ORIGINAL ARTICLE

Comparing SRI funds to conventional funds using a PCA methodology

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Abstract

In this paper, we investigate characteristic differences between Socially Responsible Investment (SRI) funds and conventional funds across 35 different categories, including previously unexplored areas, such as fund manager skills and investment strategies. Further, we examine SRI and conventional funds globally rather than from just one country (e.g., US) or one region (e.g., Europe), covering funds listed in 22 different countries. We also adopt a new Principal Component Analysis (PCA) methodology for matching SRI funds against their conventional counterparts that significantly increases the sample size from previous studies, reducing selection bias and possibly explaining contradictory findings in the prior literature. Contributing to the literature, our findings show that: (i) SRI funds have more diversified portfolios than conventional funds; (ii) SRI funds have lower cash holdings while investing more in US equities; and (iii) SRI fund managers charge a smaller fee and are more successful in managing their portfolios. This is reassuring for investors who invest in SRI funds and for the future health and sustainability of the planet.

Introduction

The mutual fund industry manages our money and investments and there is a call for the industry to do so responsibly. Growing public concern over the environment, climate change and global warming, sustainable development, workers' rights, modern slavery, and child labor has driven the growth of the socially responsible investment (SRI) industry incorporating Environmental, Social, and Governance (ESG) factors in investment decisions (Leins 2020). A wide body of literature has compared SRI funds with conventional funds at the fund level and investee company level as well as across different investment styles.

This paper has two contributions to the literature. First, unlike prior studies, most of which focus on the factors of fund performance, we investigate characteristic differences between global SRI and conventional funds across 35 different categories. These include previously unexplored areas in terms of management (e.g., management's success and experience) and investment strategies (e.g., investment style

and sector selection). While the majority of studies employ the data of US or European funds, our investigation includes funds listed in 22 countries across 5 regions: North America, Europe, Asia, Middle East, and Africa.

Second, we focus heavily in the paper on introducing a new methodology to obtain a matched sample of funds that enables the use of a dramatically increased number of matching criteria compared to prior studies, reducing any bias in the sample selection while retaining a large sample of funds. We use our large, matched sample to examine inconsistencies in the prior literature as well as the additional fund management characteristics noted above to help asset managers in their investment decisions in future.

The most commonly used fund characteristics for matching one type of fund against another are fund size (Gil-Bazo et al. 2010), fund age (Gil-Bazo et al. 2010; Humphrey and Lee 2011), management fees (Kempf and Osthoff 2008), total expense ratio, turnover ratio, and performance. Some papers also use qualitative criteria such as fund objectives (Gil-Bazo et al. 2010), currency, or the fund's domicile.

From the large sample of our study, we find that our new matching procedure is robust, and we spend time detailing the procedure to assist future studies in helping asset managers in their investment decision-making. We examine a

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comprehensive list of characteristic variables for both SRI funds and conventional funds, encompassing fund performance, age of funds, fund size, managerial ability, investment style, and sectoral bias.

In contrast to the expectations, our results show that SRI fund performance is comparable to conventional fund performance, but the measure of performance is important. Further, our global dataset shows that SRI fund managers are better stock pickers based on the success ratios for the two types of funds.[1] As a contribution to the literature, we provide the first evidence that SRI funds tend to have, on average, a shorter management tenure period but higher success ratios than those for conventional funds. The results also indicate that SRI funds have relatively more diversified investment strategies than their conventional counterparts despite investing in accordance with their funds' socially responsible objectives. This may be because they have lower cash holdings than conventional funds that are invested elsewhere, smaller investment allocations to the top 10 holdings, and greater dispersion in the sectors of investee companies.[2]

The paper is now organized as follows. Section "Literature review" covers the literature on the difference between SRI funds and conventional funds, from which we develop hypotheses for our investigation. In addition, we explore fund characteristics that can be used to match SRI funds with conventional funds. Section "Method and methodology" outlines the procedures that were undertaken in this study. Section "Results" introduces the new matching procedure, compares SRI and conventional fund characteristics, especially their fund management and investment style, and shows that our results are robust. Section "SRI funds versus conventional funds" answers our research hypotheses and section "Conclusion" concludes.

Literature review

SRI fund characteristics

The substantive literature examines SRI funds against conventional funds, but the findings are mixed with reports of significant differences between them (Luther and Matatko 1994; Bauer et al. 2006; Gregory and Whittaker 2007) or no differences between them (Bello 2005). Indeed, Markowitz et al. (2012) document that SRI fund managers try to align

their practices with those of conventional fund managers to show that their SRI funds are similar.

Capelle-Blancard and Monjon (2012) report on more than 50 academic papers on SRI fund performance between 1992 and 2011 across 20 countries. They find that, in the earlier studies, the financial performance of SRI funds did not differ significantly from conventional funds or a benchmark index (see also Statman 2000; Bauer et al. 2004; Bello 2005; Brzeszczyński and McIntosh 2014). Notably, Statman (2000) argues that SRI funds should have the same performance as traditional funds as their socially responsible mandate has no value and their price is determined only by their risk profile. However, the later literature reports the over-performance and under-performance of SRI funds. Statman (2000) argues that, instead of performing the same as conventional funds, SRI fund returns might be higher if a significant number of investors underestimate the benefits derived from being socially responsible and overestimate the corresponding costs. Confirming this assumption, Brzeszczyński and McIntosh (2014) show that UK SRI portfolios achieve substantially higher total returns than a benchmark buy-and-hold strategy over 2000–2010, even after transaction costs. Nofsinger and Varma (2014) also find that SRI funds significantly outperform conventional ones, especially during crises.

Contrary to these findings, Girard et al. (2007) and Adler and Kritzman (2008) document that SRI funds underperform conventional portfolios. Renneboog et al. (2008) note that SRI investors are willing to accept suboptimal financial performance to pursue social or ethical objectives. However, fund performance can be affected by many factors; for example, US equity funds are positively affected by board independence (Ding and Wermers 2005), but performance decreases when highly paid independent directors sit on the boards of mutual funds (Tufano and Sevick 1997). Benson et al. (2011) report that pension funds' returns improve with trustee board size and regular reviews of conflicts of interests.

Hypotheses development

We empirically test five hypotheses because the results of past empirical studies are contradictory and, as Rathner (2013) highlights, the matching procedures that have been used might influence these conflicting findings. Our first hypothesis is:

H1 SRI funds underperform conventional funds.

Our first hypothesis is that SRI funds are more likely to underperform their conventional counterparts as most of the previous literature documents. In prior studies, performance measures also vary and, to address this issue, we use seven

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[1] Unfortunately, our data does not have any information on the timing of portfolio purchases and sales, so we cannot test this. This would be a useful avenue for future research.

