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Research article

Mapping sustainable investing: Exploring ambiguities and consistencies among sustainable indices

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ABSTRACT

Sustainable investing is perceived as a confusing black-box by many researchers, practitioners, and investors. Terminology, metrics, approaches, disclosure standards are quickly evolving, while the empirical evidence provides a growing number of mixed results. In this paper, we examine the composition, performance, and the risk-return profile of reference sustainable indices for the asset management industry, distinguishing between ethical and socially-responsible, faith-based, ESG and climate ones. Our findings reveal consistent investment trends across various sustainable indices, impacting their overall performance. Specifically, our analysis highlights a prevalent inclination towards large and growth-oriented companies, as well as a persistent focus on technology, financials, and commodity sectors. These results provide valuable insights for investors, asset managers, and index providers regarding the potential misalignment between an investment vehicle's labeling and its actual composition, and the implications this discrepancy might have on investors' expectations.

1. Introduction

A sustainable world needs sustainable finance. The awareness on the enabling role of finance in ensuring a sustainable development, namely "*meeting the needs of the present without compromising the ability of future generations to meet their own needs*" (Brundtland and Chairperson, 1987), implies the need for suitable sustainable investment vehicles. To date, though, different connotations of sustainable investments coexist. For instance, according to the US Sustainable Investment Forum, sustainable investing "*refers to a range of strategies in which investors include environmental, social and corporate governance (ESG) criteria in investment decisions and investor advocacy*". The European legislator, on the other hand, puts more emphasis on minimum safeguards, with the introduction of the Do Not Significant Harm principle and the stress on the role of good governance practices as *condicio* sine *qua non* for sustainable investments. Finally, in Asia, according to the Responsible Investment Association Australasia (RIAA), the concepts of responsible, sustainable, and ethical investments converge into a "*broad-based approach to investing which factors in people, society and the environment, along with financial performance, when making and managing investments*".

The lowest common denominator among these definitions is the overall combination of non-financial and financial goals, therefore, for the sake of this study, we consider sustainable investments all those financial tools, whose goal is "*to create shared value by reconceiving the intersection between society and corporate performance*» à la Kramer and Porter (2011). Accordingly, we use the term "Sustainable Investing (SI)" as an umbrella term that encompasses a vast array of investments strategies, namely socially-responsible and ethical (SRI&E) investing, faith-based investing, Environmental Social and Governance (ESG) investing and climate investing, in the spirit of Fulton et al. (2012). Sustainable finance indices are designed to track the performance of securities from companies engaged in ethical and religious issues, environmentally and socially responsible practices and climate change mitigation. In this regard, Fulton et al. (2012) presents a helpful timeline on the evolution of sustainable investing. Its roots lie in the concept of *ethical investment*, which is guided by moral values and ethical codes. Investment decisions include non-economic criteria, which are traditionally declined through negative (or exclusionary) screening. From the 1960s to the mid-1990s, the focus gradually shifts towards the broader concept of *Socially Responsible Investing (SRI),* representing an evolution

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of the ethical approach that allows a trade-off between corporate social and financial performance when making investment decisions, still using predominantly negative screenings. SRI originally emerges as a response to concerns about human rights, labor standards, and environmental degradation. The goal of this approach is to create investment strategies, which align with investors' values and to refrain from investing in firms involved in practices deemed controversial.

During the first half of the 2000s, prompted by the UN Global Compact, SRI evolved into what is now known as *ESG investing*, which takes a more systematic approach in integrating environmental, social, and governance considerations into investment decisions and their potential impact on financial risk and performance. *Environmental* issues refer to any aspect of a company's activity that may impact the natural environment (e.g., greenhouse gas emissions, renewable energy use, resource use, etc.). *Social* issues vary from community-related aspects (e.g., improvement of health and education) to workplace-related issues (e.g., human rights, discrimination, labor standards, etc.). *Governance* issues, instead, concern the quality of a company's management, business ethics, culture, and risk management (e.g., board accountability, strategic management of social and environmental performance, fiscal fair play, etc.).

As concerns about global warming grow, investment strategies that emphasize the environmental aspect of the ESG framework have gained popularity. A particularly recent investment theme is climate investing, which focuses on companies, projects, and technologies dedicated to mitigating and adapting to climate change. This approach includes investments in renewable energy, energy efficiency, clean technology, sustainable transportation, biodiversity protection and restoration, the circular economy and other initiatives that contribute to the reduction of greenhouse gas (GHG) emissions and the transition to a low-carbon economy. Climate investing is driven by the recognition that climate change poses significant risks to the global economy and society, and that urgent action is required to mitigate these risks. The Asset under Management (AuM) attracted by climate investing reached almost USD 1.3 trillion in 2021/2022, nearly doubling the investment levels recorded in 2019/2020 (Climate Policy Initiative, 2023).

To meet the growing demand for SI investments, the asset management industry has declined the different acceptations of SI into market indices. Since the launch of the first documented SRI index, the Domini 400 Social Index (now the MSCI KLD 400 Social Index) in 1990, the number of 'sustainable indexes' in the broad sense has now exceeded 1000. Additionally, markets have been experiencing a growing number of standards setting requirements for assets to be deemed sustainable (e.g., UN's Principles for Responsible Investment of 2006 – PRI), some of them directly enforced by regulators (e.g., EU's Sustainable Finance Disclosure Regulation, 2019/2088 – SFDR), and growing alternative screening strategies (see e.g., the valuable review in Renneboog et al., 2008). This lack of common standards, coupled with an ever-increasing demand for sustainable products has led to a sharp growth in the number of investment funds and indices that adopt a variety of self-identifying SI-related labels. The "aggregate confusion" that characterizes the sustainability metrics themselves (e.g., Berg et al., 2022) and the greenwashing risk that stems from it constitute a danger for retail investors that may struggle to identify the investment products that actually meet their sustainability goals, so much so that recently the European Securities and Markets Authority (ESMA) released the Guidelines on funds' names using ESG or sustainability-related terms.[1] Additionally, from a theoretical perspective, different theories and streams of literature provide evidence of competing effects linked to the use of sustainable screenings within financial investments (Giese et al., 2019). On the one hand, the seminal paper by Merton (1987) and the stream of literature that stems from it, posits that investment constraints, such as SRI, hinder the market optimal risk-sharing capacity with repercussions on risk-adjusted returns. On the other hand, however, the more recent Social Theory of the Firm (Chegut et al., 2011), maintains that the financial performance of SI is superior because the screenings applied provide portfolio managers with additional information useful to mitigate regulatory, operational, and reputational risks. Finally, a recent contribution by Du and Sun (2023) reveal that the so-called "shunned companies" tend to have particularly high ESG scores, casting doubts on the efficacy of these metrics to identify actual sustainable investment solutions.

Despite this lack of clarity and the macroeconomic uncertainty that has marked the last four years, by the end of June 2023, sustainable funds' assets under management (AuM) had increased to over $3 trillion (Morgan Stanley, 2023). Regionally, Europe continues to outpace other areas in terms of sustainable AuM and fund counts, with 89% of total sustainable AuM domiciled in Europe compared to 10% in North America and 7% in Asia. Despite experiencing a net outflow in 2023, the United States' sustainable fund market continues to grow, with total AuM reaching $323 billion by year-end (Morningstar, 2024).

Against this backdrop, our study aims to analyze the primary US sustainable indices, assess their exposures, and compare their risk-return profiles using established methodologies in this research field, such as the Carhart model and return-based style analysis. We classify the sustainable indices according to the investment objective, grouping them into four categories: SRI and Ethical investing, Faith-based investing, ESG investing and Climate investing and then we investigate the degree of active risk-taking that characterizes these indices with respect to their parent index, the MSCI USA Index. We select indices representative of all the connotations of SI described above, and focus on the US equity market, to allow a more straightforward comparability of outcomes. We verify which portfolios deviate the most, in composition, from their respective benchmarks and analyze which industries are over- and under-weighted. Furthermore, we verify if the excess returns of SI indexes are driven by size, value, and momentum factors.

This research contributes to the ongoing debate on sustainable investing by shedding light on the gray areas of sustainable indices' identification, investment strategies and relative performances. We analyze whether the specific compositions and investment styles of SI indices possess unique characteristics and commonalities, and we examine their correlation with the parent index. Overall, our findings indicate that significant differences exist across indexes and metrics. It is unlikely that the performance variations among the sustainable investment strategies analyzed are solely due to their classification within a specific family of sustainable indices. Instead, these performance differences are likely driven by asset allocation choices, which generally favor large, growth-oriented constituents in the financial, technology, and commodity sectors across nearly all indices. However, we find significant exceptions, with consequences on risk-adjusted performance of various indices. These results are robust to alternative choices of indexes providers.

Our findings underscore the importance of exercising caution in the intricate landscape of sustainable investing. Investors should look beyond labels and be mindful of potential inconsistencies in risk-return profiles, as well as concentration risks arising from market references. To mitigate these issues, index providers should strive for greater transparency in their company selection criteria and the rationale for inclusion. A more comprehensive and unified regulatory framework would greatly support this objective. Enhanced disclosure would enable investors to make more informed decisions that better align with their values and sustainability goals. However, stricter selection criteria could increase sectoral or firm concentration, potentially affecting risk-adjusted metrics and leading to varied performance outcomes in different market conditions. The insights from this research are valuable for investors seeking sustainable financial solutions, as well as for fund managers and index providers.

The remainder of this paper is organized as follows. In Section 2 we

[1] For further reference, see https://www.esma.europa.eu/sites/default/files/2024-05/ESMA34-472-440_Final_Report_Guidelines_on_funds_names.pdf.

review the literature and formulate our research questions. In Sections 3 and 4, respectively, we present our sample and methodology. Section 5 illustrates our findings, whereas we stress the robustness of our results in Section 6. Finally, Section 7 hosts the conclusions.

