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Socially Responsible Bond ETFs in the US: A Performance Evaluation

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Abstract

This paper seeks to answer whether socially responsible bond Exchange Traded Funds (ETFs) in the USA can outperform the main local aggregate bond and stock market indices. More specifically, the performance of 62 bond ETFs with Environmental, Social and Governance (ESG) Scores of 7/10 or above is assessed over the period 1/1/2018 - 31/12/2021. The sample has been selected based on data availability over the study period. Standard research methodology is applied including the single-factor market model and the risk-adjusted return metrics of Sharpe and Information ratios. Performance persistence is evaluated too. The findings show that, in raw return terms, the mean bond ETF underperforms the Bloomberg US Aggregate Bond Index and the S&P 500 Index. In addition, the examined ETFs cannot produce any material above-market return. Furthermore, daily returns seem to persist but weekly and monthly returns display a reverting behavior. A similar reverting behavior is observed between the annual return rankings of ETFs. Overall, our results are in line with those findings in the literature that show, on average, ESG portfolios cannot beat the non-ESG peers on a consistent basis.

Keywords
ETFs, ESG, Performance, Performance Persistence, Fixed-Income

1. INTRODUCTION

A constantly increasing part of the investing community is no longer concerned only about the financial gains from their investments. Nowadays, investors take seriously into consideration the environmental, social and governance (ESG) aspects of their investments. This growing trend has resulted in the launch of thousands of so-called "sustainable funds" worldwide, which now manage trillions of dollars.

According to MSCI, the objectives of investors using ESG criteria when forming their investment decisions should be classified in three categories. The first category concerns the "values-based" investing, according to which an investor tries to align their ethical, social, environmental, religious and other values with firms and industries that abide by the same values. In this kind on investing, financial gains is not top priority for investors. The second category relates to "impact" investing. In this case, investors seek opportunities to make a positive social or environmental impact in alignment with their mission or beliefs, even at a cost to the financial return on their investments. The third category acknowledges that the integration of financial opportunities and risks relating to ESG issues to the investment decision making process may contribute to achieving enhanced long-term risk-adjusted returns.

The socially responsible segment of the fixed-income market is growing rapidly because investors have started to realize that, when identifying risks in fixed-income investments,

environmental, social and governance factors are of equal importance to the corresponding factors in equity investments.

Sustainable investing with fixed-income products is implemented with a wide range of options. These options include screening techniques, via which sectors or securities are included or excluded based on ESG criteria. They also include ESG integration, which takes ESG factors into consideration along with traditional financial analysis when making investment decisions. Other choices concern thematic investing, which chooses assets with a specific ESG theme, impact investing, which aims to deliver positive societal outcomes, and issuer engagement, which engages issuers of securities to sustainable behavior and practices.

This paper examines the performance of 62 responsible bond ETFs traded in the USA that incorporate ESG factors in their investing strategies. The consideration of ESG factors is testified by the high ESG scores awarded to the examined ETFs. Performance is evaluated in several ways including raw returns, above-market returns and risk-adjusted returns, namely the Sharpe ratio and the Information ratio. The persistence in performance is assessed too. The study period spans from 2018 to 2021.

The empirical findings show that the bond ETFs in the sample achieved slightly positive cumulative returns during the period under study. However, this performance is inferior to the return of the index used as a proxy for the entire bond market in the USA. This is also the case when the return of bond ETFs is compared to equity returns represented by the S&P 500 Index. Going further, the examined bond ETFs cannot produce any material above-market return, as the majority of the individual alpha estimates are not statistically different from zero. The risk-adjusted return measures verify that bond ETFs cannot beat the market benchmarks over the study period, even though there are cases or years during the study period where a significant number of bond ETFs can do so. Finally, when it comes to performance persistence, the findings indicate that daily returns slightly persist. However, weekly and monthly returns display a reverting behavior. A similar reverting behavior is presented by the annual rankings of bond ETFs' performance.

This study has been motivated by the growing interest in fixed-income ESG investments and it contributes to the ESG literature in several ways. To the best of our knowledge, this is the first study to examine socially responsible bond ETFs. First of all, our findings show that bond ETFs cannot beat the market. However, they can do so on an occasional basis. Therefore, our results could be somehow encouraging to investors, and not only to those who are mainly interested in the ESG aspects of their investments. In particular, the occasional outperformance of bond ESG ETFs in the USA implies that ESG investing is not an a priori lost cause from a financial perspective, as it is frequently considered to be.

Furthermore, the research methodology applied, even being standard in the literature, it gives us the opportunity to assess performance of the responsible bond ETFs from several angles. Finally, we believe that the patterns of persistence found in daily returns and of the reverting behavior observed in weekly and monthly raw returns could be exploitable, especially by short-run traders. This is also the case with the annual rankings of performance. To our view, this is a significant contribution to the relevant literature.

The remainder of this paper is structured as follows: Section 2 includes the literature review. Section 3 develops the research methodology applied in our study and describes the sample of the study. The empirical findings are provide in Section 4. Conclusions are offered in Section 5.

2. LITERATURE REVIEW

The literature on socially responsible investing with stocks and mutual funds is voluminous. Several studies have shown that the socially responsible funds do not offer investors any return advantage in comparison to traditional funds. This inference is supported by the papers of Hamilton et al. (1993), DiBartolomeo and Kurtz (1996), DiBartolomeo and Kurtz (2011). Statman (2000) finds some evidence of SR funds outperformance in the United Sates, but this outperformance is not significant in statistical terms. Goldreyer and Dlitz (1999) measure the performance of a USA sample of SR and conventional mutual funds using the Jensen's alpha, the Sharpe Ratio and the Treynor ratio. No clear advantage of one group over the other is revealed by the empirical analysis.

Similar results have been obtained by Kreander et al. (2005) who examined the performance of 60 ethical funds from the UK, Sweden, Germany and the Netherlands over 1995-2001. Halbritter and Dorfleitner (2015) construct a high and low portfolio of stocks including ESG out- and underperformers. The results show that there is no significant difference in performance between firms with high and low ESG ratings. Moreover, Dolvin et al. (2019) examine the correlation between the sustainability ratings awarded to mutual funds by Morningstar and their performance and show that funds with high sustainability scores do not outperform funds with low sustainability scores. Chang et al. (2020) verify this inference. Additional studies that support the neutrality of SR funds' performance over their traditional peers are those of Niblock et al. (2020), Plagge et al. (2020), and Yue et al. (2020).