[2] The data for this study was not disaggregated further in this paper, but future studies may analyse the investment holdings of individual funds and compare the top asset holdings to see how they differ.

different performance measures: the Beta, the Jensen alpha, the Sharpe, Treynor and Sortino ratios, the total return, and the return on invested capital. Using seven different measures, we examine whether the measure of performance that is used impacts the results across our large sample and whether they all consistently show that SRI funds underperform against conventional ones.

Our second hypothesis relates to the size and age of funds:

H2 SRI funds are smaller and younger than conventional funds.

SRI funds may underperform their conventional peers because they are smaller and younger (Gil-Bazo et al. 2010; Nofsinger and Varma 2014). Kreander et al. (2005) document the necessity of controlling for fund age and size when evaluating fund performance. As suggested by these prior studies, we use our global sample of matched funds to test whether SRI funds are smaller and younger than conventional funds.

Our third hypothesis examines fund manager characteristics that is:

H3 Fund manager characteristics of SRI funds, such as managerial ability, are worse than those of conventional funds.

Fund managers play a significant role in their funds impacting fund performance (Muñoz et al. 2014). The success of the fund's branding company, the remuneration scheme or the management fees that are charged may influence fund performance (Brown and Wu 2016; Wermers 2000). Statman (2000) also notes that SRI funds suffer from higher fees from analyzing data across both financial and socially responsible parameters. However, to the authors' knowledge, many features of fund managers have not yet been explored in the literature. In particular, we examine, for the first time, the difference in management characteristics of SRI and conventional funds in terms of the average fund managers' tenure, manager retention over 1 and 5 years, and the success of the fund manager over three different periods: long term (10 years), medium term (5 years), and short term (3 years).

The fourth hypothesis that we test relates to diversification strategies as follows:

H4 SRI funds have less diversified investment strategies than conventional funds (i.e., higher percentages of investments in US equities and in top 10 holdings, a larger amount of uninvested cash holdings, a lower degree of size dispersion, and less dispersion of investment strategies).

The investment strategies between SRI and conventional funds may be different. For example, SRI funds have greater exposure to smaller companies (Luther and Matatko 1994; Bauer et al. 2006; Gregory and Whittaker 2007). Indeed, Schröder (2004) shows that very few SRI funds focus on large-capitalization stocks and, of these, they are concentrated in the US. In Australia, Humphrey and Lee (2011) document that positive screens bias SRI funds to the selection of larger investee firm stocks, while negative screens result in the selection of smaller firm stocks. According to Hoepner et al. (2011), Islamic funds are especially oriented to small-capitalization stocks as well as growth stocks. Some studies show that SRI funds are more growth-oriented (Gregory and Whittaker 2007; Cortez et al. 2012), but others find they are more value-oriented (Bauer et al. 2006). The investment styles of SRI and conventional funds vary geographically across investee companies (Leite and Cortez 2014). However, a number of characteristics regarding strategy have not yet been examined in the literature. These include: (i) The concentration of funds' investments represented by the percentage of investments in US equities; (ii) The percentage of investments in the top 10 holdings; (iii) Cash holdings; (iv) The degree of size dispersion across all the investee companies of a fund; and (v) The dispersion of investment strategies employed by a fund. Our paper aims to fill this gap in the literature by testing for differences in these five aspects of investment strategies between SRI and conventional funds. The literature reports that SRI funds have greater exposure to particular sizes of firms depending on their screening type. Finally, we examine our fifth hypothesis that examines the sectoral bias of funds as follows:

H5 SRI funds invest in different sectors from conventional funds.

SRI funds often use negative screening that reduces diversification benefits as entire business sectors are excluded from portfolios. Muñoz et al. (2014) evidence that SRI funds have a narrower investment universe and Ooi and Laibcygier (2013) show that fully diversified portfolios are not possible for SRI funds and industry classifications explain portfolio returns. Benson et al. (2006) employ the data of US retail equity funds to show that SRI funds differ from conventional funds in investments across industries. Statman (2000) provides evidence that SRI fund returns suffer from a lack of sub-diversification. Unlike Benson et al. (2006), we examine the investment allocation of global SRI and conventional funds across 11 sectors. We propose that if SRI funds follow their fund objectives, it is likely that the sectors in which they choose to invest are different from the sectors the majority of conventional funds invest in; SRI funds will have greater exposure to sustainability-related sectors.

Matching procedure

To explore these five hypotheses, we use a procedure that selects a large sample of funds that is rigorous and replicable and controls for any factors that could discredit the findings. In earlier studies, only a few matching criteria were employed, although the number of factors has increased more recently. The selection is carried out through an iterative process that reduces the sample size at each iteration. To address this problem, in 1983, Rosenbaum and Rubin developed a multi-dimensional matching method to a one-dimensional measure in their Propensity Score Matching (PSM) approach (see Rosenbaum and Rubin 1983, 1985), allowing several criteria to be matched simultaneously. PSM is composed of two steps to investigate two different groups of subjects (Heckman et al. 1997). First, the probability of characteristics of interest are modelled and, second, the closeness of the estimated probabilities is used in selecting the sample. Rubin and Thomas (1992) show that a PSM approach solves selection bias problems and has been used from pharmaco-epidemiologic research (Perkins et al. 2000) to finance, corporate governance, and business (Ahn and Walker, 2007; Shen and Chang 2009).

In fund management research, Cooper et al. (2005) match funds using fund size (proxied by total net assets), management fees, and performance. Kempf and Osthoff (2008) match US SRI funds against conventional funds using: fund size; fund age; expense ratio; total load; and turnover ratio. Similar criteria are also employed by Agarwal et al. (2015) (except for total load). Cici et al. (2010) match US equity mutual funds using fund size and investment objective. SRI funds are often matched with conventional funds based on fund size and age (e.g., Nofsinger and Varma 2014), as well as investment objectives (e.g., Gil-Bazo et al. 2010). Humphrey and Lee (2011) match Australian SRI funds and conventional funds on the basis of fund size, fund age and Morningstar fund style. Unlike prior studies, we introduce a new PSM approach on a sample of SRI funds to obtain propensity scores from 35 variables to match against a sample of conventional funds. We now document our research method and the PSM results, followed by our testing of the five research hypotheses.

Method and methodology

This paper provides insights into SRI fund management using a matching procedure that reduces selection bias, the time spent on matching funds, and the loss of sample funds. One criticism of the extant matching process is that each characteristic is sequenced in staged order one at a time, reducing sample sizes. The number of criteria that are used is limited as matching processes are time-consuming.

Selecting just a few criteria, although easier, leads to selection bias, and past studies have often ignored important factors such as investment styles. Further, different variables can reflect the same criteria requiring a choice over which one to use, and the selection of an inappropriate one can also result in selection bias, improper fund exclusion, or a small, matched sample.

