value**			**12.5% Cut-Off Value**		
	Low ESG (1)	**High ESG (2)**	**Low-High (3)**	**Low ESG (4)**	**High ESG (5)**	**Low-High (6)**	**Low ESG (7)**	**High ESG (8)**	**Low-High (9)**
TERM	0.905***	0.906***	-0.001	0.877***	0.887***	-0.010	0.844***	0.840***	0.004
	(0.020)	(0.021)	(0.005)	(0.020)	(0.022)	(0.010)	(0.018)	(0.023)	(0.018)

DEF	0.905***	0.855***	0.049***	0.877***	0.799***	0.078***	0.841***	0.677***	0.164***
	(0.018)	(0.024)	(0.010)	(0.016)	(0.030)	(0.019)	(0.015)	(0.054)	(0.051)
Constant	0.000	0.001*	-0.000*	0.001*	0.001**	-0.000	0.001**	0.001**	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	96	96	96	96	96	96	96	96	96
Adj. R^2	0.972	0.965	0.603	0.974	0.960	0.565	0.974	0.934	0.580
F Statistic (df = 2; 93)	1,657.043***	1,310.610***	73.145***	1,787.768***	1,140.493***	62.595***	1,787.635***	675.511***	66.508***

Note: This table presents the regression coefficients of monthly OLS regressions using the Fama French (1993) two factor model. Standard errors are adjusted per Newey-West and presented in parenthesis. Columns 1 to 3 provide the 50% ESG score percentile threshold, columns 4 to 6 provide the 25% ESG score percentile threshold and columns 7 to 9 provide the 12.5% ESG score percentile threshold. Columns 1, 4 and 7 present the results for the unsustainable (Low ESG) portfolios, columns 2, 5 and 8 present the results for the sustainable (High ESG) portfolios and columns 3, 6 and 9 present the results of a Low-High difference portfolios. The sample period is from 2013 to 2020. The data is derived from Bloomberg and MSCI.
*, **, *** indicate significance at the 10%, 5% and 1% level, respectively.

We observe that the explanatory power of the Fama and French (1993) two-factor model is quite high accounting for 93.4% to 97.4% in the Low and High ESG portfolios' return variation. Unsurprisingly, we find significantly positive loadings on TERM, indicating a statistically significant interest-rate risk exposure in both portfolio types. Since the coefficient of the TERM factor does not significantly differ from zero in any of the Low-High difference portfolios, there is, however, no evidence for differences in interest-rate-risk exposure between the two portfolios. This finding again reflects a successful grouping of bonds before the regression. Furthermore, all Low and High ESG portfolios load significantly positive on the default risk (DEF) factor. We also find a significantly positive coefficient for DEF in each of the three Low-High ESG portfolios, implying that Low ESG portfolios have a significantly higher default risk than High ESG portfolios. Interestingly, the magnitude of DEF coefficients of the difference portfolio regressions is adversely related to the ESG score percentile threshold, raising from 0.049 with a 50% ESG score percentile threshold to 0.164 with a 12.5% ESG score percentile threshold. Thus, the difference in the exposure to default risk between Low and High ESG portfolios raises with the differences in the average ESG scores suggesting that a portfolio's overall default risk significantly relates to its ESG performance. The more sustainable a corporate bond portfolio is, the lower its default risk on average. This finding suggests that corporate bond portfolios' default risk can be purposefully managed by considering ESG criteria in the investment process.

We find evidence for a systemically lower exposure towards default risk of best-in-class created sustainable corporate bonds portfolios compared to their unsustainable corporate bonds peer portfolios. Hence, we can confirm that ESG score differences on the portfolio-level are associated with a lower portfolio default risk on average. Furthermore, the constants of our Low-High difference portfolios do not support a significantly outperformance of unsustainable corporate bond portfolios compared to sustainable corporate bond portfolios. We can reject a performance penalty subject to the ESG based best-in-class approach. On the contrary, we find an economically and statistically weak but significant outperformance of the sustainable 12.5% ESG score percentile threshold portfolio compared to its unsustainable peer portfolio. Based on these findings, we conclude that best-in-class strategy can be used as an instrument to control the systematic default risk exposure of a portfolio while the resulting ESG shift still allows to adequately diversify the sustainable portfolio.

