

Do Socially Responsible Index Investors Incur an Opportunity Cost?

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Abstract

We construct index-tracking portfolios using integer programming and then compare the tracking errors and performances of portfolios formed from an unrestricted and socially screened stock universe. We find that one can construct a portfolio of socially responsive stocks that deliver market performance. Thus the exclusion of a set of stocks from consideration does not exhaust the existence of efficient index-tracking portfolios, especially when the exclusionary screen is for non-financial reasons. Our results are robust to various specifications in constructing the portfolio, e.g. number of stocks included in the portfolio and weighting schemes, and robust to alternative tracking error measurement; we show that the difference induced from conducting socially responsible screen is never statistically significant.

Keywords: index tracking, SRI (socially responsible investment), tracking error, MIP (mixed integer programming)

JEL Classifications: G11

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1. Introduction

In the aftermath of the latest environmental disaster in the Gulf of Mexico, shunning BP due to Environmental, Social and Governance (ESG) concerns should be heralded as a triumph. Investors can now access many social issue exclusion screens in order to help them identify sin stocks which they may choose to exclude from (or perhaps include in) their portfolios¹. Defining a “sin stock” is, however, subjective. Generally speaking, socially responsible investors favor corporate practices that promote environmental stewardship, consumer protection, human rights, and diversity. Some (but not all) avoid businesses whose activities are involved in alcohol, tobacco, gambling, firearms, and/or abortion.

Socially responsible investing (SRI) represents a booming market in both the United States and Europe. According to Social Investment Forum (2010), SRI is a broad-based approach that now encompasses an estimated \$3.07 trillion out of \$25.2 trillion in the U.S. investment marketplace². SRI is based on the proposition that corporate responsibility and societal concerns are valid parts of investment decisions. SRI considers both the investor's financial needs and the investment's impact on society. SRI investors encourage corporations to improve their practices on environmental, social, and governance issues. Starks (2007) discuss institutional investors' views on corporate social responsibility from research and surveys. He finds that SRI institutions occasionally try to affect firms' social responsibility activities with little effect. SRI-like approaches to

¹ Socially responsible funds would exclude “sin” stocks from their portfolios for ESG concerns while vice funds would do the opposite, to include the “sin” stocks that have greater chances to pay and grow dividends.

² The numbers are cited from the new 2010 edition of the Social Investment Forum Foundation's Report on Socially Responsible Investing Trends in the United States.

investing may be referred to as mission investing, responsible investing, double or triple bottom line investing, ethical investing, sustainable investing, or green investing.

How profitable has socially responsible investing been? Previous studies mostly have been positive about the SRI performance. Hamilton, Jo and Statman (1993) look at the performance of socially responsible mutual funds. They find that 17 socially responsible mutual funds established prior to 1985 outperform traditional mutual funds of similar risk over the 1986-1990 period, but that their excess returns are not statistically significant. Similarly, Statman (2000) reports that the Domini Social Index, an index of socially responsible stocks, outperforms the S&P 500 Index and socially responsible mutual funds do better than conventional mutual funds over the 1990-1998 period, but the differences between their risk-adjusted returns are not statistically significant. Recent studies, however, find the opposite for more contemporary time periods. Ma (2008A) reports that over the 1995-2006 study period, mutual funds engage in socially responsible Investing (SRI funds) and non-SRI funds exhibit significant performance differences; in particular, an SRI portfolio is found to have underperformed its matching portfolio in recent years.

Herein we use an exclusionary approach to SRI, regarding certain types of companies or whole industries based on certain value choices. Our SRI is defined in terms of what is excluded. This approach is distinguishable from a more active sustainable investing, which focuses on what is included. Sustainable investing is an important strategy, fully integrating environmental, social and governance (ESG) factors into investment analysis and decision making. Ma (2008B) explores the relationship between environmental and financial performance by addressing the question: Does

social screening based on environmental sustainability constitute a winning strategy for socially responsible mutual funds? Using Business Ethics online magazine's Best 100 Corporate Citizens ranking, the study compares the performance of three portfolios: the "greenest" of the 20 firms on the list, which have the highest environment scores; a constructed control group of the "greenest;" and CRSP market portfolio. He finds that the "greenest" group slightly outperforms the market portfolio in raw returns, while it underperforms the CRSP market portfolio in excess standard deviation adjusted returns. On the other hand, the control group outperforms the market portfolio in both raw returns and ESDAR³.

