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Abstract

This paper evaluates the impact of a screening process based on Environment, Social, and Governance (ESG) scores for an otherwise passive portfolio of investment-grade corporate bonds. The main result is that this filtering 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 find that screening is very often associated with a substantial improvement in the risk profile. In particular, ESG-tilted portfolios lead to large negative exposure (i.e., protection) to credit risk. Screening based on the Environment score is where most of the reduction in risk takes place, making this criterion particularly relevant in moving the portfolio toward a more defensive composition. We demonstrate that screening at the regional and sectoral levels allows investors to eliminate undesirable regional and sectoral exposures while delivering similar ESG scores and risk-adjusted performances.

Keywords: Corporate bonds, ESG investing, Portfolio construction, Bond risk factors

JEL classification: G11, G24, M14, Q01

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1 Introduction

Despite the development of a substantial Sustainable and Responsible Investment (SRI) segment, corporate bond markets lag behind public equity markets in implementing Environmental, Social, and Governance (ESG) investment strategies. 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] 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. Several arguments have been put forward to explain the lag behind the sustainable investment in the equity market. In particular, studies have demonstrated a lack of differentiation between conventional and green bonds (Reed *et al.*, 2019, and Gyura, 2020). Other studies do not find convincing empirical evidence that ESG investing is profitable in the corporate bond market (Larcker and Watts, 2020, and Flammer, 2021).

Central banks and regulators promote the issuance of SRI bonds through different mechanisms. The Network of Central Banks and Supervisors for Greening the Financial System (NGFS) provides recommendations to central banks on adopting SRI practices (NGFS, 2019). The Bank for International Settlements (BIS) launched a USD-denominated green bond fund for central banks and official institutions in September 2019 and a Euro-denominated green bond fund in January 2021.[2] The European Central Bank (ECB) is the first central bank to classify sustainability-linked bonds (SLBs) as eligible as prudential collateral and for asset repurchase programs.[3] Oustry *et al.* (2020) and Jondeau *et al.* (2021) describe mechanisms to green the collateral pledged by commercial banks to central banks.

[1] According to the Climate Bonds Initiative, the issuance of GSS 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] https://www.bis.org/press/p210125.htm.

[3] The main characteristic of an SLB is that the coupon due by the issuer increases if the issuer fails to live up to its pre-agreed ESG commitments and targets, such as emissions reductions. This mechanism introduces a financial motivation for the issuer to meet such commitments and targets. An important difference between green bonds and SLBs is that the firm's commitment to green bonds is at the project level. In contrast, SLBs are associated with a commitment at the issuer level and may cover various ESG targets through the selection of key performance indicators.

Because of the relatively small size of the SRI bond market, investors have been looking at alternative ways to improve the 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 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 an exclusion process and how the risk exposures of the portfolio are affected by the exclusion 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. The screening scheme involves, for a given ESG score, excluding from the portfolio bonds issued by firms with the lowest scores, representing 10%, 25%, and 50% of the market value.

We explore the impact of the targeted score (ESG or E, S, and G separately) on regional, sectoral, and risk factor exposures depending on the level of the exclusion threshold. We find that ESG exclusion has a substantial effect on portfolio exposures, which makes the resulting portfolio very different from its conventional benchmark. However, we demonstrate that screening implemented at the regional and sectoral levels allows an investor to eliminate undesirable regional and sectoral exposures while delivering similar ESG scores and risk-adjusted performances. For instance, for the USD segment of the market index, an overall screening based on the ESG score results in respective increases of the score and Sharpe ratio to 6.69 and 0.69 from 4.97 and 0.66 for the conventional benchmark. When using regional and sectoral screening, the gain in terms of the score and Sharpe ratio remains substantial (6.4 and 0.69, respectively).

We also identify significant risk factor exposures, suggesting that the exclusion 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. Generally, we find that regional and sectoral screening screening reduces the exposure to risk factors. ESG-tilted 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 these portfolios typically overweight high-quality securities. Despite this tilt, ESG portfolios do not underperform the benchmark. The reduction in the exposure to both downside and credit risks is the greatest for the environmental criterion, 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 Pastor *et al.*, 2021).

The remainder of the paper is structured as follows. Section 2 presents a short review of the literature on the relation between bond markets and ESG investing. Section 3 describes our data and the main ESG characteristics of the bond market index. Section 4 describes the methodology we use in the empirical analysis. Section 5 contains the main analysis for bonds denominated in USD. Section 6 summarizes the main results for bonds denominated in EUR. Section 7 concludes.

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 (or, more generally, ecofriendly) 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 hundred 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. Moreover, this spread in performance is more pronounced in recessions and bear market periods, suggesting that SRI funds offer good protection from crises. Leite and Cortez (2018) obtain a similar level of outperformance for European SRI funds. 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. Typically, funds specialized in high-yield bonds tend to have high returns and low ESG scores.

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. The authors also point out that the exclusion of companies involved in controversial activities implies lower returns on average.

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, even 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. Rather, the risk-adjusted returns are slightly higher than in the overall universe. ESG investing is in general more financially relevant in high-yield than in investment-grade bonds. Ben Slimane *et al.* (2019) propose an active management strategy based on ESG-score sorted portfolios. For the 2014–2019 period, 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 exclusion 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 have economically and statistically significant risk premiums that cannot be explained by long-established stock and bond market factors. In this paper, we adopt the same 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.[4] The constituent list is retrieved from Bloomberg. Financial data on constituent bonds and accounting data from issuers are taken from Datastream. ESG scores are from the MSCI ESG database. We collected monthly data 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 9 bonds per issuer on average. We use this index as a conventional benchmark.

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 industry-adjusted average (IAA) score, which combines the three pillars and for which firms' scores are normalized by their industries.

We now briefly describe the characteristics of the constituents of the bond index in terms of regional and sectoral coverage. We also comment on the temporal evolution of the ESG scores of the index and its regional and sectoral components.

3.1 Structure and Coverage of the Conventional Benchmark

The conventional benchmark includes bonds denominated in fifteen 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.[5] We construct two portfolios based on the market index corresponding to the USD and

[4]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.

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

EUR segments. In addition, to evaluate the impact of ESG screening on the regional and sectoral structure of the portfolio, we consider four regions (North America, Europe, Pacific, and emerging countries) and 10 industries (ICB industries from the FTSE Group).[6]

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. 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 on average one-third of the market value, reflecting the fact that financial institutions usually take more debt than other corporates. Other industries have weights fluctuating between 5% and 10%, which are significantly lower than those of financials. The top 6 issuers are the largest U.S. banks, which together represent 9.5% of the USD segment on average.[7] 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 nonfinancial firms. In contrast, technology firms have a lower weight in the bond index.

For bonds denominated in EUR, we observe more heterogeneity across industries. First, financials issue 37.6% of the market value of the index on average. Among the top 6 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 with MSCI ESG scores. Figure 1 represents the proportion of the bond index (in terms of market value) for which MSCI reports ESG scores. Panels A and B correspond to the coverage of firms issuing bonds in denominated USD and EUR, respectively. For the USD segment

[6] 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.

[7] See Table A.1 in Technical Appendix A.

(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 countries are more 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 companies 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.

[Insert Table 1 and Figure 1 here]

3.2 Evolution of ESG Scores across Regions and Sectors

Figure 2 displays the evolution of the ESG scores of the firm constituents of the bond index and of the four regions for the USD and EUR segments. The score of a given region is the weighted average of the scores of the firms, located in this region, that issued bonds denominated in the given currency. The weights correspond to the market value of the bonds issued by the various firms in this currency. For the USD segment, the average score of firms in North America is close to the world score (Panel A). This result is expected because most of the firms issuing bonds in USD are from North America. For all pillars, European firms have a higher average score, whereas firms in emerging countries usually have lower scores. The fact that the scores of European firms are higher than the scores of North American firms can be explained by the more stringent regulations applied in Europe on sustainability issues (Ioannou and Serafeim, 2019). In contrast, emerging countries usually impose less control in terms of the activities of companies. As European firms have higher scores on average, investors with preferences related to ESG themes will tend to hold more bonds from this region and reduce their holding of bonds issued by firms in North America and emerging countries.

Regarding trends in the different pillars, the figure displays an increase in the IAA score for all regions, particularly for Europe and North America. The E score for the bonds issued by Pacific firms is below the average but increases over the sample period. Historically, firms in Europe and Pacific report higher S scores, but the gap seems to decrease in the last two years. The G score exhibits a downward jump in January 2015, mainly for North American firms, due to a change in

the methodology of the MSCI score. At the end of the sample period, firms in North America and Europe have higher G scores on average.

The results for bonds denominated in EUR are reported in Panel B. Firms in North America and emerging countries exhibit, on average, lower scores than firms in the other regions, except for the E pillar, where only firms in emerging countries report significantly lower scores. We note that average scores reported for emerging countries and Pacific are more volatile due to fewer bonds issued by firms from these regions. Finally, given the overrepresentation of European firms in the EUR segment, all scores are on average higher for the EUR segment than for the USD segment.

[Insert Figure 2 here]

Figure 3 displays the evolution of ESG scores of the firms in the various sectors for the USD segment. The IAA score exhibits substantial heterogeneity across sectors. For some industries, the score increases significantly over the sample period, especially in financials, healthcare, and utilities. Industry and technology are the only sectors with an above-average score for the whole period, whereas the energy, consumer discretionary, and materials sectors have low scores over the sample period.

Other pillars of interest are the E and S scores. Panel B again suggests major differences between industries. For example, telecom and healthcare have scores well above the average, whereas the energy and material sectors hardly reach a score of 4. In contrast, energy firms have a particularly high average S score, while healthcare and consumer discretionary firms have scores of below 4 on average (Panel C). Finally, after the change in the methodology for calculating the G score in 2015, healthcare and consumer discretionary firms have low G scores, while industrials and utilities have above-average scores (see Panel D).

Figure 4 displays the evolution of the various scores across the different sectors for the EUR segment. The ranking of sectors for a given score is relatively similar to the ranking obtained for the USD segment. The figure also reveals that average scores are usually higher for the EUR segment than for the USD segment.

As this analysis of the ESG scores of the bond inde constituents demonstrates, there is a considerable heterogeneity in the scores across ESG pillars, regions, and industries. This evidence suggests that portfolios based on ESG screening are likely to be very different across the targeted pillars. For instance, energy and utility firms usually have low E scores but higher S or G scores. Financial and technology firms usually have high E scores but lower S and G scores. Therefore,

excluding firms based on their E or G scores will result in portfolios with different characteristics. This clearly raises the issue of the financial implications of this screening in terms of both risk-adjusted performance and risk exposures.

[Insert Figures 3 and 4 here]

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 exclusion 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 exclusion methodology used for stocks in Alessandrini and Jondeau (2020) to the context of a bond portfolio. Some additional issues arise. First, the choice of the currency of issuance matters for a bond portfolio because currency returns are much more volatile than bond returns. Working with bonds denominated in different currencies would have a great impact on the risk-adjusted performance of the portfolio. For this reason, we construct two sets of portfolios corresponding to USD and the EUR segments of the bond Index. Second, as illustrated above, regional and sectoral risk exposures substantially differ from the exposures of a stock portfolio. In particular, the ESG quality of financials is likely to play an important role in the construction of an ESG-tilted 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. Our screening analysis is implemented on the IAA score and the three pillar scores.

In Sections 5 and 6, we present our main findings for the USD and EUR segments, respectively. 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.[8] 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

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

portfolio, such as its yield, credit spread, and duration. Then, we assess the impact of the screening process on the regional and sectoral exposures of the portfolio.

We also investigate the possible trade-off between the improvement in the ESG score and 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 tension is in fact limited because high score portfolios also tend to produce good risk-adjusted performance. In fact, investors could have benefited from the two dimensions because of the high demand of high ESG quality firms(Pastor *et al.*, 2021). We compute the so-called Efficiency of the portfolio, a measure that combines two main 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:

$$Eff_p = (1-\gamma)\left(\frac{\bar{R}_p - \bar{R}_f}{\sigma_p}\right) + \gamma\left(\frac{\text{Score}_p}{\sigma_p}\right) = (1-\gamma)SR_p + \gamma ESGR_p \tag{1}$$

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 denotes 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 $\gamma = 0.5$, which corresponds to the point of view of an investor attributing equal weight to both ESG and financial performance. Another metric of interest is the efficiency gain, which measures how the risk-adjusted performance and ESG quality (SR_p and $ESGR_p$) are affected by the exclusion process. We define the efficiency gain for portfolio p as follows:

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

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

Screening implemented at the worldwide level might result in imbalanced portfolios in terms of regional and industry allocations. Thus, in a second step, we control for regional and sectoral exposures by excluding bonds not only at the portfolio level but also for each region, for each industry, and for each region-industry. This approach allows the investor to have neutral regional and sectoral exposures, i.e., close to the benchmark, while benefiting from a higher ESG score.

Finally, we investigate the exposure of ESG-tilted portfolios to risk factors. As risk factors for bonds are different from factors defined for stocks, we follow Bai *et al.* (2019) and construct factors that are designed to explain the excess return of bonds. We compute four risk factor measures (capturing downside, credit, liquidity, and reversal risks) and evaluate how exposures to the different risk factors change with the targeted pillar and the targeted exclusion level.

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. Agencies such as Moody's and Standard & Poor's evaluate a corporate credit rating based on an extensive economic analysis that captures the bond default probability and loss severity. We collect ratings from Bloomberg and convert them 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.[9]

The first factor proposed by Bai *et al.* (2019), measuring downside risk, is based on the 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, ILLIQ, 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. Then, the monthly illiquidity measure of the bond, $ILLIQ_{i,t}$, is simply defined as follows:

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

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.

[9] 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.

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. REV is similar to the well-known 1-month reversal in the equity universe. 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:

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

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.

Figure 5 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.[10]

[Insert Figure 5 here]

5 ESG Screening for USD Denominated Bonds

5.1 Overall Exclusion

We start by considering an overall exclusion approach for the USD segment of the index. We explore three levels of exclusion, 10%, 25%, and 50% of the market value of the index.

[10]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.

