JOIM
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Journal Of Investment Management, Vol. 20, No. 4, (2022), pp. 65–86

ESG SCREENING IN THE FIXED-INCOME UNIVERSE

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This paper evaluates the impact of a screening process based on Environmental, Social, and Governance (ESG) scores for an otherwise passive portfolio of investment-grade corporate bonds. The main result is that a global exclusion strategy leads to a substantial improvement of the targeted ESG score without reducing the risk-adjusted performance but with significant biases in regional, sectoral, and risk factor exposures. We demonstrate that a best-in-class strategy implemented at the regional and sectoral levels allows investors to eliminate undesirable regional and sectoral exposures while delivering similar ESG scores and risk-adjusted performances.

1 Introduction

In corporate bond markets, the Sustainable and Responsible Investment (SRI) segment ihas developed exponentially in the last ten years. The Green, Social, and Sustainable (GSS) bond market has been very dynamic in recent years with a total issuance of USD 706 billion in 2020 and a total of USD 1.7 trillion outstanding, which still covers a small fraction of the overall bond market representing approximately USD 100 trillion.[1] However, the supply of sustainable corporate bonds is well below the demand for such bonds, as a substantial fraction of the issuers of GSS bonds are sovereign, local government, government-backed or supranational entities. Because of the still relatively small size of the SRI bond market, investors have been looking at alternative ways to improve the Environmental, Social, and Governance (ESG) profile of their corporate bond portfolios. A complement to SRI bonds, i.e., bonds that are issued with an explicit sustainable profile, is investment in bonds issued by sustainable firms or firms with a high ESG score. Following the trend observed in equity markets, exclusion or best-in-class strategies based on ESG scores have been developed. Several studies have analyzed the performance of SRI or ESG funds and indexes, but only a few papers have analyzed

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the impact of bond investment strategies based on ESG scores, including Ben Slimane *et al.* (2019), Bahra and Thukral (2020), and Mendiratta *et al.* (2020). In summary, their main conclusion is that investing in bonds issued by firms with high ESG scores does not result in underperformance, although the potential for overperformance is limited.

To our knowledge, the present paper is the first to directly and systemically assess how ESG concerns can be integrated into a bond portfolio through a screening process and how the risk exposures of the portfolio are affected by the screening process. We adopt a methodology similar to that used in previous papers in the universe of stocks, in particular Alessandrini and Jondeau (2020). We use as a benchmark the Bloomberg Barclays Global Aggregate Corporate Index, a large, conventional bond market index covering investment-grade securities worldwide, for the 2014–2020 period. We analyze the USD and EUR segments separately to prevent the characteristics of these portfolios from being affected by currency volatility. We use issuer ESG scores from MSCI-ESG database.

In a first approach (global exclusion), we exclude from the portfolio bonds issued by firms with the lowest scores, representing 25%, 33%, and 50% of the market value. The proceeds of the exclusion are reinvested proportionately in remaining bonds. We find that the resulting portfolio suffers from substantial regional and sectoral imbalances relative to its conventional benchmark. To address this issue, we implement an alternative strategy ("best-in-class" screening), in which the proceeds of the exclusion of firms with the lowest scores in a given region–sector are reinvested in bonds issued by the firms with the highest scores in the same region–sector. In doing so, we eliminate any undesirable regional and sectoral exposure while delivering similar ESG scores and risk-adjusted performances. For instance, for the USD segment of the market index, the exclusion of 33% of the benchmark market value based on the overall ESG score results in respective increases of the score and Sharpe ratio to 6.1 and 0.69 from 4.97 and 0.66 for the conventional benchmark. With best-in-class screening, the gain in terms of the score and Sharpe ratio remains substantial with an average score and a Sharpe ratio equal to 6.24 and 0.68, respectively.

We also identify significant risk factor exposures, suggesting that the screening process is not innocuous regarding the characteristics of bonds excluded from the portfolio. In this risk factor analysis, we follow Bai *et al.* (2019) in the definition of bond-specific factors. Indeed, these authors suggest using downside risk, credit risk, liquidity risk, and reversal risk factors as an alternative to factors adapted from stock markets. We find that best-in-class screening at region–sector level reduces the exposure to risk factors. Most ESG portfolios are less exposed to downside risk than the conventional benchmark. In addition, ESG portfolios are negatively exposed to the credit risk factor, suggesting that they typically overweight high-quality securities. The reduction in the exposure to both downside and credit risks is the greatest for the screening based on the E score, making this pillar particularly relevant from the perspective of creating more defensive portfolios. The good performance of ESG portfolios relative to the benchmark, while delivering better risk exposures, can be interpreted as a result of the currently high demand from investors for sustainable bonds (see Pástor *et al.*, 2021b).

2 Review of Literature

The contribution of green bonds in lowering the cost of financing sustainable investment is still a debated research topic. Reed *et al.* (2019) find

that green-labeled bonds are missing a premium, which they attribute to the inability to differentiate net environmental benefits among bonds. Zerbib (2019) finds a small negative premium relative to conventional bonds. This evidence suggests a relatively minor impact, if any, of investors' proenvironmental preferences on bond prices. Furthermore, Gyura (2020) suggests that there is only little addition in moving to green bonds. The author points out that the growth of such instruments does not directly mean that the same amount of capital flows to environmental sustainability efforts. In contrast, from a financial perspective, Larcker and Watts (2020) and Flammer (2021) find no pricing difference between green and brown bonds. However, Flammer (2021) also reports that investors tend to respond positively to the issuance announcement, reflecting the fact that issuers improve their environmental performance post issuance. This recent evidence suggests that the main argument for issuing green bonds is to signal a firm's commitment to the environment.

More generally, studies on SRI bond funds obtain mixed results about the impact of sustainability criteria on the performance profile. Derwall and Koedijk (2009) find evidence that SRI bond funds perform similar to conventional funds. Henke (2016) provides comprehensive empirical research on ESG screening in the bond universe by comparing more than a 100 SRI bond funds to conventional ones. The author finds that on average, SRI funds outperform the conventional funds by 0.33–0.49% annually. When only SRI funds with ESG screening are considered, outperformance increases to 0.58–0.70% annually. Leite and Cortez (2018) obtain a similar level of outperformance for European SRI funds. Polbennikov *et al.* (2016) investigate the relation between ESG ratings and the performance of ESG and SRI corporate bond indices. The authors conclude that ESG investing does not result in lower financial performance but instead find that a high ESG grade generates a modest incremental return on average in the fixed income universe for corporate portfolios. Governance appears to have been the largest contributor to incremental performance, while the effects of Environmental and Social scores have been weaker. Madhavan and Sobczyk (2020) go a step further and match the performance of fixed income funds to the ESG attributes of the firms held by the funds. The authors find a strong negative relation between a fund's total return and its holdings-based ESG score, and they attribute this result to the fact that funds with high ESG scores tend to invest in higher-rated bonds, which are also less volatile, resulting in lower performance.

A limited number of recent papers have analyzed bond portfolios constructed using ESG strategies. The research most related to ours is Bahra and Thukral (2020). The authors construct ESG-tilted strategies by conditioning on risk cubes, which correspond to intersections of the sector, credit rating, and duration of the bonds. The strategy is rather extreme, as it buys only the top 20% of ESG-scored bonds within each risk cube (corresponding to an overall 80% exclusion). The authors find that ESG scores can be used to enhance portfolio outcomes via lower drawdowns, reduced portfolio volatility, and, in some cases, marginally increased risk-adjusted returns. Mendiratta *et al.* (2020) also investigate the universe of corporate bonds in developed markets by considering the financial risk and performance characteristics of ESG score terciles. The authors find that investing in high ESG-rated issuers does not result in underperformance. Ben Slimane *et al.* (2019) propose an active management strategy based on ESG score-sorted portfolios. The authors find that ESG optimized portfolios deliver a positive excess return with respect to the index benchmark. Contrary to equity markets, overperformance is moderate

and significant only in the EUR investment-grade corporate bond market.

Our paper also analyzes the impact of ESG screening on the risk factor exposure of the ESG-tilted portfolios. Following the research of Fama and French (1993, 2015) on equity markets, several papers document similar factors on corporate bond, including value (Correia *et al.*, 2012), momentum (Jostova *et al.*, 2013), low volatility (Frazzini and Pedersen, 2014), and size (Houweling and van Zundert, 2017). Bektić *et al.* (2019) construct Fama and French (2015) factors for the U.S. and European bond markets. The authors find strong economic and statistical significance for all factors for the U.S. high-yield market but mixed evidence for investment-grade markets. As pointed out by Hong and Sraer (2013), given the particular payoff structure of bonds relative to stocks, investors in bond portfolios are more likely to suffer from downside risk than benefit from a large upside because upside payoffs are capped. Building on this key feature, Bai *et al.* (2019) take a different avenue and acknowledge that bonds and stocks should be described by different factors. The authors find that downside risk is the strongest predictor of future bond returns. They also introduce common risk factors based on credit risk, liquidity risk, and return reversal risk and find that these bond factors command economically and statistically significant risk premiums that cannot be explained by long-established stock and bond market factors. We adopt the same definition of the risk factors as Bai *et al.* (2019).