Our concept of SRI, the notion that one can deliver comparable performance by shrinking the investment universe, is somewhat counterintuitive; opportunity cost is naturally assumed to exist with SRI. Some research has explored the impact of socially responsible investing in a number of different ways. Sauer (1997) compares the performance characteristics of a carefully constructed, well-diversified portfolio of socially screened stocks with two unrestricted benchmark portfolios concluding that applying social-responsibility screens does not necessarily adversely impact investment performance. Geczy, Stambaugh, and Levin (2005) construct optimal portfolios of mutual funds whose objectives include socially responsible investment (SRI) and compare these portfolios to those constructed from the broader fund universe. Assuming that investors seek the highest Sharpe ratios, they suggest that SRI cost depends crucially on the investor's views about asset pricing models and stock-picking skill by fund managers. Ma (2008C) explores the measuring of the opportunity cost associated with

³ ESDAR represents "excess standard-deviation-adjusted return"; this measure is a modified version of the Sharpe ratio. More details on the calculation refer to Statman (1987), Modigliani, and Modigliani (1997).

social screening from a creative angle – by how much the performance ceiling is lowered when a group of stocks of varying characteristics are excluded.

Herein we seek to quantify the cost of imposing the SRI constraint on the choice set. In contrast to current studies, we directly explore the tracking performance of SRI portfolios of stocks rather than their investment performance. Arguably, SRI investing carries a significant sector bias, e.g. SRI performance mostly should be driven by the performance of technology, consumer staples, and other green sectors; performance comparison based on certain time periods is not necessarily indicative of the future. Traditional index fund performance is independent of economic cycle and free of sector bias. Accordingly, we explore herein whether shrinking the investment universe to a socially responsible universe allows for market performance.

We directly address the questions: Does socially responsible screening hamper a desirable and close tracking of a specific index? If so, to what extent does the screening hamper the process? We find that, on average, a socially responsible screened portfolio has only a slightly greater (statistically insignificant) tracking error than a matched unrestricted portfolio. Thus, social screening may impose a small opportunity cost but to a degree that may well be tolerable to the SRI oriented investor. We target index tracking portfolios, which are designed to track a specified index return. We explore the cost of being socially responsible investors by assessing the tracking error impact of restricting the investment universe to SRI stocks. We also examine the portfolio performance of the two types of portfolios.

Our paper is structured as follows: in Section 2, we discuss the index-tracking problem. Details of our portfolio construction, methodology and data used are found in Section 3. In Section 4, results are reported and conclusions are drawn in Section 5.

2. Index tracking

While an important topic, index tracking has received relatively little academic attention. It is most relevant to passive investors who wish to capture the performance of a chosen index. It also matters for active investment strategies which seek to replicate a type of performance when the true instrument does not exist or its use is restricted.

Buy and hold and indexing represent two types of passive investing. With buy and hold, assets are selected on the basis of some fundamental or other criteria and little or no active trading takes place thereafter. With indexing, a portfolio is formed and maintained without any attempt to time the market or select mispriced securities. The goal is to manage a portfolio that mirrors the movements of a broad or narrow market population or index. Many index funds choose a broad market index such as the S&P 500 as a proxy.

One method of index tracking is full replication, which consists of purchasing all the issues in the index at their exact index weights. This approach tends to be impractical (many small positions) and expensive (high rebalancing costs) unless the fund's net asset value is substantial with minimal cash flow. An index fund composed of q representative stocks, where q is substantially smaller than n , the size of the target population, seems generally preferable. Thus, we focus on a partial replication strategy with more manageable q stocks in the portfolio.

Many commonly used methodologies for index tracking are based on sample optimization e.g. minimize a loss function or maximize the similarity of the portfolio and the index. In section 3, we discuss and adopt one such method for empirical study. However, most portfolios derived from these methodologies fail to satisfy a highly desired property of index tracking portfolios: that the tracking error contains no low frequency or integrated components. Corielli and Marcellino (2006) rigorously examine the necessary condition for an index-tracking portfolio to have such property.