5.1.1 ESG Screening and Financial Performance

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 IAA score, the table reveals that the portfolio score increases from 5 for the benchmark to 5.4, 5.8, and 6.7 for the 10%, 25%, and 50% exclusion levels, respectively which represent substantial improvements (Panel A).[11] In addition, despite the high exclusion 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 efficiency gain measures reveal, the screening process results in an increase in the ESG score with the exclusion level, while the Sharpe ratio gain is essentially equal to 0, meaning that the risk-adjusted performance is unaffected by the exclusion. 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 exclusion levels, the tracking error increases to 0.17%, 0.24%, and 0.51% per year.

The table also provides interesting results regarding the financial characteristics of the portfolios. Interestingly, the credit profile of the exclusion portfolio tends to improve, suggesting that excluded bonds (with the lowest scores) have a higher credit spread. 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 exclusion 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.

[Insert Table 2 here]

Targeting the E score is associated with a more substantial increase in the Sharpe ratio, from 0.66 for the benchmark to 0.75 for the 50% exclusion (see Panel B). This increase is mainly due to a decline in volatility. At the same time, the tracking error increases more, up to 0.84% per year for the 50% exclusion, 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

[11] Figure A.1 in Technical Appendix B displays the evolution of the scores of the ESG-tilted portfolios.

score from 6.16 to 7.94 with the 50% exclusion, 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 IAA 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% exclusion 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 score 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 exclusion 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. We now explore what may drive such differences between the three pillars, especially the regional and sectoral exposures of the ESG-tilted portfolios.

5.1.2 Regional and Sectoral Exposures

We start by investigating on how regional and sectoral exposures of the portfolio are affected by the exclusion process. Table 3 (Panel A) reports these exposures for the overall screening, averaged over the sample period, for the 50% threshold.[12] Regarding regional exposures, we find that, for the exclusion based on the IAA score, firms in Europe and Pacific benefit from a positive bias compared to the benchmark portfolio: the weight of European firms increases by 4.4 percentage points on average, while the weight of Pacific firms increases by 1.4 points. In contrast, firms in North America and emerging countries are underweighted by 4.1 and 1.7 points, respectively.

[12]Figures A.2 and A.3 in Technical Appendix B also illustrate the evolution of the regional and sectoral exposures for the various levels of exclusion. In Figure A.3, to conserve space, we report only the change in sectoral weights relative to the benchmark for the 50% exclusion level.

In fact, these biases reflect great heterogeneity across ESG pillars. For the E score, firms in Pacific have a lower weight in the portfolio such that only European firms are overweighted with this screening. 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.

[Insert Table 3 here]

When we consider sectoral exposures, heterogeneity across ESG pillars is even more pronounced. For the IAA score, some industries become highly underweighted after the screening procedure (Panel A). In particular, financial, telecom, and consumer discretionary sectors report a weight at least 2% 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 score, we largely obtain exposures that run contrary to those obtained for the IAA score. Indeed, material and energy companies are almost entirely excluded from the index due to their very low average scores. The weight for energy firms is reduced to 0.7% with 50% exclusion from 7.8% with the benchmark. In contrast, the financial and telecom sectors are respectively overweighted by 10.5% and 5.9% on average. In terms of the S score, financials are again overweighted, but firms in the energy, technology, and consumer staple sectors also benefit from higher weights compared to the benchmark. In terms of underweighted industries, there are mainly two, the consumer discretionary and healthcare sectors Finally, for the G score, we obtain biases that are almost the opposite to those found for the E score: the financial, telecom, and healthcare sectors are severely underweighted, whereas firms in industrial, consumer staple, and utility sectors are heavily overweighted.

This analysis demonstrates that there is a substantial impact of ESG exclusion on regional and sectoral exposures. This impact depends on the targeted ESG criterion and varies over time. In the next section, we consider the case of an investor willing to maintain the same exposures reflected in the benchmark.

5.2 Screening by Region and Industry

The large regional and sectoral tilts implied by ESG screening may be undesirable for passive asset managers. The targeted score and level of exclusion may create important distortions by

overweighting one region or industry and increase the overall risk exposures and tracking error of the portfolio. Additionally, one might argue that the fact that performance is not affected by screening is a consequence of portfolio imbalances. This issue is particularly relevant for the exclusion based on the E score. In the resulting portfolio, 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 biases were particularly favorable in the period we study and allowed the portfolios to compensate for any eventual loss due to the ESG screening process.

To mitigate these biases, several solutions are available. Our approach in this paper consists of implementing the screening procedure at the regional and sectoral levels.[13] Excluding 10% of the overall market value or 10% of each region or industry in the portfolio corresponds to the same level of exclusion. One advantage of the second approach over overall screening is that regional and sectoral exposures are not affected by the screening. Thus, investors are able to increase the ESG scores of their portfolios relative to the benchmark while maintaining the initial weights on regions and industries. It is interesting to evaluate by how much the score and efficiency measure are affected by the regional and sectoral screening.

In Table 3 (Panel B), we implement a 50% screening at the regional level such that each region has the same exposure as in the benchmark portfolio. Compared to Panel A, we find that the average score is not sensitive to restraining regional exposures. The efficiency measure is barely affected, as the ESG gain in efficiency and Sharpe ratio gain remain at the same levels. However, sectoral exposures, which are not restricted, are similar to those reported with overall screening (Panel A). At this stage, tracking errors do not decrease, which suggests that country allocation is not the dimension that generates most of the deviations.

In Table 3 (Panel C), regional exposures are free, but sectoral exposures are restricted to be the same as those of the benchmark portfolio. In this case, we find that the average scores are slightly lower than those reported in Panel A, suggesting that sectoral restrictions have a more severe impact on allocation. This effect is particularly pronounced for the screening based on the E score: both the score and Sharpe ratio are reduced under these restrictions, resulting in a substantial loss in the efficiency measure. Tracking errors, this time, decline significantly.

[13] 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).

Ideally, from the investor's point of view, both exposures need to be fixed in the ESG portfolio. This is what is done in Panel D. We observe that efficiency measures are lower than those found in the unconstrained case. For the E score, the decline in the score and Sharpe ratio is substantial, resulting in a larger decrease in the efficiency measure of approximately 0.15, although its efficiency remains above that of the other pillars. For the S score, we do not observe any material difference with the overall exclusion: the portfolio score is barely reduced and the efficiency measure and tracking error are not altered. For the G score, we find that almost all metrics improve compared to overall screening: the Sharpe ratio increases, the tracking error decreases, and the efficiency measure improves.

In general, for all pillars, the strategy based on both regional and sectoral screening could be the best recommendation for a passive investor with ESG preferences because it maintains the same exposures as the initial index and provides a significant improvement in the average score relative to the benchmark while not deteriorating the risk-adjusted measures and generating minor tracking errors with the benchmark. As this analysis reveals, restricting regional and sectoral exposures to be the same as those of the benchmark reduces the benefit of ESG screening, although the improvement in the portfolio score is still substantial with no impact on the overall financial performance. Consequently, regional and sectoral biases are not the main drivers behind the efficiency gains of the screened portfolios.

5.3 Exposure to Risk Factors

Finally, we discuss the exposure of the ESG-tilted portfolios to the bond risk factors described in Section 4. We measure risk exposures for the IAA score and the three ESG pillars separately. Factor betas are obtained by running the following equation:

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

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

Table 4 reports the risk factor exposures for the ESG-tilted portfolios with different levels of exclusion. Panel A corresponds to the overall screening and Panel B corresponds to the regional and sectoral screening. 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 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-tilted portfolios can be interpreted in relation to those of the benchmark.

As results associated with the overall screening clearly indicate (Panel A), the ESG exclusion has a considerable effect on the risk exposures of the resulting portfolios. When based on the IAA score, the screening allows to cancel the positive exposure to DRF. It also leads to a more pronounced negative exposure to CRF. For the screening based on the E score, we find that the E-tilted portfolio has significant and negative exposures to DRF and CRF. Therefore, bonds issued by firms with high environmental practices tend to be also exposed to low downside risk. This result is consistent with Polbennikov *et al.* (2016) and Mendiratta *et al.* (2020), as ESG screening allows investors to reduce their exposure to downside risk. Exposure to credit risk also becomes much more negative than that of the benchmark. Bonds reporting high E scores therefore also exhibit high credit ratings. Targeting the E pillar definitely allows investors to reach the greatest reduction in exposure to both drawdowns and credit losses. This result 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. The LRF exposure is not significant regardless of the exclusion threshold. Finally, the positive exposure to the REV found for the benchmark disappears for all exclusion portfolios, meaning that short-term losers tend to be screened out when the exclusion is based on the E score.

Screening based on the S and G scores results in highly positive and significant exposures to the DRF and REV. These results suggest that these strategies load very differently on risk factors compared to screening based on the E score. For these pillars, the screening selects bonds issued by firms with higher VaR and lower credit ratings (50% exclusion). Exposures to the reversal risk factor (β_{REV}) are 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-tilted portfolios may be due to the large regional and sectoral biases implied by the overall screening. For this reason, we now consider the risk exposures of portfolios based on regional and sectoral screening (Panel B). Interestingly, we find that risk exposures are more homogeneous for E, S, and G screenings. In particular, all

these portfolios have significantly negative exposures to CRF. Additionally, portfolios based on E and G screening have limited exposure to the DRF, while portfolios based on S screening still show considerable positive exposure. Overall, these results allow for a better understanding of the good performance of overall screening based on the E score: The overall screening excludes almost all firms in energy, materials, and utilities, which results in a highly negative exposure (i.e., protection) of the portfolio against downside risk. In our sample, this strategy delivered higher risk-adjusted performance because of the relatively low financial performance of these excluded sectors. However, when sectoral weights are imposed close to the benchmark weights, the screening based on the E score loses its protection from downside risk, which has resulted in a lower financial performance in our sample.

[Insert Table 4 here]

6 ESG Screening for EUR Denominated Bonds

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

6.1 Overall Exclusion

Table 5 reports the results for the overall exclusion.[14] Many of the results observed for the USD segment remain valid, though some divergences are worth noting. If we start by comparing the characteristics of the benchmark for the EUR and USD segments, we note that returns are much lower in the EUR segment than in the USD segment over the period. In addition, the yield and credit spread of EUR bonds are much lower than their USD counterparts. The yield is on average 1.3% lower, and the credit spread is approximately 30 bp lower. This difference may be partly due to corporate bonds with lower ESG ratings having a wider spread as suggested by Polbennikov *et al.* (2016). This may also be due to the shorter duration of EUR bonds relative to that of USD bonds. Despite the large difference in returns, Sharpe ratios benefit from a lower volatility and are relatively close to those found for the USD segment. The table also reveals higher values for the ESG scores of the benchmark than for the USD segment. The reason is that companies issuing

[14] Figure A.4 in Technical Appendix C displays the evolution of the scores of the tilted portfolios for the EUR segment. Figures A.5 and A.6 show the evolution of the regional and sectoral exposures for the various levels of exclusion.

bonds in EUR are often located in Europe and incorporate more ESG practices than those issuing bonds in USD.

If we turn to ESG screening, 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. We also find that the tracking errors associated with overall screening are always limited (up 0.3% per year), which suggests that the rebalancing between regions and sectors required to increase the targeted score does not significantly affect the performance of the portfolio.

[Insert Table 5 here]

Summary statistics on regional and sectoral exposures for the overall screening are reported in Table 6 (Panel A). 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 50% threshold, 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 scores on average than North American firms issuing bonds in USD and that the opposite applies for European firms. For the S and G scores, we find that fewer firms from North America and emerging countries and more firms from Europe and Pacific are included in the portfolio. Similar to what was found for the USD segment, emerging countries report less exposure for all criteria, which is simply explained by the fact that this region receives the lowest grades.

The results for sectoral exposures reveal that the impact of exclusion is often similar for the EUR and USD segments. We note in particular that financial and telecom firms benefit from high overweighting when screening is based on the E and S scores but 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.

[Insert Table 6 here]

6.2 Screening by Region and Industry

We now evaluate the role of regional and sectoral biases in explaining the efficiency gain of the screening strategies. Previously, European firms were overweighted in the screened portfolio, while North American firms were underweighted by approximately 8% for the IAA score. Regional

weights are now those of the benchmark. Table 6 (Panel B) reveals that, with regional screening, the score, the risk-adjusted performance, and the tracking error are barely affected by the screening.

With sectoral screening (Panel C), the impact on the ESG quality and financial performance of the portfolio is more substantial. The average scores decrease relative to those of the overall screening (Panel A) by approximately 0.2–0.3 points. Performance measures are also more sensitive: The annualized return decreases, annualized volatility increases, and the Sharpe ratio slightly decreases. efficiency is reduced relative to that of the unconstrained portfolio with more significant decreases in the E and S scores.

Finally, the results for the case of constraining both regional and sectoral exposures are reported in Table 6 (Panel D). The Sharpe ratio is reduced relative to that of the overall screening (Panel A), but it remains higher than the value obtained with the benchmark. As we control both exposures, the average score is now corrected with a reduction of between 0.3 and 0.4 and efficiency measures are only 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 increased by approximately 0.9 points, 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 based on the EUR segment with overall screening (Panel A) and regional and sectoral screening (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 overall screening of the E and S scores eliminate exposure to downside risk, whereas the screening based on the G score reinforces this exposure (Panel A). In addition, the screening portfolios based on the E and S scores exhibit large negative exposure to CRF, suggesting that the exclusion process based on these scores allows investors to be less exposed to firms with high credit risk.

When we consider the strategy based on regional and sectoral screening (Panel B), we find some important differences. First, the portfolios based on the E and S scores are now positively exposed to DRF and negatively exposed to CRF.

Again similar to the USD segment, risk factor exposures allow us to interpret the good performance of the overall screening based on the E score: With overall screening, by underweighting firms from energy and materials and overweighting financial and telecom firms, this strategy eliminates exposure to downside risk. In our sample period, due to the rebalancing, the strategy also delivers higher risk-adjusted performance. However, with regional and sectoral screening, the strategy has been more exposed to downside risk in our sample, which has resulted in a lower financial performance.