While earlier studies employed only a few quantitative or ordinal criteria to match funds, more recent studies combine a larger set of fund characteristics using PSM (e.g., Cooper et al. 2005; Kempf and Osthoff 2008). These papers use regression techniques to assign a value to each fund and match the estimated values from the regressions allowing more than one factor to be considered at a time. However, the loss of degrees of freedom or the correlation between variables causes difficulty selecting the regression variables. The PSM approach reduces the problem of choosing just a few arbitrarily selected criteria, but there are still methodological issues in selecting the proxies for each criterion. We contribute to the literature by introducing a rigorous matching procedure incorporating a large set of variables, applied simultaneously to overcome sequencing decisions and the time needed to match thousands of funds together. Using factor analysis on a broad set of fund characteristics, we generate a composite index of SRI funds to be matched against conventional funds. We then test how well-matched the resultant samples are in practice. The PSM method involves three stages: sampling; identifying the matching criteria; and constructing the index as outlined in the following sub-sections.

Sampling

Figure 1 outlines the research method process. We use the Morningstar database, with around 150,000 funds, with the earliest fund's inception date going back to 1924. We first select a sample of SRI funds with a fund name containing keywords such as "responsible", "sustainable", "ecological", "environment", "green", "social", "Catholic", and "Islamic" resulting in 544 SRI funds.[3] Second, we use Morningstar to select all conventional funds located in countries with at least one SRI fund. Third, we remove all funds with extreme values such as percentages greater than 100% and funds with missing data on criteria such as management, fund allocations, and performance. This reduces the number of funds in the sample from around 150,000 to 34,504 funds. Among these, some funds have the same Fund ID; some are in the same currencies but are different in fund size or performance data. We screen our sample of multiple funds with the same Fund ID by choosing each currency and, where there are

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[3] A full list of keywords is available upon request from the authors.

Sampling		Screening out		Factor analysis and Index construction		Finding matched funds	

- •Extracting data from Morningstar Direct.
- •Selecting 7 criteria: performance, management, investment strategy, investing sector, size, age, and growth.
- •Selecting variables for each criteria.

- •The conventional funds located in countries that do not have SRI funds are excluded from the list.
- •Among funds with the same fund code of which values are quoted in the same currency, only the largest and oldest funds with more complete data are selected.
- •Funds with missing data on size are removed from the sample

- •Applying principal component analysis to extract principal factors for each of the four sets of variables.
- •Constructing 4 representative indexes for performance, management, investment strategy, and investing sector.
- •Introducing a composite index representing all 7 criteria/aspects of funds.

- •Ordering the composite index scores.
- •Applying 3 different approaches: identifying funds with: (1) 5 conventional funds above and below each SRI fund; (2) +/- 0.025 of the score of each SRI fund; (3) the mix of the first two approaches (choosing 5 funds above and below with +/-0.025 of the score of each SRI fund). In all 3 approaches, the conventional funds with the same score are selected.
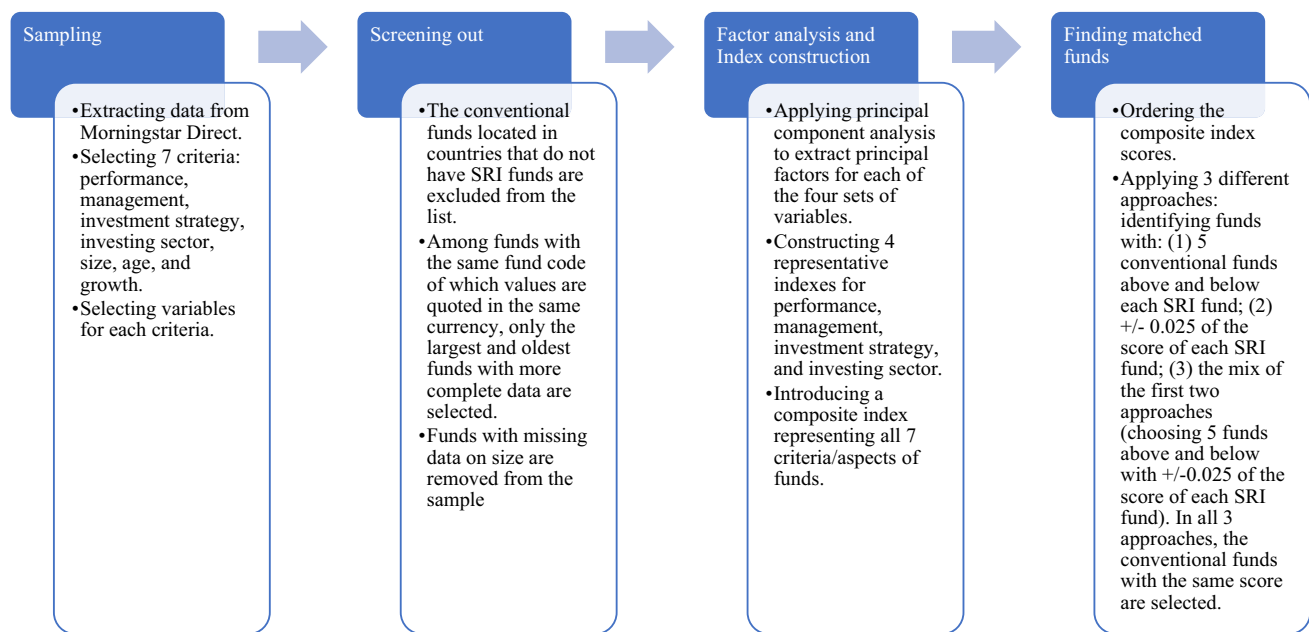
Fig. 1 The research design process

several funds with the same currency, we select the largest, oldest funds with the most complete data. This screening reduces our sample size to 10,270 funds. Among these funds, the oldest SRI fund has an inception date going back to 1972, while the oldest conventional fund has an inception date going back to 1958.