3 Data

Our analysis is based on the Bloomberg Barclays Global Aggregate Corporate Total Return Index, a global corporate bond index including investment-grade bonds only.[2] The constituent list is retrieved from Bloomberg, with collected monthly data covering the period from January 2014 to December 2020. The number of constituents of the bond index increased from 6,405 securities in January 2014 to 11,117 in December 2020. As a company may have issued several constituent bonds, our sample includes 817 firms for January 2014 and 1,121 firms for December 2020, resulting in approximately nine bonds per issuer on average. We use this index as a conventional benchmark.

ESG scores from issuers are from the MSCI-ESG database. The ESG quality of a firm is evaluated according to three pillars: the Environmental (E), Social (S), and Governance (G) pillars. The E pillar covers all questions regarding climate change, natural capital, pollution and waste, and environmental opportunities. The S pillar covers concerns related to human capital, product liability, stakeholder opposition, and social opportunities. The G pillar pertains to issues related to ownership and control but also to business ethics and tax transparency. In addition to the E, S, and G scores, we also consider the overall ESG score, which combines the three pillars and for which firms' scores are normalized by their industries. Initially, ESG scores were defined at the firm's level, which corresponds to the scores one typically uses for equity portfolios. More recently, ESG data providers have started to produce scores at the securities level (i.e., equities and bonds). To our knowledge, all recent papers on ESG investing in corporate bonds still rely on ESG scores at issuer, not security, level. One reason is that, with except for green bonds, securities scores are usually the same as the issuers scores. In the benchmark index we use, green bonds represent a very small fraction of the total market value, from 0.01% at the beginning of our sample to 1.2% at the end of our sample. This small market share explains why we view our approach as an alternative or complement to investing in green bonds, whose market

value is currently insufficient to satisfy investors' demand.[3]

We now briefly describe the characteristics of the constituents of the bond index in terms of currency, regional, and sectoral coverage. The conventional benchmark includes bonds denominated in 15 different currencies but our research focuses on the two most relevant ones, i.e., the U.S. Dollar (USD) and the Euro (EUR). On average, bonds issued in USD represent approximately 67.5% of the index and those in EUR represent 23%. Thus, both currencies account for more than 90% of the market value of the index.[4] We construct two separate portfolios based on the market index corresponding to the USD and EUR segments to avoid issues related to currency volatility. In addition, we consider four regions (North America, Europe, Pacific, and emerging countries) and 10 industries (ICB industries from the FTSE Group) to evaluate the impact of ESG screening on the regional and sectoral structure of the portfolio.[5]

Even if firms located in a given country can issue bonds in any of these currencies, firms from North America more naturally issue bonds denominated in USD, and European firms more naturally issue bonds denominated in EUR. As Table 1 (Panel A) reveals, firms from North America and Europe represent 79.9% an 11.1% of the USD segment and 19.4% and 72.4% of the EUR segment, respectively. Therefore, it is likely that the ESG quality of the USD and EUR segments will reflect the ESG quality of these regions (see Ben Slimane *et al.*, 2019).

Table 1 (Panel B) reports the weights of the different industries in the USD and EUR segments of the bond index. For bonds denominated in USD, financials represent 30% of the market value, reflecting the fact that financial institutions usually take more debt than other corporates. The top six issuers are the largest U.S. banks, which together represent 9.5% of the USD segment on average (See Appendix A). We note that utilities and energy firms have a weight in the bond index well above their weight in the equity index, as they tend to take on more leverage than other non-financial firms. In contrast, technology firms have a lower weight in the bond index.

Table 1 Regional and sectoral composition of the USD and EUR segments (in %).

	USD segment	EUR segment
Panel A: Regional composition		
North America	79.91	19.43
Europe	11.14	72.44
Pacific	4.14	3.89
Emerging countries	4.81	4.24
Panel B: Sectoral composition		
Financials	30.50	34.10
Healthcare	9.38	5.32
Utilities	8.37	8.56
Industrials	8.26	9.68
Consumer staples	7.82	8.57
Energy	7.79	5.04
Technology	7.06	2.60
Consumer discretionary	6.74	9.11
Telecom	6.30	8.83
Materials	5.20	4.68
Real estate	2.58	3.51

Note: The table reports summary statistics on regional and sectoral structures of the USD and EUR segments of the benchmark portfolio on average over the sample period.

We observe some differences across industries for bonds denominated in EUR. First, financials issue 34.1% of the market value of the index on average. Among the top six issuers, five are large European banks, representing 9.1% of the market value of the EUR segment. The top 10 issuers also include three car producers (4.1% of the market value). In contrast, technology firms represent

only 2.6%, while energy and healthcare firms also have lower weights than in the USD segment. Such differences between the USD and EUR segments partly echo the industrial structure of the North American and European economies.

To construct portfolios based on the ESG characteristics of the issuers, we identify constituents of the bond index for which MSCI-ESG scores are available. Figure 1 represents the proportion of the bond index (in terms of market value) with ESG scores. For the USD segment (Panel A), the coverage of firms located in North America and Pacific ranges between 88% and 96% over the sample period, and the coverage of European firms increases from 78% to 96%. For emerging countries, the coverage raises from 74% to 82% showing a significant gap from other regions. This gap can be explained by the fact that companies established in developed economies are more

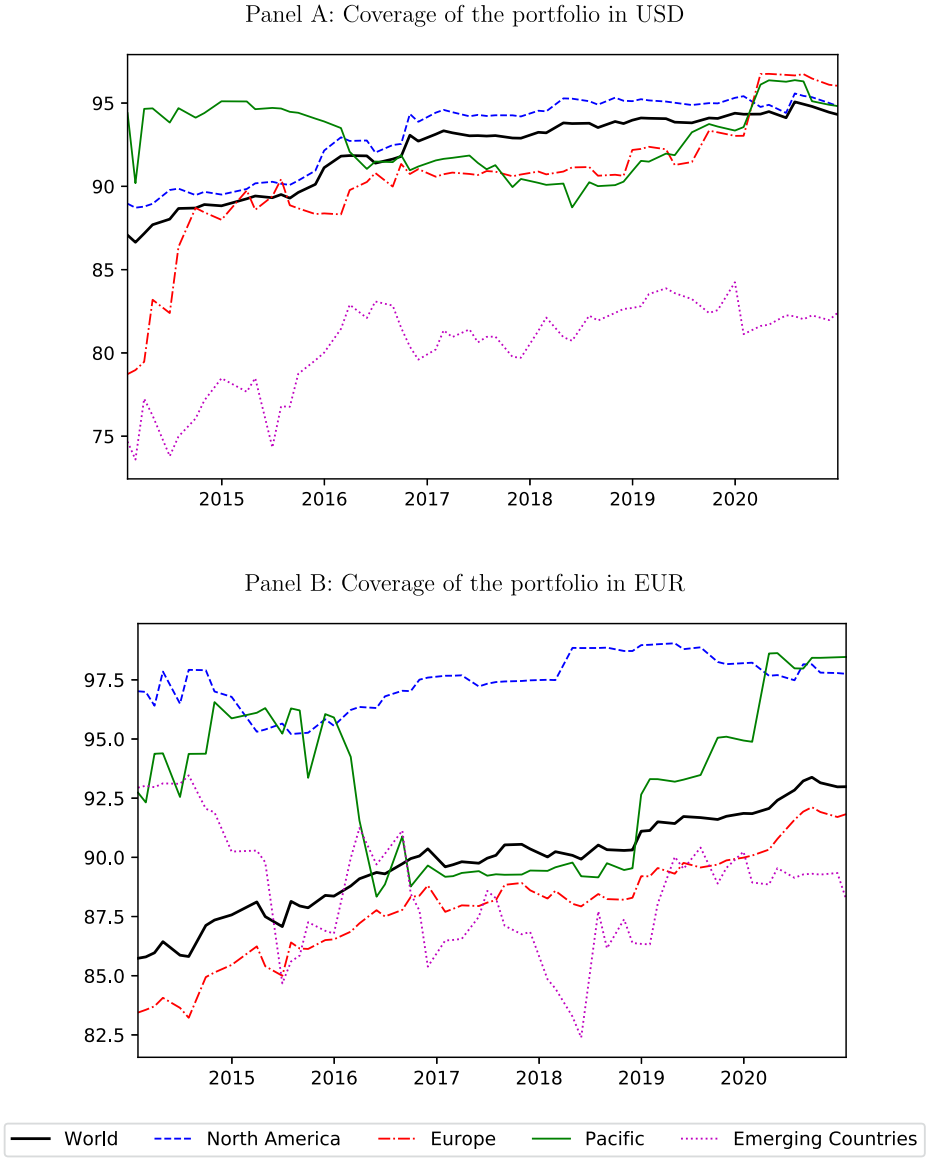


Figure 1 Coverage by region (% of total market value).

likely to report information on their activities and more prone to receiving ESG scores.