[Insert Table 7 here]

7 Conclusion

Using data for January 2014 to December 2020, we find that an overall ESG screening 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, and Bahra and Thukral, 2020) using a similar universe. For both the USD and EUR segments, targeting the E score results in the largest gain in efficiency, which combines the risk-adjusted return and the score per unit of risk. However, we also obtain considerable biases in regional and sectoral exposures. Because of the heterogeneous distribution of scores across regions and sectors, the ESG screening generates very different exposures depending on the targeted pillar and the currency segment. To mitigate these biases in risk exposures, we construct ESG-tilted portfolios with the same regional and sectoral exposures as those of the benchmark. The results remain robust, with still substantial Sharpe ratio gain and ESG gain 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.

Finally, 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-tilted 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 selecting 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 to trade off between the ESG quality and the financial performance of ESG-tilted portfolios. As suggested by Pastor *et al.* (2021), the large realized return of ESG-tilted portfolios may have been driven by the large demand from institutional investors for green assets. 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.

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Table 1: Regional and Sectoral Composition of the USD and EUR Segments (in %)

	USD segment	EUR segment
Panel A: Regional structure		
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 structure		
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 report summary statistics on regional and sectoral structures of the USD and EUR segments of the benchmark portfolio.

Table 2: Performance of Portfolios with Overall Screening – USD Segment

	Benchmark	10% Exclusion	25% Exclusion	50% Exclusion
Panel A: IAA score				
Return (%)	4.31	4.31	4.33	4.36
Volatility (%)	5.22	5.18	5.20	5.07
Sharpe ratio	0.66	0.67	0.67	0.69
Tracking error (%)	0.09	0.17	0.24	0.51
Turnover (%)	35.9	35.8	36.7	38.2
Yield (%)	3.10	3.07	3.06	3.00
Credit spread (bp)	130.7	127.9	125.8	119.4
Duration (year)	6.74	6.80	6.90	6.95
ESG Score	4.97	5.36	5.83	6.69
Efficiency measure	–	0.85	0.90	1.01
SR gain in efficiency	–	0.00	0.00	0.02
ESG gain in efficiency	–	0.04	0.09	0.18
Panel B: E score				
Return (%)	4.31	4.27	4.35	4.34
Volatility (%)	5.22	5.07	4.91	4.68
Sharpe ratio	0.66	0.68	0.71	0.75
Tracking error (%)	0.09	0.32	0.60	0.84
Turnover (%)	35.9	35.8	35.8	35.9
Yield (%)	3.10	3.05	2.99	2.96
Credit spread (bp)	130.7	125.7	121.0	119.7
Duration (year)	6.74	6.77	6.76	6.57
ESG Score	6.16	6.60	7.12	7.94
Efficiency measure	–	0.99	1.08	1.22
SR gain in efficiency	–	0.01	0.03	0.04
ESG gain in efficiency	–	0.06	0.13	0.26
Panel C: S score				
Return (%)	4.31	4.32	4.34	4.33
Volatility (%)	5.22	5.21	5.24	5.24
Sharpe ratio	0.66	0.67	0.67	0.67
Tracking error (%)	0.09	0.12	0.18	0.23
Turnover (%)	35.9	36.2	36.1	37.2
Yield (%)	3.10	3.09	3.08	3.06
Credit spread (bp)	130.7	130.1	129.8	129.2
Duration (year)	6.74	6.73	6.72	6.62
ESG Score	4.45	4.72	5.04	5.58
Efficiency measure	–	0.79	0.81	0.87
SR gain in efficiency	–	0.00	0.00	0.00
ESG gain in efficiency	–	0.03	0.06	0.11
Panel D: G score				
Return (%)	4.31	4.36	4.38	4.39
Volatility (%)	5.22	5.35	5.47	5.61
Sharpe ratio	0.66	0.66	0.65	0.63
Tracking error (%)	0.09	0.17	0.29	0.46
Turnover (%)	35.9	37.7	38.2	39.6
Yield (%)	3.10	3.13	3.11	3.11
Credit spread (bp)	130.7	131.4	129.6	129.3
Duration (year)	6.74	6.91	6.98	7.00
ESG Score	4.89	5.17	5.57	6.10
Efficiency measure	–	0.81	0.83	0.86
SR gain in efficiency	–	0.00	−0.01	−0.02
ESG gain in efficiency	–	0.02	0.04	0.08

Note: The table report summary statistics on portfolios based on the 10%, 25%, and 50% exclusion screening, for the IAA, E, S, and G scores. Statistics are: the annual return, the annual standard deviation, the Sharpe ratio, the annual tracking error, the annual turnover, the average yield, credit spread, and duration, the average score, the efficiency measure and its two components.

Table 3: Statistics of Portfolios with 50% Exclusion – USD Segment

	Bench-mark	Panel A: Overall exclusion				Panel B: Regional exclusion			
		IAA	E	S	G	IAA	E	S	G
Performance									
Return (%)	4.31	4.36	4.34	4.33	4.39	4.40	4.37	4.34	4.40
Volatility (%)	5.22	5.07	4.68	5.24	5.61	5.12	4.68	5.29	5.57
Sharpe ratio	0.66	0.69	0.75	0.67	0.63	0.69	0.75	0.66	0.64
Tracking error (%)	0.09	0.51	0.84	0.23	0.46	0.49	0.84	0.24	0.43
Turnover (%)	35.9	38.2	35.9	37.2	39.6	37.8	36.8	38.0	40.4
Yield (%)	3.10	3.00	2.96	3.06	3.11	3.02	2.97	3.07	3.11
Credit spread (bp)	130.7	119.4	119.7	129.2	129.3	120.3	120.6	129.5	130.3
Duration (year)	6.74	6.95	6.57	6.62	7.00	7.02	6.58	6.69	6.94
Benchmark score	–	4.97	6.16	4.45	4.89	4.97	6.16	4.45	4.89
Average score	–	6.69	7.94	5.58	6.10	6.64	7.90	5.56	6.08
Efficiency measure	–	1.01	1.22	0.87	0.86	1.00	1.22	0.86	0.86
SR gain	–	0.02	0.04	0.00	-0.02	0.02	0.05	0.00	-0.01
ESG gain	–	0.18	0.26	0.11	0.08	0.17	0.25	0.10	0.08
Regional exposures									
North America	79.91	-4.11	-0.68	-4.55	1.41	-0.06	-0.05	-0.06	-0.07
Europe	11.14	4.43	3.35	2.49	0.76	0.02	0.02	0.03	0.04
Pacific	4.14	1.39	-0.82	2.43	-0.08	0.02	0.02	0.02	0.02
Emerging countries	4.81	-1.71	-1.85	-0.37	-2.09	0.01	0.01	0.01	0.02
Sectoral exposures									
Financials	33.08	-5.07	10.45	4.12	-6.22	-5.97	9.89	3.66	-6.20
Healthcare	9.38	-1.19	2.63	-5.42	-3.12	-1.27	2.12	-5.27	-3.07
Utilities	8.37	3.01	-3.38	2.75	3.46	3.85	-2.99	2.97	3.33
Industrials	8.26	3.82	-2.07	-2.46	5.51	4.16	-2.09	-2.02	5.47
Consumer Staples	7.82	2.62	-2.45	-0.02	4.00	2.44	-2.41	0.41	4.00
Energy	7.79	-1.20	-7.09	3.95	2.08	-1.39	-7.13	3.65	2.13
Technology	7.06	4.38	0.53	4.00	-1.73	4.56	0.95	4.29	-1.77
Consumer Discretionary	6.74	-2.06	0.29	-4.15	-0.52	-1.72	0.44	-4.03	-0.47
Telecom	6.30	-2.32	5.88	-1.66	-3.22	-2.47	5.89	-1.79	-3.36
Materials	5.20	-1.99	-4.78	-1.12	-0.23	-2.18	-4.66	-1.87	-0.06

Note: The table report summary statistics on portfolios based on the 50% exclusion screening, for the IAA, E, S, and G scores. Statistics are: the annual return, the annual standard deviation, the Sharpe ratio, the annual tracking error, the annual turnover, the average yield, credit spread, and duration, the average score, the efficiency measure and its two components. For regional and sectoral exposures, numbers for the benchmark are the average weights, number for exclusion portfolios are over/under weighting. Panels to D correspond to the overall exclusion, the regional exclusion, the sectoral exclusion, and the regional/sectoral exclusion, respectively.

Table 3 (cont.): Statistics of Portfolios with 50% Exclusion – USD Segment

	Bench-mark	Panel C: Sectoral exclusion				Panel D: Regional/ sectoral exclusion			
		IAA	E	S	G	IAA	E	S	G
Performance									
Return (%)	4.31	4.30	4.28	4.36	4.42	4.33	4.28	4.37	4.36
Volatility (%)	5.22	5.00	4.99	5.13	5.32	5.06	5.06	5.14	5.29
Sharpe ratio	0.66	0.69	0.69	0.69	0.67	0.69	0.68	0.69	0.67
Tracking error (%)	0.09	0.39	0.56	0.28	0.16	0.34	0.46	0.30	0.15
Turnover (%)	35.9	41.6	39.7	41.2	43.7	42.9	40.9	42.2	44.5
Yield (%)	3.10	3.00	2.99	3.05	3.10	3.01	3.01	3.06	3.11
Credit spread (bp)	130.7	121.1	120.0	127.9	130.3	121.8	121.5	128.0	131.1
Duration (year)	6.74	6.70	6.86	6.66	6.85	6.78	6.84	6.75	6.84
Benchmark score	–	4.97	6.16	4.45	4.89	4.97	6.16	4.45	4.89
Average score	–	6.52	7.51	5.45	5.98	6.40	7.43	5.38	5.91
Efficiency measure	–	1.00	1.10	0.87	0.90	0.98	1.07	0.87	0.89
SR gain	–	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00
ESG gain	–	0.18	0.16	0.11	0.09	0.16	0.14	0.10	0.09
Regional exposures									
North America	79.91	-5.86	1.47	-3.94	-0.34	-0.51	-0.60	-0.49	-0.54
Europe	11.14	5.32	2.29	2.02	1.76	0.23	0.30	0.20	0.20
Pacific	4.14	1.98	-1.79	2.10	0.24	0.12	0.13	0.12	0.13
Emerging countries	4.81	-1.43	-1.97	-0.18	-1.67	0.16	0.17	0.17	0.22
Sectoral exposures									
Financials	33.08	-0.06	-0.06	-0.06	-0.06	-0.23	-0.26	-0.20	-0.23
Healthcare	9.38	0.02	0.00	0.01	0.02	0.05	0.03	0.05	0.08
Utilities	8.37	-0.01	-0.01	-0.01	0.01	0.01	0.00	-0.01	0.00
Industrials	8.26	0.00	-0.01	0.00	-0.06	0.06	0.10	0.03	-0.02
Consumer Staples	7.82	0.01	0.02	0.01	0.02	0.02	-0.01	0.01	0.04
Energy	7.79	0.01	0.00	0.00	-0.01	0.02	0.02	0.01	-0.01
Technology	7.06	0.02	0.02	0.01	0.03	0.01	0.01	0.03	0.04
Consumer Discretionary	6.74	0.00	0.00	0.01	0.01	-0.02	-0.01	0.01	0.01
Telecom	6.30	0.03	0.05	0.02	0.02	0.06	0.07	0.05	0.05
Materials	5.20	0.00	0.00	0.01	0.02	0.02	0.05	0.03	0.04

Table 4: Factor Exposures of Portfolios – USD Segment

	Bench-mark	10% excl.	25% excl.	50% excl.	10% excl.	25% excl.	50% excl.
Panel A: With overall screening							
			IAA score			**E score**	
α	−0.01	−0.05	−0.10	−0.07	−0.07	0.00	0.16
β_{MKT}	0.98*	0.99*	1.01*	0.99*	1.00*	1.02*	0.96*
β_{DRF}	2.40*	2.40*	−0.30	0.40	−2.80*	−7.40*	−4.50
β_{CRF}	−1.50*	−5.50*	−8.20*	−16.40*	−10.30*	−19.30*	−22.00*
β_{LRF}	−0.80	−0.70	0.70	1.40	1.70	4.40	3.40
β_{REV}	1.80*	2.20*	1.80*	2.20*	−0.10	−1.60	−0.80
			S score			**G score**	
α	−0.01	0.02	0.02	0.04	−0.06	−0.16	−0.22
β_{MKT}	0.98*	0.97*	0.97*	0.96*	1.00*	1.04*	1.07*
β_{DRF}	2.40*	3.90*	5.10*	4.60*	4.00*	2.50*	−3.20
β_{CRF}	−1.50*	−0.80	1.30	3.80*	−1.70*	−0.70	4.00*
β_{LRF}	−0.80	−1.30	−2.10	−1.20	−1.80	−2.60	2.40
β_{REV}	1.80*	2.90*	4.50*	4.60*	3.00*	2.60*	2.10
Panel B: With regional and sectoral screening							
			IAA score			**E score**	
α	−0.01	−0.03	−0.06	0.00	−0.04	−0.10	−0.07
β_{MKT}	0.98*	0.99*	1.00*	0.98*	1.00*	1.01*	0.99*
β_{DRF}	2.40*	1.70*	0.00	1.30	0.30	−1.70	0.00
β_{CRF}	−1.50*	−5.70*	−8.00*	−9.80*	−4.70*	−8.80*	−15.20*
β_{LRF}	−0.80	−0.30	1.70	−0.10	0.90	2.70	2.50
β_{REV}	1.80*	1.50*	1.70*	1.80*	1.60*	1.20	2.10*
			S score			**G score**	
α	−0.01	0.04	0.08	0.10	−0.01	−0.04	−0.04
β_{MKT}	0.98*	0.97*	0.96*	0.94*	1.00*	1.01*	1.01*
β_{DRF}	2.40*	4.10*	5.20*	9.60*	1.80*	−0.20	0.40
β_{CRF}	−1.50*	−4.40*	−7.60*	−5.30*	−3.50*	−2.00*	−1.70
β_{LRF}	−0.80	−0.50	−1.20	−4.70*	−0.10	0.80	0.60
β_{REV}	1.80*	2.50*	2.40*	4.20*	1.90*	1.50*	2.30*

Note: The table report risk factor exposures for the portfolios based on the 10%, 25%, and 50% exclusion screening, for the overall screening (Panel A) and the regional and sectoral screening (Panel B). Parameters are multiplied by 100 and alpha is annualized.