2. Literature review

The literature on SI is vast and heterogeneous, especially when considering the different connotations that the term takes, and it is still growing at an astonishing rate. Several bibliometric reviews and meta-analyses have been drawn up over the last few years and provide a systematization of the literature's state-of-the-art (e.g., Chitimiea et al., 2021; Koenigsmarck and Geissdoerfer, 2021; Luo et al., 2022; Migliavacca et al., 2022; Jasuja et al., 2022; Kapil and Rawal, 2023; Alshater er al., 2023; Naeem et al., 2023; Singhania et al., 2024).

The following paragraph, though, aims to offer an overview of the key studies and the evolution of the literature on sustainable indices, specifically, their relationship with risk, return and pricing (e.g., Gompers et al., 2003, Bebchuk et al., 2009). The review incorporates different perspectives to present a nuanced understanding of the subject, offering insights for scholars, practitioners, and policymakers alike. This specific niche of the literature is not as populated as the stream on general SI, and, to the best of our knowledge, only Seth and Singh (2024) and partially Afego (2017) provide a systematic review on the topic. The latter offers a comprehensive review of academic literature on how changes in stock index compositions impact prices, risk levels, and trading volumes. The analysis systematizes a vast array of heterogeneous and sometimes contradicting results that do not allow to identify strong consensus among scholars. The former, on the other hand, shows that research on sustainable indices experiences a steep rise from 2019 onwards and that sustainable investment has progressively shifted its focus from funds to indices. One of the strongest results of the analysis highlights that confusion still reigns among scholars and practitioners on the multiple labels used to identify the different facets of SI; for instance, it is observed that "CSR" and "sustainability" are used as synonyms in the majority of studies. Another relevant finding of this bibliometric review reveals that the academic research revolves primarily around three sub-streams: performance and forecasting of the indices, connectedness, and volatility spillovers among them and towards other traditional investment solutions and their contribution to portfolio diversification. The analysis points out that the most-populated sub--stream is focused on the performance comparison of sustainable and conventional indices and although results remain somehow mixed, they are mostly tilted towards a positive association between the sustainable dimension of the indices and their performance.

Over and above the technical differences that characterize the studies within this literature stream (e.g., time horizon, market, econometric approach, etc.), the lack of taxonomy for sustainable indices may potentially influence the documented heterogeneity of the empirical analyses. As suggested by Eccles and Viviers (2011), academic studies examining the relationship between investments and sustainability factors adopt a heterogeneous array of terms often improperly used as synonyms. The lack of standardization and resulting confusion not only applies to academic literature but also extends to certain financial indices and funds, which often adjust their labels to align with the latest market trends (e.g., see Cochardt et al., 2023; Moeller et al., 2022; Fisch and Robertson, 2023). Finally, Seth and Singh (2024) prompt further investigation to fully develop the "Green Finance" theme, which appears to be the latest added to sustainable indices literature, to assess whether and to what extent climate-related indices might assist in reducing GHG, environmental pollution and global warming and facilitate investments in clean energy and alternative sources of energy.

Among the most relevant contributions, the closest to the purposes of our research, are Xiao et al. (2013) and Demiralay et al. (2023). The former investigates whether the sustainability variable leads to a risk premium once accounting for the Fama–French factors, within the framework of conventional asset pricing models. The study does not identify a significant negative or positive impact of the sustainability factor on returns; this result suggests the need for a more complex approach to SI that allows the specificities of the different strategies to emerge. Moreover, our results are not directly comparable to Xiao et al. (2013), because they investigate CSR investments only, without looking at the sectoral allocation decisions. Demiralay et al. (2023), instead, investigate the risk-return profile of environmentally friendly assets, providing evidence of significant heterogeneity across clean energy sub-sectors. As mentioned, our analysis is partially comparable to Demiralay et al. (2023), and we reach similar conclusions, but the perspective we adopted is broader, as we open the analysis to a wider range of SI approaches over and above the environmental theme, then we deepen the empirical analysis beyond the risk-adjusted performance measurements (RAPM), by applying the Carhart four-factor model and the Return-Based Style Analysis (RBSA). Globally considering the previous comparable studies, we share part of the conclusions they reach, such as how heterogeneity within SI solutions prompts to carefully compare indices with similar labels and encourage an active management approach.

As mentioned in the previous paragraph, the aim of our paper is to shed light on sustainable indices compositions, return and riskiness profiles and to contribute to reducing the confusion surrounding terminology, metrics, disclosures standards, and the impact on the risk-return profiles of this growingly requested investment solutions. Consistently with the mixed evidence showcased by the extant literature, we do not formulate *ex-ante* expectations on the empirical findings of our analyses, but our goal is to provide robust evidence on the similarities and differences across alternative sustainable indices, synthetize their exposure to different industries and the implications in terms of active risk and return and finally to provide some guidance to investors, practitioners and policy-makers.

3. Data sample and index design

Our first step involves categorizing sustainable investing (SI) approaches and associating each approach with a corresponding MSCI "sustainable" index. Drawing on Fulton et al. (2012) and Bolognesi (2023), Fig. 1 provides a conceptual overview of the four categories of sustainable investments upon which we rely and the sixteen indices that we have identified as representative of these categories. For the main analyses, we rely on MSCI indices being the most widely used in asset management. Each index is Total Return (TR), thus considering stocks' dividends paid out. Table A1 in the appendix offers a detailed description of each index utilized in our analyses.

SRI and Ethical investing indices are primarily built on the exclusion of specific investment sectors or industries. The selection of sectors to exclude depends on various factors, including the individual investor's preferences and the assessment made by index providers regarding sectors considered detrimental from a societal perspective. Understandably, there can be wide variations across countries. Commonly excluded industries include, but are not limited to, alcohol, fossil fuels (particularly coal), gambling, nuclear energy, pornography, tobacco, and weapons (Boffo et al.).

Faith-based investing aims to select investments that align with religious beliefs and values. For example, a Catholic investment approach seeks equity ownership in alignment with the moral and social teachings of the Catholic Church while Islamic investing follows Sharia investment principles.

Focusing on ESG investing, the number and variety of indices has been growing over time. Some indices target companies showing the highest ESG rating performance in each sector of the parent index, or target companies with positive ESG characteristics while closely representing the risk and return profile of the underlying market.

Lastly, the most recent indices focus on Climate investing, aimed at

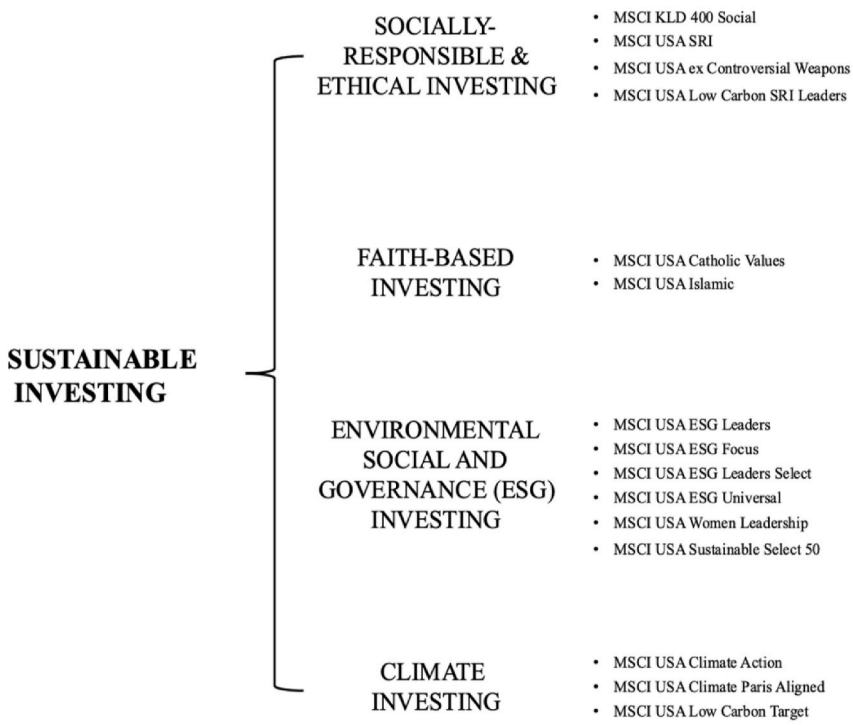

Fig. 1. Sustainable investing and indexation: conceptual framework.

helping investors incorporate climate risk considerations into their investment strategies (e.g., Guenster et al., 2011; Birindelli et al., 2023). These indices enable investors to seek financial returns by investing in companies that, for instance, align with the Paris Agreement's goal of limiting global warming to 1.5 °C.

We analyze these indices from August 4, 2021, to May 31, 2024, based on daily observations. The chosen time frame aligns with the objective of encompassing all three types of climate indices introduced by MSCI, including the latest versions. Each index serves distinct purposes: one focuses on minimizing carbon intensity, another provides exposure to companies leading the transition within their sectors, and the third aims to mitigate climate risks and align with the 1.5 °C target. Within our sample, we include one index representing each of these objectives.

It's noteworthy that this period also presents an interesting context for evaluating the performance of the indices, encompassing both a "bear" and a "bull" market phase (Lins et al., 2017). These phases were influenced by the rapid increase in U.S. interest rates, climbing from approximately 0%–5% within a few months—a notable shock in the financial market history. Fig. 2 illustrates the dynamics of the 1-month US interest rate and the MSCI USD Total Return Index. Specifically, we concentrate on the bear market phase from December 31, 2021 to October 14, 2022, and the subsequent bull market phase from October 14, 2022 to July 28, 2023.

4. Methodology

We proceed with an in-depth analysis of the characteristics and the risk-return profile of the selected sustainable indices focused on the US stock market. As previously mentioned, we use the MSCI USA Index as the parent-index benchmark for our sustainable indices. This index is designed to measure the performance of the large and mid-cap segments of the US market. With nearly 600 constituents, it covers approximately 85% of the free float-adjusted market capitalization in the US.