With Corielli and Marcellino (2006)'s notation, the index is given as $I_t = WP_t$ while the N by 1 price vector P_t follows factor model $P_t = \Lambda F_t + e_t$. Under such an integrated dynamic approximate factor model setup, the index replica comes in the form $i_t = \beta SP_t$, with β being the 1 by q weight vector and S being a specific q by N selection matrix. To satisfy the property described, or equally speaking for the index and the replica to share the same factor structure, the necessary condition is for the weight vector to satisfy ⁴

$$\beta^* = W (\Lambda : P_0) (S \Lambda : SP_0)^+ + h [I_q - (S \Lambda : SP_0) (S \Lambda : SP_0)^+]$$

As suggested by this proposition in Corielli and Marcellino (2006), the necessary condition will identify a set of admissible replicas including a set of socially responsible portfolios with zero assigned to sin stocks in the selection matrix S . Equally speaking, the need to exclude sin stocks from consideration does not exhaust the existence of efficient index-tracking portfolios⁵.

3. Data and methodologies

⁴ The detailed proof of the proposition can be referred to in Corielli and Marcellino (2006).

⁵ This is especially true since the exclusionary is for non-financial reasons; the restriction on selection matrix S is independent of any other variables in the set-up.

In this section, we examine empirically whether socially responsible screening hampers efficient market index tracking. We select the S&P 500 as our target market index. Accordingly, here we adopt a large-scale deterministic model for aggregating a broad stock market index into a smaller more manageable index portfolio as proposed in Cornuejols and Tutuncu (2007). This approach will not necessarily yield mean/variance efficient portfolios but should produce a portfolio that closely replicates the underlying market population. The basic idea behind this model is to select q stocks from the n stocks universe, which are most representative of the original n stocks universe according to correlations among these n stocks. Mathematically, this index portfolio construction model can be represented as a MIP (mixed integer problem) below:

$$\begin{aligned}
& \rho_{ij} = \text{similarity between stock } i \text{ and stock } j \\
& \rho_{ii} = 1, \rho_{ij} \leq 1 (i \neq j), \rho_{ij} \text{ is larger for more similar stocks} \\
& Z = \max \sum_{i=1}^n \sum_{j=1}^n \rho_{ij} x_{ij} \\
& \text{subject to} \\
& \sum_{j=1}^n y_j = q \\
& \sum_{j=1}^n x_{ij} = 1 \text{ for } i=1, \dots, n \\
& x_{ij} \leq y_j \text{ for } i=1, \dots, n; j=1, \dots, n \\
& x_{ij}, y_j = 0 \text{ or } 1 \text{ for } i=1, \dots, n; j=1, \dots, n
\end{aligned}$$

A most natural choice for ρ_{ij} in our context would be correlation between stock i and stock j . The variables y_j describe which stocks j are in the index fund ($y_j = 1$ if j is selected in the fund, 0 otherwise). For each stock $i = 1 \dots n$, the variable x_{ij} indicates which stock j in the index fund is most similar to i ($x_{ij} = 1$ if j is the most similar stock in the index fund, 0 otherwise). The first constraint selects q stocks to be included in the portfolio. The second constraint requires that each stock i has exactly one representative

stock j in the portfolio. The third constraint guarantees that stock i can be represented by stock j only if j is included in the portfolio. The objective is to maximize the in sample similarity between the n stocks and their q representatives in the portfolio.

Once the optimization program has been solved and a set of q stocks has been selected for the index portfolio, we apply market-cap weights to form our portfolio since the S&P 500 is a market-cap weighted index. To explore whether the result is driven by this weighting scheme, we also consider the alternative of equal weighting.

We construct each of our unrestricted index portfolios in three steps. First, we use the 500 stocks, which make up the S&P 500 Index in December of Year $t-1$ to calculate a 500 by 500 correlation matrix using monthly data from 1972 up to Year $t-1$. Then, we solve the MIP (mixed integer problem) above using the correlation matrix constructed in step one to pick q representative stocks ($q = 25, 50, 75$ and 100) to form our index portfolio. Finally, we construct a market-cap, or equally weighted portfolio, and calculate monthly portfolio performance for Year t (from January to December). We repeat these three steps every year from 1996 to 2008. Thus, index portfolios are rebalanced annually.