Table 5: Performance of Portfolios with Overall Screening – EUR Segment

	Benchmark	10% Exclusion	25% Exclusion	50% Exclusion
Panel A: IAA score				
Return (%)	2.15	2.19	2.19	2.25
Volatility (%)	4.23	4.19	4.08	4.06
Sharpe ratio	0.58	0.60	0.61	0.63
Tracking error (%)	0.09	0.12	0.20	0.26
Turnover (%)	34.7	34.8	34.3	34.8
Yield (%)	0.84	0.84	0.81	0.79
Credit spread (bp)	104.3	103.0	100.6	98.1
Duration (year)	5.08	5.12	5.12	5.15
ESG Score	6.07	6.52	7.01	7.74
Efficiency measure	–	1.08	1.17	1.27
SR gain in efficiency	–	0.01	0.02	0.02
ESG gain in efficiency	–	0.06	0.14	0.23
Panel B: E score				
Return (%)	2.15	2.20	2.21	2.27
Volatility (%)	4.23	4.18	4.16	4.15
Sharpe ratio	0.58	0.60	0.61	0.62
Tracking error (%)	0.09	0.15	0.21	0.28
Turnover (%)	34.7	34.2	33.6	34.8
Yield (%)	0.84	0.82	0.83	0.83
Credit spread (bp)	104.3	102.1	102.0	102.6
Duration (year)	5.08	5.08	5.10	5.10
ESG Score	6.74	7.09	7.47	8.08
Efficiency measure	–	1.15	1.20	1.28
SR gain in efficiency	–	0.01	0.01	0.02
ESG gain in efficiency	–	0.05	0.10	0.18
Panel C: S score				
Return (%)	2.15	2.18	2.19	2.23
Volatility (%)	4.23	4.12	4.04	4.03
Sharpe ratio	0.58	0.60	0.62	0.63
Tracking error (%)	0.09	0.14	0.21	0.23
Turnover (%)	34.7	35.1	34.8	35.7
Yield (%)	0.84	0.82	0.82	0.81
Credit spread (bp)	104.3	102.2	102.4	102.5
Duration (year)	5.08	5.03	4.96	4.95
ESG Score	4.88	5.16	5.47	5.96
Efficiency measure	–	0.93	0.99	1.05
SR gain in efficiency	–	0.01	0.02	0.02
ESG gain in efficiency	–	0.05	0.10	0.16
Panel D: G score				
Return (%)	2.15	2.20	2.22	2.22
Volatility (%)	4.23	4.26	4.23	4.20
Sharpe ratio	0.58	0.59	0.60	0.60
Tracking error (%)	0.09	0.15	0.23	0.31
Turnover (%)	34.7	36.4	36.4	36.4
Yield (%)	0.84	0.85	0.85	0.83
Credit spread (bp)	104.3	104.2	103.2	101.7
Duration (year)	5.08	5.19	5.23	5.19
ESG Score	5.10	5.42	5.85	6.47
Efficiency measure	–	0.93	0.99	1.07
SR gain in efficiency	–	0.00	0.01	0.01
ESG gain in efficiency	–	0.03	0.09	0.17

Note: The table report summary statistics on portfolios based on the 10%, 25%, and 50% exclusion screening, for the IAA, E, S, and G scores. Statistics are: the annual return, the annual standard deviation, the Sharpe ratio, the annual tracking error, the annual turnover, the average yield, credit spread, and duration, the average score, the efficiency measure and its two components.

Table 6: Statistics of Portfolios with 50% Exclusion – EUR Segment

	Bench-mark	Panel A: Overall exclusion				Panel B: Regional exclusion			
		IAA	E	S	G	IAA	E	S	G
Performance									
Return (%)	2.15	2.25	2.27	2.23	2.22	2.26	2.22	2.25	2.26
Volatility (%)	4.23	4.06	4.15	4.03	4.20	4.20	4.07	4.10	4.31
Sharpe ratio	0.58	0.63	0.62	0.63	0.60	0.61	0.62	0.63	0.60
Tracking error (%)	0.09	0.26	0.28	0.23	0.31	0.20	0.30	0.22	0.37
Turnover (%)	34.7	34.8	34.8	35.7	36.4	37.2	36.0	35.8	38.1
Yield (%)	0.84	0.79	0.83	0.81	0.83	0.82	0.82	0.82	0.86
Credit spread (bp)	104.3	98.1	102.6	102.5	101.7	100.4	102.0	102.0	103.0
Duration (year)	5.08	5.15	5.10	4.95	5.19	5.23	5.02	5.08	5.36
Benchmark score	–	6.07	6.74	4.88	5.10	6.07	6.74	4.88	5.10
Average score	–	7.74	8.08	5.96	6.47	7.62	8.05	5.92	6.41
Efficiency measure	–	1.27	1.28	1.05	1.07	1.21	1.30	1.03	1.04
SR gain	–	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01
ESG gain	–	0.23	0.18	0.16	0.17	0.19	0.19	0.14	0.14
Regional exposures									
North America	19.43	-8.03	5.14	-7.04	-8.24	0.02	0.06	0.03	0.04
Europe	72.44	8.98	-4.28	8.37	6.24	-0.15	-0.16	-0.12	-0.16
Pacific	3.89	0.80	0.50	0.30	2.17	0.06	0.07	0.06	0.06
Emerging countries	4.24	-1.74	-1.37	-1.63	-0.17	0.07	0.04	0.04	0.05
Sectoral exposures									
Financials	37.61	-10.85	6.68	5.60	-13.89	-11.54	5.67	5.10	-16.94
Industrials	9.68	3.17	-1.06	-2.02	4.15	3.13	-1.15	-2.37	3.05
Consumer Discretionary	9.11	-2.00	-1.93	-5.83	-3.31	-1.90	-1.26	-6.10	-3.40
Telecom	8.83	0.95	8.81	1.22	-1.55	0.86	8.68	1.21	-0.16
Consumer Staples	8.57	2.73	-4.23	-0.06	5.90	3.57	-4.60	0.56	7.08
Utilities	8.56	6.51	0.77	3.98	7.46	5.94	1.11	3.54	7.20
Healthcare	5.32	-2.19	-1.23	-4.15	-2.37	-1.45	-0.59	-3.30	-1.57
Energy	5.04	-0.47	-4.25	1.10	0.57	-1.30	-4.10	1.02	0.64
Materials	4.68	0.22	-3.92	-1.65	2.99	0.50	-3.86	-1.56	3.15
Technology	2.60	1.93	0.65	1.81	0.05	2.20	0.45	1.90	0.95

Note: The table report summary statistics on portfolios based on the 50% exclusion screening, for the IAA, E, S, and G scores. Statistics are: the annual return, the annual standard deviation, the Sharpe ratio, the annual tracking error, the annual turnover, the average yield, credit spread, and duration, the average score, the efficiency measure and its two components. For regional and sectoral exposures, numbers for the benchmark are the average weights, number for exclusion portfolios are over/under weighting. Panels to D correspond to the overall exclusion, the regional exclusion, the sectoral exclusion, and the regional/sectoral exclusion, respectively.

Table 6 (cont.): Statistics of Portfolios with 50% Exclusion – EUR Segment

	Bench-mark	Panel C: Sectoral exclusion				Panel D: Regional/ sectoral exclusion			
		IAA	E	S	G	IAA	E	S	G
Performance									
Return (%)	2.15	2.20	2.18	2.18	2.16	2.25	2.16	2.21	2.18
Volatility (%)	4.23	4.06	4.26	4.13	4.03	4.26	4.20	4.24	4.14
Sharpe ratio	0.58	0.62	0.59	0.60	0.61	0.60	0.59	0.60	0.60
Tracking error (%)	0.09	0.23	0.25	0.17	0.26	0.21	0.17	0.20	0.20
Turnover (%)	34.7	38.6	37.7	39.8	42.9	40.8	40.6	41.9	43.7
Yield (%)	0.84	0.80	0.82	0.81	0.80	0.83	0.82	0.83	0.83
Credit spread (bp)	104.3	99.8	101.4	102.3	102.1	101.6	101.4	102.9	103.1
Duration (year)	5.08	5.11	5.15	4.98	4.95	5.26	5.11	5.11	5.09
Benchmark score	–	6.07	6.74	4.88	5.10	6.07	6.74	4.88	5.10
Average score	–	7.56	7.70	5.83	6.17	7.31	7.62	5.71	6.00
Efficiency measure	–	1.24	1.20	1.01	1.07	1.16	1.20	0.97	1.03
SR gain	–	0.02	0.00	0.01	0.02	0.01	0.00	0.01	0.01
ESG gain	–	0.21	0.11	0.13	0.16	0.14	0.11	0.10	0.12
Regional exposures									
North America	19.43	-9.94	5.57	-6.56	-9.38	0.27	0.30	0.33	0.22
Europe	72.44	10.30	-2.93	7.27	8.74	-1.08	-1.07	-1.21	-1.03
Pacific	3.89	1.47	-0.74	-0.20	1.47	0.34	0.39	0.37	0.35
Emerging countries	4.24	-1.83	-1.90	-0.51	-0.83	0.47	0.38	0.51	0.46
Sectoral exposures									
Financials	37.61	-0.18	-0.17	-0.16	-0.13	-0.56	-0.64	-0.62	-0.55
Industrials	9.68	-0.02	-0.01	0.00	-0.01	0.01	-0.01	0.01	-0.02
Consumer Discretionary	9.11	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.05	-0.05
Telecom	8.83	0.02	0.00	0.02	0.02	0.12	0.09	0.10	0.10
Consumer Staples	8.57	0.01	0.02	0.01	0.00	0.00	0.09	-0.01	0.04
Utilities	8.56	-0.01	0.00	0.00	0.00	0.02	-0.03	0.04	0.01
Healthcare	5.32	0.03	0.05	0.04	0.04	0.08	0.11	0.16	0.13
Energy	5.04	0.08	0.04	0.03	0.03	0.12	0.12	0.13	0.13
Materials	4.68	0.01	0.02	0.02	0.02	0.11	0.11	0.13	0.10
Technology	2.60	0.05	0.06	0.06	0.04	0.11	0.17	0.09	0.12

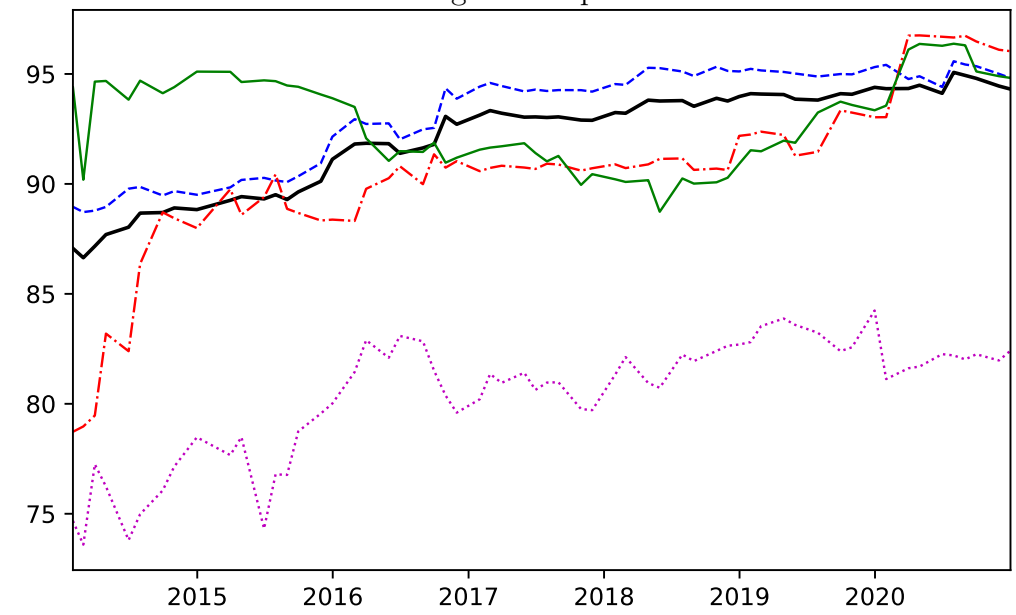
Table 7: Factor Exposures of Portfolios – EUR Segment

	Bench-mark	10% excl.	25% excl.	50% excl.	10% excl.	25% excl.	50% excl.
Panel A: With overall screening							
			IAA score			**E score**	
α	−0.04	0.02	0.05	0.08	0.07	0.11	0.16
β_{MKT}	1.01*	0.97*	0.94*	0.94*	1.01*	1.00*	1.04*
β_{DRF}	1.50*	4.30*	4.70*	−2.80	−0.60	0.40	−3.90
β_{CRF}	−1.90	−4.10*	0.00	−2.90	−11.00*	−13.60*	−15.50*
β_{LRF}	0.50	1.50	2.30	5.50	0.40	−1.00	−1.30
β_{REV}	0.90*	1.00	1.00	0.40	0.30	1.70	2.80
			S score			**G score**	
α	−0.04	0.09	0.16	0.16	−0.03	−0.04	−0.06
β_{MKT}	1.01*	0.99*	0.98*	0.97*	1.00*	0.95*	0.94*
β_{DRF}	1.50*	0.30	−0.60	0.20	3.50*	7.60*	5.40
β_{CRF}	−1.90	−8.10*	−1.90	−0.70	0.60	3.20	3.20
β_{LRF}	0.50	−1.00	−3.70	0.10	0.90	4.40	8.70*
β_{REV}	0.90*	0.30	0.60	0.40	1.90*	1.20	−2.60
Panel B: With regional and sectoral screening							
			IAA score			**E score**	
α	−0.04	0.00	0.07	0.05	0.02	0.07	0.05
β_{MKT}	1.01*	0.99*	0.99*	0.99*	0.99*	0.99*	0.99*
β_{DRF}	1.50*	2.40*	3.60*	5.40*	3.60*	3.40*	3.20*
β_{CRF}	−1.90	−3.10*	−6.40*	−6.00*	−4.80*	−8.60*	−7.20*
β_{LRF}	0.50	1.00	0.20	0.70	0.50	−0.60	−2.80
β_{REV}	0.90*	1.70*	2.00*	2.20	1.60*	1.90*	1.60
			S score			**G score**	
α	−0.04	−0.01	0.08	0.05	0.00	0.04	0.04
β_{MKT}	1.01*	1.00*	0.99*	1.00*	1.01*	1.01*	0.97*
β_{DRF}	1.50*	2.00*	1.20	2.40	1.30*	1.00	1.70
β_{CRF}	−1.90	−2.50	−8.30*	−10.90*	−2.90*	−2.00	1.30
β_{LRF}	0.50	−0.80	0.90	2.10	0.00	−0.50	1.00
β_{REV}	0.90*	1.80*	0.40	0.20	0.60	0.10	−1.70

Note: The table report risk factor exposures for the portfolios based on the 10%, 25%, and 50% exclusion screening, for the overall screening (Panel A) and the regional and sectoral screening (Panel B). Parameters are multiplied by 100 and alpha is annualized.