The first analysis aims at providing several performance statistics, in terms of average return and standard deviation. To measure performance, we use total returns (i.e., returns include dividends and distributions realized over the observation period). Next, we calculate the Sharpe ratio, which reflects the indices' risk/reward efficiency by adjusting excess returns over the risk-free interest rate by the volatility of the index. As a proxy of the risk-free rate, we use the 1-month US interest rate.

Moreover, we showcase the difference between the composition of the sustainable indices and the overall US equity market, proxied by the MSCI USA Index. Therefore, we calculate the tracking error, the tracking error volatility, and the information ratio of each index with respect to the parent index. These statistics are commonly used to identify the degree of active management of a portfolio, i.e., its deviation from the benchmark. In particular, the tracking error is a measure of the active return of the index while the tracking error volatility indicates the active risk, i.e., a measure of how closely a portfolio follows the index to which it is benchmarked. The relation between the active return and active risk is the information ratio that aims at quantifying the excess portfolio returns over the returns of the benchmark, relative to the volatility of the excess returns. These statistics provide insight into how closely the composition of sustainable indices aligns with the overall US equity market (the definitions of the financial indicators used in these analyses are provided in Table A.3 in the Appendix).

To measure the extra returns of our sustainable indices we also calculate the Jensen's alpha and the beta, based on the CAPM, and defined as the difference between a portfolio's excess return over the risk-free rate and the return explained by the market model (see Equation (1)).

$$R_t^{SI} - R_t^F = \propto_{JEN} + b \bullet (R_t^{BMK} - R_t^F) + \varepsilon_t \quad (1)$$

where $\propto_{JEN}$ is the Jensen's alpha, R_t^{SI} is the return of the Sustainable Index on day t (i.e. SRI and Ethical, Faith-based, ESG and Climate Indices), R_t^{BMK} is the return of the parent index on day t (MSCI USA Index) and R_t^F is the return on a risk-free asset on day t (1-month US interest rate). $\propto_{JEN}$ provides an estimate of the risk-adjusted return, assuming that b is an appropriate measure for the systematic risk. The

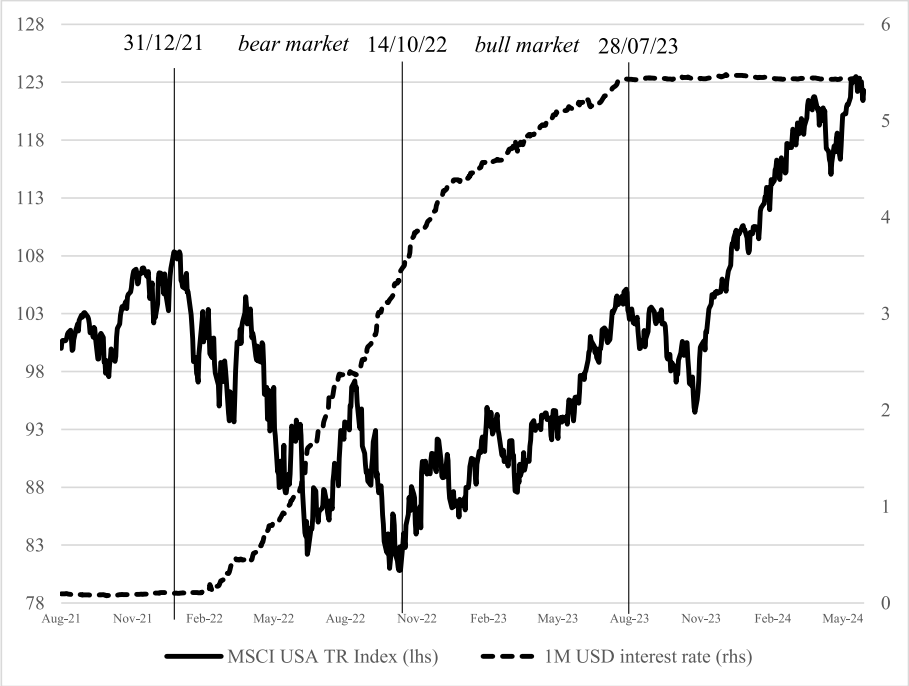

Fig. 2. Dynamics US interest rates and equity market.

standard errors for the time series are consistent both in the case of heteroscedasticity and in the case of serial autocorrelation of residuals (Newey-West standard errors).

The consensus in the extant literature, and among practitioners, is that the simple one-factor model is not entirely effective in capturing the cross section of expected stock returns (Amenc et al., 2011). The parameter alpha can also lead to misleading considerations in comparing different portfolios when they are invested in securities with distinctive characteristics, such as low-beta stocks, smaller stocks, or value stocks (Fama and French, 1993), therefore we opt for a more comprehensive model. As such, we perform the Carhart four-factor regression analysis. The aim of this step of the analysis is to verify whether the differences in performance between the sustainable indices and the parent index could be explained by common risk factors, such as mid-small cap, value, or momentum stocks. Thus, we run the following regression (see Equation (2)):

$$R_t^{SI} - R_t^F = \alpha + b \bullet (R_t^{BMK} - R_t^F) + s \bullet SMB_t + h \bullet HML_t + m \bullet WML_t + \varepsilon_t \quad (2)$$

Where, on day t, R_t^{SI} is the return of a SI Index, R_t^{BMK} is the return of the parent index, R_t^F is the return on the risk-free asset, SMB is the factor focused on the stock's size, HML is the value factor and WML is the momentum stock. Specifically, SMB refers to a portfolio with a long position in small-cap stocks and a short position in large stocks. HML denotes a portfolio with a long position in high book-to-price stocks (value stocks) and a short position in low book-to-price stocks (growth stocks). WML represents a portfolio with a long position in a winner portfolio (comprising the best-performing stocks of the previous year) and a short position in a loser portfolio (consisting of the worst-performing stocks). For this analysis, we resort to the data library provided by Kenneth R. French.[2]

The rationale behind this model is that larger companies are less risky than smaller ones and, consequently, may offer lower expected returns. Conversely, the small/mid-caps generally present higher risk and, therefore, investors require a higher premium to compensate for the additional risk. The ratio between book-to-market values also usually holds a high explanatory power: high ratios (low Price-to-Book Value) characterizes stocks with low expected growth and, therefore, less risky, and *vice versa*, securities that show a low ratio denote good growth opportunities and high intangible assets which are reflected in the market value rather than into the book value. The momentum factor is based on the observation that securities that have performed well in the recent past are likely to continue performing well, while those that have performed poorly are likely to continue performing poorly.

Furthermore, we investigate the dynamics of the selected indices during the bearish and bullish market phases associated with the rise in the US interest rates. Moved by this purpose, we identified the bearish market period, from year's end 2021 to the October 14, 2021, and the subsequent bullish market period until the July 28, 2023.

The next step is to estimate the sectorial average deviations of the selected sustainable indices compared to their parent index. With this objective, we apply Return-Based Style Analysis (RBSA), introduced by W. Sharpe in 1992, a technique that allows estimating the composition of a portfolio based on possible investment asset classes. In our case, the focus is on the sectoral allocation. In statistical terms, RBSA takes the form of a multivariate linear regression in which the dependent variable is the performance over time of the sustainable index under consideration, while the independent variables are the explicative factors identified in the sectoral indices (in our case industry indices developed by MSCI). This is generally indicated as the Sharpe style regression and is written as reported in Equation (3):

$$R_t^{SI} = \sum_{i=1}^{11} w_i^{SI} \bullet R_t^i + \varepsilon_t \quad (3)$$

where:

R_t^{SI} = Return of the sustainable index over the time period t.

R_t^i = Return of the 11 industry indices i (with i = MSCI Communication Services; MSCI Consumer Discretionary; MSCI Consumer Staples; MSCI Energy; MSCI Financials; MSCI Health Care; MSCI Industrials; MSCI Information Technology; MSCI Materials; MSCI Real Estate; MSCI

[2] For further reference, see https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Utilities), over the time period t.

w_i^{SI} = Regression coefficient for each independent variable R_t^i.

ε_t = Residual return, the portion of the return of the sustainable index not explained by or related to the set of independent variables (i.e., the sectoral indices).

The main objective of RBSA estimation is to clearly determine w_i^{SI}, i.e., the unknown values of the regression coefficients. To facilitate an intuitive interpretation of the estimated coefficients in terms of the sectoral weights in the sustainable portfolio, the range of values that w_i^{SI} can take has to be constrained.

The first constraint, known as portfolio constraint or restriction, requires that the total assets under management of the fund are exposed to the dynamics of the selected benchmarks. Consequently, this constraint is imposed with Equation (4):

$$\sum_{i=1}^{11} w_i^{SI} = 1 \tag{4}$$

The second constraint, called short-selling restriction or non-negativity constraint, seeks to exclude the possibility of short exposures to the asset class benchmarks:

$w_i^{SI} \geq 0$ with i = Communication Services; Consumer Discretionary; Consumer Staples; Energy; Financials; Health Care; Industrials; Information Technology; Materials; Real Estate; Utilities.