Concerning the EUR segment (Panel B), firms located in North America and Pacific also have high coverage. European firms follow a positive trend in terms of coverage with an increase from 83% to 92% over the period, resulting in a coverage close to that of firms in emerging countries on average.

4 ESG Screening Methodology and Risk Analysis

Most studies dealing with ESG investing focus on stock markets. As ESG data are available at the firm level, working with stocks instead of bonds can be viewed as sufficient to address questions such as the construction of screening portfolios. In addition, even if several corporate bond indexes are available, only very few have their list of constituents available for academic research, which is necessary to implement screening strategies.

We adapted the screening methodology used for stocks in Alessandrini and Jondeau (2020) to the context of a bond portfolio. Some additional issues arise. First, we construct two sets of portfolios corresponding to USD and the EUR segments of the bond index to avoid the performance of the bond portfolio to be contaminated by the currency dynamics. Second, as illustrated above, regional and sectoral risk exposures substantially differ from the exposures of a stock portfolio. In particular, as financials represent approximately one-third of the benchmark's market value, their ESG quality is likely to play an important role in the construction of an ESG portfolio. Third, risk factors also differ from those usually considered for a portfolio of stocks, and it is essential to identify the impact of ESG screening on the risk exposures of the resulting portfolio. We address these issues in the next section.

We first investigate how the ESG screening affects the financial performance of the portfolio. We consider the annualized return, annualized standard deviation, and Sharpe ratio.[6] Another measure of particular interest to an investor is the tracking error, which measures the annualized volatility of the difference between the return of the constructed ESG portfolio and the return of the corresponding segment. We also consider additional characteristics of interest for a bond portfolio, such as its yield, credit spread, and duration.

An important aspect of the construction of an ESG portfolio is the impact on the financial performance of the resulting portfolio. This trade-off has often been used as an argument for why investors are reluctant to invest in a sustainable way. More recent research suggests that, at least in the last decade, the problem is in fact limited because high score portfolios also tend to produce good risk-adjusted performance. In fact, investors may have benefited from the two dimensions because of the high demand of high ESG quality firms (Pástor *et al.*, 2021b). We compute the so-called Efficiency of the portfolio, a measure that combines both dimensions of interest, the Sharpe ratio and ESG score, into a single metric (Alessandrini and Jondeau, 2021). The efficiency measure weighs the gain in the risk-adjusted measure and the gain in the ESG score of portfolio p:

$$\begin{aligned} \mathit{Eff}_p &= (1-\gamma)\left(\frac{\bar{R}_p - \bar{R}_f}{\sigma_p}\right) + \gamma\left(\frac{\text{Score}_p}{\sigma_p}\right) \\ &= (1-\gamma)SR_p + \gamma ESGR_p \end{aligned} \tag{1}$$

where $\bar{R}_p$, σ_p, and Score_p denote the average return, the volatility, and the average score of the portfolio, and $\bar{R}_f$ denotes the average risk-free rate. The first component is the usual Sharpe ratio (SR_p) and the second component represents the ESG score per unit of risk ($ESGR_p$). We set the investor's ESG preference parameter $\gamma = 0.5$.

We also define the efficiency gain of portfolio p relative to the benchmark as follows:

$$\Delta Eff_p = (1-\gamma)(SR_p - SR_b) + \gamma(ESGR_p - ESGR_b) \quad (2)$$

where SR_b and $ESGR_b$ correspond to the benchmark metrics.

Finally, we investigate the exposure of ESG portfolios to risk factors, following Bai *et al.* (2019) in the construction of the factors designed for bond markets. We briefly describe the construction of these factors with our data. As the bond credit rating plays a fundamental role in bond returns, it is used to construct all of the risk factors.[7]

The first factor proposed by Bai *et al.* (2019), measuring downside risk, is based on the value-at-risk (VaR). We approximate the 5% VaR by taking the second lowest monthly return observation for the past 36 months. Then, we independently sort corporate bonds into 5×5 quintiles based on the 5% VaR and credit rating. Finally, the downside risk factor (DRF) is the value-weighted average return difference between the highest-VaR portfolio minus the lowest-VaR portfolio within each rating portfolio.

Past studies have shown the importance of illiquidity in corporate bond returns. Following Bao *et al.* (2011), we construct a bond-level illiquidity measure, which aims to account for the transitory component of bond prices. Specifically, we let $\Delta p_{i,t,d} = p_{i,t,d} - p_{i,t,d+1}$ be the log price change for bond i on day d of month t. The monthly illiquidity of the bond is defined as:

$$ILLIQ_{i,t} = -\mathrm{Cov}(\Delta p_{i,t,d}, \Delta p_{i,t,d+1}) \quad \text{for all day } d \text{ of month } t. \quad (3)$$

The liquidity risk factor (LRF) is constructed by sorting corporate bonds into 5×5 quintiles based on the illiquidity measure and credit rating. The LRF is the value-weighted average return difference between the highest-illiquidity portfolio minus the lowest-illiquidity portfolio within each rating portfolio.

The next factor of interest is return reversal (REV), which captures the fact that bonds performing poorly have better returns in the short-term, while the inverse applies for those performing well. Similar to other risk factors above, bonds are sorted into 5×5 quintiles based on the previous month's return and credit rating. Then, REV is the value-weighted average return difference between the short-term loser and short-term winner portfolios within each rating portfolio. We also include this variable as a potential factor, although Bai *et al.* (2019) find that it is not a common risk factor.

The last factor is the credit risk factor (CRF), which is simply given by the following formula:

$$CRF = \frac{1}{3}(CRF_{VaR} + CRF_{ILLIQ} + CRF_{REV}), \quad (4)$$

where CRF_{VaR} is the value-weighted average return difference between the lowest rating (i.e., highest credit risk) portfolio and highest rating (i.e., lowest credit risk) portfolio across the VaR portfolios. CRF_{ILLIQ} and CRF_{REV} are given the same definition as their respective variables. Appendix B represents the temporal evolution of the bond factors for the USD and EUR segments.

5 ESG Screening for USD Denominated Bonds

5.1 Global exclusion

We start by considering a global exclusion strategy for the USD segment of the index. We explore three levels of exclusion, 25%, 33%, and 50%, of the index market value. The proceeds of the exclusion are reinvested in all remaining bonds in proportion of their market value.

Table 2 Performance of portfolios with global exclusion – USD segment.

	Bench -mark	Panel A: 25% screening				Panel B: 33% screening				Panel C: 50% screening			
		ESG	E	S	G	ESG	E	S	G	ESG	E	S	G
Performance													
Annual return	4.31	4.33	4.35	4.34	4.38	4.34	4.36	4.35	4.41	4.36	4.34	4.33	4.39
Annual volatility	5.22	5.20	4.91	5.24	5.47	5.09	4.88	5.24	5.52	5.07	4.68	5.24	5.61
Sharpe ratio	0.66	0.67	0.71	0.67	0.65	0.69	0.72	0.67	0.64	0.69	0.75	0.67	0.63
Annual track. err.	0.09	0.24	0.60	0.18	0.29	0.35	0.66	0.19	0.33	0.51	0.84	0.23	0.46
Annual turnover	35.9	36.7	35.8	36.1	38.2	37.2	35.4	36.4	37.9	38.2	35.9	37.2	39.6
Yield	3.10	3.06	2.99	3.08	3.11	3.03	2.99	3.08	3.12	3.00	2.96	3.06	3.11
Credit spread	130.7	125.8	121.0	129.8	129.6	123.6	120.3	130.0	129.6	119.4	119.7	129.2	129.3
Duration	6.74	6.90	6.76	6.72	6.98	6.85	6.76	6.69	7.02	6.95	6.57	6.62	7.00
Benchmark score	—	4.97	6.16	4.45	4.89	4.97	6.16	4.45	4.89	4.97	6.16	4.45	4.89
Average score	—	5.83	7.12	5.04	5.57	6.10	7.38	5.21	5.74	6.69	7.94	5.58	6.10
Efficiency measure	—	0.90	1.08	0.81	0.83	0.94	1.12	0.83	0.84	1.01	1.22	0.87	0.86
– SR gain	—	0.00	0.03	0.00	−0.01	0.01	0.03	0.00	−0.01	0.02	0.04	0.00	−0.02
– ESG gain	—	0.09	0.13	0.06	0.04	0.12	0.17	0.07	0.05	0.18	0.26	0.11	0.08
Regional exposures													
North America	79.91	−1.87	0.74	−3.31	1.78	−3.02	0.66	−4.30	2.11	−4.11	−0.68	−4.55	1.41
Europe	11.14	2.03	0.87	2.32	0.57	2.84	1.61	2.96	0.45	4.43	3.35	2.49	0.76
Pacific	4.14	0.92	−0.27	1.03	−0.94	1.31	−0.55	1.47	−0.74	1.39	−0.82	2.43	−0.08
Emerging countries	4.81	−1.09	−1.33	−0.04	−1.41	−1.13	−1.72	−0.13	−1.82	−1.71	−1.85	−0.37	−2.09
Sectoral exposures													
Financials	33.08	−2.58	3.78	3.10	−8.34	−2.71	5.46	4.38	−8.07	−5.07	10.45	4.12	−6.22
Healthcare	9.38	−1.45	0.91	−1.92	1.38	−1.77	1.08	−3.02	−0.25	−1.19	2.63	−5.42	−3.12
Utilities	8.37	1.53	0.45	1.14	2.02	1.83	−0.44	1.73	2.77	3.01	−3.38	2.75	3.46
Industrials	8.26	1.59	0.37	−1.16	2.22	2.28	−0.65	−2.18	3.19	3.82	−2.07	−2.46	5.51
Consumer staples	7.82	1.36	−0.72	−1.07	1.87	1.52	−1.10	−0.61	2.19	2.62	−2.45	−0.02	4.00
Energy	7.79	−0.38	−6.13	1.74	1.53	−0.07	−6.53	2.35	1.69	−1.20	−7.09	3.95	2.08
Technology	7.06	1.41	0.08	1.62	0.04	2.14	0.29	2.35	0.07	4.38	0.53	4.00	−1.73
Consumer discretionary	6.74	−0.86	1.18	−2.51	−0.58	−1.04	1.79	−2.89	−0.85	−2.06	0.29	−4.15	−0.52
Telecom	6.30	−0.41	2.09	−0.67	0.93	−1.01	3.09	−1.75	0.14	−2.32	5.88	−1.66	−3.22
Materials	5.20	−0.22	−2.01	−0.27	−1.07	−1.18	−2.99	−0.33	−0.87	−1.99	−4.78	−1.12	−0.23