Figure 1: Coverage by Region (% of total market value)

Panel A: Coverage of the portfolio in USD



Panel B: Coverage of the portfolio in EUR

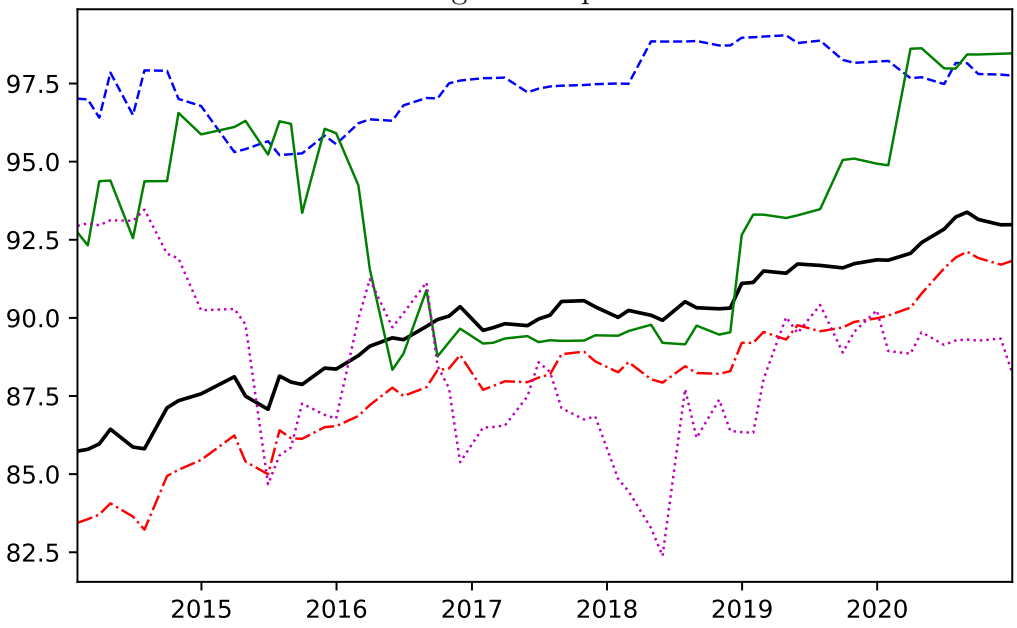


Figure 2: Evolution of the Average ESG Scores by Region

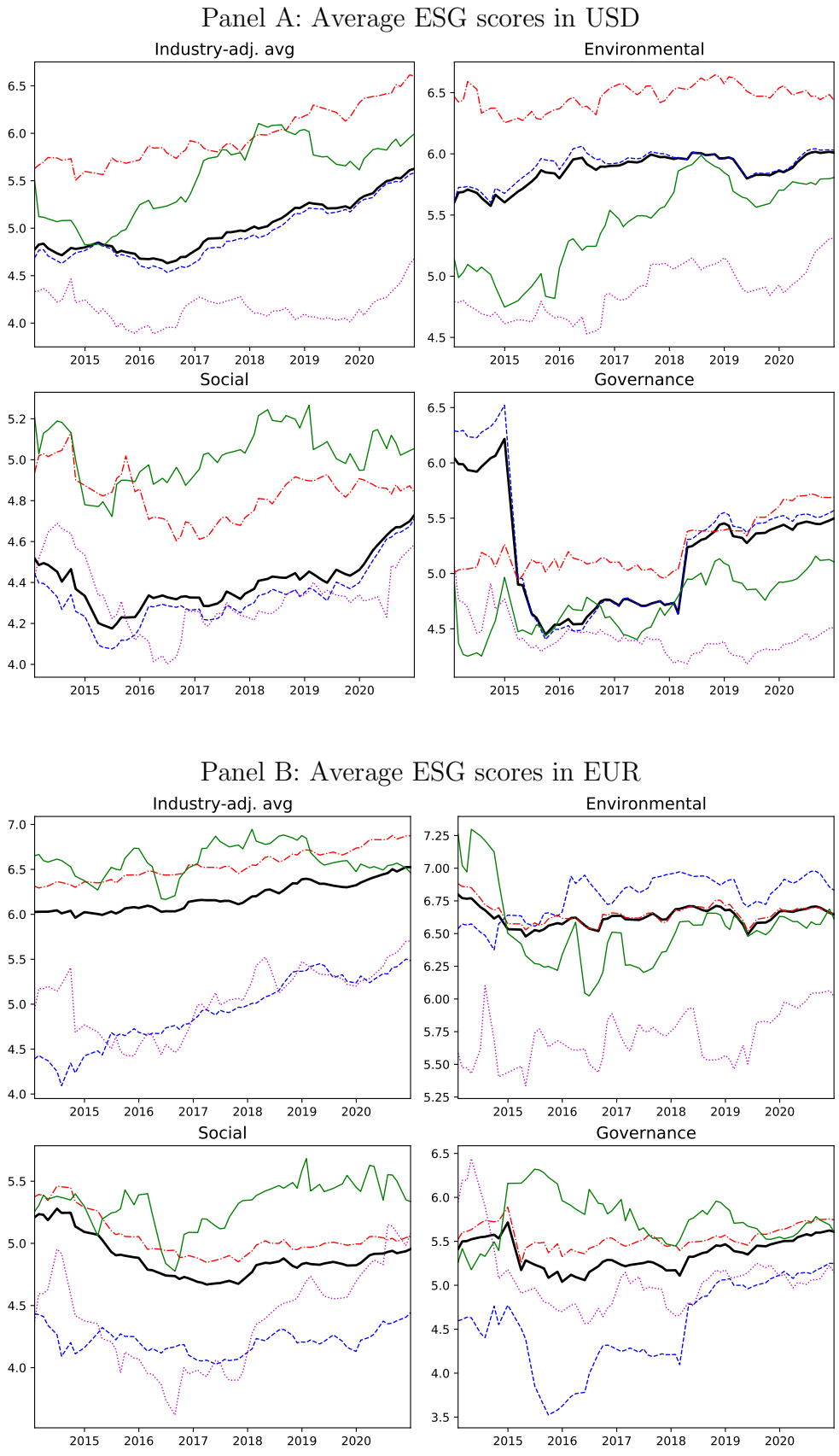


Figure 3: Evolution of the Average ESG Scores by Sector – USD Segment

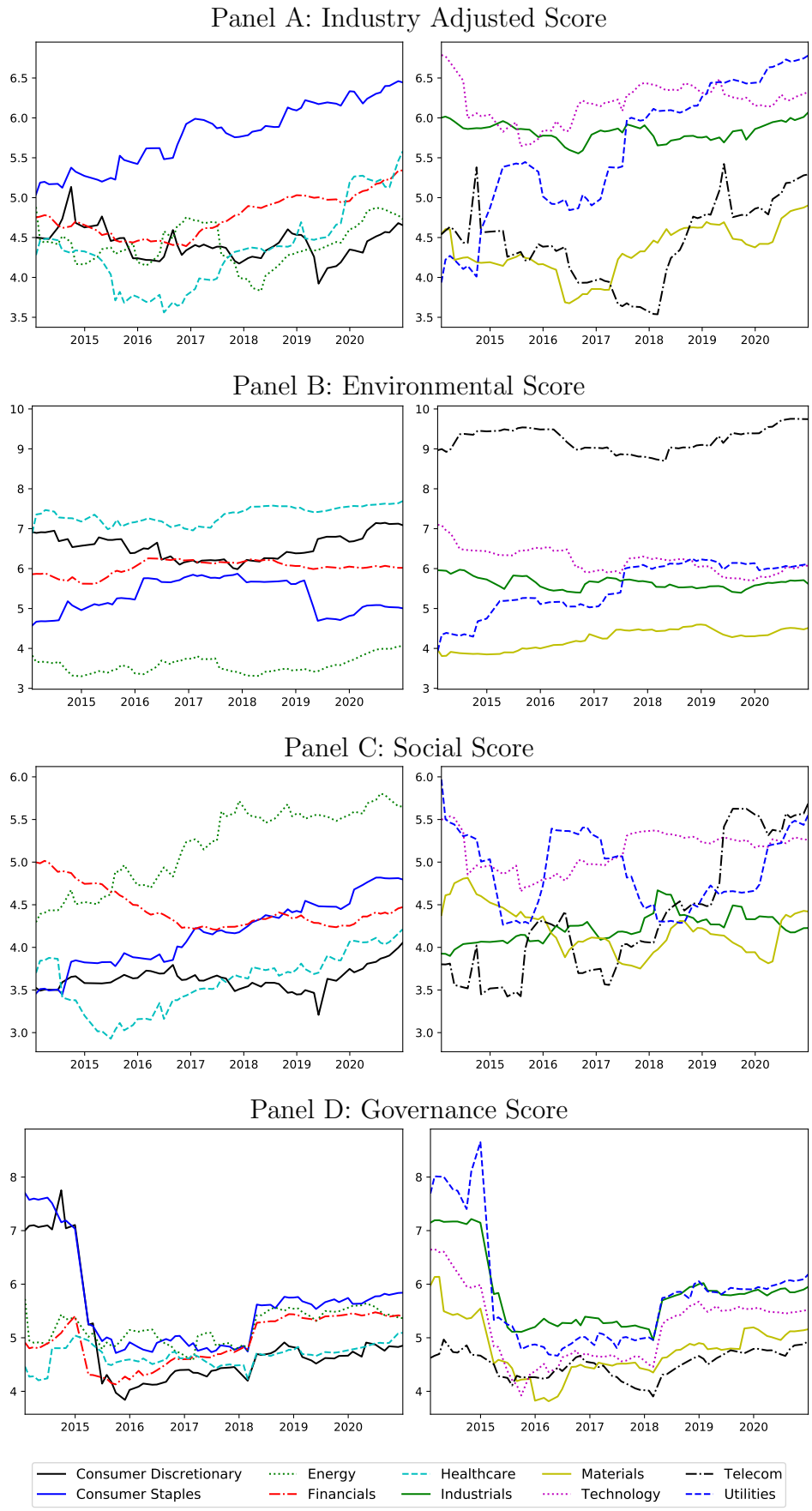


Figure 4: Evolution of the Average ESG Scores by Sector – EUR Segment

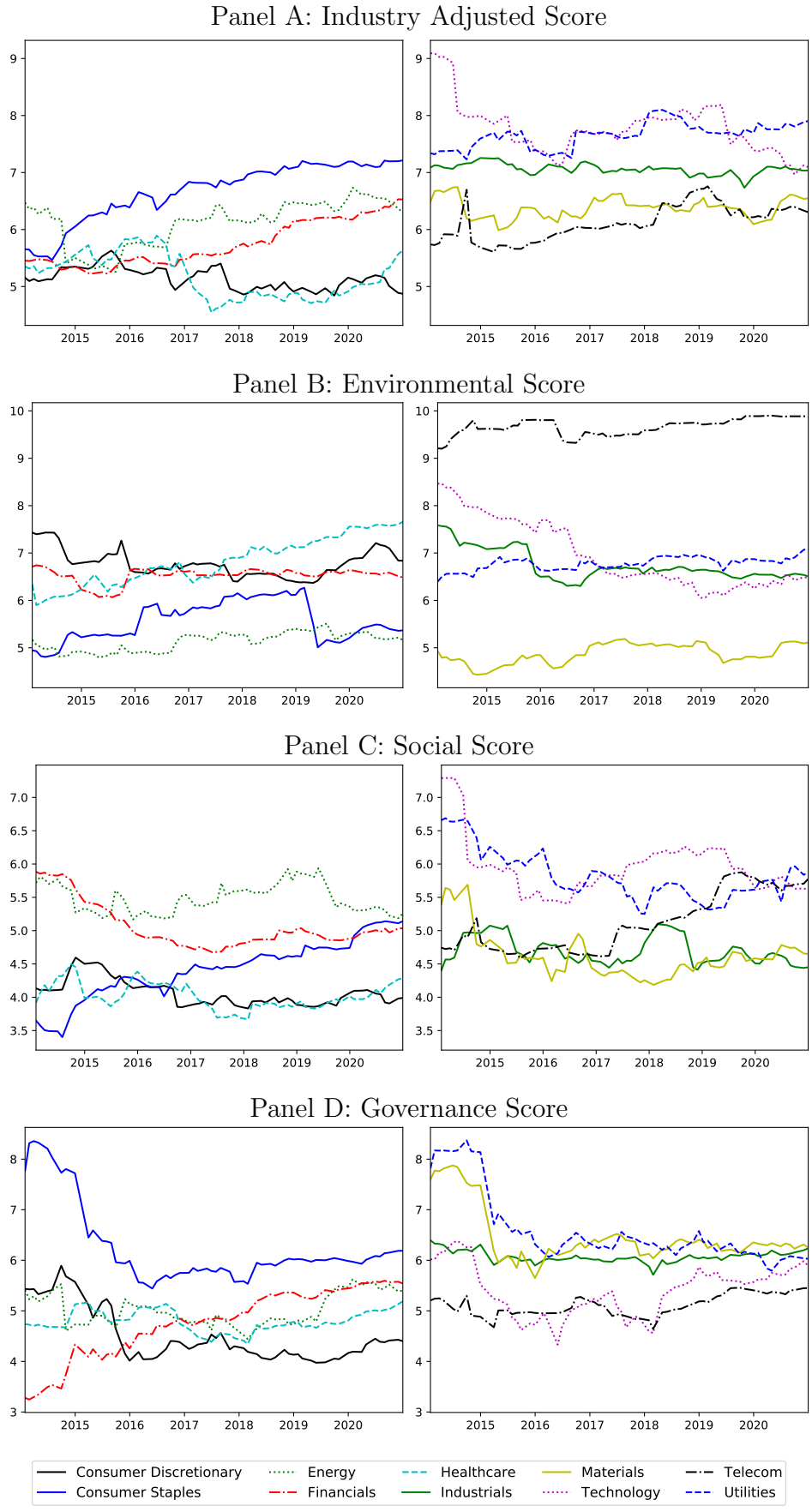


Figure 5: Bond Risk Factors (Return in %)

Panel A: Factors for USD segment

Panel B: Factors for EUR segment

Technical Appendix

This document, not intended for publication, provides supplementary material to the paper "ESG Screening in the Fixed-Income Universe." We provide additional results on the composition of the bond index (Section A), the overall exclusion with the USD segment (Section B) and the overall exclusion with the EUR segment (Section C).