Although the addition of constraints to Sharpe's RBSA is natural and logical from a financial perspective, it does have an impact on the way in which the regression coefficients are estimated. In fact, the presence of the constraints means that an ordinary least squares (OLS) approach can no longer be used. Instead, a quadratic programming algorithm must be applied to accommodate the weights w_i^{SI}. To identify the combination of sectoral exposures, among the many possibilities, we resort to the minimization of the error terms variance, ε_t, each of which expresses the difference between the actual return of the sustainable index in a given time t and the return that a portfolio would have registered over the same period if represented by the linear combination of the sectoral indices that seeks to interpret the sustainable index composition. In practice, a generic residual return is defined as in Equation (5):

$$\varepsilon_t = R_t^{SI} - \left(w_1^{SI} \bullet R_t^1 + w_2^{SI} \bullet R_t^2 + w_3^{SI} \bullet R_t^3 + \ldots + w_{11}^{SI} \bullet R_{11}^3\right) \tag{5}$$

Thus, the estimates of the coefficients of the constrained multivariate linear regression representing the RBSA are obtained by resolving Equation (6):

$$minVar\ (\varepsilon_t) = minVar\left(R_t^{SI} - \sum_{i=1}^{11} w_i^{SI} \bullet R_t^i\right) \tag{6}$$

$$with \quad \sum_{i=1}^{11} w_i^{SI} = 1$$

$$and \quad w_i^{SI} \geq 0$$

5. Results presentation and discussion

5.1. Risk-return profile

Table 1 presents the summary statistics of the risk and return parameters for the selected MSCI sustainable investing indices and their parent index, based on daily observations during different periods. Panel A focuses on the entire period, from August 4, 2021, to May 31, 2024. Panel B provides a comparison between the bear market phase (December 31, 2021, to October 14, 2022) and the subsequent bull market phase (October 14, 2022, to July 28, 2023).

Considering the entire period, the performance of the SI is quite varied. They range from +2.36% for the MSCI USA Women Leadership Index to +26.84% for the MSCI USA Low Carbon SRI Leaders Index, while the parent index records a performance of +22.29%. Overall, the best performers, in terms of returns, are the faith-based indices (+24.16%). This result is also confirmed when considering risk-adjusted performance, through the Sharpe ratio (0.36 on average, compared to 0.33 for the MSCI USA Index). The worst results are recorded by the ESG indices (+18.98% in aggregate), which show significant variability within the category, demonstrating the existence of multiple, diverse strategies within the ESG world (such as best-in-class, ESG integration, exclusionary screening, corporate engagement and shareholders action, impact voting, etc.).

Focusing on the tracking error volatility statistics, which express the degree of deviation of the indices from the parent index, the results show that the most similar indices are the Climate change, while the Faith-based show the greatest deviation in composition. The category showing the highest information ratio is the SRI and Ethical (+0.18 in aggregate), while the lowest value is recorded by Climate change.

The market model results confirm the significant underperformance of the MSCI Women Leadership Index (−2.0%), while the betas, all highly significant, range from 0.87 for the Islamic index (the most defensive index compared to the market) to 1.07 for the Catholic Values index (amplifying market trends).

To visualize the risk-return profile of the selected indices, Fig. 3 presents the average daily return and standard deviation for each index group, along with the parent index. Except for the Islamic index, all indices show a higher volatility compared to the market. This graphical representation further highlights the difference between the religious-based indices, with one being more defensive (Islamic) and the other more aggressive (Catholic) relative to the market. ESG indices are the most heterogeneous in terms of returns (half underperform the parent index) and of risks (one similar, the rest higher compared to the parent index). These results are broadly in line with previous studies on ESG funds (e.g., Dmuchowski et al., 2023). Finally, the climate indices exhibit slightly lower performance but higher standard deviation compared to the parent index.

Fig. 4 allows us to visualize which of the indices diverge the most from the market portfolio, using the parameters of tracking error and tracking error volatility. It suggests that: i) the indices that deviate the most are the religious-based ones; ii) the indices most similar to the market are the climate change ones; iii) the SRI & ethical indices and the ESG indices are the least homogeneous categories: some indices are similar to the parent index, while others deviate significantly.

Panel B focuses on the main statistics during the bear (2021–2022) and bull (2022–2023) market phases, highlighting the market's response to the sharp increase in US interest rates. The parent index shows an overall return of −25.41% in the first phase, and of 30.06% in the second one. The standard deviation decreased from 24.49% to 17.60%, respectively. Combined, the risk-adjusted return measured by the Sharpe ratio moved from −1.14 to 1.96.

Starting from the bear market phase, only the Islamic index performed better than the parent index (−18.43%), while maintaining a lower standard deviation (21.05%). Conversely, the worst performers are spread across different categories, including the Catholic Values (−29.73%), the SRI (−28.92%), and the Climate Paris Aligned (−28.79%) indices. Focusing on the risk-return ratio, the best group of indices is the faith-based one (Sharpe ratio of −1.09), driven by the Islamic index, while the worst is the ESG indices. Moving to the bull market period, each group of indices, on aggregate, presents a performance superior to that of the parent index, thus confirming the greater aggressiveness in composition compared to the market, as already verified through the estimation of the betas. In terms of risk-adjusted returns (Sharpe ratio), results show that the most efficient portfolios were the Faith-based (2.14), followed by the SRI and Ethical, while the most disappointing indices were the ESG indices, driven by the Women Leadership index.

To visually represent the heterogeneous response in terms of risk-return profiles across different market phases (overall period, bear

Table 1
Summary statistics
This table presents summary statistics of the selected indices over the overall period of analysis, grouped by sub-sectoral sustainable investing category, in this order: period performance, average annualized daily return, annual standard deviation, Sharpe ratio, Tracking Error, Tracking Error Volatility, Information Ratio, Jensen's Alpha and Beta, in Panel A. Panel B provides the main descriptive statistics in Bear and Bull market conditions (i.e., 31/12/21–14/10/22 and 14/10/22–28/07/23). Significance codes: *** at 1%, ** at 5%, * at 10%.

PANEL A: DESCRIPTIVE STATISTICS

CATEGORY	INDEX	Return 04/08/21–31/05/24 %	Average Return (annual) %	Standard Deviation (annual) %	Sharpe Ratio	Tracking Error %	Tracking Error Volatility %	Inform. Ratio	Alpha Jensen		Beta	
SRI AND ETHICAL	MSCI KLD 400 Social	22.99	9.44	18.69	0.33	0.33	2.58	0.13	0.003		1.02	***
	MSCI USA SRI	21.44	9.09	19.36	0.30	0.01	4.62	0.00	0.002		1.04	***
	MSCI USA ex Controversial Weapons	22.31	9.09	18.03	0.33	0.02	0.16	0.11	0.003		1.00	***
	MSCI USA Low Carbon SRI Leaders	26.84	10.65	18.82	0.39	1.45	3.09	0.47	0.008		1.02	***
	Average	**23.39**	**9.57**	**18.72**	**0.34**	**0.45**	**2.61**	**0.18**				
FAITH BASED	MSCI USA Catholic Values	23.05	9.65	19.63	0.33	0.53	3.28	0.16	0.003		1.07	***
	MSCI USA Islamic	25.27	9.73	16.54	0.39	0.60	5.81	0.10	0.007		0.87	***
	Average	**24.16**	**9.69**	**18.09**	**0.36**	**0.57**	**4.55**	**0.13**				
ESG	MSCI USA ESG Leaders	26.63	10.45	18.11	0.40	1.26	2.51	0.50	0.008		0.99	***
	MSCI USA ESG Focus	19.86	8.32	18.05	0.28	−0.69	0.58	−1.19	–		1.00	***
	MSCI USA ESG Leaders Select	15.91	7.12	18.37	0.22	−1.79	2.32	−0.77	−0.004		1.01	***
	MSCI USA ESG Universal	22.93	9.26	17.92	0.34	0.18	1.07	0.16	0.004		0.99	***
	MSCI USA Women Leadership	2.36	2.65	18.93	−0.02	−5.89	5.01	−1.18	−0.020	**	1.02	***
	MSCI USA Sustainable Select 50	26.19	10.29	18.04	0.39	1.12	4.13	0.27	0.008		0.97	***
	Average	**18.98**	**8.02**	**18.24**	**0.27**	**−0.97**	**2.60**	**−0.37**				
CLIMATE CHANGE	MSCI USA Climate Action	21.82	8.99	18.27	0.32	−0.08	1.47	−0.05	0.002		1.00	***
	MSCI USA Climate Paris Aligned	16.44	7.49	19.39	0.22	−1.45	2.73	−0.53	−0.004		1.06	***
	MSCI USA Low Carbon Target	20.67	8.57	18.02	0.30	−0.46	0.44	−1.04	0.001		1.00	***
	Average	**19.64**	**8.35**	**18.56**	**0.28**	**−0.66**	**1.55**	**−0.54**				
PARENT INDEX	**MSCI USA TR**	**22.29**	**9.07**	**17.96**	**0.33**							

PANEL B: DESCRIPTIVE STATISTICS IN BEAR AND BULL MARKETS

CATEGORY	INDEX	Return BEAR mkt 31/12/21 14/10/22 %	Average Return (annual) %	Standard Deviation (annual) %	Sharpe Ratio	Return BULL mkt 14/10/22 28/07/23 %	Average Return (annual) %	Standard Deviation (annual) %	Sharpe Ratio
SRI AND ETHICAL	MSCI KLD 400 Social	−28.16	−30.55	25.00	−1.24	32.94	45.25	18.48	2.10
	MSCI USA SRI	−28.92	−31.10	25.88	−1.22	35.91	49.71	19.70	2.18
	MSCI USA ex Controversial Weapons	−25.58	−27.64	24.57	−1.14	30.10	40.98	17.68	1.96
	MSCI USA Low Carbon SRI Leaders	−27.70	−29.98	25.11	−1.21	32.60	44.66	18.31	2.08
	Average	−27.59	−29.82	25.14	−1.20	32.89	45.15	18.54	2.08
FAITH BASED	MSCI USA Catholic Values	−29.73	−32.22	26.22	−1.25	34.92	48.30	19.53	2.13
	MSCI USA Islamic	−18.43	−19.28	21.05	−0.94	32.00	43.77	17.30	2.16
	Average	−24.08	−25.75	23.64	−1.09	33.46	46.03	18.42	2.14
ESG	MSCI USA ESG Leaders	−26.79	−29.06	24.15	−1.22	32.02	43.84	18.03	2.07
	MSCI USA ESG Focus	−26.33	−28.56	24.58	−1.18	29.66	40.43	17.80	1.92
	MSCI USA ESG Leaders Select	−28.03	−30.41	24.68	−1.25	29.83	40.87	18.53	1.86
	MSCI USA ESG Universal	−26.16	−28.36	24.32	−1.19	30.22	41.06	17.50	1.98
	MSCI USA Women Leadership	−26.29	−28.58	25.34	−1.15	23.85	32.95	18.84	1.43
	MSCI USA Sustainable Select 50	−27.64	−30.20	23.65	−1.30	36.15	49.08	17.58	2.41
	Average	−26.87	−29.20	24.45	−1.21	30.29	41.37	18.05	1.95
CLIMATE CHANGE	MSCI USA Climate Action	−27.66	−30.12	24.98	−1.22	32.18	44.07	17.89	2.10
	MSCI USA Climate Paris Aligned	−28.79	−31.10	26.30	−1.20	31.78	43.34	19.14	1.93
	MSCI USA Low Carbon Target	−26.08	−28.28	24.55	−1.17	29.88	40.64	17.66	1.94
	Average	−27.51	−29.83	25.28	−1.20	31.28	42.69	18.23	1.99
PARENT INDEX	MSCI USA TR	−25.41	−27.46	24.49	−1.14	30.06	40.88	17.60	1.96