Matching criteria

We calculate the propensity matching scores across seven criteria from a large, comprehensive set of 35 variables: (i) *Performance* (seven variables); (ii) *Management* (seven variables); (iii) *Investment strategy* (seven variables); (iv) *sector* (11 variables); (v) *Size* (one variable); (vi) *Age* (one variable), and (vii) *Price to book ratio (P/B)* (one variable). For fund *performance*, the seven measures reflect both returns and risk: the return on invested capital (ROIC); the total return over a period; the Jensen alpha; the Sharpe ratio; the Treynor ratio; the Sortino ratio; and the Beta. The *management* criterion is also based on seven variables: management fees; the tenure of fund managers; the retention of fund managers over 1 and 5 years; and the success ratio over 3, 5, and 10 years. *Investment strategy* variables are: the cash holdings (of funds); the percentage of US equity investments; the percentage of investment in the top 10 holdings; a growth-focused investment style; a value-focused investment style; the dispersion of investment in different investee firm sizes; and different investment styles. The fourth criterion, *sector*, is the spread over 11 sectors using the percentages of investment of each fund in finance, technology, basic materials,

communication, consumer cyclical, consumer defensive, energy, healthcare, industrials, real estate, and utilities. Our fifth, sixth and seventh criteria are single variables popular in the literature: fund *size*; fund *age*; and *price to book ratio*. A PSM index is constructed from these seven criteria and 35 variables as outlined next.[4]

Index construction

In order to find a representative factor for each criterion, we employ a nonparametric method, so-called Principal Component Analysis (PCA), to reduce the dimensional space of data, collapsing the dataset into a smaller number of uncorrelated factors (Jolliffe 2002; Shlens 2009). Two main advantages of this factor analysis method are that: (i) It analyses the co-movement of variables (see, for example, Abhakorn and Tantisantiwong 2012); and (ii) Provides loadings that can be used to construct principal factors representing the movement of variables considered (see, for example, Alomari et al. 2018). To avoid the overloading or underloading problem due to different units and sizes of variables, we first transform the variables to be unitless by standardizing the data.

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[4] Although Morningstar includes some data on actively and passively managed funds, the information was only available on less than a quarter of all the funds, so we were not able to include this important characteristic as a variable. However, of the funds with data, around two-thirds of the SRI funds and two-thirds of conventional funds were actively managed and one-third passively managed.

After the values of variables have been standardized, we extract principal components (PCs) for the four criterion sets of variables using the PCA. The score for each criterion is calculated using the loadings of the variables in the set. Even though, according to Kaiser (1960), components with eigenvalues being greater than one should be retained, a strict interpretation of Kaiser's criterion may result in the discarding of small but important PCs. Therefore, the Kaiser criterion was relaxed slightly in this paper to retain some of those components with a latent root slightly below one. We follow Fifield et al. (2002) and Alomari et al. (2018) by constructing each PC using the loadings of all variables. This approach will permit each variable, even those with small weights, to add to the explanatory ability of the PC. For each matching criterion, at least 70% of the variation in variables can be explained by the PCs.

In particular, for each of the first four criteria, we apply the PCA to the set of variables and use the loadings of the variables obtained from the PCA to calculate the value of each PC k for the criterion. For example, considering the vector of variables for the criterion i (denoted as X_i), PC_{ik} for fund j is the sum of the products between the kth principal's loading for each variable x_i in the vector X_i denoted as $loading_k(x_i)$ and the jth fund's values of the variable x_i in X_i (x_{ij}). For fund j:

$$PC_{ik}^j = \sum_{x_i \in X_i} loading_k(x_i)x_{ij} \tag{1}$$

for each k and $i=1, 2, 3, 4$.

Next, the weighted average component is then used to calculate the score for each criterion (Y). For instance, for the criterion i, the score for fund j (Y_{ij}) is the sum of the products between the proportion of variation explained by PC_{ik} and the jth fund's value of PC_{ik} (PC_{ik}^j)

$$Y_{ij} = \sum_{k \text{ for } X_i} proportion_k(PC_{ik})PC_{ik}^j \tag{2}$$

for $i=1, 2, 3, 4$.

After the PCA for the first four criteria with several variables each, another PCA is then applied to the scores of the first four criteria and the values of the three additional single variable criteria (fund size, fund age, and P/B ratio), giving seven criteria. A final set of principal factors is extracted; we calculate the propensity matching score using the principal proportions as weights of principal factors. For each fund, we use the loadings of the variables obtained from the final PCA to calculate the value of each principal component m—that is, PC_{mj} is the sum of the products between the loading of criterion i ($loading_m(Y_i)$) and the jth fund's score of criterion i (Y_{ij}). The propensity score for each fund j (Z_j) is the sum of the products between the proportion of variation explained by PC_m and the value of PC_m for fund j.

Table 1 Principal component analysis for performance indicators

Principal component	PC 1	PC 2	PC 3
Eigenvalues	3.3904	1.0655	0.9987
Proportion	0.4843	0.1522	0.1427
Cumulative Proportion	0.4843	0.6366	0.7792
Loadings			
ROIC	−0.0209	−0.2144	**0.9733**
Jensen alpha	**0.4305**	−0.1584	−0.0089
Beta	−0.0694	**0.9170**	0.2108
Sharpe ratio	**0.4992**	0.1158	0.0493
Sortino ratio	**0.4095**	0.1052	−0.0398
Treynor ratio	**0.3916**	−0.1675	−0.0023
Total return	**0.4890**	0.1883	0.0641

This table shows the PCA for the seven variables used for performance. Loadings where the absolute value is greater than 0.4 are emboldened

$$PC_{mj} = \sum_i loading_m(Y_i)Y_{ij} \tag{3}$$

for each m

$$Z_j = \sum_m proportion_m(PC_m)PC_{mj} \tag{4}$$

for each fund j.

Overall, we improve on previous PSM approaches by simultaneously considering more than one proxy for a criterion and more than one characteristic of the fund samples using the PCA.

We then examine whether SRI and conventional funds are characterized differently regarding our five hypotheses outlined above on our matched sample using the propensity score Z_j procedure above. We carry out both a parametric test (T-test) on the mean difference and as a robustness check, a nonparametric Rank test is conducted on the median difference. Our results are reported in the next section.

Results

PCA matching procedure and construction of propensity matching index

Table 1 reports the PCA results applied to the first set of variables to extract the main factors of fund performance. The loadings present in Table 1 are used to compute the score for our performance criteria with three factors with eigenvalues of one or above, explaining 77.92% of the variation of sample performance. According to reported loadings, we note PC1 as risk-adjusted performance, PC2 as fund's sensitivity to systemic risk (Beta) and PC3 as the fund

Table 2 Principal component analysis for management indicators

Principal component	PC 1	PC 2	PC 3
Eigenvalues	2.4029	1.8511	0.9321
Proportion	0.3433	0.2644	0.1332
Cumulative Proportion	0.3433	0.6077	0.7409
Loadings			
Management fee	−0.2156	0.0009	**0.9760**
Branding Company: Average Manager Tenure (Longest)	−0.2071	**0.4783**	−0.0356
Branding Company: Manager Retention 1 Year	−0.1484	**0.5597**	−0.0486
Branding Company: Manager Retention 5 Year	−0.1192	**0.6181**	−0.0221
Branding Company: Success Ratio 10 Year	**0.5009**	0.1552	0.0979
Branding Company: Success Ratio 3 Year	**0.5395**	0.1751	0.1403
Branding Company: Success Ratio 5 Year	**0.5766**	0.1453	0.1188

This table shows the PCA for the seven variables used for management. Loadings where the absolute value is greater than 0.4 are emboldened.