ROBUSTNESS CHECKS

Our initial analysis has already revealed robust results for varying ESG score percentile thresholds. In addition to the application of those different thresholds, we run two further robustness checks integrating the findings of previous academic studies. Recent research, e.g., revealed inconsistencies between ESG ratings of different rating providers (Berg, Koelbl and Rigobon 2019; Chatterji et al. 2016; Dorfleitner, Halbritter and Nguyen 2015; Dumrose, Rink and Eckert 2022). Chatterji et al. (2016), therefore, propose using scores from different ESG rating providers to ensure the robustness of studies' results. Following this proposal, we replace MSCI ESG scores with Refinitiv ESG scores, and re-run the Fama and French two-factor model under consideration of the aforementioned ESG score percentile thresholds. Exhibit 4 presents the results using Refinitiv ESG scores. This analysis confirms the results of our initial analysis revealing that the exposure to the default risk factor increases adversely to the ESG score percentile threshold in the Low-High ESG portfolios. While the differences in the default risk are statistically significant for all Low-High ESG portfolios when using MSCI ESG ratings, we only observe a statistically significant difference for the 12.5% ESG score percentile threshold. These results, however, underpin our conclusion stating that the differences in the default risk rises with the difference in the average ESG scores of the corporate bond portfolios.

Exhibit 4: Fama and French two Factor (1993) Model using Refinitiv ESG Data

	50% Cut-Off Value			25% Cut-Off Value			12.5% Cut-Off Value		
	Low ESG (1)	**High ESG (2)**	**Low-High (3)**	**Low ESG (4)**	**High ESG (5)**	**Low-High (6)**	**Low ESG (7)**	**High ESG (8)**	**Low-High (9)**
TERM	0.886***	0.876***	0.010	0.879***	0.864***	0.015	0.835***	0.824***	0.010
	(0.021)	(0.019)	(0.010)	(0.023)	(0.018)	(0.012)	(0.025)	(0.017)	(0.016)
DEF	0.864***	0.839***	0.025	0.894***	0.853***	0.042	0.873***	0.791***	0.082**
	(0.016)	(0.033)	(0.026)	(0.023)	(0.022)	(0.032)	(0.028)	(0.022)	(0.039)
Constant	0.000*	0.001*	-0.000	0.000*	0.000	0.000	0.001**	0.001*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	96	96	96	96	96	96	96	96	96
Adj. R^2	0.971	0.964	0.061	0.972	0.971	0.112	0.968	0.971	0.266
F Statistic (df = 2; 93)	1,608.437***	1,261.860***	4.101**	1,622.348***	1,571.153***	6.976***	1,431.400***	1,599.776***	18.208***

Note: This table presents the regression coefficients of monthly OLS regressions using the Fama and French (1993) two- factor model. Standard errors are adjusted per Newey-West and presented in parenthesis. Columns 1 to 3 provide the 50% ESG score percentile threshold, columns 4 to 6 provide the 25% ESG score percentile threshold and columns 7 to 9 provide the 12.5% ESG score percentile threshold. Columns 1, 4 and 7 present the results for the unsustainable (Low ESG) portfolios, columns 2, 5 and 8 present the results for the sustainable (High ESG) portfolios and columns 3, 6 and 9 present the results of a Low-High differences portfolio with respect to each ESG score percentile threshold. The sample period is from 2013 to 2020.
*, **, *** indicate significance at the 10%, 5% and 1% level, respectively.

In our second test, we replace the Fama and French (1993) two-factor model with a more sophisticated four-factor model introduced by Elton, Gruber and Blake (1995). This model provides two major enhancements with respect to our findings. First, Elton, Gruber and Blake (1995) takes a slightly different approach in measuring the default factor. The authors use the difference in returns from a US-high yield corporate bond index and a US-intermediate treasury bond index as gauge for the systematic default risk factor. And second, the four-factor model by Elton, Gruber and Blake (1995) covers not only systematic default risk (DEF2) but

also incorporates a risk factor related to the risk in the overall bond market (BOND), an optionality premium factor (OPTION) and a risk factor relating to the systematic equity risk (EQUITY) [8]. Therefore, we apply the following regression model:

$$r_{p,t} = \alpha + \beta_1 * EQUITY_t + \beta_2 * BOND_t + \beta_3 * DEF2_t + \beta_4 * OPTION_t + \varepsilon_t \qquad (2)$$