Other studies which find that sustainable investing can also be beneficial in financial terms. In this respect, Kempf and Osthoff (2007) assess the return of a strategy which buys stocks with high SR ratings and sells stocks with low SR ratings and find that this strategy can offer material after-transaction-costs annual abnormal returns up to 8.7%. Gil-Bazo et al. (2010) show that SR funds in the USA performed better than comparable conventional mutual funds during the period 1997-2005. Some other studies supporting the return advantage of socially responsible portfolios over non-socially responsible peers are those of Derwall et al. (2005), Nofsinger and Varma (2014), Chong and Phillips (2016), and Filbeck et al. (2019).

Contrary to the findings above, many studies provide evidence on a negative effect of SR investing strategies on financial performance. Bauer et al. (2006) report that ethical funds in Australia underperformed their conventional peers during 1992-1996. Renneboog et al. (2008) show that responsible funds in the USA, the UK and in many other European and Asian-Pacific countries underperform their domestic benchmarks by a rate between 2.2% and 6.5%. Other studies reaching similar inferences are those of Girard et al. (2007), Lee et al. (2010), Capelle-Blancard and Monjon (2014), and Silva and Cortez (2016).

When it comes to ETFs, the relevant ESG literature is rather poor and focused exclusively on equity ETFs. In this respect, studies such as those of Marozva (2014), Meziani (2014 & 2020), Rompotis (2016 & 2022), Kanuri (2020), and Plagge and Grim (2020), Milonas et al. (2022), have shown that, with some exceptions, ESG ETFs cannot achieve above market returns.

3. METHODOLOGY

The research methodology and the sample used to assess the performance of the bond ETFs in the USA are discussed in this section.

3.1 Empirical Research

In this section, we develop the methodology that is used in our empirical analysis on the performance of bond ETFs. First, we compute the raw returns of ETFs. A single-factor

regression analysis of ETFs' performance follows. Then, the risk-adjusted return of ETFs is calculated. Finally, the persistence in returns and performance rankings is assessed.

3.1.1 Raw Returns

We compute the raw return of bond ETFs in percentage terms over the period 2018-2021 with daily data found on www.nasdaq.com. Return is calculated with formula (1):

$$R_{i,t}= \frac{P_{i,t}-P_{i,t-1}}{P_{i,t-1}} \quad (1)$$

where $R_{i,t}$ refers to the percentage daily return of the *ith* ETF on the trade day *t* and $P_{i,t}$ refers to the close trade price of the ETF on day *t*.[1] Formula (1) is also used for the calculation of market performance. We use the Bloomberg US Aggregate Bond Index as a proxy for the market.[2] We also use the S&P 500 Index as a benchmark to make comparisons with the equity market. In addition, formula (1) is used for the calculation of total (or cumulative) return of ETFs and market over the entire period under study. Finally, the risk of ETFs and the market indexes is calculated as the standard deviation in daily returns.

3.1.2 Performance Regression Analysis

The regression model used to examine the performance of bond ETFs is the following:

$$R_i-R_f=\alpha_i+\beta_i(R_m-R_f)+\varepsilon_i \quad (2)$$

where R_i denotes the daily return of bond ETFs, R_m represents the return of the Bloomberg US Aggregate Bond Index, as well as the S&P 500 Index, and R_f is the risk-free rate expressed by the one-month US Treasury bill rate (found on the website of Kenneth French).

Alpha represents the above-market return that can be achieved by an ETF. If ETFs can achieve above-market returns, alpha estimates will be positive and statistically significant. Beta measures the part of risk that cannot be mitigated by diversification techniques and indicates the systematic risk of bond ETFs.

3.1.3 Risk-Adjusted Returns

We employ two standard risk-adjusted return measures to rate the performance of socially responsible bond ETFs. The first evaluation method used is the Sharpe ratio shown in formula (3):

$$S_i = \frac{R_i - R_f}{\sigma_i} \quad (3)$$

where R_i and R_f are defined as above and σ_i is the standard deviation of ETF excess return, that is ETF return minus the risk-free rate. The Sharpe ratio is used to determine how well an ETF

[1] We have also calculated the absolute returns with dividend-adjusted trade price data without returns differing significantly from the dividend-free returns. For simplicity purposes, we only report the returns which are not adjusted for dividends.

[2] The Bloomberg Aggregate Bond Index is a broad-based fixed-income index used by bond traders and the managers of mutual funds and ETFs as a benchmark. The index includes government Treasury securities, corporate bonds, mortgage-backed securities MBS, asset-backed securities ABS, and munis to simulate the universe of bonds in the market. It tracks bonds that are of investment-grade quality or better (refer to https://www.investopedia.com/terms/l/lehmanaggregatebondindex.asp).

compensates its investors for the per unit risk they take. The higher he Sharpe ratio is, the better the performance of the ETF is too.

The second risk-adjusted return metric used in the Information ratio (IR) shown in formula (4):

$$IR_i = \frac{R_i - R_m}{TE_i} \quad (4)$$

where R_i is defined as above, R_m is the successively return of the Bloomberg US Aggregate Bond Index and S&P 500 Index, and TE_i is tracking error, that is, the standard deviation in return differences between the bond ETFs and the market index. The IR is used as a measure of an ETF's excess return against the market return. Thus, positive IRs will indicate that the respective bond ETFs outperform the market.

3.1.4 Performance Persistence

The persistence in raw returns of bond ETFs is assessed via the following time-series regression model (5):

$$R_i = \lambda_0 + \lambda_1 R_{t-1,i} + u \quad (5)$$

where R_i is defined as above. Persistence in returns will be assessed by the slope of the model. Statistically significant slopes approximating unity will indicate a high degree of performance persistence.

In addition to the time-series regression analysis of daily, weekly and monthly returns, we also perform a cross-sectional regression analysis on annual performance rankings based on the average daily return, the cumulative return, the Sharpe Ratio and the Information Ratios calculated against the Bloomberg US Aggregate Bond Index and the S&P 500 Index, respectively. We classify the annual return measures of bond ETFs in four groups; the top group receives four stars, the second-top group receives three stars, the third group receives two stars and the bottom group receives one star. After this classification, we run the following regression model (6):

$$Rank_t = \lambda_0 + \lambda_1 Rank_{t-1} + u \quad (6)$$

where $Rank_t$ is the ranking of bond ETFs' performance in year *t*. Persistence in performance rankings will be assessed by the slope of the model. Statistically significant slopes approximating unity will indicate a high degree of persistence in performance rankings.