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.

B Overall Exclusion with the USD Segment

Figure A.1: Evolution of the ESG Score of the Tilted Portfolios

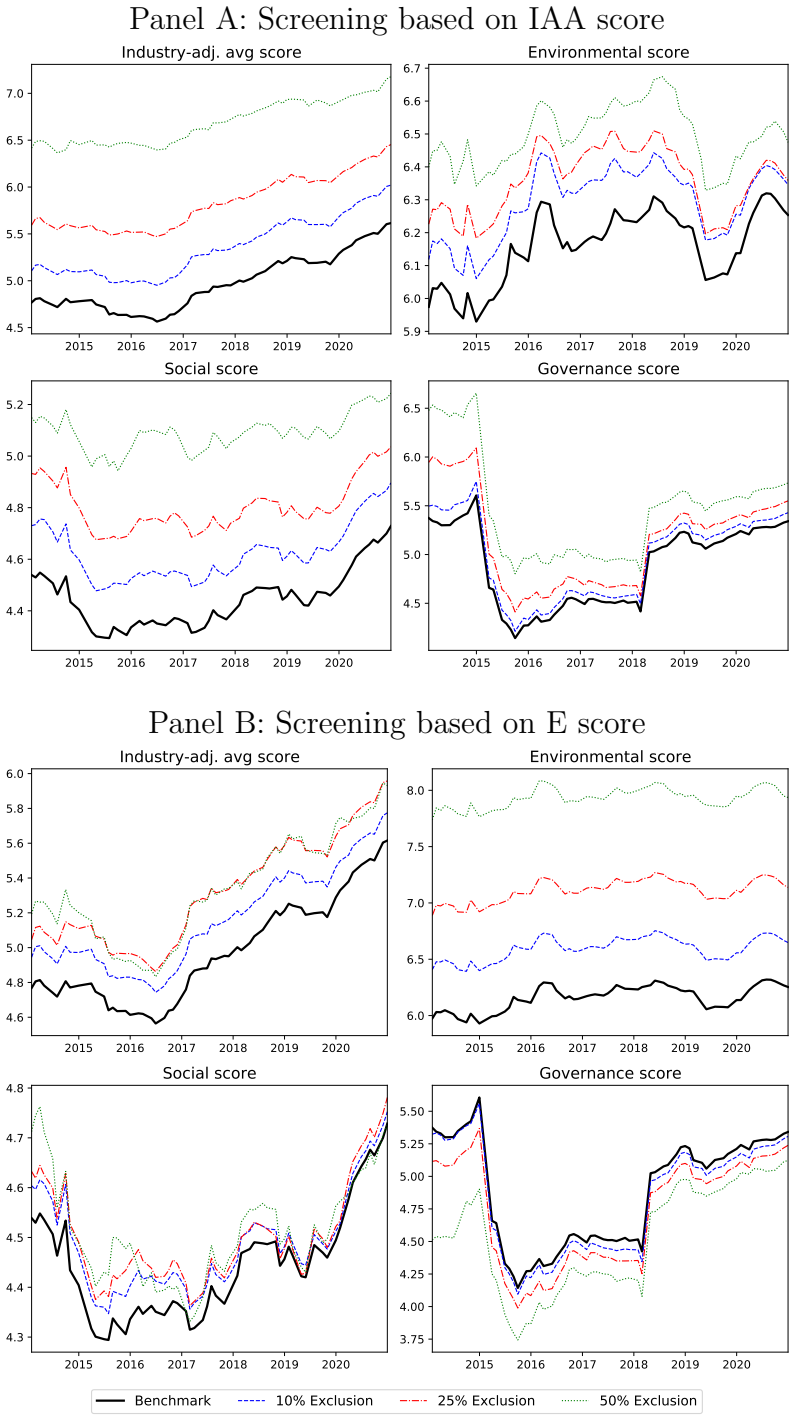
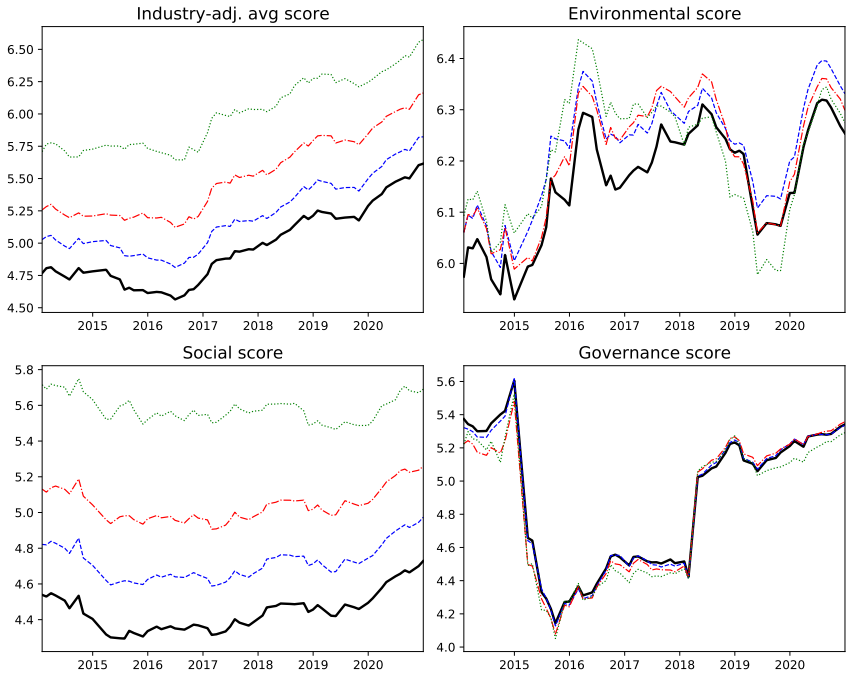


Figure A.1 (cont.): Evolution of the ESG Score of the Tilted Portfolios

Panel C: Screening based on S score



Panel D: Screening based on G score

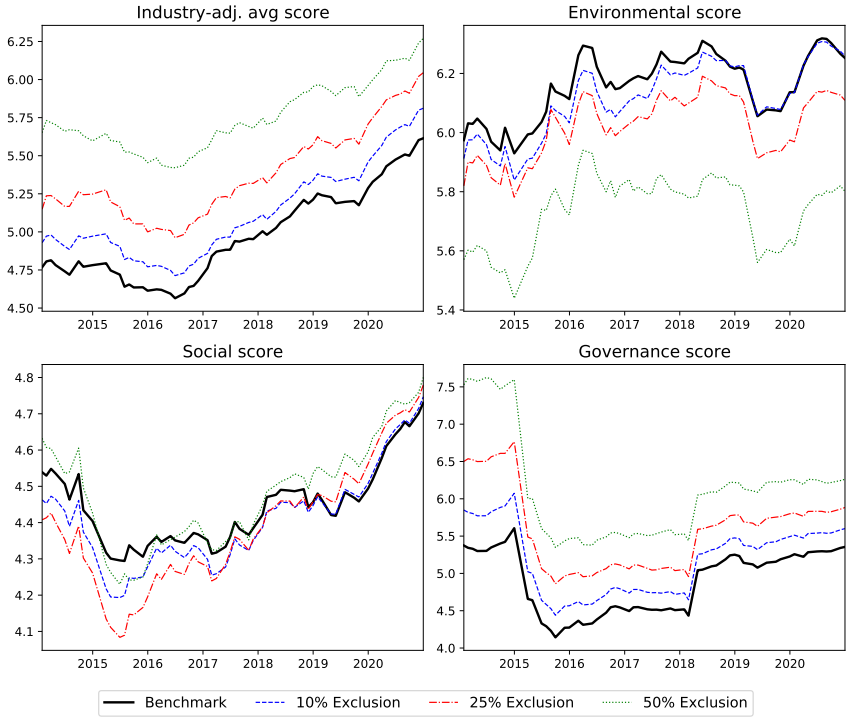
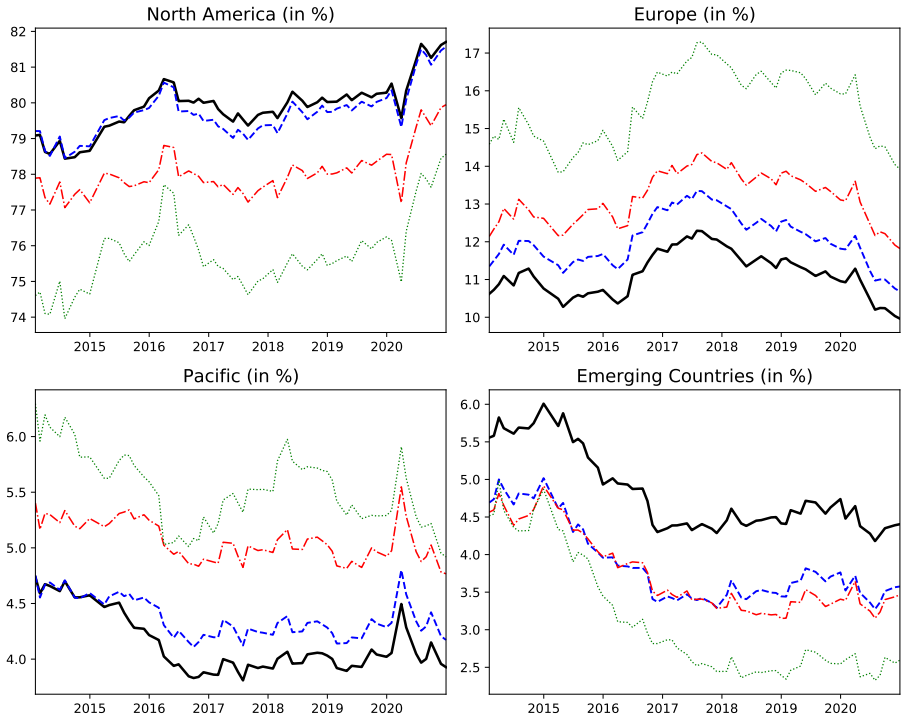


Figure A.2: Evolution of Regional Exposures of the Tilted Portfolios

Panel A: Screening based on IAA score



Panel B: Screening based on E score

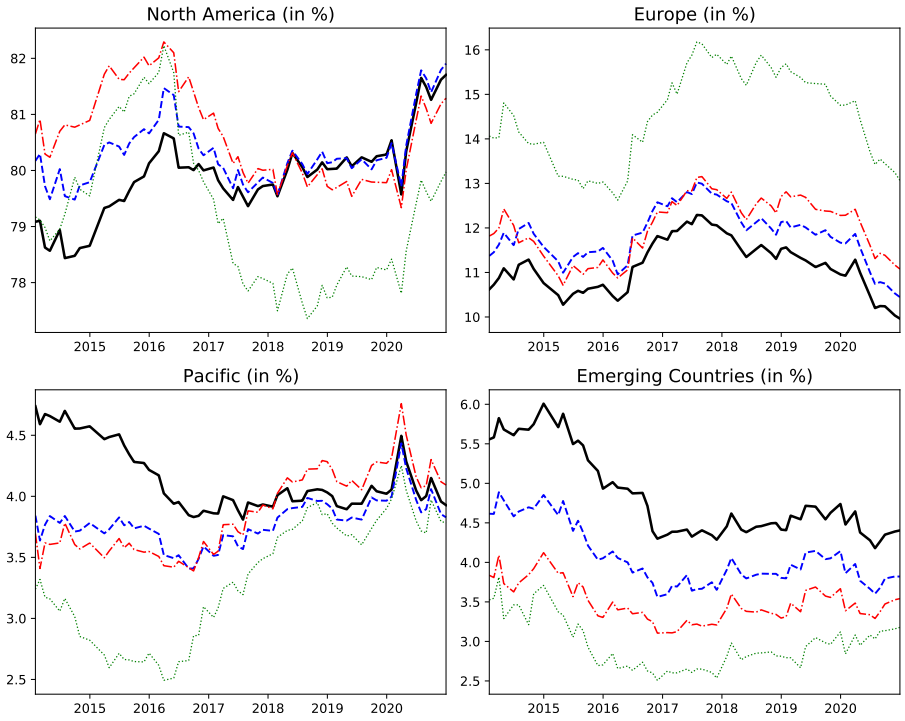
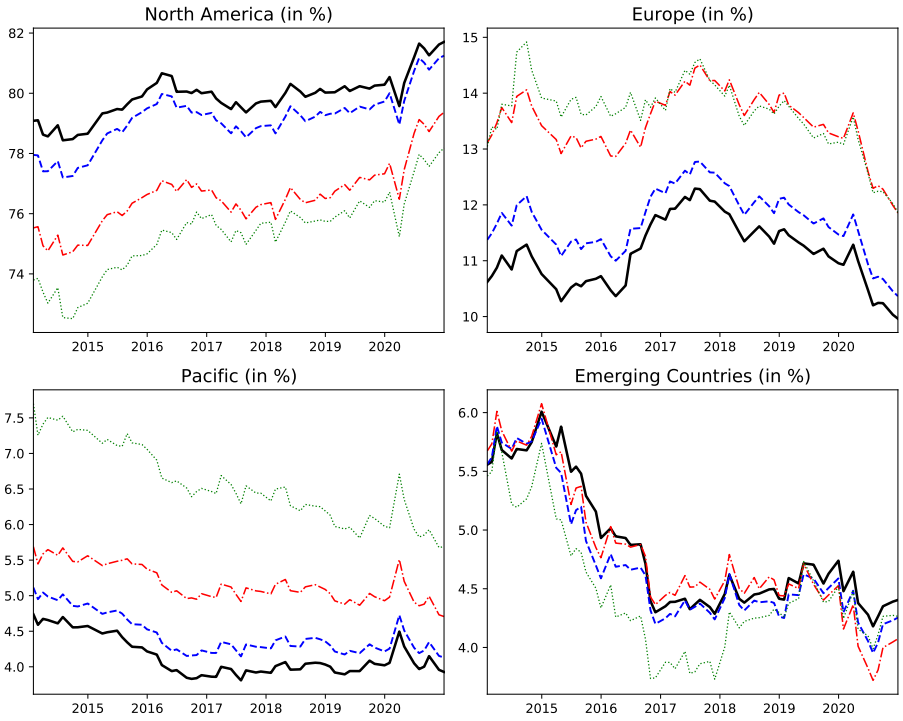