ROIC. The risk-adjusted performance accounts for 48.43%, while the other two factors account for 15.22% and 14.27%, respectively.

Table 2 reports the eigenvalues and proportions of PCs and loadings for each variable for the funds' management characteristics with three factors explaining 74.09% of the variation. We labelled PC1 as the management company's success (34.33% of the variation), PC2 as the continuity of fund management (26.44%), and PC3 as management fees (13.32% of the variation).

Tables 3 and 4 report the eigenvalues and proportions of PCs for investment strategy and sector criteria. Investment strategy had four components labelled value-focused, dispersion and outside the US, dispersion and in the US, and lack of investment opportunity. These four PCs explain 79.95% of the funds' investment strategies variation.

The eigenvalues in Table 4 suggest that six factors should be retained; these six factors represent overweight in a sector or underweight in a sector. PC1 has a high positive loading for investment in the energy sector and a high negative loading for investment in the technology sector, so we call this PC as "Energy investment with underweighting in technology". Similarly, for PC2, we label it "Finance with underweighting in healthcare"; PC3 is named "Industrials and utilities"; PC4 is "Consumer defensive with underweighting in technology"; PC5 is "Healthcare investment with underweighting in basic materials," and PC6 is "Communication with underweighting in real estate and healthcare". These six PCs explain 71.17% of the variation in fund investment across sectors, of which more than half can be explained by the first three PCs.

For each fund j, we compute the scores for each of the four criteria using loadings reported in Tables 1, 2, 3, 4 (i.e., Y_{1j} for performance, Y_{2j} for management, Y_{3j} for investment strategy, Y_{4j} for investing sector). Next, we apply PCA to all seven criteria: performance; management; investment

Table 3 Principal component analysis for investment strategy indicators

Principal component	PC 1	PC 2	PC 3	PC 4
Eigenvalues	1.9539	1.5433	1.1283	0.9709
Proportion	0.2791	0.2205	0.1612	0.1387
Cumulative Proportion	0.2791	0.4996	0.6608	0.7995
Loadings				
Cash holdings	0.0217	0.1769	**−0.3995**	**0.8715**
% investment on US equity	−0.1216	**−0.4588**	**0.4616**	0.1371
% in Top 10 holdings	−0.0972	**0.4706**	**−0.4111**	**−0.4266**
Size dispersion	0.1933	**0.5405**	**0.3941**	0.0237
Style dispersion	0.2804	**0.4210**	**0.5056**	0.1626
Growth-focused	**−0.6602**	0.1473	0.1926	0.0373
Value-focused	**0.6507**	−0.2138	−0.1014	−0.1063

This table shows the PCA for the seven variables used for investment strategy. Loadings where the absolute value is greater than 0.4 are emboldened

strategy; investing sector; fund size (Y_5); fund age (Y_6); and P/B ratio (Y_7). Table 5 reports the result of the final PCA, which is used to construct our propensity matching index. The eigenvalues suggest that four PCs should be retained, explaining 73.57% of the variations in the seven fund criteria across sample funds. According to loadings for each PC, we name PC1 as "Performance and investment concentration", PC2 as "Fund reputation", PC3 as "Fund management relative to its experience", and PC4 as "Management ability relative to fund size".[5] These results are then used to calculate the

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[5] For PC1, fund performance and P/B ratio have positive loadings, while investment strategy has a negative loading. For PC2, fund size, age, and management all have positive loadings. For PC3, management and investment sector have a positive loading but fund age has a negative loading. For PC4, fund size has a positive loading but management has a negative loading.

Table 4 Principal component analysis for investing sectors indicators

Principal component	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6
Eigenvalues	1.7468	1.4162	1.3262	1.2069	1.1527	0.9802
Proportion	0.1588	0.1287	0.1206	0.1097	0.1048	0.0891
Cumulative proportion	0.1588	0.2875	0.4081	0.5178	0.6226	0.7117
Loadings						
Basic materials	0.3158	−0.2175	−0.1214	−0.1231	**−0.6525**	−0.0677
Communication services	0.2767	0.2240	−0.0306	0.1572	0.3143	**0.4932**
Consumer cyclical	−0.3735	0.3998	0.1509	0.0565	−0.2838	−0.0080
Consumer defensive	−0.0133	0.2837	−0.1973	**0.6497**	−0.2205	0.1686
Energy	**0.4760**	−0.1552	−0.2101	−0.2355	−0.0057	0.0217
Finance	0.1678	**0.5577**	−0.2085	−0.1492	0.2125	−0.2556
Healthcare	−0.2151	**−0.4353**	−0.2411	0.3646	**0.4002**	**−0.4273**
Industrials	−0.0599	−0.1266	**0.6775**	0.1614	−0.1525	−0.0821
Real estate	0.1734	0.3085	0.3380	−0.1924	0.1577	**−0.4955**
Technology	**−0.5009**	−0.0643	−0.0497	**−0.4998**	0.1214	0.3710
Utilities	0.3137	−0.1491	**0.4485**	0.1064	0.2794	0.2923

This table shows the PCA for the 11 variables used for sectors. Loadings where the absolute value is greater than 0.4 are emboldened

propensity matching score for each fund using the formula in the previous section.

Identifying matched mutual funds

The SRI funds were matched against the conventional mutual funds to create a sample of funds for our investigation by first, computing the propensity matching score for each of the 10,270 funds using Equation (4) and ranking the scores, and second, matching the SRI funds with conventional funds using three matching procedures (see Figure 1). A decision was made to match the 544 SRI funds to 5440 conventional funds reflecting a 10: 1 ratio. The index scores were sorted into rank order, but some SRI funds had index scores very close to each other, so on matching, there was an overlap of one conventional fund being matched against two or more SRI funds. We applied three matching approaches detailed below.