Note: The table report summary statistics on portfolios based on the 25%, 33%, and 50% global exclusion, for the ESG, E, S, and G scores. Statistics are: the annual return (in %), the annual standard deviation (in %), the Sharpe ratio, the annual tracking error (in %), the annual turnover (in %), the average yield (in %), the credit spread (in bp), and duration (in year), the benchmark and average scores, the efficiency measure, and the two components of the efficiency gain. For the Benchmark column, regional exposures and sectoral exposures represent the absolute exposures (in %); For subsequent columns, they represent the exposures relative to the benchmark (in %).

In Table 2, we report summary statistics for the benchmark portfolio (including all bonds in the USD segment with an ESG score) and the three exclusion portfolios for the four scores. For the overall ESG score, the portfolio score increases from 5 for the benchmark to 5.8, 6.1, and 6.7 for the 25%, 33%, and 50% screening levels, respectively, which represent substantial improvements (Panel A). In addition, despite the high screening levels, measures of financial performance are barely affected. The annualized return slightly increases, while the volatility level slightly decreases, resulting in a marginal increase in the Sharpe ratio.

As the overall ESG score increases with the screening level and the Sharpe ratio gain is essentially unaffected, we find that the efficiency measure benefits from its two components. The annual tracking error remains at relatively low

levels. For the benchmark portfolio, the tracking error is equal to 0.09% with respect to the bond index, reflecting that some firms with no available ESG score are missing in the benchmark portfolio. For the three screening levels, the tracking error increases to 0.24%, 0.35%, and 0.51% per year.

The table also reports some financial characteristics of the ESG portfolios. Interestingly, the credit profile of the portfolios tends to improve with the level of exclusion, suggesting that excluded bonds (with the lowest scores) have higher credit spreads. The average bond yield also decreases with the level of exclusion, meaning that excluded bonds also tend to have higher yields. Duration remains quite stable over the portfolios. It is worth noting that the lower yield of the ESG portfolios is not associated with a lower average return. This result can be interpreted by a change in the risk exposure of the portfolio or by the excess demand for bonds with high ESG scores.

Targeting the E score is associated with a more substantial increase in the Sharpe ratio, from 0.66 for the benchmark to 0.72 for the 33% screening (see Panel B). This increase is mainly due to a decline in volatility. At the same time, the tracking error increases more, up to 0.66% per year for the 33% screening, which may reflect larger imbalances in the portfolio. The efficiency measure increases the most for the E score: the ESG gain is the highest, with an increase in the score from 6.16 to 7.38 with the 33% screening, and the Sharpe ratio contributes positively to the efficiency gain. Improvements in other risk metrics (credit spread and duration) tend to mirror the decline in volatility, indicating that screening based on the E score is associated with more defensive portfolios. Our results also suggest that the decrease in the yield and credit spread obtained for the overall ESG score screening in Panel A is mainly driven by the E score.

Screening based on the S score has essentially no impact on the risk-adjusted performance of the portfolio or on the financial characteristics of the portfolio (Panel C). The Sharpe ratio, average yield, duration, and credit spread are not altered and the tracking error remains low, even with the 50% screening threshold. These results suggest that the individual S score has low correlation with the financial characteristics of the associated bonds.

The results for the G pillar are again different from those reported for the previous pillars (Panel D). The Sharpe ratio decreases from 0.66 for the benchmark to 0.63 with the 50% threshold. This suggests a trade-off between the ESG dimension and risk-adjusted measures. As the increase in the score is moderate and the Sharpe ratio slightly decreases, the efficiency gain is the smallest for the G score, although it remains positive.

To summarize, the screening process allows for a substantial improvement in portfolio scores with a positive/neutral/negative impact on the risk-adjusted performance of screening based on the E/S/G scores.

Table 2 also reports how regional and sectoral exposures of the ESG portfolios are affected by the exclusion process. Regarding regional exposures, we find that, for the 33% exclusion based on the overall ESG score, firms in Europe and Pacific benefit from a positive bias compared to the benchmark portfolio: the weight of European firms increases by 2.8 percentage points on average, while the weight of Pacific firms increases by 1.3 points. In contrast, firms in North America and emerging countries are underweighted by 3 and 1.1 points, respectively.

In fact, these biases reflect great heterogeneity across ESG pillars. For the E score screening, only European firms benefit from a large overweighting. With S score screening, bonds issued

by North American firms are severely underweighted. Conversely, with G score screening, bonds issued by North American firms are overweighted, whereas the shift in favor of European firms vanishes.

When we consider sectoral exposures, heterogeneity across ESG pillars is even more pronounced. For the overall ESG score, some industries become highly underweighted after the screening procedure. In particular, with 33% exclusion, financial and healthcare sectors report a weight at least 1.5% lower on average. On the other hand, technology and industrial companies and, to a lesser extent, consumer staple and utility firms are overweighted.

For the E pillar, we largely obtain exposures that run contrary to those obtained for the overall ESG score. Indeed, the financial and telecom sectors are overweighted by 5.5% and 3.1% on average, respectively. In contrast, energy and material firms are almost entirely excluded from the index due to their very low average scores. The weight for energy firms is reduced to 1.3% with 33% screening from 7.8% with the benchmark. Regarding the S pillar, financials are again overweighted, but firms in the energy, technology, and utilities sectors also benefit from higher weights compared to the benchmark. In terms of underweighted industries, there are mainly two, the healthcare and consumer discretionary sectors. Finally, for the G pillar, we obtain biases that are almost the opposite to those found for the E score: financials are severely underweighted, whereas firms in industrial, utility, and consumer staple sectors are heavily overweighted.

The large regional and sectoral imbalances implied by the global exclusion may be undesirable for passive asset managers. The targeted score and level of screening may create important distortions by overweighting one region or sector and increase the overall risk exposures and tracking error of the portfolio. This issue is particularly relevant for the screening based on the E score. In the resulting portfolio with 50% exclusion, the weight of financials is increased to 45% and the weight of energy and material firms is decreased to essentially 0. This reweighting may explain why screening based on E scores generates greater tracking errors. It might also be that the observed imbalances were particularly favorable in the period under study and allowed the ESG portfolios to compensate for any eventual loss due to the ESG screening process.

5.2 Best-in-class screening at region–sector level

We now consider an investor willing to maintain the same exposures reflected in the benchmark. Our approach consists in implementing a "best-in-class" screening at the regional and sectoral levels.[8] Excluding 25% of the overall market value or 25% of each region–sector in the portfolio corresponds to the same level of screening. However, in the "best-in-class" approach, the proceeds of the exclusion of firms in a given region–sector are reinvested in firms operating in the same region–sector. Thus, investors are able to increase the ESG scores of their portfolios relative to the benchmark while maintaining the initial exposures to regions and sectors. It is interesting to evaluate by how much the score and efficiency measure are affected by this best-in-class screening.