Figure A.2 (cont.): Evolution of Regional Exposures of the Tilted Portfolios

Panel C: Screening based on S score



Panel D: Screening based on G score

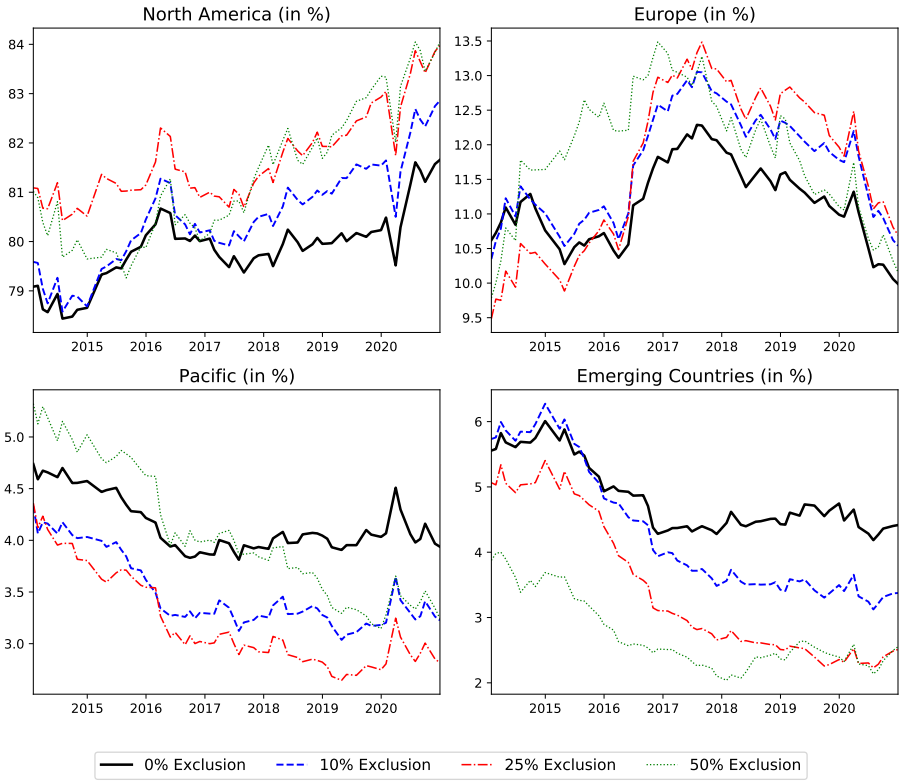
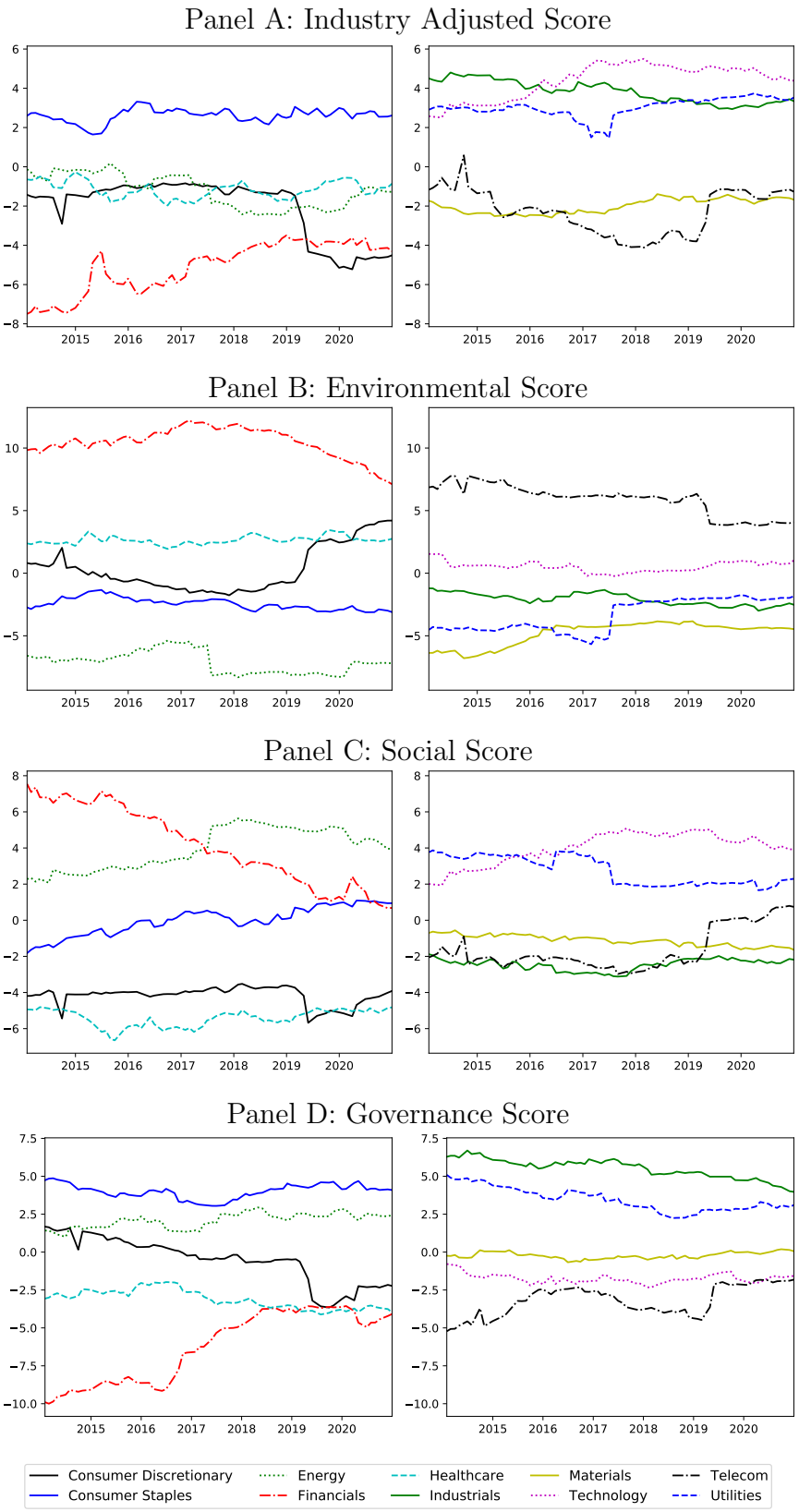