First, we selected five funds with an index score above and five funds below the index score of the SRI fund and included all conventional funds with the same score as the 5th fund. This resulted in 3932 conventional funds and 544 SRI funds, giving a ratio of 7.23:1 rather than 10:1. To address this problem, we then selected funds with an index score +/− 0.025 of the index score of SRI funds that increased the number of conventional funds to 8412.[6] The matching ratio was, therefore, above 10:1 and some SRI funds were matched with up to 60 conventional funds depending upon the clustering of scores. A third method was

Table 5 Principal component analysis for all seven criteria

Principal component	PC 1	PC 2	PC 3	PC 4
Eigenvalues	2.0577	1.1266	1.0429	0.9227
Proportion	0.2940	0.1609	0.1490	0.1318
Cumulative proportion	0.2940	0.4549	0.6039	0.7357
Loadings				
Performance	**0.5570**	0.1332	−0.0903	−0.2004
Management	0.0388	**0.5451**	**0.5189**	**−0.5847**
Investment strategy	**−0.4368**	0.2473	−0.2808	−0.3220
Investing sectors	−0.3997	−0.0925	**0.4184**	0.2589
Fund size	0.0512	**0.6002**	0.2613	**0.6424**
Fund age	0.0270	**0.4911**	**−0.6182**	0.1542
P/B ratio	**0.5782**	−0.1181	0.1350	0.1039

This table shows the PCA for all the seven variables used for the PSM. Loadings where the absolute value is greater than 0.4 are emboldened

a mix of the first two approaches by selecting conventional funds within +/− 0.025 of the index score of an SRI fund, but only selecting up to five funds above or below the score.[7] This approach resulted in 3,880 conventional funds matched against the 544 SRI funds, a total of 4424 altogether.[8]

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[6] No conventional fund was matched against the last SRI fund.

[7] Another selection issue arose where many conventional funds had the same score. If the 5th (+5) conventional funds had the same index score as four other funds (+6, +7, +8, and +9), all nine funds were selected to avoid selection bias.

[8] We did not compare the results of the three matching approaches as the other two were inferior - either almost the whole population was

Table 6 Descriptive Statistics – SRI Funds

	Mean	Median	SD	Skew	Kurt	Min	Max
Performance	−0.18	−0.27	0.92	1.28	7.67	−3.54	6.57
ROIC	12.33	12.46	5.27	0.32	10.72	−10.73	44.61
Jensen alpha	−0.40	−0.62	5.28	1.16	4.69	−14.62	27.65
Beta	0.90	0.93	0.19	−0.47	5.17	−0.09	2.10
Sharpe ratio	0.75	0.68	0.67	1.61	10.44	−1.97	5.49
Sortino ratio	1.55	1.13	3.41	16.66	337.27	−1.82	71.83
Treynor ratio	8.19	6.77	10.75	2.68	25.38	−58.12	115.59
Total return	7.44	6.80	6.71	0.30	4.63	−35.52	38.36
Management	0.19	0.13	1.04	−0.03	0.38	−3.65	3.44
Management fee	0.93	0.80	0.56	0.54	−0.14	0.00	2.99
Average manager tenure (longest)	7.35	7.17	2.51	3.29	31.92	0.65	35.74
Manager retention 1Y	0.94	0.96	0.06	−2.55	11.91	0.45	1.00
Manager retention 5Y	0.93	0.93	0.04	−1.02	2.29	0.74	1.00
Success ratio 10Y	0.55	0.54	0.23	0.05	−0.24	0.00	1.00
Success ratio 3Y	0.51	0.51	0.15	−0.48	1.36	0.00	1.00
Success ratio 5Y	0.55	0.53	0.18	−0.05	0.29	0.00	1.00
Investment strategy	0.08	0.13	0.59	−0.41	−0.10	−1.50	2.09
Cash holdings	3.98	2.27	7.44	6.93	63.72	0.00	89.70
% invest on US equity	38.72	43.08	33.85	0.24	−1.25	0.00	99.61
% in Top 10 holdings	30.72	29.92	12.08	0.63	0.92	4.78	76.79
Size dispersion	1.41	1.00	0.54	−0.10	−1.06	0	2
Style dispersion	1.72	2.00	0.45	−0.99	−1.02	1	2
Growth-focused	34.87	33.97	15.63	0.49	0.17	0.00	85.70
Value-focused	26.61	25.80	13.79	0.37	−0.28	0.92	73.65
Sector Allocations	0.08	0.03	0.35	0.84	1.59	−0.72	1.69
Finance	13.59	16.61	9.59	−0.21	−1.10	0.00	38.55
Technology	17.07	17.06	10.98	0.83	1.45	0.00	60.85
Basic materials	7.23	6.39	6.37	2.65	11.18	0.00	44.86
Communication services	2.38	1.80	2.65	1.21	1.29	0.00	11.77
Consumer cyclical	10.06	10.33	6.05	1.22	5.73	0.00	48.40
Consumer defensive	7.15	6.36	6.63	2.14	7.04	0.00	46.31
Energy	4.39	2.29	8.65	7.88	80.91	0.00	99.55
Healthcare	14.54	10.45	20.89	3.10	9.06	0.00	99.64
Industrials	13.88	11.10	11.15	1.68	3.16	0.00	61.20
Real estate	1.92	1.39	2.41	1.85	5.24	0.00	18.31
Utilities	3.83	2.21	6.07	3.76	21.50	0.00	59.29
Fund size							
(market value: $ millions)	492.29	191.73	907.36	4.20	22.13	0.42	7165.19
Fund age (weeks)	113.55	92.90	90.28	1.37	2.17	2.50	564.03
P/B ratio	2.56	2.39	0.93	1.16	2.11	0.88	6.95
Propensity Score	12.01	11.89	2.26	0.82	1.01	7.37	21.30

This table shows the descriptive statistics of the SRI funds across the 35 variables plus the four criteria of performance, management, investment strategy, and sector

Comparison of PCA-PSM matched sample against conventional matched samples

To test our matching method, we also matched the SRI funds against conventional funds on the three characteristics used most commonly in the prior literature: fund age; fund size

(USD); and currency. We first calculated the number of months that each fund had operated [(report date–inception date)/30] and matched the same number of months for each SRI fund against conventional funds. Next, we proxied for size similarity within the range of +/−10% of the total value of each SRI fund. The number of funds matched by their age and size gave us 329 SRI funds and 559 conventional funds; 888 funds in total.[9] More than 90% of the 10,270 funds were excluded from the sample. When the 888 funds were also matched by currency, the number reduced to just 341 funds, of which 153 were SRI funds. Applying our PSM method retained far more funds in the sample and avoided selection bias problems of conventional methods.

Robustness of our samples

We then tested whether SRI and conventional funds shared similar characteristics or were different, purely on the basis that one is an SRI fund and the other is a conventional fund. Tables 6 and 7 show the mean, median, standard deviation, skewness, kurtosis, minimum, and maximum of the 544 SRI funds and 3,880 matched conventional funds. The last row of Table 7 highlights the evidence that the propensity scores of both fund types in this matched sample have similar distributions. A two-sample unpooled T-test assuming unequal variances and a two-sample F-test indicate that the propensity scores of SRI and conventional funds have an equal mean and variance. However, the descriptive statistics of the variables used as matching criteria differ between the SRI and conventional funds. Thus, these samples can be used to investigate the differences between SRI and conventional funds, as shown in the next section.