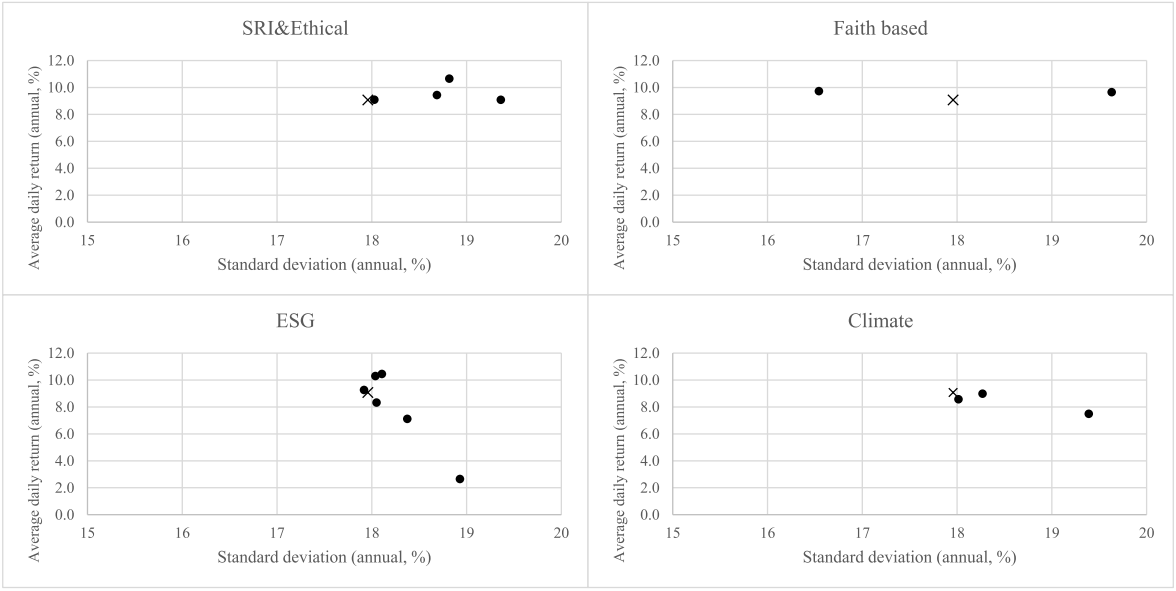

Fig. 3. Sustainability Indices: risk-return profile.

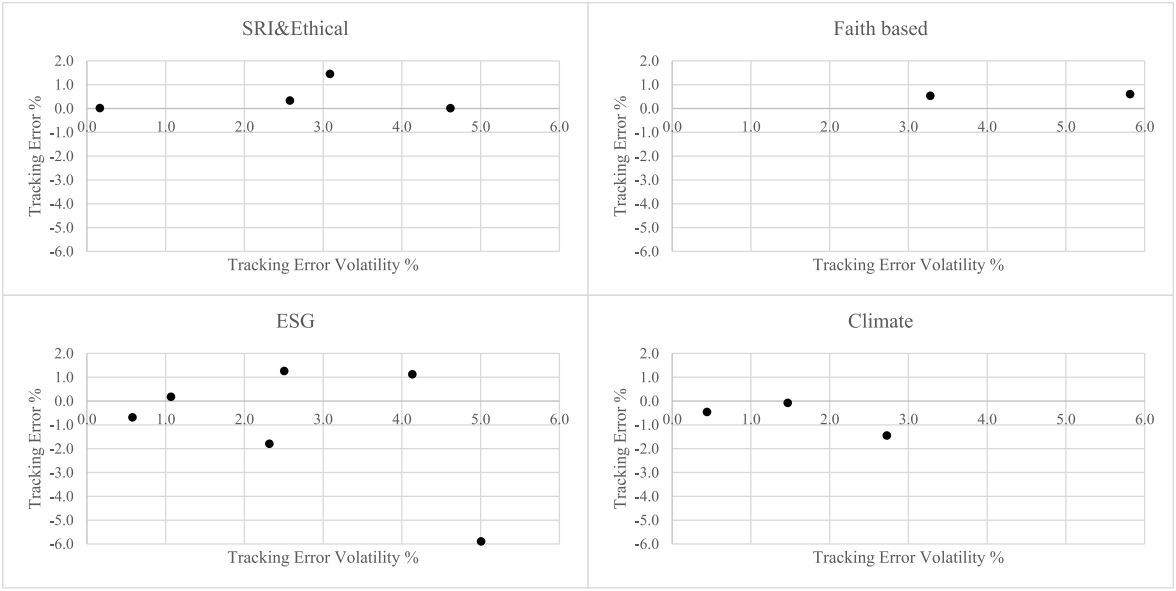

Fig. 4. Sustainability indices: Tracking error and tracking error volatility.

market, bull market), Fig. 5 summarizes each index's performance relative to the parent index values.

SRI and Ethical indices exhibit a risk-return profile quite similar to the parent index over the entire period, especially the Ex Controversial Weapons index, showing the effect of the underlying strategy aimed at excluding investments in firms focused on selected businesses. However, overall, this group of indices demonstrates overperformance during bull markets and underperformance during bear markets, indicating a more aggressive asset allocation. Faith-based indices confirm notable differences with each other. While the Catholic index shows an overall performance similar to the parent index but an aggressive attitude during bear and bull markets, the Islamic index shows its higher risk-return profile in each period considered. The broader ESG category exhibits the highest variability across the four categories, reflecting the diverse approaches within ESG strategies. During bear markets, all indices underperform their benchmark, while in bull markets, they display the widest range of outcomes, from negative (Women Leadership) to positive (Sustainable Select 50). Notably, the Women Leadership index is the sole index significantly underperforming the parent index during bull markets. Finally, Climate Change indices closely track the benchmark. It's important to reiterate that we selected representative indices aligned with three distinct climate objectives ("contribute", "align", "reduce"). Despite their different aims, their performance aligns with the market, confirming a composition similar to the benchmark.

5.2. *Carhart four-factors model: size, value and momentum*

To investigate the drivers of the differences in performance, we focus on the factors widely tested in the academic literature such as size, value, and momentum. Specifically, we aim to determine whether different sustainability strategies influence the selection of target firms and result in divergent performance among specific indexes compared to their benchmarks. For instance, the size of firms is often linked to their superior sustainability performance in the literature, influenced by

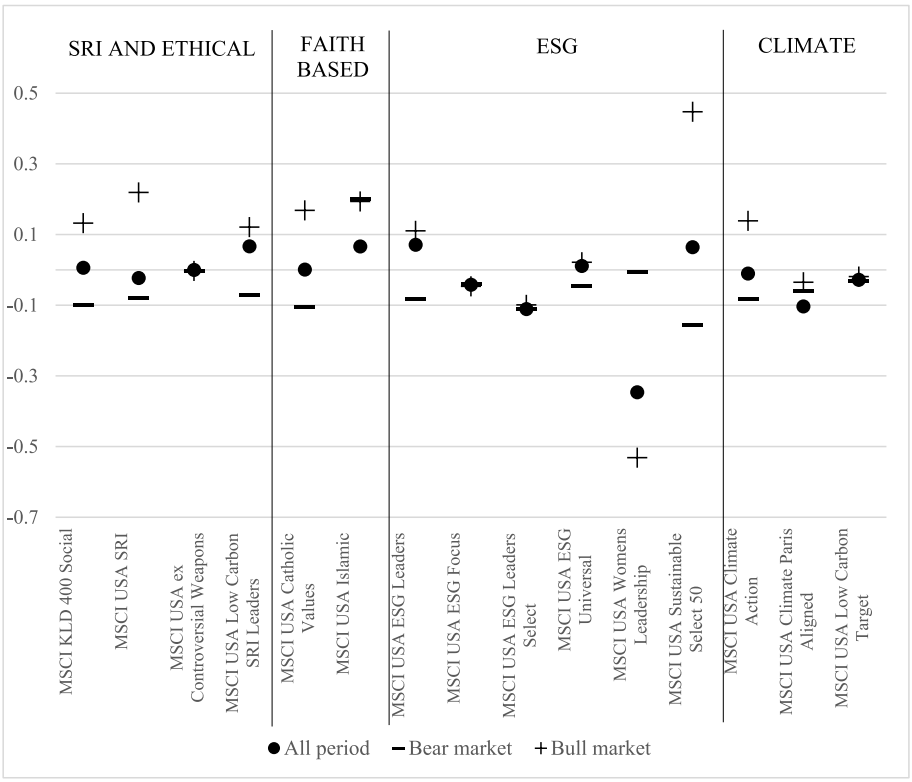

Fig. 5. – Differences in Sharpe Ratios between sustainable and parent indexes.

regulatory pressures and resource availability dedicated to these issues.