3.2 Sample

According to etfdb.com, there are 483 fixed-income ETFs traded on the US market today but this study focuses on socially responsible bond ETFs. In order for a bond ETF to be considered as socially responsible in our study, it must have been awarded a MSCI ESG score equal or higher than 7 (the absolute ESG score is 10/10). This choice leaves us with 113 bond ETFs potential to be examined. However, several of these 113 ETFs have been launched over the last two years (2020-2021). In our analysis, we need sufficient return data to apply substantive testing on performance. Thus, we decided that a period spanning from 1/1/2018 to 31/12/2021 is decent enough for the purposes of our analysis. No other selection criterion has been applied. As a result, our sample is limited to these 62 bond ESG ETFs.

Table 1 presents the profiles of ESG ETFs, which include their ticker, name, inception date, age as of 31/12/2021 (in years), expense ratio, average daily volume over the period 1/1/2018-31/12/2021, average trading frequency, as the fraction of the days with no zero volume to the entire to total trade days over the period 1/1/2018-31/12/2021, average intraday volatility, computed as (Daily Highest Price-Daily Lowest Price)/Daily Close Price, assets under management as of 31/12/2021, MSCI ESG score as of 31/12/2021 and carbon intensity measure (Tons of CO2e / $M Sales) as of 31/12/2021.[3]

The mean age of bond ETFs approximates 8.5 years while the oldest ETF in the sample is about 20 years old. The mean expense ratio of bond ETFs is equal to 20 basis points (bps). The minimum expense ratio is 3 bps, which is comparable or lower to the expense ratios of several popular traditional equity ETFs. The maximum expense record in the sample is 53 bps.

When it comes to trading activity, the mean daily volume in Table 1 amounts to 576 th. shares. It is notable that the gap between the minimum and maximum volumes in the sample is huge amounting to 11.3 million shares. If we focus on the median term of volumes, we can see that the daily trading activity for most of bond ETFs in the sample just exceeds 62 th. shares per day. This is not a might trading activity relative to the popular traditional equity ETF products.

The mean trading frequency is high at 97%. This indicates that, on average, bond ETFs present only a few days of zero trading activity. The minimum trading frequency in the sample just exceeds 57%. Therefore, there are bond ETFs whose trading activity is lower than the mean term in the sample. Lower trading activity might imply liquidity issues for the corresponding ETFs.

With respect to intraday volatility, the respective mean term in Table 1 amounts to 30 bps. The median term is slightly lower at 28 bps. These low measures indicate that the period under study has been a smooth era for the bond ETF market.

In regard to assets, Table 1 shows that the averagr bond ETF in the sample managed about $4.3 billion at the end of 2021. The largest ETF in the sample is the Vanguard Intermediate-Term Corporate Bond ETF, with assets exceeding $46 billion. On the other hand, the bottom record of assets in the sample is just $4 million. Overall, only some of the assets figures can be somehow compared to the hundreds of billions managed by several successful traditional equity ETFs.

Finally, when it comes to ESG metrics, the mean (median) MSCI ESG score of the sample's bond ETFs is 8.26/10 (8.25/10). Four ETFs receive the absolute ESG scores (10/10). The mean carbon intensity measure is 267 Tons of CO2e per $M of sales. Overall, the ESC scores verify that the selected bond ETFs can be treated as socially responsible ones.

4. RESULTS

The empirical results of our study are presented in this section.

4.1 Raw Returns

The descriptive statistics of returns are provided in Table 2. The Table presents the average daily return of the sample, the cumulative daily return, the risk, the daily excess return, excess cumulative return and excess risk against the Bloomberg US Aggregate Bond Index, and the daily excess return, excess cumulative return and excess risk against the S&P 500 Index. The statistics are presented on an annual and an aggregate basis over the period 2018-2021.

[3] Tickers, names, inception dates, expense ratios, assets under management, ESG scores and carbon intensity measures as of 31/12/2021 have been found on www.etfdb.com. Volumes have been found on www.nasdaq.com.

The mean daily return of bond ETFs over the entire period under study is not different from zero. However, the majority of ETFs present a positive return (51 out of 62 funds). At the annual level, the mean returns were slightly negative in 2018 and 2021 and positive in 2019 and 2020. Cumulative returns are in line with daily returns. Overall, the mean bond ETF offered a cumulative return of about 3% over the period under study. Moreover, the mean bond ETF did not achieve any above-market return. On the contrary, the mean excess return of the sample against the Bloomberg US Aggregate Bond Index is negative (-12% in cumulative terms) and very negative against the S&P 500 Index (-74%).

These figures indicate that the bond ETFs underperform the broad fixed-income market index but also the equity market. This is an inference that can be drawn by referring to overall returns in the period 2018-2021. However, if we examine annual returns, we can identify bond ETFs that actually perform better than the market indexes. For instance, in 2018 the majority of bond ETFs performed better than the S&P 500 Index (56 out of 62 cases at the cumulative level). In years 2019 to 2021 a sufficient number of bond ETFs outperformed the Bloomberg US Aggregate Bond Index.

Overall, the analysis of annual returns shows that fixed-income investors can have socially responsible ETF choices that can actually beat the broad fixed-income market - even the equity market, at least at the raw return level.

The mean risk estimate of bond ETFs over the period 2018-2021 is 0.37, which is rather low. Moreover, the mean bond ETF is slightly more risky than the Bloomberg US Aggregate Bond Index. This is the case over the entire period under study and in 2018 and 2020 but not in 2019 and 2021. At the fund level, 49 bond ETFs present higher risk than the bond market index over the period 2018-2021. On the annul basis, there is a wide dispersion in excess risk estimates.

Not surprisingly, when compared to the S&P 500 Index, the socially responsible bond ETFs are significantly less risky than the equity market index. With no exceptions, all the annual and overall excess risk calculations against the S&P 500 Index are negative. By combining this finding with the cases in which bond ETFs performed better than the equity market index, we may conclude that fixed-income investors can select bond ETFs that stand good chances of beating the equity market without undertaking high risk to do so.