In Table 3, we implement a 25%, 33%, and 50% screening at the region–sector level such that each region has the same exposure as in the benchmark portfolio. We observe that efficiency measures are barely affected compared to those found with the global exclusion strategy. For the E pillar, the score and the Sharpe ratio are slightly reduced, resulting in a decrease in the efficiency measure from 1.12 to 1.06. For the S and G pillars, on the contrary, we observe that almost all metrics

Table 3 Performance of portfolios with best-in-class screening – USD segment.

	Bench	Panel A: 25% screening				Panel B: 33% screening				Panel C: 50% screening			
	-mark	ESG	E	S	G	ESG	E	S	G	ESG	E	S	G
Performance													
Annual return	4.31	4.34	4.29	4.34	4.35	4.35	4.27	4.35	4.36	4.35	4.28	4.35	4.36
Annual volatility	5.22	5.13	5.12	5.18	5.25	5.16	5.08	5.17	5.31	5.06	5.06	5.15	5.30
Sharpe ratio	0.66	0.68	0.67	0.67	0.67	0.68	0.67	0.68	0.66	0.69	0.68	0.68	0.66
Annual tracking error	0.09	0.28	0.31	0.19	0.10	0.25	0.37	0.22	0.14	0.33	0.45	0.28	0.16
Annual turnover	35.9	43.3	43.5	43.7	45.5	44.5	44.3	44.4	46.7	43.2	41.9	42.9	44.5
Yield	3.10	3.04	3.03	3.07	3.09	3.04	3.02	3.06	3.10	3.01	3.01	3.06	3.11
Credit spread	130.7	124.4	123.6	128.4	130.2	124.1	122.5	127.7	130.8	122.0	121.5	127.9	131.2
Duration	6.74	6.84	6.84	6.76	6.80	6.84	6.82	6.74	6.79	6.77	6.86	6.75	6.81
Benchmark score	—	4.97	6.16	4.45	4.89	4.97	6.16	4.45	4.89	4.97	6.16	4.45	4.89
Average score	—	6.07	7.17	5.19	5.63	6.24	7.31	5.30	5.77	6.39	7.43	5.38	5.90
Efficiency measure	—	0.93	1.04	0.84	0.87	0.94	1.06	0.85	0.87	0.98	1.07	0.86	0.89
- SR gain	—	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00
- ESG gain	—	0.12	0.11	0.08	0.07	0.13	0.13	0.09	0.08	0.15	0.14	0.10	0.09

Note: The table report summary statistics on portfolios based on the 10%, 25%, and 50% best-in-class screening, for the ESG, E, S, and G scores. Statistics are: the annual return (in %), the annual standard deviation (in %), the Sharpe ratio, the annual tracking error (in %), the annual turnover (in %), the average yield (in %), the credit spread (in bp), and duration (in year), the benchmark and average scores, the efficiency measure, and the two components of the efficiency gain.

improve compared to global exclusion. In particular, the Sharpe ratio and the efficiency measure slightly increase. It is important to note that in this approach, as all regional and sectoral exposures are neutralized, the resulting portfolios are closer to the benchmark and the tracking error values decrease substantially, especially for the E and G pillars.

Overall, for all pillars, the best-in-class screening would be the best recommendation for a passive investor with ESG preferences: Reweighting at the region–sector level allows investors to keep the same exposures as in the initial benchmark; it significantly improves the average score relative to the benchmark, while not deteriorating the risk-adjusted measures; and it generates minor tracking errors with the benchmark. As these results suggest, the regional and sectoral biases are not the main drivers behind the efficiency gains of the ESG portfolios.

5.3 Exposure to risk factors

We now explore if the exposure of the ESG portfolios to the bond risk factors can account for the relatively good financial performance of these portfolios. Factor betas are obtained by running the following equation:

$$R_{p,t} = \alpha_p + \beta_{MKT,p}\, R_{m,t} + \beta_{DRF,p} + \beta_{DRF,p} \times DRF_t + \beta_{CRF,p}\, CRF_t + \beta_{LRF,p} \times LRF_t + \beta_{REV,p}\, REV_t + \epsilon_{p,t} \quad (5)$$

where $R_{m,t}$ denotes the value-weighted return of all the bonds in the USD segment.

Table 4 reports the risk factor exposures for the ESG portfolios with the different levels of screening. Panel A corresponds to the global exclusion and Panel B corresponds to best-in-class screening at the region–sector level. All estimates of the alphas and risk factor betas are multiplied by 100. Stars denote statistical significance at the 5% level.

The first column of the table reports parameter estimates associated with the conventional benchmark portfolio, which includes all bonds issued by firms with an ESG score. We find that the benchmark is positively exposed to

Table 4 Factor exposures of portfolios – USD segment.

	Bench-mark	25% excl.	33% excl.	50% excl.	25% excl.	33% excl.	50% excl.
Panel A: Global exclusion							
			ESG score			**E score**	
α	−0.01	−0.10	−0.04	−0.07	0.00	0.02	0.16
β_{MKT}	0.98*	1.01*	0.99*	0.99*	1.02*	1.01*	0.96*
β_{DRF}	2.37*	−0.28	0.53	0.42	−7.42*	−6.76*	−4.53
β_{CRF}	−1.46*	−8.23*	−11.23*	−16.38*	−19.27*	−20.76*	−21.96*
β_{LRF}	−0.80	0.68	0.86	1.42	4.31	4.30	3.44
β_{REV}	1.80*	1.81*	2.03*	2.19*	−1.54	−1.32	−0.76
			S score			**G score**	
α	−0.01	0.02	0.03	0.04	−0.16	0.17	−0.22
β_{MKT}	0.98*	0.97*	0.97*	0.96*	1.04*	1.05*	1.07*
β_{DRF}	2.37*	5.05*	4.43*	4.62*	2.51*	1.74	−3.20
β_{CRF}	−1.46*	1.34	2.92*	3.78*	−0.74	−0.65	4.03*
β_{LRF}	−0.80	−2.15	−1.88	−1.16	−2.57*	−1.32	2.41*
β_{REV}	1.80*	4.55*	4.74*	4.60*	2.60*	2.48*	2.07*
Panel B: Best-in-class screening at region–sector level							
			ESG score			**E score**	
α	−0.01	−0.03	−0.04	0.02	−0.09	−0.09	−0.09
β_{MKT}	0.98*	0.99*	1.00*	0.98*	1.00*	1.00*	0.99*
β_{DRF}	2.37*	0.94	0.54	2.26*	−1.53	−1.37	−0.11
β_{CRF}	−1.46*	−8.46*	−7.73*	−9.07*	−10.58*	−12.35*	−15.18*
β_{LRF}	−0.80	0.62	0.77	−1.08	2.57	2.74	2.49
β_{REV}	1.80*	2.24*	2.00*	2.12*	1.38	1.38	2.11*
			S score			**G score**	
α	−0.01	0.05	0.05	0.08	−0.03	−0.05	−0.04
β_{MKT}	0.98*	0.96*	0.97*	0.95*	1.01*	1.02*	1.00*
β_{DRF}	2.37*	5.98*	6.19*	9.07*	−0.38	−0.08	1.07
β_{CRF}	−1.46*	−4.39*	−4.38*	−4.77*	−2.19*	−0.04	−0.37
β_{LRF}	−0.80	−2.18*	−3.40*	−4.36*	0.05	−0.47	0.08
β_{REV}	1.80*	2.50*	3.03*	4.15*	1.24*	1.66*	2.81*

Note: The table report risk factor exposures for the portfolios based on the 25%, 33%, and 50% screening, for the global exclusion (Panel A) and the best-in-class screening at region–sector level (Panel B). Parameters are multiplied by 100 and alpha is annualized.

DRF but negatively exposed to CRF. These estimates suggest that firms with an ESG score tend to be more exposed to DRF (i.e., they have higher VaR on average) and less exposed to CRF (i.e., they have higher credit ratings on average). The factor exposures of the ESG portfolios can be interpreted in relation to those of the benchmark.

As results associated with the global exclusion clearly indicate, the ESG screening has a considerable effect on the risk exposures of the resulting portfolios (Panel A). When the screening is based on the overall ESG score, the positive exposure to DRF vanishes and the negative exposure to CRF is more pronounced.

For the screening based on the E score, we find that the resulting portfolio has significant and negative exposures to DRF. Therefore, bonds issued by firms with high environmental practices tend to be also exposed to firms with low downside risks, which is consistent with Polbennikov *et al.* (2016) and Mendiratta *et al.* (2020). Exposure to CRF also becomes much more negative than that of the benchmark. Therefore, bonds issued by firms reporting high E scores also tend to exhibit high credit ratings. These results may explain the lower average yield of E-tilted portfolios reported in Table 2. However, it does not result in a lower overall annualized return. Finally, the LRF exposure is not statistically significant, regardless of the screening threshold and the positive exposure to the REV found for the benchmark disappears for all E-tilted portfolios.