Table 2 presents the results of the four-factor model and their interpretation in deriving investment strategies. Additionally, we provide statistics on the number of constituents for each index to better understand their degree of concentration.

The coefficients alpha and the beta related to the market risk premium confirm the results provided by the market model. Focusing on the size factor, the beta coefficients are negative and statistically

Table 2
Carhart four-factors model This table presents the results of the Carhart four-factor model on the indices targeted by our analysis. Significance codes: *** at 1%, ** at 5%, * at 10%.

CATEGORY					Four-factors Model								Investment strategy		
	INDEX	Constituents	Alpha		Rmkt - Rf		SMB (Small - Big)		HML (Value - Growth) =		WML (Winner - Loser) =		SMB	HML	WML
SRI AND ETHICAL	MSCI KLD 400 Social	400	0.00		1.02	***	−0.15	***	−0.08	***	0.00		LARGE	GROWTH	
	MSCI USA SRI	166	0.00		1.01	***	−0.15	***	−0.11	***	−0.04	**	LARGE	GROWTH	LOSER
	MSCI USA ex Controversial Weapons	620	−0.00		1.00	***	−0.13	***	−0.04	***	−0.01	***	LARGE	GROWTH	LOSER
	MSCI USA Low Carbon SRI Leaders	277	0.01		1.01	***	−0.17	***	−0.13	***	0.03	***	LARGE	GROWTH	WINNER
FAITH BASED	MSCI USA Catholic Values	399	0.00		1.05	***	−0.14	***	−0.11	***	0.01		LARGE	GROWTH	–
	MSCI USA Islamic	137	−0.00		0.93	***	−0.12	***	0.07	***	0.04	**	LARGE	VALUE	WINNER
ESG	MSCI USA ESG Leaders	291	0.00		0.99	***	−0.18	***	−0.08	***	0.01		LARGE	GROWTH	
	MSCI USA ESG Focus	309	−0.00		1.00	***	−0.13	***	−0.03	***	−0.01	***	LARGE	GROWTH	LOSER
	MSCI USA ESG Leaders Select	182	−0.01		1.00	***	−0.08	***	−0.02	***	−0.02	***	LARGE	GROWTH	LOSER
	MSCI USA ESG Universal	611	0.00		0.99	***	−0.12	***	−0.04	***	0.00		LARGE	GROWTH	–
	MSCI USA Women Leadership	305	−0.01	*	0.99	***	0.20	***	0.07	***	−0.10	***	SMALL	VALUE	LOSER
	MSCI USA Sustainable Select 50	54	0.00		0.99	***	−0.16	***	−0.06	***	0.06	***	LARGE	GROWTH	WINNER
CLIMATE CHANGE	MSCI USA Climate Action	313	−0.00		1.00	***	−0.20	***	−0.08	***	−0.03	***	LARGE	GROWTH	LOSER
	MSCI USA Climate Paris Aligned	269	−0.00		1.02	***	−0.12	***	−0.15	***	−0.01	*	LARGE	GROWTH	LOSER
	MSCI USA Low Carbon Target	502	−0.00		1.00	***	−0.13	***	−0.04	***	−0.01	**	LARGE	GROWTH	LOSER
PARENT INDEX	**MSCI USA**	**625**													

significant (suggesting a tilt towards large caps), except for the Women Leadership index, which shows a positive value (0.20), highlighting an underweight of large caps compared to the parent index. The Climate Action index is the most exposed to large caps (−0.20), followed by the ESG Leaders index and the Low Carbon SRI Leaders index.

Results also provide insights into the value premium, where all coefficients show statistical significance. Only two indices exhibit positive values: Islamic (0.1) and Women Leadership (0.03), suggesting a preference for value-oriented firms. Conversely, this model identifies the remaining indices as growth, with values ranging from −0.02 for the ESG Leaders Select to −0.15 for the Climate Paris Aligned index.

Finally, results related to the momentum factor are quite mixed. Only three portfolios (Low Carbon SRI Leaders, Islamic, and Sustainable Select 50) present a positive coefficient, indicating a portfolio composition that tilts towards momentum stocks (i.e., the winners).

5.3. Sectoral allocation

To deepen our understanding of performance disparities, we further analyze the sectoral composition of sustainable investment indices compared to the parent index. First, we focus on aggregate results for groups of indices, then we will delve into the detailed sectoral composition of each index.

Fig. 6 illustrates the sectoral divergences of the four SI approaches compared to their parent index, relying on the Global Industry Classification Standard (GICS) (i.e., Communication Services, Consumer Discretionary, Consumer Staples, Energy, Financials, Health Care, Industrials, Information Technology, Materials, Real Estate, Utilities).

Even though each SI approach has a characteristic mix of exposures towards the eleven industries considered, some clear common patterns emerge. All four SI approaches underweight Utilities, Real Estate, and Consumer Discretionary. Interestingly, only the Climate investing approach overweights Communication Services and Health Care. Similarly, the Energy and Industrial sectors are underweighted by each SI approach except, on average, by Faith-based and ESG investing, respectively. Finally, Consumer Staples, IT, and Materials are overweighted by each approach, similar to Financials which only Faith-based approaches underweight compared to the parent index.

Table 3 provides the estimated sectoral weights for each index. The first and most surprising result is the magnitude of the IT overweight for almost every index. Moreover, the overall weight of the investment in IT and Communication Services (the sectors of the big tech stocks also known as “magnificent”), in many cases exceeds 40% of the portfolio, led by the Low Carbon SRI Leaders index and followed by the Catholic Values and Climate Paris indices. Similarly, a second interesting statistic is the strong overweight of the financials except for the Islamic index.

Furthermore, results provide evidence of the strong sectoral divergence from the parent index of the Islamic and the Women Leadership index. Regarding the uniqueness of the Islamic index, it is not surprising that it is characterized by the absence of the financial sector and a strong overweight of the energy sector, which together can explain the mentioned best risk-return profile during each time frame considered. Moreover, we further examined the index constituents (137 compared to 625 of the parent index) and found a high concentration on a single technological firm (almost 30%) and an overall exposure to the top five stocks that exceed 45% of the portfolio. Moving to the Women Leadership index, the strong underweight of the big tech stocks can explain its inferior performance. In this case, the number of constituents is half that of the parent index, and the highest overweight is in the financial sector. To sum up, the more complex requirements of abiding by religious principles, in the first case, and maximizing the governance dimension, in the second, lead to a smaller universe of potential target firms and, on the other hand, greater concentration in fewer sectors or firms, compared to broader approaches adopted in Ethical, SRI, ESG, and Climate indices.

5.4. Discussion of the findings

Taken together, our results can be discussed and interpreted as follows. We observe that risk-return profiles exhibit more similarities than differences among the four sustainability approaches, amplifying market performance, especially during the bear market phase.

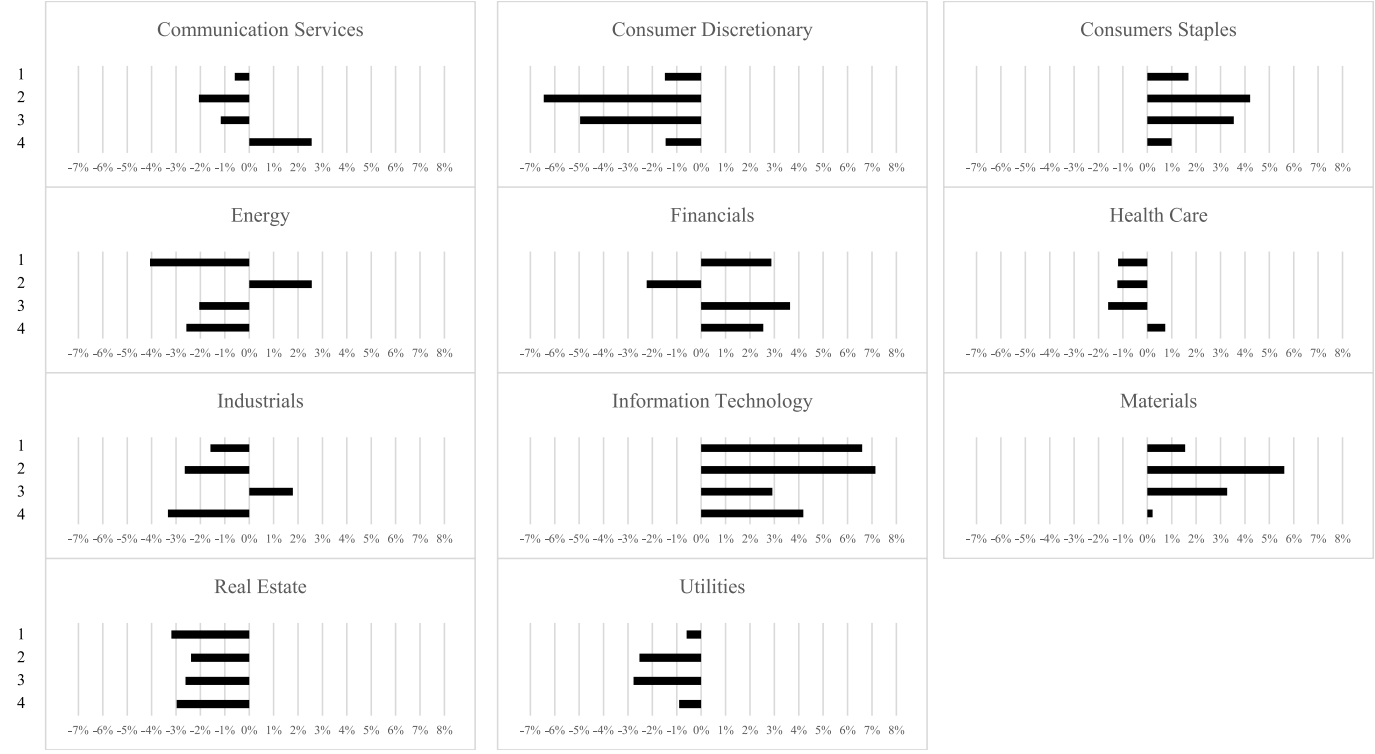

Fig. 6. Sectoral divergence in SI approaches’ exposures.