4.2 Performance Regression Analysis

The results of model (2) are reported in Table 3. The table includes the alpha and beta estimates along with t-tests on the statistical significance of estimates and R-squared on the explanatory power of the model. The number of significantly and insignificantly positive and negative alphas are provided too along with the number of betas which are significantly higher and lower than unity, respectively.

The mean alpha estimate of bond ETFs against the fixed-income market index is slightly negative amounting to -1 bps. Moreover, all the individual alphas are negative but the majority of them are statistically insignificant (53 out 62 estimates). On the one hand, these results show that bond ETFs in the US cannot produce any material alpha relative to the broad fixed-income market performance. On the other hand, the insignificant alphas also indicate that the performance of ETFs is quite aligned to the performance of the Bloomberg US Aggregate Bond Index. When considering the S&P 500 Index, the majority of alphas are insignificantly negative, even though there are 5 ETFs that present positive but insignificant alpha coefficients.

When it comes to systematic risk, Table 3 reports a mean beta against the Bloomberg US Aggregate Bond Index of 0.77. The median beta is over lower at 0.64. Furthermore, at the fund level, just 19 ETFs present betas that are higher than unity. These results may indicate a

conservatism of bond ETFs relative to the market index. However, these results might be viewed as if the bond ETFs in the sample invest in securities and markets which are not absolutely comparable to the constitutes of the Bloomberg US Aggregate Bond Index. Finally, the betas obtained over the S&P 500 Index are all very low (0.23 at a maximum). This finding is in line with the total risk figures computed with raw daily returns.

4.3 Risk-Adjusted Returns

The estimates of risk-adjusted returns are provided in Table 4. The table reports the three alternative types of risk-adjusted returns computed, that is the Sharpe ratio, the Information ratio calculated against the fixed-income market index and the Information ratio calculated against the equity market index. The ratios are presented on an annual basis and over the entire period under study.

The mean Sharpe ratio of the period 2018-2021 is slightly negative but it was positive in 2019 and 2020 (as the raw returns were). In addition, the majority of single Sharpe ratios over the study period are negative (37 out of 62 cases). At the annual level, all Sharpe ratios are negative in 2018, while the majority of them are positive in 2019 and 2020 but negative in 2021.

The mean Information ratios against the Bloomberg US Aggregate Bond Index are slightly negative (both at the annual and the overall level). In 2018, all the single ratios are negative. In years 2019 to 2021, the majority of single Information ratios are negative. However, a sufficient number of ETFs present a positive Information ratio in these years (as it was the case with excess raw returns).

In the case of the Information ratio obtained against the S&P 500 Index, the results in Table present a behavior similar to that of the corresponding excess raw returns in Table 2. At the mean level, these ratios are positive in 2018 but negative in 2019 to 2021 and over the entire period under study. In addition, at the fud level, the ratios are sufficiently positive only in 2018.

Overall, the analysis of risk-adjusted returns verify the inferences drawn via analyzing raw returns in a previous section. In particular, based on these results, we may conclude that conservative socially responsible investors choosing less risky bond ETFs compared to equity investments can find ETF choices that can actually offer above-(fixed-income and equity) market returns.

4.4 Performance Persistence

The outcomes of model (5) on performance persistence are provided in Table 5. The Table includes the estimates of the model's constant and slope along with t-tests on their statistical significance. R-squared on the explanatory power of the model are reported too along with the number of significantly and insignificantly positive and negative estimates.

Panel A in Table 5 reports the results on daily returns. The majority of intercepts (52 out of 62 cases) are positive. However, all slopes are statistically insignificant. With respect to the slopes of the model, the mean estimate is positive at 0.11 (0.16 in median terms). This number implies that after a positive return on day *t*, a positive return follows on day *t+1*. Moreover, the majority of the individual slopes in the sample are positive (50 cases) with 43 of them being statistically significant. Overall, the regression results on daily returns accentuate that lagged returns can bear an impact on concurrent returns. This impact is positive and could possibly be exploited by short-term traders.

In addition to the persistence in daily returns, we wanted to examine whether the positive relationship among daily returns just established applies to longer investment windows, that is,

over weekly and monthly return periods. In doing so, we run model (5) again with weekly and monthly returns. The results of these regressions are provided in Panels B and C in Table 5.

In the case of weekly returns, 52 constant estimates are positive but statistically insignificant. Furthermore, 50 slopes are negative, with 35 of them being significant, while just 5 slopes are significantly positive. Contrary to the results on daily returns, we may conclude that a negative correlation exists between the concurrent and lagged weekly returns for the majority of the examined bond ETFs. This trend could also be exploitable by investors with very short-term horizons.

When it comes to monthly returns, the results resemble those obtained with weekly returns. More specifically, the mean intercept is positive. The majority of the single intercepts (46 cases) are positive but insignificant. The rest 16 constant estimates are insignificantly negative. Going further, the mean slope is negative at -0.12. At the fund level, 48 slopes are significantly negative. The rest slopes are insignificant. Based on these results, we may conclude that the negative relationship between concurrent and lagged weekly returns apply to monthly returns too.

The results of model (6) are provided in Table (6). The Table presents the estimates of the model's constants and slopes, the relevant t-tests and R-squared. All intercepts are positive and statistically significant at 10% or better. When it comes to slopes, a specific pattern is detected in all return measures used. In particular, all the slopes obtained when years 2018 and 2019 are taken into consideration are negative and significant. Slopes become positive in 2019-2020 and return to a negative territory in 2020-2021. These slope estimates reveal a, possibly exploitable, reverting pattern in performance rankings among the socially responsible bond ETFs.

5. DISCUSSION AND CONCLUSION

This study offers new empirical insights on the performance of fixed-income ETFs traded in the US market. Standard research issues are examined for a sample of 62 socially responsible bond ETFs over the four-year period 2018-2021. The issues investigated concern the performance of these funds and their ability to beat the broad fixed-income and equity market indices. Performance persistence is evaluated too.

The results obtained are very interesting. The various return measures employed indicate that the examined ETFs achieved slightly positive cumulative returns over the entire period under study. However, this mean performance is lower than the return of the Bloomberg US Aggregate Bond Index, which has been used as a proxy for the entire fixed-income market in the US. This is also the case when the return of bond ETFs is compared to the return of the S&P 500 Index. Besides this general inference, our analysis identified bond ETFs that can actually beat the broad fixed-income market or the equity market.