Our results also suggest that strategies based on the S and G scores load very differently on risk factors compared to screening based on the E score. For the S pillar, the screening selects bonds issued by firms with higher VaR and lower credit ratings (all thresholds). For the G pillar, the screening selects higher VaR firms (25% screening) or higher credit risk firms (50% screening). Exposures to the reversal risk factor (β_{REV}) are also positive and significant, meaning that the return reversal explains part of the portfolio excess return.

Part of the risk factor exposures we uncover for the ESG portfolios may be due to the large regional and sectoral biases implied by the global exclusion. When we consider the risk exposures of portfolios based on best-in-class screening (Panel B), we find that risk exposures are more homogeneous for E, S, and G screenings. In particular, almost all portfolios have large and negative exposures to CRF. Additionally, portfolios based on E and G screening have insignificant exposures to the DRF, while portfolios based on S screening still show considerable positive exposure.

Our results allow for a better understanding of the good performance of global screening based on the E score: The global exclusion excludes almost all firms in energy and heavily overweights financials, resulting in a highly negative exposure (i.e., protection) of the portfolio against downside risk. In our sample, this strategy delivered a higher risk-adjusted performance because of the relatively low portfolio volatility implied by the reweighting. In contrast, the best-in-class strategy, which imposes sectoral weights to be the same as the benchmark, loses its protection from downside risk and suffers from a relatively higher volatility, which has resulted in a lower risk-adjusted performance in our sample. Overall, for all best-in-class strategies, the ESG score is substantially increased with no deterioration in the risk-adjusted performance. This result is consistent with the evidence reported by Pástor *et al.* (2021b): The demand pressure for securities with high ESG scores has resulted in the recent period in high risk-adjusted returns, despite lower expected returns implied by asset pricing models with ESG preference (Pástor *et al.*, 2021a).

6 ESG Screening for EUR Denominated Bonds

In this section, we summarize the main results associated with the segment of the bond market denominated in EUR and compare them with those reported for the USD segment.

Table 5 Performance of portfolios with global exclusion – EUR segment.

	Bench	Panel A: 25% screening				Panel B: 33% screening				Panel C: 50% screening			
	-mark	ESG	E	S	G	ESG	E	S	G	ESG	E	S	G
Performance													
Annual return	2.15	2.19	2.21	2.19	2.22	2.23	2.24	2.15	2.24	2.25	2.27	2.23	2.22
Annual volatility	4.23	4.08	4.16	4.04	4.23	4.09	4.15	4.00	4.20	4.06	4.15	4.03	4.20
Sharpe ratio	0.58	0.61	0.61	0.62	0.60	0.62	0.61	0.61	0.61	0.63	0.62	0.63	0.60
Annual tracking error	0.09	0.20	0.21	0.21	0.23	0.20	0.23	0.23	0.24	0.26	0.28	0.23	0.31
Annual turnover	34.7	34.3	33.6	34.8	36.4	34.1	33.7	35.4	36.1	34.8	34.8	35.7	36.4
Yield	0.84	0.81	0.83	0.82	0.85	0.81	0.83	0.81	0.84	0.79	0.83	0.81	0.83
Credit spread	104.3	100.6	102.0	102.4	103.2	99.8	102.3	102.4	102.9	98.1	102.6	102.5	101.7
Duration	5.08	5.12	5.10	4.96	5.23	5.13	5.09	4.92	5.20	5.15	5.10	4.95	5.19
Benchmark score	—	6.07	6.74	4.88	5.10	6.07	6.74	4.88	5.10	6.07	6.74	4.88	5.10
Average score	—	7.01	7.47	5.47	5.85	7.24	7.65	5.62	6.05	7.74	8.08	5.96	6.47
Efficiency measure	—	1.17	1.20	0.99	0.99	1.20	1.23	1.01	1.02	1.27	1.28	1.05	1.07
– SR gain	—	0.02	0.01	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01
– ESG gain	—	0.14	0.10	0.10	0.09	0.17	0.12	0.13	0.12	0.23	0.18	0.16	0.17
Regional exposures													
North America	19.43	−7.92	0.66	−4.79	−4.52	−8.49	2.16	−4.66	−6.10	−8.03	5.14	−7.04	−8.24
Europe	72.44	8.55	1.18	4.74	4.63	9.03	−0.63	5.44	5.74	8.98	−4.28	8.37	6.24
Pacific	3.89	1.00	−0.33	0.95	0.37	1.05	−0.14	0.50	0.85	0.80	0.50	0.30	2.17
Emerging countries	4.24	−1.63	−1.51	−0.90	−0.49	−1.60	−1.39	−1.28	−0.49	−1.74	−1.37	−1.63	−0.17
Sectoral exposures													
Financials	37.61	−3.32	3.97	5.96	−8.44	−3.86	5.01	6.13	−10.23	−10.85	6.68	5.60	−13.89
Industrials	9.68	1.88	−0.98	−2.34	2.99	2.81	−0.94	−2.09	3.98	3.17	−1.06	−2.02	4.15
Consumer discretionary	9.11	−2.02	0.79	−2.99	−2.64	−2.97	0.01	−4.19	−2.98	−2.00	−1.93	−5.83	−3.31
Telecom	8.83	−0.58	2.93	0.59	1.53	−0.84	4.34	1.14	0.32	0.95	8.81	1.22	−1.55
Consumer staples	8.57	1.10	−2.16	−0.79	2.48	1.50	−2.62	−0.87	3.10	2.73	−4.23	−0.06	5.90
Utilities	8.56	2.42	1.65	2.11	2.35	3.41	0.98	2.80	3.61	6.51	0.77	3.98	7.46
Healthcare	5.32	−0.88	0.10	−2.63	0.56	−0.88	0.36	−3.50	−0.35	−2.19	−1.23	−4.15	−2.37
Energy	5.04	0.55	−2.69	1.06	0.18	−0.36	−3.58	1.16	0.72	−0.47	−4.25	1.10	0.57
Materials	4.68	0.22	−3.47	−1.63	0.94	0.19	−3.60	−1.55	1.53	0.22	−3.92	−1.65	2.99
Technology	2.60	0.64	−0.15	0.66	0.03	1.01	0.04	0.96	0.30	1.93	0.65	1.81	0.05

Note: The table report summary statistics on portfolios based on the 25%, 33%, and 50% global exclusion, for the ESG, E, S, and G scores. Statistics are: the annual return (in %), the annual standard deviation (in %), the Sharpe ratio, the annual tracking error (in %), the annual turnover (in %), the average yield (in %), the credit spread (in bp), and duration (in year), the benchmark and average scores, the efficiency measure, and the two components of the efficiency gain. For the Benchmark column, regional exposures and sectoral exposures represent the absolute exposures (in %); For subsequent columns, they represent the exposures relative to the benchmark (in %).

6.1 Global exclusion

Table 5 reports the results for the global exclusion strategy. Many of the results observed for the USD segment remain valid, though some differences are worth noting. Regarding the benchmark portfolios, we note that average returns are much lower in the EUR segment than in the USD segment. Despite this large difference in returns, the benchmark's Sharpe ratio for the EUR segment benefits from a lower volatility and are relatively close to that found for the USD segment. In addition, the yield and credit spread of EUR bonds are much lower than their USD counterparts. The table also reveals higher values for the ESG scores of the benchmark than for the USD segment. The reason is that companies issuing bonds in EUR are often located in Europe and incorporate stronger ESG practices than those issuing bonds in USD.

If we turn to the global exclusion, we find that, for all pillars, the increase in the portfolio score is

obtained with no deterioration in the risk-adjusted performance of the portfolio. Scores, Sharpe ratios, and therefore efficiency measures increase in all cases. Furthermore, the tracking errors associated with global exclusion are always limited (up to 0.3% per year), suggesting that the rebalancing between regions and sectors required to increase the targeted score does not significantly affect the performance of the portfolio.

Summary statistics on regional and sectoral exposures for the global exclusion are also reported in Table 5. Regarding regional exposures, for the screening based on the E score, we find a large overweighting of North American firms and a large underweighting of European firms for the 33% and 50% thresholds, which runs contrary to what we found for the USD segment. This result suggests that North American firms issuing bonds in EUR tend to have higher E scores on average than North American firms issuing bonds in USD and that the opposite applies for European firms. In contrast, for the S and G scores, we find that fewer firms from North America and more firms from Europe are included in the portfolio. Similar to what was found for the USD segment, ESG portfolios have a lower exposure to emerging countries than the benchmark for all pillars, which can be explained by the lower scores obtained by firms operating in emerging countries on average.

The results for sectoral exposures reveal that the impact of screening is often similar for the EUR and USD segments. In particular, financial and telecom firms benefit from high overweighting when screening is based on the E and S scores but financials suffer from severe underweighting when screening is based on the G score. Energy and materials firms are underweighted for the E score and overweighted for the G score.