SRI funds versus conventional funds

As set out in our first hypothesis, existing studies tend to suggest that, with fewer choices of investee companies, SRI funds may underperform conventional funds. Our pairwise T-test on the mean difference and a Rank test on the median difference in Table 8 suggest that, although the performance index of SRI funds has a lower mean and median, the SRI funds' underperformance is insignificant. Thus, the evidence from our matched sample does not support our first hypothesis that SRI funds generally underperform conventional funds. When considering each performance measure, we find that SRI funds have a lower median value of total return rates but a higher median value of ROIC. Meanwhile, the mean and median values of the fund's Beta

and risk-adjusted-performance measures for both types of funds are insignificantly different at a 0.05 significance level. These results may show why previous studies report inconsistent results if the performance measures used are different. Tables 6 and 7 show that the standard deviation (SD) of ROIC (total return) for conventional funds is 8.95 (7.49), equivalent to about 70% (12%) greater than the SD for SRI funds (ROIC SD 5.27, total return SD 6.71). The finding suggests that the ROIC and total return for SRI funds is clustered more than the ROIC and total return for conventional funds and that SRI funds have a greater chance of earning a higher ROIC but a lower total return.

In accordance with our second hypothesis, the T-test shows that SRI funds are younger than conventional funds and the growth of SRI funds is higher than the growth of conventional funds. Although the median values of fund size are indifferent between SRI and conventional funds, SRI funds have much lower mean and standard deviation values of fund size. That is, the size of conventional funds is more variable than the size of SRI funds. Our findings that SRI funds tend to be smaller and younger support prior arguments by Gil-Bazo et al. (2010) as well as Nofsinger and Varma (2014) that may impact SRI funds' performance.

With regard to our third hypothesis, an inspection of Table 8 indicates that the management of SRI funds is generally better than the management of conventional funds. In particular, management companies for SRI funds have, on average, a shorter management tenure period, but higher success ratios than those for conventional funds. In contrast with Statman's (2000) argument that higher search costs for SRI funds may result in higher management fees, we find that the management fees charged by SRI funds are, on average, lower than the fees charged for conventional funds. The retention of fund managers is indifferent between both types of funds. The lower fee and higher success ratios may suggest that SRI funds tend to be managed by well-developed or large management companies that, with economies of scale, can charge a lower management fee, while having a good record in fund management. Thus, our third hypothesis is not held.

Our fourth hypothesis on investment strategy is also shown in Table 8, where the results of T-tests and Rank tests indicate an interesting finding—that is, SRI funds and conventional funds use different strategies. First, SRI funds have lower cash holdings than conventional funds. Second, SRI funds invest more in US equity than conventional funds. Further, not as expected, SRI portfolios are more diversified than conventional funds, possibly due to a number of reasons. For example, we find that SRI funds have a smaller investment allocation to the top 10 holdings and greater dispersion in the sector of investee companies. Lastly, SRI funds have more growth-focused investments (less value-focused investments) than conventional funds, confirming

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[9] Some SRI funds do not match against a conventional fund resulting in the number of SRI funds obtained being lower than 544.

Table 7 Descriptive Statistics – Conventional Funds

	Mean	Median	SD	Skew	Kurt	Min	Max
Performance	−0.16	−0.21	0.94	0.71	2.82	−3.74	6.27
ROIC	11.94	12.03	8.95	16.58	507.99	−49.10	307.96
Jensen alpha	−0.42	−0.66	5.34	0.75	4.55	−23.47	45.21
Beta	0.91	0.93	0.19	−0.22	2.26	−0.10	2.24
Sharpe ratio	0.72	0.68	0.68	1.75	21.04	−2.10	11.83
Sortino ratio	1.53	1.15	2.12	6.11	71.16	−1.86	39.36
Treynor ratio	8.22	7.25	10.74	4.89	70.85	−35.01	213.92
Total return	8.06	7.60	7.49	0.73	5.51	−24.81	92.53
Management	−0.02	−0.01	0.87	−0.01	1.69	−3.65	3.76
Management fee	1.01	0.90	0.60	0.42	0.37	0.00	4.98
Average manager tenure (longest)	7.81	7.41	2.94	1.62	6.66	0.65	30.32
Manager retention 1Y	0.95	0.96	0.06	−2.42	11.76	0.33	1.00
Manager retention 5Y	0.93	0.93	0.04	−1.03	2.94	0.68	1.00
Success ratio 10Y	0.50	0.50	0.19	−0.14	0.82	0.00	1.00
Success ratio 3Y	0.49	0.51	0.15	−0.19	1.36	0.00	1.00
Success ratio 5Y	0.50	0.51	0.17	−0.22	1.16	0.00	1.00
Investment Strategy	0.07	0.14	0.60	−0.39	−0.20	−2.28	1.80
Cash holdings	5.18	2.67	8.76	4.99	32.75	0.00	94.70
% invest on US equity	31.02	3.60	38.14	0.75	−1.13	0.00	100.00
% in Top 10 holdings	34.46	33.60	14.65	0.38	0.00	1.48	92.96
Size dispersion	1.37	1.00	0.54	−0.02	−0.92	0	2
Style dispersion	1.66	2.00	0.48	−0.78	−1.07	0	2
Growth-focused	31.52	30.53	16.48	0.53	0.02	0.00	86.47
Value-focused	29.78	29.84	15.44	0.34	0.01	0.00	94.20
Sector Allocations	0.03	−0.02	0.44	1.49	8.04	−1.52	3.25
Finance	17.11	17.63	9.13	−0.09	−0.32	0.00	45.54
Technology	15.29	14.15	11.75	1.73	6.77	0.00	97.51
Basic materials	7.80	6.09	10.33	5.53	39.15	0.00	99.13
Communication services	3.00	2.25	4.31	9.81	181.41	0.00	96.55
Consumer cyclical	11.97	11.68	6.92	1.68	11.17	0.00	77.60
Consumer defensive	7.67	6.67	7.13	4.39	40.92	0.00	98.16
Energy	6.53	4.80	9.93	5.44	39.98	0.00	100.00
Healthcare	9.10	7.55	11.54	5.37	37.17	0.00	100.00
Industrials	11.54	10.42	8.15	2.23	13.30	0.00	93.07
Real estate	2.46	1.53	3.12	2.22	9.88	0.00	39.40
Utilities	2.79	1.50	6.20	8.52	99.02	0.00	97.76
Fund size (Market value: $ millions)	777.31	173.98	2,167.90	9.08	124.34	0.02	46,446.04
Fund age (months)	140.20	122.48	100.20	1.11	1.78	3.77	736.50
P/B ratio	2.30	2.10	0.95	1.50	3.06	0.73	7.04
Propensity score	12.05	11.85	2.30	0.76	0.64	7.35	21.31
Unpooled t-statistics: $\mu_{SRI} = \mu_{conventional}$ (P-value)	−0.35	(0.376)	F-statistics: $SD_{SRI} = SD_{conventional}$ (P-value)			0.968	(0.897)

This table shows the descriptive statistics of the conventional funds across the 35 variables plus the four criteria of performance, management, investment strategy, and sector

the finding of Gregory and Whittaker (2007) and Cortez et al. (2012).