Furthermore, the bond ETFs under examination cannot produce any significant above-market return, as the majority of the individual alpha estimates against Bloomberg US Aggregate Bond Index and the S&P 500 Index are not statistically different from zero. The risk-adjusted return measures verify that, overall, bond ETFs cannot beat the market benchmarks over the study period. However, there are cases or years in which a sufficient number of bond ETFs can do so.

Finally, when it comes to performance persistence, the findings indicate that daily returns slightly persist. However, weekly and monthly returns display a reverting behavior. A similar reverting behavior is presented by the annual rankings of bond ETFs' performance. Profitable investment strategies could possibly be built on the basis of these relationships among the daily, weekly and monthly returns of socially responsible bond ETFs, especially by traders with very-short investment horizons. This is also the case for annual performance rankings.

Overall, our results are in line with those studies in the literature on mutual funds and equity ETFs which show that the socially and environmentally responsible investment portfolios cannot beat their non- ESG peers or the stock market indices on a consistent basis. However, the fact that some bond ETFs in our sample can actually do so is quite encouraging. Thus, responsible fixed-income investors can search for relevant ESG bond ETFs that will offer enhanced returns along with helping them fulfil their environmental and social goals.

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Appendices

Table 1: Profiles of ETFs

This Table presents the profiles of ETFs, which include their ticker, name, inception date, age in years as of 31/12/2021, expense ratio, average daily volume over the period 1/1/2018-31/12/2021, average trading frequency, as the fraction of the days with no zero volume to the entire to total trade days over the period 1/1/2018-31/12/2021, average intraday volatility, computed as (Daily Highest Price-Daily Lowest Price)/Daily Close Price, assets under management (AUM) as of 31/12/2021, the ESG score as of 31/12/2021 and the carbon intensity (Tons of CO2e / $M Sales) as of 31/12/2021.

Ticker[1]	Name[1]	Inception[1]	Age	Exp. Ratio[1]	Volume[2]	Trade Freq.	Intr. Vol.	AUM ($ M)[1]	ESG Score[1]	Carbon Intensity[1]
FLTR	VanEck Investment Grade Floating Rate ETF	Apr 25, 2011	10.69	0.0014	173,256	100.00%	0.21	967	10.00	75.44
FLOT	iShares Floating Rate Bond ETF	Jun 14, 2011	10.56	0.15%	1,371,267	100.00%	0.13	8,622	10.00	103.19
FLRN	SPDR Bloomberg Investment Grade Floating Rate ETF	Nov 30, 2011	10.09	0.15%	963,656	100.00%	0.15	2,676	10.00	112.33
SUSB	iShares ESG Aware 1-5 Year USD Corporate Bond ETF	Jul 11, 2017	4.48	0.12%	104,899	100.00%	0.29	1,032	10.00	143.20
IBND	SPDR Bloomberg International Corporate Bond ETF	May 19, 2010	11.63	0.50%	58,725	100.00%	0.65	133	9.75	92.34
ESCR	Xtrackers Bloomberg US Investment Grade Corporate ESG ETF	Mar 03, 2015	6.84	0.15%	2,174	88.47%	0.33	7	9.54	122.50
PICB	Invesco International Corporate Bond ETF	Jun 03, 2010	11.59	0.50%	23,801	100.00%	0.77	156	9.53	125.06
SPSB	SPDR Portfolio Short Term Corporate Bond ETF	Dec 16, 2009	12.05	0.07%	1,382,880	100.00%	0.15	7,629	9.41	193.54
SLQD	iShares 0-5 Year Investment Grade Corporate Bond ETF	Oct 15, 2013	8.22	0.06%	252,493	100.00%	0.15	2,340	9.21	175.85
VCSH	Vanguard Short-Term Corporate Bond ETF	Nov 19, 2009	12.12	0.04%	2,512,793	100.00%	0.16	42,701	9.14	198.83
ICSH	BlackRock Ultra Short-Term Bond ETF	Dec 11, 2013	8.06	0.08%	577,123	100.00%	0.07	6,241	8.95	298.18
QLTA	iShares Aaa – A Rated Corporate Bond ETF	Feb 14, 2012	9.88	0.15%	129,107	100.00%	0.37	1,091	8.86	241.45
IBDN	iShares iBonds Dec 2022 Term Corporate ETF	Mar 12, 2015	6.81	0.10%	173,322	100.00%	0.23	1,572	8.84	169.93
IBDO	iShares iBonds Dec 2023 Term Corporate ETF	Mar 12, 2015	6.81	0.10%	163,493	100.00%	0.29	1,680	8.81	235.70
IBDP	iShares iBonds Dec 2024 Term	Mar 11, 2015	6.81	0.10%	132,191	100.00%	0.34	1,604	8.78	229.39