6.2 Best-in-class screening at region–sector level

We now evaluate how maintaining the same regional and sectoral exposures as the benchmark affects the overall performance of the

Table 6 Performance of portfolios with best-in-class screening – EUR segment.

	Bench	Panel A: 25% screening				Panel B: 33% screening				Panel C: 50% screening			
	-mark	ESG	E	S	G	ESG	E	S	G	ESG	E	S	G
Performance													
Annual return	2.15	2.28	2.19	2.24	2.25	2.28	2.18	2.23	2.22	2.27	2.14	2.21	2.18
Annual volatility	4.23	4.23	4.18	4.18	4.24	4.23	4.21	4.21	4.17	4.26	4.19	4.23	4.14
Sharpe ratio	0.58	0.61	0.60	0.61	0.60	0.61	0.59	0.60	0.61	0.61	0.58	0.60	0.60
Annual tracking error	0.09	0.14	0.14	0.14	0.14	0.16	0.18	0.16	0.16	0.20	0.18	0.20	0.19
Annual turnover	34.7	43.6	43.0	43.6	46.1	44.6	44.1	44.6	47.3	42.9	42.8	44.5	45.6
Yield	0.84	0.83	0.83	0.83	0.85	0.83	0.82	0.83	0.84	0.83	0.81	0.83	0.83
Credit spread	104.3	102.6	102.6	103.3	104.0	102.0	102.1	103.1	103.6	101.6	101.4	102.7	102.8
Duration	5.08	5.15	5.12	5.05	5.14	5.19	5.10	5.08	5.12	5.24	5.09	5.10	5.08
Benchmark score	—	6.07	6.74	4.88	5.10	6.07	6.74	4.88	5.10	6.07	6.74	4.88	5.10
Average score	—	7.05	7.45	5.55	5.78	7.20	7.55	5.65	5.89	7.32	7.63	5.72	6.00
Efficiency measure	—	1.14	1.19	0.97	0.98	1.16	1.19	0.97	1.01	1.16	1.20	0.97	1.02
– SR gain	—	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01
– ESG gain	—	0.12	0.10	0.09	0.08	0.13	0.10	0.09	0.10	0.14	0.11	0.10	0.12

Note: The table report summary statistics on portfolios based on the 25%, 33%, and 50% best-in-class screening, for the ESG, E, S, and G scores. Statistics are: the annual return (in %), the annual standard deviation (in %), the Sharpe ratio, the annual tracking error (in %), the annual turnover (in %), the average yield (in %), the credit spread (in bp), and duration (in year), the benchmark and average scores, the efficiency measure, and the two components of the efficiency gain.

ESG portfolios, by considering the best-in-class screening at region–sector level. As Table 6 reveals, the Sharpe ratio is slightly reduced relative to that of the global exclusion strategy but it remains higher than the value obtained with the benchmark. In contrast, the tracking error is reduced for all pillars and thresholds (never exceeding 0.2% per year).

Table 7 Factor exposures of portfolios – EUR segment.

	Benchmark	25% excl.	33% excl.	50% excl.	25% excl.	33% excl.	50% excl.
Panel A: Global exclusion							
			ESG score			**E score**	
α	−0.04	0.05	0.09	0.08	0.11	0.14	0.16
β_{MKT}	1.01*	0.94*	0.96*	0.94*	1.00*	1.02*	1.04*
β_{DRF}	1.49*	4.74*	2.98	2.80	0.41	−1.31	−3.89
β_{CRF}	−1.90	−0.01	−1.39	−2.94	−13.63*	−13.88*	−15.51*
β_{LRF}	0.50	2.28	1.64	5.48	−1.02	−1.53	−1.35
β_{REV}	0.87*	1.03	0.79	0.40	1.68	2.08	2.83
			S score			**G score**	
α	−0.04	0.16	0.14	0.16	−0.04	−0.03	−0.06
β_{MKT}	1.01*	0.98*	0.97*	0.97*	0.95*	0.95*	0.94*
β_{DRF}	1.49*	−0.64	−0.30	0.24	7.57*	6.04*	5.38
β_{CRF}	−1.90	−1.87	−0.55	−0.74	3.18	6.17	3.24
β_{LRF}	0.50	−3.65	−3.18	0.12	4.44	5.52*	8.71*
β_{REV}	0.87*	0.57	0.33	0.39	1.24	0.47	−2.62
Panel B: Best-in-class screening at region–sector level							
			ESG score			**E score**	
α	−0.04	0.10	0.10	0.06	0.08	0.08	0.03
β_{MKT}	1.01*	1.00*	0.99*	1.00*	0.99*	1.00*	1.00*
β_{DRF}	1.49*	1.93	3.81*	3.52	2.89*	1.94	1.95
β_{CRF}	−1.90	−4.59*	−6.88*	−6.23*	−7.60*	−8.90*	−7.39*
β_{LRF}	0.50	0.46	0.16	1.18	−1.18	−2.57	−2.89
β_{REV}	0.87*	0.90	1.00	2.17	0.80	0.60	1.49
			S score			**G score**	
α	−0.04	0.09	0.07	0.06	0.04	0.05	0.04
β_{MKT}	1.01*	1.00*	1.00*	1.00*	1.02*	1.00*	0.99*
β_{DRF}	1.49*	0.55	1.39	1.73	−0.79	−0.41	−0.02
β_{CRF}	−1.90	−7.65*	−8.28*	−11.34*	−1.75	0.88	0.37
β_{LRF}	0.50	1.27	1.63	2.00	1.78	1.89	1.08
β_{REV}	0.87*	0.51	0.74	0.05	−1.57	−1.33	−1.80

Note: The table report risk factor exposures for the portfolios based on the 25%, 33%, and 50% screening, for the global exclusion (Panel A) and the best-in-class screening at region–sector level (Panel B). Parameters are multiplied by 100 and alpha is annualized.

As we control both regional and sectoral exposures, the average score is marginally reduced for the 25% and 33% thresholds and more substantially for the 50% threshold. Similarly, efficiency measures are slightly below those of the case without exposure restrictions (for the three pillars). Again, similar to what was found for the USD segment, this portfolio would appear as the best alternative for an otherwise passive investor: The ESG score is on average substantially increased relative to the benchmark, the Sharpe ratio is higher than that of the benchmark, and the regional and sectoral exposures are the same as those of the benchmark.

6.3 Exposure to risk factors

Table 7 reports risk factor exposures of the portfolios of bonds denominated in EUR with global exclusion (Panel A) and best-in-class screening at the region–sector level (Panel B). We first note that, similar to the USD segment, the EUR benchmark is positively exposed to DRF and REV. Portfolios based on the global exclusion of the E and S scores eliminate exposure to downside risk, whereas the exclusion based on the G score reinforces this exposure. In addition, as for the USD segment, the exclusion portfolios based on the E score exhibit large negative exposure to CRF, suggesting that the screening process based on this score allows investors to be less exposed to firms with high credit risk.

When we consider the strategy based on best-in-class screening, we find some important changes, which make the factor exposures of the EUR screening portfolios similar to those of the USD screening portfolios: First, these portfolios have no exposure to downside risk (except, marginally, the portfolio based on the E score with 25% threshold). Second, the portfolios based on the E and S scores have large negative exposures to credit risk. Despite the protection they offer against credit risk, these best-in-class strategies deliver a risk-adjusted performance that is higher than that of the benchmark. This result suggests that the demand pressure for firms with high ESG scores was sufficiently strong in the recent period to compensate the lower expected return these strategies would command. This evidence is again consistent with results reported by Pástor *et al.* (2021b) for bond and stock markets.

7 Conclusion

For an investment-grade corporate bond portfolio, a global ESG exclusion strategy results in a substantial increase in the targeted score with no deterioration of risk-adjusted returns. This conclusion is in line with the results reported by previous studies (Polbennikov *et al.*, 2016; Bahra and Thukral, 2020) using a similar universe. For both the USD and EUR segments, targeting the E score results in the largest efficiency gain, which combines the risk-adjusted return and the score per unit of risk. However, we also obtain considerable regional and sectoral imbalances. Because of the heterogeneous distribution of scores across regions and sectors, the ESG exclusion generates very different exposures depending on the targeted pillar and the currency segment. To mitigate these biases in risk exposures, we construct best-in-class portfolios with the same regional and sectoral exposures as those of the benchmark. The results remain robust, with still substantial Sharpe ratio gains and ESG gains relative to the benchmark for all pillars and currency segments. In particular, the E-tilted portfolios still deliver the highest values of the efficiency measure for both the USD and EUR segments.