Table 3
Estimated sectoral weights This table presents the sectoral asset allocation as categorized by the Global Industry Classification Standard - GICS (Communication Services, Consumer Discretionary, Consumer Staples, Energy, Financials, Health Care, Industrials, Information Technology, Materials, Real Estate, Utilities) for each sustainable index as well as for their common parent index.

	Comm. Services %	Cons. Discr. %	Cons. Staples %	Energy %	Financials %	Health Care %	Industrials %	Inf. Tech. %	Materials %	Real Estate %	Utilities %
MSCI KLD 400 Social	6.37	12.21	4.54	0.31	6.45	14.26	10.19	32.33	2.75	5.40	5.19
MSCI USA SRI	0.00	19.34	8.88	0.28	10.04	12.16	4.05	36.41	1.73	0.55	6.57
MSCI USA ex Controversial Weapons	8.08	7.18	5.37	0.35	10.09	16.53	11.63	30.72	3.06	2.73	4.26
MSCI USA Low Carbon SRI Leaders	9.05	8.48	8.65	0.00	10.77	15.45	8.19	37.01	0.00	0.32	2.09
MSCI USA Catholic Values	6.79	13.59	4.29	0.31	8.45	5.93	12.47	37.36	2.98	4.17	3.65
MSCI USA Islamic	2.01	0.08	14.49	13.41	0.00	23.20	2.45	31.96	8.92	1.94	1.53
MSCI USA ESG Leaders	7.98	7.00	11.77	0.14	10.33	14.25	10.40	32.82	1.23	1.30	2.78
MSCI USA ESG Focus	8.06	10.70	9.25	3.27	9.54	14.66	8.38	29.21	2.44	0.76	3.75
MSCI USA ESG Leaders Select	4.85	6.68	8.29	1.48	9.05	12.03	13.25	32.00	6.45	3.75	2.18
MSCI USA ESG Universal	5.78	9.90	9.33	3.50	8.99	15.52	9.23	30.62	1.87	1.02	4.23
MSCI USA Women Leadership	5.14	15.46	0.00	2.37	14.32	13.96	15.49	16.62	8.91	7.72	0.00
MSCI USA Sustainable Select 50	0.00	0.19	13.69	2.75	8.36	14.72	14.58	41.35	0.77	2.41	1.18
MSCI USA Climate Action	11.15	11.64	7.49	1.91	10.98	17.83	3.57	29.96	0.00	0.41	5.06
MSCI USA Climate Paris	7.27	12.91	1.38	0.00	6.32	16.25	9.06	36.50	0.00	6.06	4.25
MSCI USA Low Carbon Target	8.67	10.95	9.64	3.27	9.70	15.50	7.67	28.65	1.66	0.93	3.36
MSCI USA (parent index)	6.47	13.29	5.18	4.30	6.46	15.80	10.10	27.52	0.34	5.44	5.12

A closer inspection of some sustainable indices reveals a substantial presence of large caps and growth stocks. Looking at the sectoral composition, these companies are identified as technology firms. On the one hand, this overweight is motivated by the fact that IT companies often play a crucial role in enabling sustainable practices across various industries by providing the necessary tools and infrastructure. For instance, numerous technology firms develop software for energy efficiency or manufacture electric vehicle components. Many indices include these companies based on their indirect contributions to sustainability through innovative solutions and support of green initiatives. On the other hand, this sectoral allocation might be surprising or, at least, not entirely in line with investors' expectations; for example, climate-focused investors typically prefer portfolios to prioritize sectors directly contributing to specific positive environmental outcomes, such as renewable energy, water management, and the circular economy. Our findings, however, indicate significant exposure to the so-called "magnificent" big tech companies, whose business operations only partially align with the topics of interest.

Similar considerations about investors' awareness of portfolio allocation can be advanced by focusing on the prevailing overweight of financial stocks. Financial institutions typically have lower direct GHG emissions compared to industrial and manufacturing sectors, making them more attractive for sustainable indices that prioritize low-carbon footprints. Moreover, financial institutions frequently integrate ESG criteria into their business models and investment decisions, aligning them with the goals of sustainable indices.

The SRI and Ethical indices present similar results except for the Ex Controversial Weapons index, which is a portfolio based on the exclusion of a limited number of constituents that permits a strong alignment to the parent index.

Focusing on the two religious-based indices, the highest discrepancy both compared to other indices and within their own category, can be justified by different selection criteria. On the one hand, typically, Catholic indices exclude companies involved in activities contrary to Catholic teachings, such as those involved in abortion, contraceptives, and certain biomedical practices. We register a substantial underweight in the healthcare sector. Moreover, they might also emphasize corporate governance and human rights. On the other hand, Islamic indices follow Sharia principles, which include prohibiting investments in companies dealing with alcohol, pork products, conventional financial services (like interest-bearing banks and insurance), gambling, and certain entertainment industries. They also avoid companies with excessive debt or financial leverage, meaning portfolios that tilt towards value stocks. Moreover, as already mentioned, portfolios are concentrated in a few stocks, determining a higher level of specific risk.

Moving to the ESG group of indices, we find the most varied risk-return profiles due to the increasing number of strategies and targets characterizing this field. This discrepancy is visible also if we consider the number of constituents, which varies between 54 for the Sustainable Select 50 index to 611 for the ESG Universal index. Particularly interesting is the profile of the Women's Leadership index, which clearly differs from the others. In this case, the selection is for those companies that exhibit a commitment towards gender diversity among their board of directors and among the leadership positions. From this selection, it appears that the companies that reward women the most are mainly financial companies and those belonging to the materials sector. Furthermore, a strong underweight in large technology stocks also emerges.

6. Robustness checks

To test the robustness of our findings, we resort to a different provider of sustainable indices: Standard and Poor's. The robustness tests replicate the main analyses employing to nine sustainable indices (S&P500 Catholic Values, Shariah Industry, Sustainability Screen, ESG index, ESG leaders index, ESG + Index, Net Zero, 2050 Climate and Net Zero, 2050 Paris Aligned and Paris-aligned sustainability screened index) that cover the same four SI strategies considered in the main analysis and compare them to the parent index S&P500. A thorough description of the indices can be found at Table A2 in the Appendix.

The resulting empirical evidence (available upon request) is qualitatively in line with those presented in the main analysis, confirming an overall homogeneous behavior of the four SI approaches analyzed, regardless of the specific indices' choice. We therefore can claim that our results are not driven by the specific constituents' mix of each index, but by the investment style that characterizes each of the four SI strategies analyzed.

7. Conclusions

The multi-faceted nature of sustainability and the increase in demand for adequate solutions for sustainable investments is stimulating the growth of the sector and the need for differentiating purposes and directions of the different investment solutions on the market. Moreover, alternative investment strategies are available when investors seek to include sustainability in their portfolios, ranging from negative

(ethics- or norm-based exclusions) and positive (i.e., best-in-class, screenings, activism-based, rating-based integration), to maximization of specific scopes (environmental, social and governance).

Motivated by the growth of available SI alternatives, and by the heterogeneous results provided by the extant literature, we analyze and compare the composition, risk-return profiles and performance of the most relevant sustainable indices adopted in the asset management industry. Our analysis bridges the gap in the literature on the ability of sustainable investing alternatives and related indexes to provide consistent outcomes in terms of (risk-adjusted) performance and to provide an actual alternative to traditional investing in terms of composition. To verify how similarities and differences impact their risk-return profiles, we analyze a selection of representative and widely used sustainable indices pertaining to four categories: SRI and ethical, faith-based, ESG and climate investing. We compare them using different, well-established methodologies (i.e., Carhart model and RBSA) to their parent MSCI USA index and highlight deviations in asset allocations, identifying the factors driving excess returns.

Our results show that investing in one of the four SI approaches *per se* does not grant superior or inferior risk-adjusted performance compared to the parent index. Moreover, the empirical evidence highlights persistent common investment patterns across different sustainable indices, namely a tilt towards large and growth firms coupled with a persistent common overweight of financial, information technology and commodity sectors. Finally, to add a further layer of ambiguity to the complex SI panorama, significant differences within the same category of indices have been identified, for instance, the ESG indices show profoundly heterogeneous asset allocation strategies.

The prevalent heterogeneity complicates the association of uniform asset allocation strategies with indices that have similar labels, making it challenging for investors to navigate the sustainable investment sector. Consequently, the current lack of regulation of sustainable investment indices may result in a disconnect between investors' expectations and the actual portfolio composition of these indices.

Our research provides useful insights for investors attracted by SI, as well as fund managers and regulators; it sheds light on the importance of educating investors about the criteria used in constructing SI indices and the role of different industries in advancing sustainability.

Based on the aforementioned results, we recommend a cautious approach when selecting indexes and investment vehicles solely based on benchmarks and labels, since significant deviations from expected results can occur even when using well-established performance metrics. Above all, the specific approach adopted to build an index could lead to a significant reduction in the potential investment universe, resulting in an increase in concentration in specific sectors or firms. This, in turn, could significantly impact risk-adjusted metrics, depending on market phases, leading to over- or under-performance of the market portfolio. Furthermore, our evidence supports the need for a clearer taxonomy and regulatory framework to support an orderly growth of the sector.