	Corporate ETF									
JPST	JPMorgan Ultra-Short Income ETF	May 17, 2017	4.63	0.18%	2,074,924	100.00%	0.08	18,390	8.74	126.21
RAVI	FlexShares Ready Access Variable Income Fund	Oct 09, 2012	9.23	0.25%	30,478	99.80%	0.08	495	8.73	265.41
IBDD	iShares iBonds Mar 2023 Term Corporate ETF	Jul 09, 2013	8.48	0.10%	7,817	99.11%	0.32	65	8.73	210.04
SUSC	iShares ESG Aware USD Corporate Bond ETF	Jul 11, 2017	4.48	0.18%	100,262	99.20%	0.42	888	8.72	177.37
IGSB	iShares 1-5 Year Investment Grade Corporate Bond ETF	Jan 05, 2007	15.00	0.06%	2,049,876	100.00%	0.17	22,569	8.71	236.04
GIGB	Goldman Sachs Access Investment Grade Corporate Bond ETF	Jun 06, 2017	4.57	0.14%	47,592	99.90%	0.36	754	8.68	128.12
SPIB	SPDR Portfolio Intermediate Term Corporate Bond ETF	Feb 10, 2009	12.90	0.04%	1,764,243	100.00%	0.28	5,323	8.65	237.81
VNLA	Janus Henderson Short Duration Income ETF	Nov 16, 2016	5.13	0.26%	278,184	100.00%	0.12	2,586	8.64	116.30
SKOR	FlexShares Credit-Scored US Corporate Bond Index Fund	Nov 12, 2014	7.14	0.22%	13,552	92.64%	0.16	303	8.51	254.68
IGHG	ProShares Investment Grade-Interest Rate Hedged	Nov 05, 2013	8.16	0.30%	58,011	100.00%	0.75	939	8.51	145.08
IBDQ	iShares iBonds Dec 2025 Term Corporate ETF	Mar 12, 2015	6.81	0.10%	117,277	100.00%	0.39	1,291	8.44	231.17
ARCM	Arrow Reserve Capital Management ETF	Mar 31, 2017	4.76	0.50%	993	57.26%	0.04	51	8.42	216.33
SFIG	WisdomTree U.S. Short Term Corporate Bond Fund	Apr 27, 2016	5.68	0.18%	2,453	83.90%	0.11	40	8.37	261.23
IBDR	iShares iBonds Dec 2026 Term Corporate ETF	Sep 13, 2016	5.30	0.10%	93,167	100.00%	0.43	1,037	8.31	225.15
LQD	iShares iBoxx $ Investment Grade Corporate Bond ETF	Jul 22, 2002	19.54	0.14%	11,271,072	100.00%	0.44	32,637	8.30	160.64
VCIT	Vanguard Intermediate-Term Corporate Bond ETF	Nov 19, 2009	12.12	0.04%	2,514,686	100.00%	0.31	46,426	8.29	261.15
LQDH	iShares Interest Rate Hedged Corporate Bond ETF	May 27, 2014	7.60	0.24%	37,471	100.00%	0.36	1,238	8.20	160.64
IBD	Inspire Corporate Bond Impact ETF	Jul 10, 2017	4.48	0.49%	36,134	99.80%	1.00	227	8.18	303.79
VTC	Vanguard Total Corporate Bond ETF	Nov 07, 2017	4.15	0.04%	36,803	100.00%	0.40	642	8.17	316.03

SPBO	SPDR Portfolio Corporate Bond ETF	Apr 06, 2011	10.75	0.03%	49,723	97.61%	0.41	367	8.13	309.62
IBCE	iShares iBonds Mar 2023 Term Corporate ex-Financials ETF	Apr 17, 2013	8.71	0.10%	2,804	91.25%	0.20	31	8.12	306.53
FTSM	First Trust Enhanced Short Maturity ETF	Aug 05, 2014	7.41	0.25%	732,912	100.00%	0.08	4,066	7.99	273.18
IGIB	iShares 5-10 Year Investment Grade Corporate Bond ETF	Jan 05, 2007	15.00	0.06%	1,235,484	100.00%	0.30	11,137	7.91	299.17
FLCO	Franklin Liberty Investment Grade Corporate ETF	Oct 03, 2016	5.25	0.35%	64,382	92.25%	0.27	961	7.85	466.45
IBDS	iShares iBonds Dec 2027 Term Corporate ETF	Sep 12, 2017	4.30	0.10%	57,273	100.00%	0.54	541	7.83	244.55
USIG	iShares Broad USD Investment Grade Corporate Bond ETF	Jan 05, 2007	15.00	0.04%	624,540	100.00%	0.36	6,464	7.77	360.68
VRIG	Invesco Variable Rate Investment Grade ETF	Sep 22, 2016	5.28	0.30%	112,683	100.00%	0.19	558	7.74	156.91
AGZ	iShares Agency Bond ETF	Nov 05, 2008	13.16	0.20%	60,443	100.00%	0.19	717	7.72	605.76
WFIG	WisdomTree U.S. Corporate Bond Fund	Apr 27, 2016	5.68	0.18%	4,030	86.38%	0.22	45	7.72	338.57
PFIG	Invesco Fundamental Investment Grade Corporate Bond ETF	Sep 15, 2011	10.30	0.22%	24,574	100.00%	0.38	41	7.65	276.64
GSY	Invesco Ultra Short Duration ETF	Feb 12, 2008	13.89	0.22%	485,788	100.00%	0.07	2,629	7.64	328.70
NEAR	BlackRock Short Maturity Bond ETF	Sep 25, 2013	8.27	0.25%	1,009,338	100.00%	0.09	4,681	7.59	172.39
MINT	PIMCO Enhanced Short Maturity Active ETF	Nov 16, 2009	12.13	0.35%	1,092,380	100.00%	0.04	14,026	7.47	174.46
FLTB	Fidelity Limited Term Bond ETF	Oct 06, 2014	7.24	0.36%	48,623	100.00%	0.25	282	7.45	301.51
FCOR	Fidelity Corporate Bond ETF	Oct 06, 2014	7.24	0.36%	28,073	100.00%	0.51	254	7.38	351.10
CORP	PIMCO Investment Grade Corporate Bond Index ETF	Sep 20, 2010	11.29	0.20%	54,110	100.00%	0.49	734	7.34	361.17
BNDC	FlexShares Core Select Bond Fund	Nov 18, 2016	5.12	0.35%	13,845	90.95%	0.27	135	7.32	294.29
SPLB	SPDR Portfolio Long Term Corporate Bond ETF	Mar 10, 2009	12.82	0.04%	770,995	100.00%	0.67	987	7.30	453.87
VCLT	Vanguard Long-Term Corporate Bond ETF	Nov 19, 2009	12.12	0.04%	580,952	100.00%	0.72	4,639	7.29	458.80
GRNB	VanEck Green Bond ETF	Mar 03, 2017	4.83	0.20%	8,565	99.01%	0.26	101	7.25	873.38
NUSA	Nuveen Enhanced Yield 1-5 Year U.S. Aggregate Bond	Mar 31, 2017	4.76	0.20%	7,191	91.35%	0.13	39	7.24	731.05