Exhibit 5 presents the results of the four-factor model. We do not find a significant exposure towards the EQUITY factor for either the Low or High ESG portfolio. However, both portfolios are symmetrically exposed towards the BOND, DEF2 and OPTION factor. In line with our expectations, the significant factor exposure does not persist for the BOND and OPTION factor in the Low-High ESG portfolio. However, the results of the four-factor model support our previous findings regarding significant differences in the Low-High ESG corporate bond portfolios' exposure towards the default factor. The regression coefficient is positive and statistically different from 0. A one percentage point increase in the return of the default risk factor is associated with an increase in the Low-High ESG portfolio return by 0.13 percentage points on average. Thus, our finding of significantly different exposure towards the default risk factor relating to large differences in portfolios' ESG scores can be confirmed using the more sophisticated Elton, Gruber and Blake (1995) model.

Exhibit 5: Elton et al. (1995) Model 12.5% Cut-Off Level

	Low ESG (1)	High ESG (2)	Low-High (3)
EQUITY	-0.017	0.011	-0.028
	(0.016)	(0.023)	(0.020)
BOND	1.368***	1.367***	0.001
	(0.081)	(0.065)	(0.039)
DEF2	0.359***	0.226***	0.133*
	(0.059)	(0.017)	(0.073)
OPTION	-0.274**	-0.317**	0.043
	(0.115)	(0.127)	(0.083)
Constant	-0.000	0.000	-0.000
	(0.001)	(0.000)	(0.000)
N	96	96	96
Adj. R^2	0.911	0.928	0.427
F Statistic (df = 4; 91)	243.677***	306.262***	18.681***

Note: This table presents the coefficients of monthly OLS regressions using the Elton, Gruber and Blake (1995) four-factor model. Standard errors are adjusted per Newey-West and presented in parenthesis. Column 1 presents the coefficients for the unsustainable (Low ESG) portfolio, column 2 presents the coefficients for the sustainable (High ESG) portfolio and column 3 presents the coefficients of a Low-High differences portfolio using a 12.5% ESG score percentile threshold. The sample period is from 2013 to 2020. The data is derived from Bloomberg and MSCI.
*, **, *** indicate significance at the 10%, 5% and 1% level, respectively.

8 The respective factors are measured as follows: (1) EQUITY = S&P 500 TR Index (Bloomberg ticker: "SPXT Index") – return from a risk-free investment (1-week USD LIBOR), (2) BOND = Bloomberg Barclays US Agg Index (Bloomberg ticker: "LBUSTRUU Index") – return from a risk-free investment (1-week USD LIBOR), (3) DEF (2) = Bloomberg Barclays U.S. Corporate Bond High Yield Index (Bloomberg ticker: "LF98TRUU Index") – Bloomberg Barclays US Intermediate Treasury Index (Bloomberg ticker: "LT08TRUU Index"), (4) OPTION = Bloomberg Barclays US MBS Fixed Rate Index (Bloomberg ticker: "LD10TRUU Index") - Bloomberg Barclays US Treasury 1-5y Index (Bloomberg ticker: "LTR1TRUU Index").

CONCLUSION

The aim of this study is to give academics and investment professionals important insights on the impact of sustainability on the systematic default risk exposure of corporate bond portfolios. Controlling for several portfolio characteristics, our findings highlight that the implementation of a best-in-class strategy significantly affects the credit risk exposure without any performance- or diversification penalty. There is a clear adverse relation between a corporate bond portfolio's sustainability and its credit risk: the higher the sustainability, the lower the credit risk. Hence, our results are consistent with the risk mitigation view (Goss and Roberts 2011) which states that companies with a superior sustainability performance are less risky. The findings of this study are robust to the usage of ESG ratings from different providers and different asset pricing models.

Our study further has implications for investment professionals. First, the consideration of ESG criteria in portfolio management is a suitable tool to systematically manage credit risk. Second, investment professionals have to account for the resulting bias in their portfolios to control their active risks. For instance, asset managers tracking a sustainable portfolio against a conventional benchmark need to overweight companies with lower credit ratings to compensate for the risk mitigating effect from higher sustainability to reduce systematic credit risk tracking error.

This is the first academic study that analyzes the effect of incorporating a best-in-class ESG approach on corporate bonds, which noticeably contributes to the current academic discussion. Further research could investigate the stated relationships for different fixed-income segments, like high-yield or emerging market credit, because the demand from clients in these segments is rising and the impact of sustainability could be more pronounced due to higher information-asymmetries and lower regulations.

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