Future research may overcome some limitations of the present study. Although this paper does not aim to find the reasons underlying superior or inferior performance in the sustainable investing landscape, larger observation windows could allow identifying what drives long-term results for these innovative investment opportunities, and possibly finding if recurrent differences in investment patterns exist. Moreover, longer time series could help identifying different cause-effect trends of bear or bull markets: for instance, our time window encompasses both the Ukraine-Russia war, as well as the return to a new normality after the pandemic phase and, more importantly, the recent return of significant inflationary trends that may be subject of future research.

This figure presents the framework adopted to compare different typologies of sustainable investing; it also provides the list of indices associated to each approach used in the main analyses (i.e., MSCI indices). For the robustness checks we use the following S&P indices: S&P500 Sustainability Screened, Fidelity Sustainable US Broad Market and DJ Sustainability North America for SRI investing; S&P 500 Catholic Values and S&P 500 Shariah Industry Exclusion for Faith-based investing; S&P 500 ESG Index, S&P 500 ESG Leaders and S&P 500 ESG + for ESG Investing and S&P500 Net Zero 2050 Climate Transition ESG, S&P500 Net Zero 2050ParisAligned ESG and S&P500 Net Zero 2050 Carbon Budget for Climate Investing. Source: authors' elaboration.

This figure plots the dynamics of the MSCI USA TR Index from August 2021 to May 2024, with evidence of "bear" and "bull" market phases as a response to the rise of US interest rates (proxied by the 1-month US interest rate). Source: authors' elaboration of data from Bloomberg Finance LP.

This figure presents the positioning of all MSCI indices (●), distinguishing the four SI categories, and their benchmark (×), in terms of annualized daily returns and standard deviation.

This figure presents the positioning of all MSCI indices (●), distinguishing the four SI categories, in terms of tracking error and tracking error volatility.

This figure presents the comparison, across categories and indices, of Sharpe Ratios, in the form of differences between each index figure and the one expressed by the parent index.

This table presents the comparison between the four SI approaches analyzed, compared to the benchmark (the MSCI USA TR Index) in terms of sectoral allocation, as categorized by the Global Industry Classification Standard - GICS (Communication Services, Consumer Discretionary, Consumer Staples, Energy, Financials, Health Care, Industrials, Information Technology, Materials, Real Estate, Utilities). Figures express the percentage of over- and under-weighting compared to the parent index. In each row, the first horizontal histogram (1) represents SRI and Ethical investing, (2) faith-based investing, (3) ESG investing and (4) Climate investing.

CRediT authorship contribution statement

Enrica Bolognesi: Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Alberto Dreassi:** Writing – review & editing, Writing – original draft, Validation, Conceptualization. **Milena Migliavacca:** Writing – review & editing, Writing – original draft, Validation, Project administration. **Andrea Paltrinieri:** Validation, Supervision.

Declaration of competing interest

The authors did not receive support from any organization for the submitted work.

The authors have no competing interests to declare that are relevant to the content of this article.

Data availability

Data will be made available on request.

Appendix

Table A1
MSCI Indices descriptions. This table presents the descriptions of the indices used in the main analyses. Source: MSCI Index Factsheets.

PARENT INDEX		
	MSCI USA Index	Free-float weighted parent index. Designed to measure the performance of the large and mid-cap segments of the US market. With 627 constituents, the index covers approximately 85% of the free float-adjusted market capitalization in the US.
SRI AND ETHICAL	MSCI KLD 400 Social Index	Designed to provide exposure to companies with high MSCI ESG Ratings while excluding companies whose products may have negative social or environmental impacts. It consists of 400 companies selected from the MSCI USA Index
	MSCI USA SRI Index	Designed to provide exposure to companies with outstanding ESG ratings and excludes companies whose products have negative social or environmental impacts. The Index is designed for investors seeking a diversified Socially Responsible Investing (SRI) benchmark comprised of companies with strong sustainability profiles while avoiding companies incompatible with values screens.
	MSCI USA ex Controversial Weapons Index	Designed to exclude investments in cluster bombs, landmines, depleted uranium, chemical and biological weapons, blinding laser weapons, non-detectable fragments and incendiary weapons.
	MSCI USA Low Carbon SRI Leaders Index	Designed to focus on companies that have low carbon transition risk than that of the broad market and have high ESG performance. The Index excludes companies whose products have negative social or environmental impacts.
RELIGIOUS BASED	MSCI USA Catholic Values Index	Designed to be aligned with the moral and social teachings of the Catholic Church.
	MSCI USA Islamic Index	Designed to exclude non-Sharia-compliant securities through business activity.
SUSTAINABLE	MSCI USA Sustainable Select 50 Index	Designed to represent the performance of a set of 50 stocks from USA that have a large free-float adjusted market capitalization and a robust ESG profile.
ESG	MSCI USA ESG Leaders Index	Designed to focus on companies that have the highest ESG rated performance in each sector of the parent index.
	MSCI USA ESG Focus Index	Designed to target companies with positive ESG characteristics while closely representing the risk and return profile of the underlying market.
	MSCI USA ESG Leaders Select Index	Designed to target companies with positive ESG factors while exhibiting risk and return characteristics similar to those of the MSCI USA Index.
	MSCI USA ESG Universal Index	Designed to reflect the performance of an investment strategy that, by tilting away from free-float market cap weights, seeks to gain exposure to those companies demonstrating both a robust ESG profile as well as a positive trend in improving that profile, using minimal exclusions from the MSCI USA index.
	MSCI USA Women Leadership Index	Designed to represent the performance of companies that exhibit a commitment towards gender diversity among their board of directors and among the leadership positions.
CLIMATE CHANGE	MSCI USA Climate Action Index	Designed to represent the performance of companies that have been assessed to lead their sector peers in terms of their positioning and actions relative to a climate transition, identifing companies that are involved in the following business activities such as Controversial Weapons, Tobacco, Thermal Coal Mining, Oil Sands and Nuclear Weapons.
	MSCI USA Climate Paris Aligned Index	Designed to address climate change in a holistic way by minimizing its exposure to transition & physical climate risks and helping investors pursue new opportunities, while aiming to align with the Paris Agreement requirements of limiting global warming to no more than 1.5 °C.
	MSCI USA Low Carbon Target Index	Designed for investors who wish to manage potential risks associated with the transition to a low carbon economy. By over weighting companies with low carbon emissions (relative to sales) and those with low potential carbon emissions (per dollar of market capitalization) the index reflects a lower carbon exposure than that of the broad market.

Table A2
S&P Indices descriptions. This table presents the descriptions of the indices used in our robustness tests. Source: S&P Index Factsheets.

PARENT INDEX		
	S&P 500 Index	Designed to measure the performance of the large-cap US equities. With 500 constituents, the index covers approximately 80% of the free float-adjusted market capitalization in the US.
RELIGIOUS BASED	S&P 500 Catholic Values Index	Designed to exclude certain activities from S&P500, which are aligned with Responsible Investment Guidelines of the US Conference of Catholic Bishops. The index is designed for investors who do not want to breach religious norms in their passive investing strategies.
	S&P 500 Shariah Industry Exclusions Index	Designed to offer investors a set of indices that are compliant with Islamic canonical law.
SUSTAINABLE	S&P 500 Sustainability Screened Index	Designed to exclude companies involved in controversial weapons, small arms, tobacco, and fossil fuels at specific involvement thresholds.
	Fidelity Sustainable U.S. Broad Market Index	Designed to reflect the performance of stocks of large and mid-capitalization U.S. companies with favorable environmental, social, and governance practices.
	Dow Jones Sustainability North America Index	Designed to comprise North American sustainability leaders as identified by S&P Global through the Corporate Sustainability Assessment (CSA). It represents the top 20% of the largest 600 North American companies in the S&P Global BMI based on long-term economic, environmental and social criteria.
ESG	S&P 500 ESG Index	Designed to measure the performance of securities meeting sustainability criteria, while maintaining similar overall industry group weights as the S&P 500.
	S&P 500 ESG Leaders Index	Designed to measure the performance of securities with stronger than average ESG characteristics while excluding controversial business activities with negative social or environmental impacts.
	S&P 500 ESG + Index	Designed to measure the performance of securities meeting sustainability criteria, while maintaining similar overall industry group weights as the S&P 500.
CLIMATE CHANGE	S&P 500 Net Zero 2050 Climate Transition ESG Index	Designed to measure the performance of eligible equity securities from the S&P 500, selected and weighted to be collectively compatible with a 1.5 °C global warming climate scenario at the index level.
	S&P 500 Net Zero 2050 Paris-Aligned ESG Index	Designed to measure the performance of eligible equity securities from the S&P 500, selected and weighted to be collectively compatible with a 1.5 °C global warming climate scenario at the index level.
	S&P 500 Net Zero 2050 Carbon Budget Index	Designed to measure the performance of equity securities from the S&P 500, selected and weighted to target a defined carbon budget from each index's launch year to 2050, compatible with the Intergovernmental Panel on Climate Change (IPCC) estimate for worldwide emissions to limit global warming from pre-industrial levels to 1.5 °C.

Table A3
Financial Indicators definitions. This table summarizes the definitions and abbreviations of the financial indicators used in our analysis.

Financial Indicator	Abbreviation	Definition
Yearly Average return	Av. Return (annual)	Mathematical average of a stock's returns accumulated over on year
Market return	Rmkt	Return on the market portfolio of a specific sector of the economy
Risk-free return	Rf	Theoretical return on an investment that carries no risk. As a proxy, we use the 1-month USD Libor rate.
Sharpe ratio	SR	Measure of the excess return, compared to the risk-free rate, in relation to the volatility of a risky asset.
Tracking error	TE	Measure of the average excess return of a risky asset, compared the benchmark
Tracking error volatility	TEV	Volatility of the excess return of a risky asset compared to the benchmark
Information Ratio	IR	Measure of the excess return, compared to the benchmark, in relation to the volatility of the tracking error of a risky asset.
Jensen's Alpha	Alpha	Abnormal return of an asset over the theoretical expected return
Beta	Beta	Measure of the systematic risk of an asset, compared to the market

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