	ETF									
LKOR	FlexShares Credit-Scored U.S. Long Corporate Bond Index Fund	Sep 24, 2015	6.27	0.22%	5,142	88.07%	0.38	53	7.23	481.05
FFIU	UVA Unconstrained Medium-Term Fixed Income ETF	Aug 21, 2017	4.36	0.53%	4,015	80.42%	0.19	78	7.15	120.47
IGEB	iShares Investment Grade Bond Factor ETF	Jul 11, 2017	4.48	0.18%	16,903	95.43%	0.28	161	7.08	403.96
NUBD	Nuveen ESG U.S. Aggregate Bond ETF	Sep 29, 2017	4.26	0.15%	29,044	99.50%	0.29	262	7.06	296.38
HOLD	AdvisorShares North Square McKee Core Reserves ETF	Jan 14, 2014	7.97	0.35%	3,118	79.52%	0.05	38	7.05	364.18
MENV	AdvisorShares North Square McKee ESG Core Bond ETF	Jun 20, 2011	10.54	0.47%	1,852	87.67%	0.26	4	7.01	187.68
Mean			**8.47**	**0.20%**	**575,564**	**96.77%**	**0.30**	**4,329**	**8.26**	**266.82**
Median			**7.78**	**0.18%**	**62,413**	**100.00%**	**0.28**	**914**	**8.25**	**239.63**
Min			**4.15**	**0.03%**	**993**	**57.26%**	**0.04**	**4**	**7.01**	**75.44**
Max			**19.54**	**0.53%**	**11,271,072**	**100.00%**	**1.00**	**46,426**	**10.00**	**873.38**

[1] Source: www.etfdb.com
[2] Source: www.nasdaq.com

Table 2: Descriptive Statistics of Returns

This Table presents the descriptive statistics of ETF's return and risk, that is the average daily return, the cumulative daily return, the risk (in standard deviation terms of daily returns), the daily excess return, the excess cumulative return and the excess risk against the Bloomberg US Aggregate Bond Index, and the daily excess return, the excess cumulative return and excess risk against the S&P 500 Index. The statistics are presented on an annual and an aggregate basis over the period 2018-2021.

				Benchmark: Bloomberg US Aggregate Bond Index			**Benchmark: S&P 500 Index**		
Stat	**Aver.**	**Cumul.**	**StDev**	**Daily Exc.Ret**	**Cum.Exc.Ret.**	**Exc. Risk**	**Daily Exc.Ret.**	**Cum.Exc.Ret.**	**Exc. Risk**
Period: 1/1-31/12/2018									
Mean	-0.02	-3.78	0.22	-0.02	-4.58	0.04	0.01	3.22	-0.86
Median	-0.01	-3.39	0.20	-0.02	-4.19	0.02	0.01	3.62	-0.88
Min	-0.04	-10.44	0.04	-0.05	-11.24	-0.14	-0.02	-3.44	-1.04
Max	0.00	0.16	0.67	0.00	-0.64	0.49	0.02	7.17	-0.41
No of Pos.	2	2	62	0	0	34	47	56	0
No of Neg.	60	60	N/A	62	62	28	15	6	62
Period: 1/1-31/12/2019									
Mean	0.02	6.29	0.19	-0.01	-1.89	-0.02	-0.08	-22.59	-0.59
Median	0.02	5.65	0.19	-0.01	-2.53	-0.02	-0.08	-23.22	-0.59
Min	0.00	0.30	0.04	-0.03	-7.88	-0.17	-0.10	-28.58	-0.74
Max	0.07	19.15	0.49	0.04	10.97	0.27	-0.03	-9.72	-0.30
No of Pos.	62	62	62	21	22	28	0	0	0
No of Neg.	0	0	N/A	41	40	34	62	62	62
Period: 1/1-31/12/2020									

Mean	0.02	3.69	0.64	-0.01	-3.81	0.34	-0.07	-12.57	-1.53
Median	0.02	3.32	0.64	-0.01	-4.19	0.35	-0.07	-12.94	-1.53
Min	-0.01	-4.30	0.11	-0.04	-11.80	-0.18	-0.10	-20.55	-2.06
Max	0.05	11.37	1.56	0.02	3.87	1.26	-0.03	-4.89	-0.61
No of Pos.	58	52	62	12	7	51	0	0	0
No of Neg.	4	10	N/A	50	55	11	62	62	62
Period: 1/1-31/12/2021									
Mean	-0.01	-2.64	0.20	-0.01	-1.10	-0.02	-0.11	-29.53	-0.63
Median	-0.01	-2.86	0.17	-0.01	-1.32	-0.05	-0.11	-29.76	-0.66
Min	-0.04	-8.88	0.02	-0.03	-7.34	-0.20	-0.13	-35.77	-0.81
Max	0.00	0.93	0.65	0.01	2.47	0.43	-0.10	-25.96	-0.17
No of Pos.	4	2	62	15	16	25	0	0	0
No of Neg.	58	60	N/A	47	46	37	62	62	62
Period: 1/1/2018-31/12/2021									
Mean	0.00	3.11	0.37	-0.01	-12.31	0.14	-0.06	-73.69	-0.97
Median	0.00	2.73	0.37	-0.01	-12.69	0.14	-0.06	-74.06	-0.97
Min	-0.01	-9.37	0.08	-0.02	-24.79	-0.15	-0.07	-86.17	-1.26
Max	0.01	11.60	0.92	0.00	-3.82	0.69	-0.05	-65.20	-0.42
No of Pos.	51	45	62	2	0	49	0	0	0
No of Neg.	11	17	N/A	60	62	13	62	62	62

Table 3: Performance Regression Results

This Table presents the results of the single-factor performance regression model via which the daily excess return (return minus risk free rate) of each ETF is regressed on the excess return of the Bloomberg US Aggregate Bond Index and the S&P 500 Index, respectively. Alpha reflects the above-market return that can be achieved by an ETF. Beta counts for the systematic risk of ETFs. The study period spans from 1/1/2018 to 31/12/2021.

Benchmark: Bloomberg US Aggregate Bond Index					
Stat	**alpha**	**T-test**	**beta**	**T-test**	**R2**
Mean	-0.01	-0.95	0.77	16.49	0.30
Median	-0.01	-0.81	0.64	15.89	0.32
Min	-0.02	-2.05	0.14	1.15	0.01
Max	0.00	-0.19	2.60	42.05	0.64
Sig. Pos.	0		62		
Sig. Pos.>1	N/A		19		
Sig. Pos.<1	N/A		43		
Ins. Pos.	0		0		
Sig. Neg.	9		0		
Ins. Neg.	53		0		
Benchmark: S&P 500 Index					
	alpha	T-test	beta	T-test	R2
Mean	0.00	-0.57	0.14	7.54	0.16
Median	0.00	-0.35	0.14	7.74	0.16
Min	-0.02	-2.41	0.04	0.50	0.10
Max	0.00	0.43	0.23	20.64	0.40
Sig. Pos.	0		62		
Sig. Pos.>1	N/A		0		
Sig. Pos.<1	N/A		62		
Ins. Pos.	5		0		
Sig. Neg.	6		0		
Ins. Neg.	51		0		

Table 4: Risk-Adjusted Returns

This Table presents the risk-adjusted returns of ETFs, that is, the Sharpe ratio and the Information ratio calculated against the Bloomberg US Aggregate Bond Index and the S&P 500 Index. The ratios are presented on an annual and an aggregate basis over the period 2018-2021.