Another source of concern when considering portfolios based on ESG screening is the exposure to risk factors. The conventional benchmark exhibits exposures to the downside risk, credit risk, and reversal risk factors (Bai *et al.*, 2019). A key result for ESG portfolios is that screening implemented

with ESG scores leads to large negative exposures (i.e., protection) to credit risk. This result holds for both segments and most targeted pillars. This means that selected firms with higher ESG scores also have higher credit quality. With regional and sectoral screening, E-tilted portfolios benefit less from the negative exposure to downside risk (USD segment) or are more exposed to downside risk (EUR segment).

Our results suggest that, over the recent period, investors would not have had to trade off between the ESG quality and the financial performance of ESG portfolios. As suggested by Pástor *et al.* (2021b), the large realized return of ESG portfolios may have been driven by the strong demand from institutional investors for securities with high ESG scores. It is worth noting that given the recent focus on environmental issues, the screening based on the E score delivers the best combination of financial performance and score gain for both USD and EUR segments.

Appendices

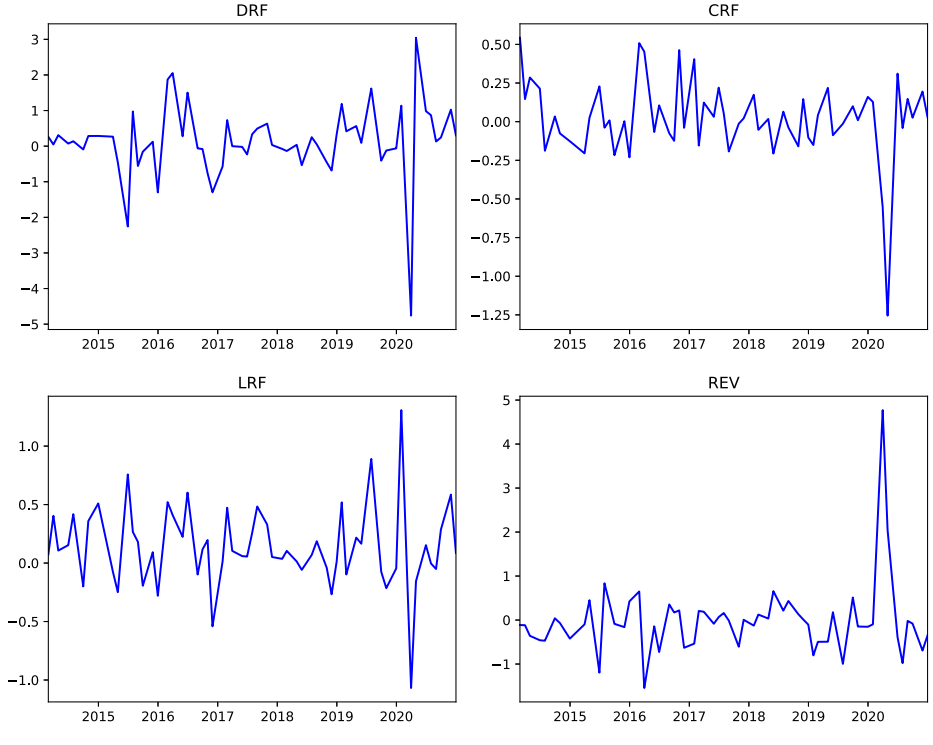
A Composition of the Bond Index

Table A.1 Top 10 corporates by market value of bonds included in the bond index.

Company	Weight (%)	Sector	Market value ($ million)	IAA score	E score	S score	G score
Panel A: USD segment							
JPMorgan	1.76	Financials	83,649	2.99	7.19	4.60	2.15
Bank of America	1.69	Financials	79,059	2.95	6.51	4.21	2.71
Goldman Sachs	1.62	Financials	78,309	4.72	7.17	6.32	2.25
Morgan Stanley	1.49	Financials	71,333	5.44	8.47	5.36	3.49
Citigroup	1.47	Financials	71,591	3.76	7.25	4.73	2.58
Wells Fargo	1.44	Financials	71,113	1.52	6.48	3.40	3.22
AT&T	1.34	Telecom	65,446	3.49	9.97	3.43	4.23
Berkshire Hathaway	1.32	Materials	64,765	3.68	5.33	3.83	3.29
Verizon	1.26	Telecom	61,604	4.39	10.00	3.58	4.83
Comcast	1.24	Telecom	62,803	2.39	9.08	2.36	4.36
Panel B: EUR segment							
Rabobank	2.48	Financials	39,050	5.35	6.95	4.38	4.90
BNP Paribas	1.97	Financials	32,670	6.32	7.66	5.66	3.49
Crédit Mutuel	1.79	Financials	30,243	6.26	5.82	5.14	4.74
Volkswagen	1.58	Cons. Discret.	27,057	0.78	6.11	2.39	1.19
Santander	1.54	Financials	25,894	5.36	7.63	4.76	3.99
Crédit Agricole	1.36	Financials	23,182	6.02	6.59	5.95	2.67
Telefonica	1.33	Telecom	21,840	6.62	9.95	5.53	4.87
BMW	1.29	Cons. Discret.	21,680	6.92	6.67	4.77	4.30
Daimler	1.26	Cons. Discret.	21,885	5.06	6.06	4.05	4.25
AB InBev	1.25	Cons. Staples	21,465	7.77	6.01	6.04	5.96

Note: The table report the weight (within the currency segment), the sector, the market value of bonds issued by the firms in the currency segment, and the ESG, E, S, and G scores averaged over the 2013–2020 period.

Panel A: Factors for USD segment



Panel B: Factors for EUR segment

Figure A.1 Bond risk factors (return in %).

B Bond Factors

Figure A.1 plots the monthly time series of the value-weighted downside risk factor (DRF), credit risk factor (CRF), liquidity risk factor (LRF), and return reversal factor (REV) for the period of January 2014 to December 2020 based on bonds denominated in USD and EUR. In particular, we note large peaks in March 2020 due to the COVID-19 pandemic. REV is the only factor to exhibit positive performance during this episode. The remaining factors undergo significant decreases but rapidly recover in subsequent months. Comparison with factors computed by Bai *et al.* (2019) is difficult, as the common sample only covers the 2014–2016 period. For this short period of time, measures are similar.

Endnotes

[1] According to the Climate Bonds Initiative, the issuance of Green, Social, and Sustainable bonds boomed to USD 297 billion, 249 billion, and 160 billion, respectively, in 2020. Entities from the 27 European Union countries are the main issuers, with USD 228 billion issued by (nonfinancial and financial) corporates out of USD 430 billion worldwide in 2020. Statistics from Climate Bonds Initiative (2020).

[2] The Bloomberg Barclays Global Aggregate Corporate Index is a flagship measure of global investment grade, fixed-rate corporate debt. This multicurrency benchmark includes bonds from developed and emerging market issuers within the industrial, utility, and financial sectors. Ticker: LGCPTRUU.

[3] Berg *et al.* (2022) argue that there is some confusion among ESG ratings due to the existence of several data providers with rather different methodologies and indicators. Divergence in methodologies and in the use of indicators to build scores is likely to generate disagreement among ratings and therefore confusion among investors. As our goal is to demonstrate the feasibility of ESG screening in fixed income markets, addressing the question of disagreement is beyond the scope of our paper and we do not follow the avenue suggested by Berg *et al.* (2021), which consists in correcting the noise using instrument ESG ratings. Instead, we focus on a particular data provider. We believe that our approach is internally consistent, although applying the same approach to a different ESG database could result in different screening portfolios.

[4] The British pound represents approximately 5%, whereas the Canadian dollar, Japanese yen, and Swiss franc each represent less than 2%.

[5] We include among emerging countries all countries that are not in the first three regions, i.e., emerging, frontier, and standalone countries. We use the Industrial Classification Benchmark (ICB) for 11 industries. As real estate firms represent a small proportion of the bond index (2.6% and 3.5% on average for the USD and EUR segments, respectively), we merge real estate firms and financials in a unique "financials" industry.

[6] The proxy for the risk-free rate is the 1-month federal fund rate for the USD portfolio and the 1-month Euribor for the EUR portfolio.

[7] Credit ratings are collected from Bloomberg and converted into numbers. Firms with the highest rating, AAA, are given a value equal to 1, and firms with the lowest rating in our data, B-, are given a value equal to 16. In principle, investment-grade ratings range from AAA to BBB-. However, in the bond index, a bond may be downgraded before it is effectively excluded from the index such that the index may contain bonds with a rating of less than BBB-. Values below BBB- are exceptional.

[8] Andersson *et al.* (2016) propose to minimize the tracking error with the benchmark index while excluding the most polluting firms. This approach could be easily adapted to impose the sectoral exposures to be the same as those of the benchmark. An alternative solution could be to use an optimization procedure that would impose restrictions on the level of exposure to each region and industry, as done in Alessandrini and Jondeau (2021).

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Keywords: Corporate bonds, ESG investing, portfolio construction, bond risk factors.

JEL Classification: G11, G24, M14, Q01