Table 8 also highlights differences in investment allocation between the two types of funds to answer our fifth hypothesis on sector diversification. SRI funds invest less in equities of finance, real estate, communication services, consumer cyclical, consumer defensive, and energy sectors than conventional funds. Meanwhile, SRI funds invest in equities in the sectors relating to sustainable development (such as

Table 8 Difference tests

	SRI-conventional		Difference			
	Mean	Median	*T*-Test	Sig.	Rank test	Sig.
Performance	−0.018	−0.063	−0.42		−0.62	
ROIC	0.389	0.429	1.45		3.33	*
Jensen alpha	0.014	0.040	0.06		−0.06	
Beta	−0.012	0.006	−1.36		−0.61	
Sharpe ratio	0.026	0.003	0.83		0.77	
Sortino ratio	0.022	−0.023	0.15		0.17	
Treynor ratio	−0.027	−0.478	−0.05		−0.58	
Total return	−0.617	−0.800	−1.98		−2.03	*
Management	0.205	0.146	4.38	*	3.71	*
Management fee	−0.077	−0.100	−3.00	*	−3.42	*
Average manager Tenure	−0.462	−0.243	−3.93	*	−3.32	*
Manager retention 1Y	−0.002	0.004	−0.73		−0.21	
Manager retention 5Y	0.002	0.002	0.94		0.89	
Success ratio 10Y	0.056	0.038	5.30	*	4.59	*
Success ratio 3Y	0.019	0.002	2.71	*	3.29	*
Success ratio 5Y	0.046	0.017	5.68	*	4.88	*
Investment Strategy	0.005	−0.004	0.18		0.18	
Cash holdings	−1.196	−0.397	−3.43	*	−4.17	*
% investment on US equity	7.705	39.481	4.89	*	5.25	*
% in Top 10 holdings	−3.743	−3.683	−6.57	*	−5.69	*
Size dispersion	0.043	0.000	1.75		1.75	
Style dispersion	0.065	0.000	3.15	*	2.88	*
Growth-focused	3.348	3.446	4.64	*	4.87	*
Value-focused	−3.178	−4.037	−4.95	*	−4.46	*
Sector allocations	0.053	0.047	3.22	*	3.68	*
Finance	−3.521	−1.021	−8.06	*	−6.73	*
Technology	1.780	2.910	3.51	*	4.41	*
Basic materials	−0.570	0.296	−1.78		0.71	
Communication services	−0.621	−0.450	−4.66	*	−4.01	*
Consumer cyclical	−1.910	−1.351	−6.76	*	−6.53	*
Consumer defensive	−0.519	−0.309	−1.69		−2.22	*
Energy	−2.142	−2.516	−5.30	*	−8.31	*
Healthcare	5.440	2.894	5.94	*	6.33	*
Industrials	2.342	0.679	4.72	*	3.17	*
Real estate	−0.540	−0.144	−4.69	*	−3.38	*
Utilities	1.036	0.714	3.72	*	4.40	*
Fund size (market value: $ millions)	−285.024	17.751	−5.46	*	0.29	
Fund age	−26.653	−29.583	−6.35	*	−6.38	*
P/B ratio	0.263	0.290	6.16	*	7.51	*

This table shows the difference tests (*T*-tests and Rank tests) between SRI funds and conventional funds across the 35 variables plus the four criteria of performance, management, investment strategy, and sector. * denotes the significance of their differences at a 0.05 significance level

technology, industrials, utilities, and healthcare sectors)[10] more than conventional funds.

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[10] Technology, industrials and utilities relate to the UN's sustainable development goal (SDG) no. 9 which is about industry, innovation and infrastructure while healthcare relates to SDG no. 3 which is about good health and well-being.

Conclusion

For many decades, prior studies have matched one type of fund against another in the investment management stream of the literature, but the samples may have been potentially biased by choice of fund characteristics used in matching

either: (i) Because it has been too time-consuming to match different variables on an iterative basis, so only a few criteria are applied; or (ii) Chosen fund characteristics that can be proxied by several variables may produce different outcomes. This paper addresses these issues by introducing a procedure to calculate propensity scores for matching several traits of SRI funds with those of conventional funds. Thus, unlike previous studies, the samples obtained in this study contain enough variability to allow rigorous investigations of the differences between the two groups of funds. We then test the characteristics of global SRI funds against those of conventional funds. The paper adds to the literature by investigating, in addition to the examination of fund performance and fund size, the differences in fund management (e.g., fee, management's success and experience) and investment strategies (e.g., investment style and sector selection).

Having selected our two samples on a rigorously justified basis across 35 variables, we examine five hypotheses regarding SRI funds compared to their conventional counterparts. As a contribution to the literature, we show that SRI funds generally underperform conventional funds in terms of total returns but outperform in terms of ROIC. In addition, as they are younger and faster-growing, there is potential that over time SRI funds will be more attractive to investors and make more sustainable returns. As another contribution, we show that, when using global data instead of just US data, SRI fund managers are more skilled in their managerial abilities. In addition, we find that SRI funds tend to be managed by well-developed or large management companies which, with economies of scale, can charge a lower management fee while having a good record in fund management.

A significant contribution to the literature is that we provide evidence that diversification is not restricted by an SRI focus. In particular, SRI funds have smaller cash holdings, a smaller investment allocation to the top 10 holdings and are also diversified in terms of sector of investee companies. We also fill the gap in the literature by showing that SRI funds invest more in US equities and sustainability-related sectors than conventional funds. This may indicate that the search for investments with an ESG focus provides a more diverse investment universe than expected, with greater efficiency in fund allocation toward activities with social, environmental, and sustainable benefits.

As Leins (2020) notes: "moral concerns and financial forms of valuation" (p.75) are being merged together; ESG is now far more successful than the "responsible investment" of the past. We hope that our paper enables a better understanding of the investment industry and the role of SRI within it. Future studies could separate out the difference in styles of SRI funds from environmental funds to social or governance, or Christian versus Islamic funds or green versus ecological funds. In addition, the difference between active or passive funds could be analyzed across SRI categories. Market selection and timing models could also be used in future studies to verify whether SRI managers are better at stock picking. Future research could also examine whether a US equity focus allows more diversification because of a very large investee company universe. Further, an analysis of the top asset holdings of different funds could examine the asset diversification of SRI and conventional funds in more detail. We, thus, look forward to more ESG focused investment management research in future using our new methodological approach.

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