Figure A.3: Evolution of Sectoral Exposures of the 50% Tilted Portfolio



C Overall Exclusion with the EUR Segment

Figure A.4: Evolution of the ESG Score of the Tilted Portfolios

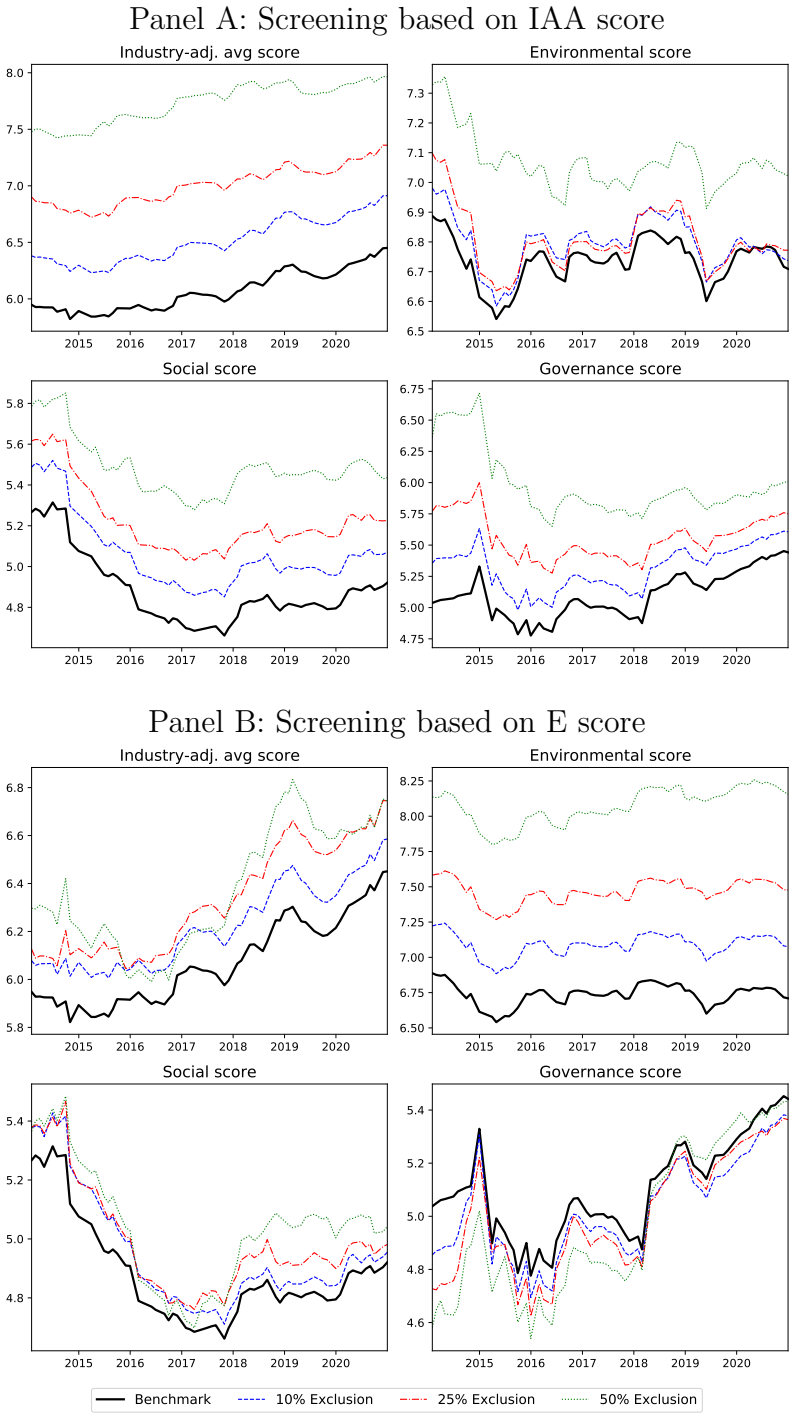


Figure A.4 (cont.): Evolution of the ESG Score of the Tilted Portfolios

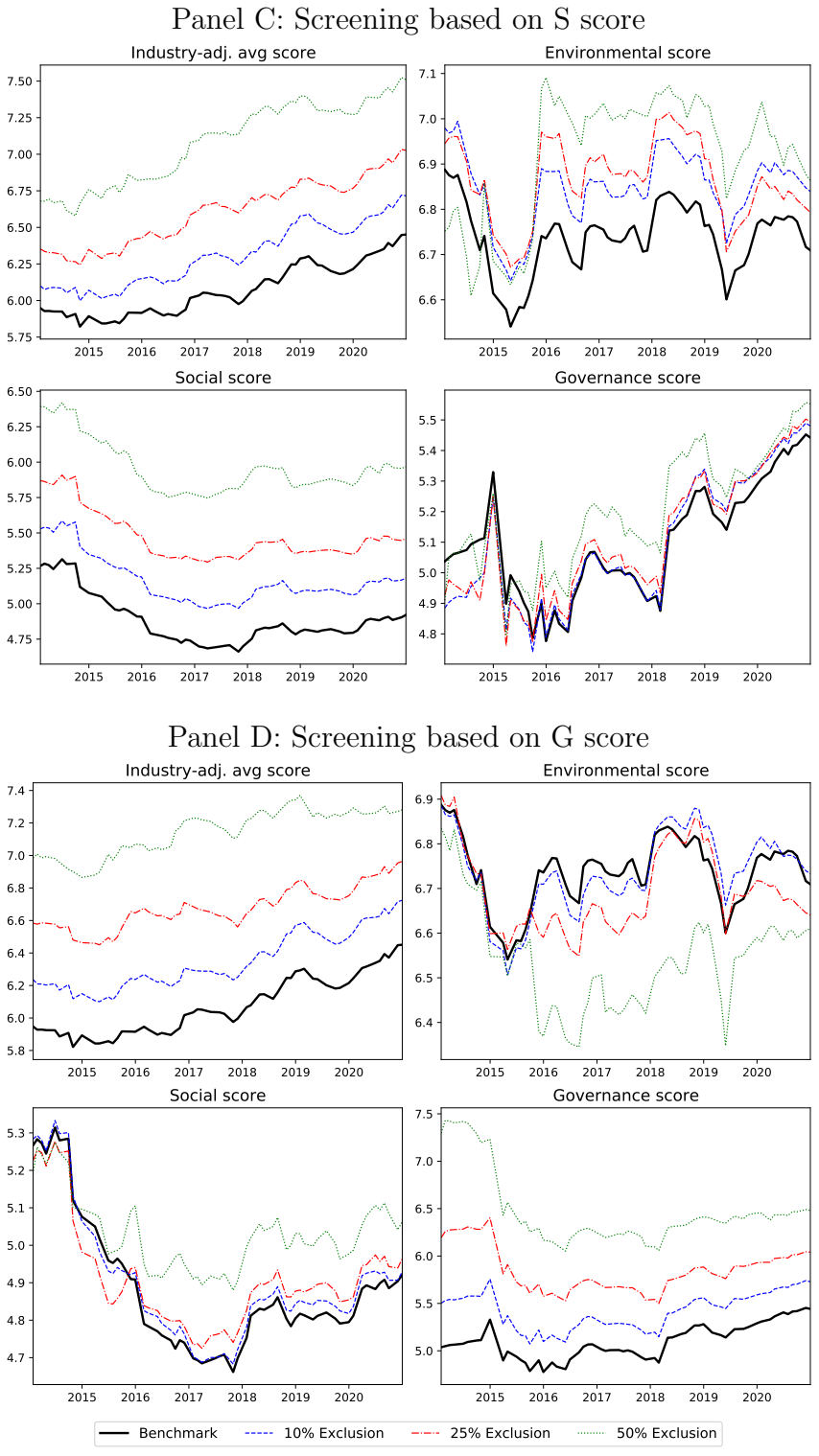
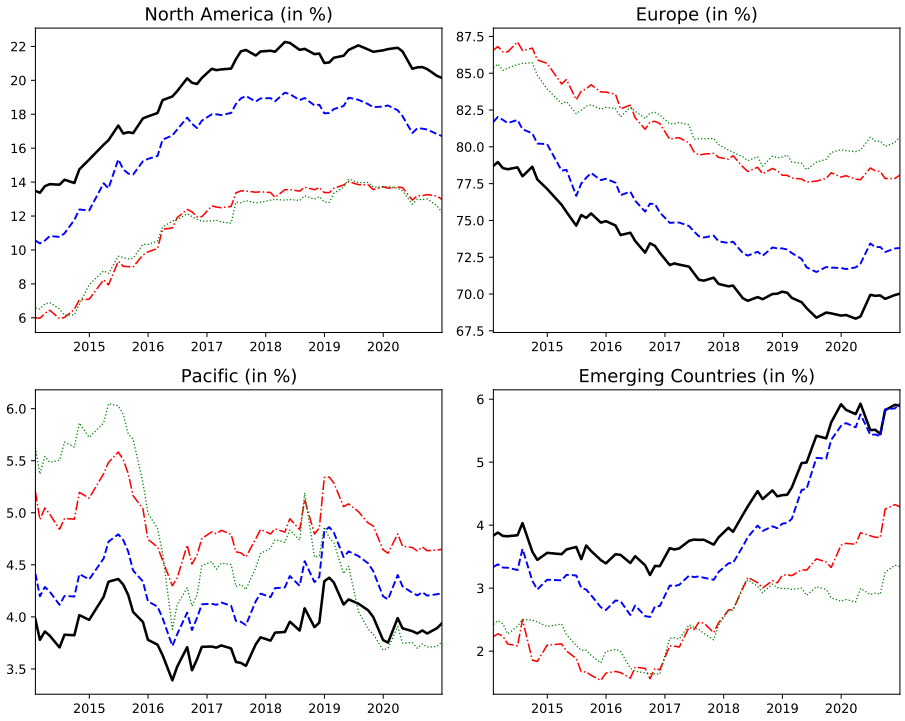


Figure A.5: Evolution of Regional Exposures of the Tilted Portfolios

Panel A: Screening based on IAA score



Panel B: Screening based on E score

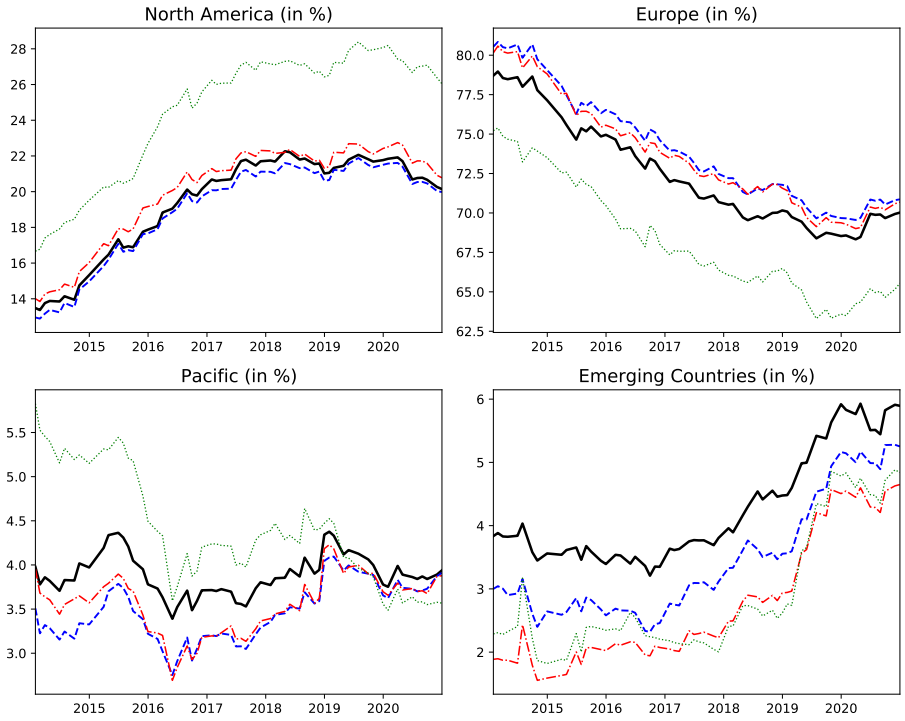
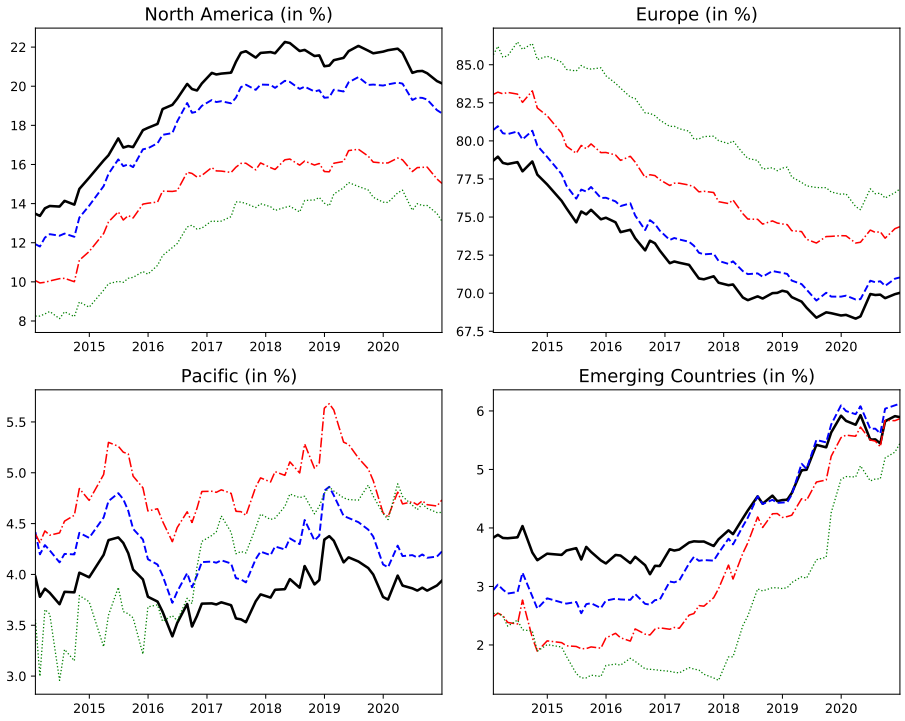


Figure A.5 (cont.): Evolution of Regional Exposures of the Tilted Portfolios

Panel C: Screening based on S score



Panel D: Screening based on G score

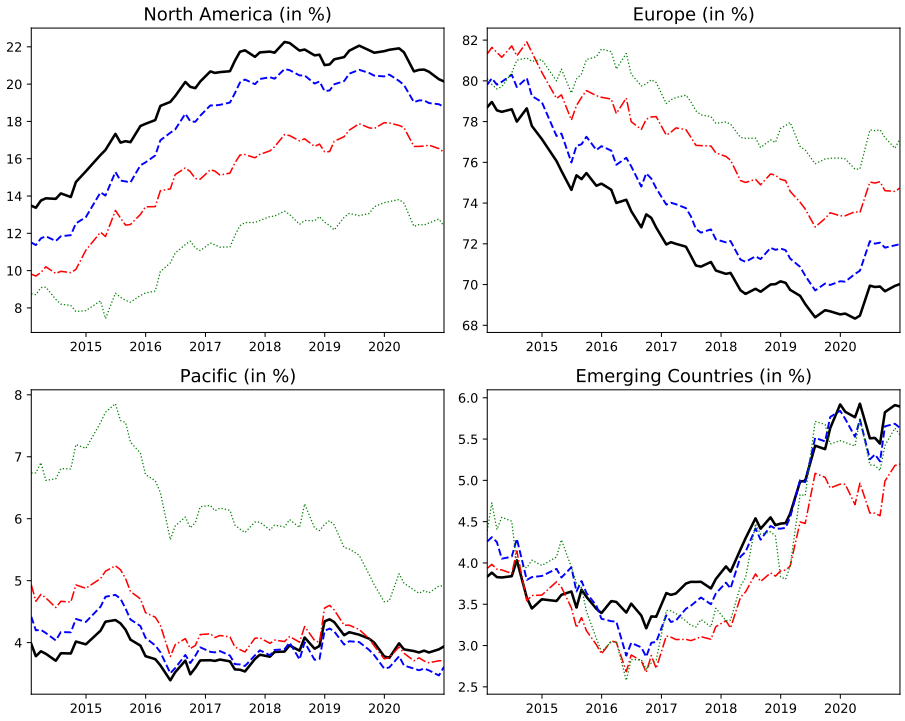
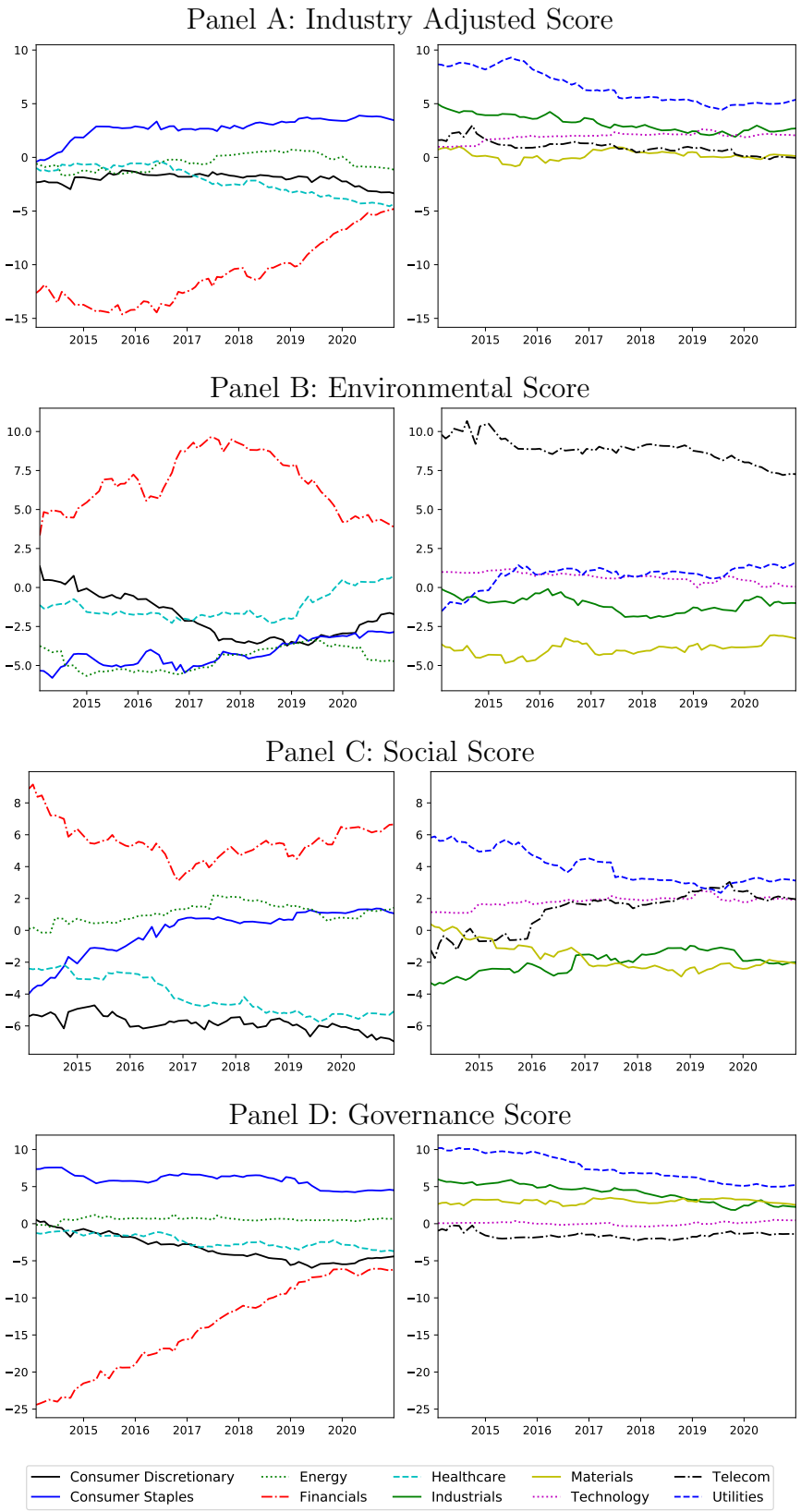


Figure A.6: Evolution of Sectoral Exposures of the 50% Tilted Portfolio



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