Stat	**Sharpe Ratio18**	**Sharpe Ratio19**	**Sharpe Ratio20**	**Sharpe Ratio21**	**Sharpe Ratio18-21**
Mean	-0.12	0.05	0.02	-0.07	-0.01
No of Pos.	0	49	55	4	25
No of Neg.	62	13	7	58	37
Median	-0.12	0.07	0.03	-0.07	0.00
Min	-0.22	-0.16	-0.03	-0.15	-0.05
Max	-0.04	0.14	0.07	0.03	0.01
Benchmark: Bloomberg US Aggregate Bond Index					
Stat	Informat. Ratio18	Informat. Ratio19	Informat. Ratio20	Informat. Ratio21	Informat. Ratio18-21
Mean	-0.08	-0.04	-0.03	-0.03	-0.04
No of Pos.	0	21	12	15	2
No of Neg.	62	41	50	47	60
Median	-0.07	-0.04	-0.03	-0.02	-0.03
Min	-0.19	-0.18	-0.11	-0.12	-0.08
Max	-0.01	0.11	0.02	0.03	0.00
Benchmark: S&P 500 Index					
Stat	Informat. Ratio18	Informat. Ratio19	Informat. Ratio20	Informat. Ratio21	Informat. Ratio18-21
Mean	0.01	-0.10	-0.03	-0.13	-0.05
No of Pos.	47	0	0	0	0
No of Neg.	15	62	62	62	62
Median	0.01	-0.10	-0.03	-0.13	-0.05
Min	-0.02	-0.13	-0.05	-0.17	-0.06
Max	0.02	-0.03	-0.01	-0.12	-0.04

Table 5: Performance Persistence Regression Results

This Table presents the results of a single-factor regression model via which the daily return of each ETF is regressed on its one-day lagged return. Similar regressions are performed for weekly and monthly returns. The study period spans from 1/1/2018 to 31/12/2021.

Panel A: Daily Returns					
Stat	**λ_0**	**T-test**	**λ_1**	**T-test**	**R^2**
Mean	0.00	0.24	0.11	3.46	0.14
Median	0.00	0.27	0.16	4.98	0.13
Min	-0.01	-0.54	-0.36	-12.08	0.10
Max	0.01	0.78	0.34	11.42	0.23
Sig. Pos.	0		43		
Ins. Pos.	52		7		
Sig. Neg.	0		7		
Ins. Neg.	10		5		
Panel B: Weekly Returns					
	alpha	**T-test**	**beta**	**T-test**	**R^2**
Mean	0.02	0.28	-0.09	-1.34	0.13
Median	0.02	0.32	-0.13	-1.86	0.12
Min	-0.04	-0.40	-0.36	-5.58	0.10
Max	0.10	0.84	0.36	5.51	0.23
Sig. Pos.	0		5		

Ins. Pos.	52		7		
Sig. Neg.	0		35		
Ins. Neg.	10		15		
Panel C: Monthly Returns					
	alpha	**T-test**	**beta**	**T-test**	**R^2**
Mean	0.09	0.41	-0.12	-0.85	0.12
Median	0.08	0.60	-0.12	-0.81	0.11
Min	-0.23	-0.65	-0.34	-2.41	0.10
Max	0.32	0.91	0.10	0.70	0.21
Sig. Pos.	0		0		
Ins. Pos.	46		6		
Sig. Neg.	0		48		
Ins. Neg.	16		8		

Table 6: Performance Ranking Persistence Regression Results

Panel A: Average Return					
Period	**λ_0**	**T-test**	**λ_1**	**T-test**	**R^2**
2018-2019	4.59[a]	23.65	-0.84[a]	-11.82	0.70
2019-2020	0.60[b]	2.60	0.76[a]	9.09	0.58
2020-2021	4.53[c]	21.86	-0.81[a]	-10.75	0.66
Panel B: Cumulative Return					
Period	**λ_0**	**T-test**	**λ_1**	**T-test**	**R^2**
2018-2019	4.59[a]	23.65	-0.84[a]	-11.82	0.70
2019-2020	0.53[b]	2.44	0.79[a]	9.85	0.62
2020-2021	4.53[a]	21.86	-0.81[a]	-10.75	0.66
Panel C: Sharpe Ratio					
Period	**λ_0**	**T-test**	**λ_1**	**T-test**	**R^2**
2018-2019	1.92[a]	5.57	-0.23[c]	-1.85	0.42
2019-2020	1.07[a]	3.68	0.57[a]	5.41	0.33
2020-2021	2.52[a]	7.10	-0.01	-0.05	0.00
Panel D: Information Ratio (against Bloomberg US Aggregate Bond Index)					
Period	**λ_0**	**T-test**	**λ_1**	**T-test**	**R^2**
2018-2019	4.37[a]	18.60	-0.75[a]	-8.74	0.56
2019-2020	0.50[b]	2.36	0.80[a]	10.28	0.64
2020-2021	4.06[a]	14.63	-0.62[a]	-6.16	0.39
Panel E: Information Ratio (against S&P 500 Index)					
Period	**λ_0**	**T-test**	**λ_1**	**T-test**	**R^2**
2018-2019	4.34[a]	18.09	-0.74[a]	-8.42	0.54
2019-2020	0.28[c]	1.73	0.89[a]	14.86	0.79
2020-2021	3.90[a]	13.28	-0.56[a]	-5.23	0.31
a: Statistically significant at 1%; b: Statistically significant at 5%; c: Statistically significant at 10%.					

This Table presents the results of a cross-sectional regression model via which the ranking ETFs' return in year t is regressed on the corresponding ranking in year t-1. ETFs are classified in four groups; the top group receives four stars, the second-top group receives three stars, and so on. The return measures used are the average daily return, the cumulative return, the Sharpe Ratio and the Information Ratio calculated against the Bloomberg US Aggregate Bond Index and the S&P 500 Index, respectively. The study period spans from 1/1/2018 to 31/12/2021