For socially responsible index portfolios, we would have preferred access to the Domini 400 Social Index components information. This DS400 was launched in 1990 and is designed to help socially conscious investors weigh social and environmental factors in their investment choices. It aims to be comprised chiefly of large cap stocks in the S&P 500 and is composed of some 250 companies in the S&P 500; 100 companies not in the S&P 500, but providing sector diversification and exceeding pre-determined market cap limitations; and 50 companies that have shown excellence in their social and environmental dealings. Unfortunately, we do not have access to DS400 components. As

a result, we construct our own socially responsible S&P 500 universe. This socially screened universe results from two levels of filtering – one to filter out socially responsible stocks and the other to filter out S&P Index stocks. We accomplish this purpose as follows: First, we examine the portfolio holdings of socially responsible mutual funds as included in CRSP database. Then, we identify 1,254 stocks as a result of level one filtering (socially responsible filtering). Next, we take the stocks into our double-screened universe if they enter S&P 500 index at least once before year t . The resulting number of double screened stocks ranges from 165 in 1996 up to 281 in 2008 with more stocks entering every year. Details on the number of stocks resulting from this double-screened universe are reported in Table 1.

Table 1

Number of Stocks in Double Screened Universe for Each Year

Table 1 reports on the resulted number of stocks from two levels of filtering – social responsible filtering and index stock filtering. Each stock in the double-screened sample meets two requirements; 1) It has been held in the portfolio of socially responsible mutual funds, and 2) It has been an S&P 500 Index stock prior to the specific year. Later on, our socially responsible index portfolio will be constructed from this double-screened universe.

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
N	165	174	187	201	219	238	246	253	257	264	268	276	281

Then, we repeat the three-step portfolio construction process as described in the previous paragraph for the unrestricted index portfolio, except that here for the socially responsible screened index portfolio, our universe is made up of the number of SRI stocks indicated in Table 1.

As the screened index portfolios are rebalanced every year, we pick q stocks from the double-screened universe based on solving the MIP using a correlation matrix formed

from data up to year $t-1$. We then record the performance of our screened index portfolio for year t . Similarly for the unrestricted index portfolio, we pick q stocks every year except that these q stocks are selected from the S&P 500 components in Dec./year $t-1$. As a result, both the unrestricted and socially responsible universes are changing each year. However, since the turnover among the S&P 500 components is always low, the changes are relatively minor.

Once our annually rebalanced index portfolios' performances are recorded month by month for both the unrestricted index portfolio and socially responsible index portfolio, we measure how closely the index portfolio follows the S&P 500 Index return by examining the average monthly tracking error for each year from 1996 to 2008. The calculation of this tracking error follows a root mean square error concept in which we first, calculate the monthly squared deviation of portfolio returns from the reported index return for each of the 12 months of a specific year. Then we take the average of these 12 monthly squared deviations. Finally, we take the square root of that average number. The same procedure is followed for semi tracking error calculations except that we only take into account the downside deviations and ignore upside tracking errors⁶.

4. Results

As described in the previous section, we calculate tracking errors and semi-tracking errors year by year for our annually rebalanced index portfolios from 1996 to 2008 for both the unrestricted index portfolio and the socially responsible portfolios. The corresponding results are included in Table 2 and Table 3. Table 2 reports the average monthly tracking error for each year from 1996 to 2008 while Table 3 reports semi tracking error (downside difference only). We consider this semi tracking error relevant because upside tracking error (portfolio produces a greater return than the target index) is

⁶ Upside tracking deviations are made zero in computing the semi tracking error.

a desirable error for wealth maximizing investors while investors wish to avoid downside-tracking error.

Table 2

Tracking Error of Market Capitalization Weighted Portfolios

Table 2 includes tracking errors of our index portfolios that target to track the S&P 500 Index. We consider difference sizes of index portfolios, of 25, 50, 75 and 100 stocks in the portfolios. For a specific portfolio size, we place side by side the tracking errors of an unrestricted index portfolio and a socially-responsible screened index portfolio. All the index portfolios are market capitalization weighted. For the two sub periods and the whole period, we also include *t*-statistic to test whether the mean tracking error is significantly difference from zero.

q	25		50		75		100	
	TE	SR-TE	TE	SR-TE	TE	SR-TE	TE	SR-TE
1996	0.0222	0.0208	0.0183	0.0151	0.0072	0.0135	0.0091	0.0082
1997	0.0217	0.0212	0.0111	0.0285	0.0154	0.0176	0.0137	0.0214
1998	0.0201	0.0287	0.0173	0.0176	0.0182	0.0313	0.0161	0.0184
1999	0.0294	0.0273	0.0262	0.0212	0.0185	0.0230	0.0284	0.0173
2000	0.0366	0.0344	0.0240	0.0425	0.0401	0.0338	0.0363	0.0314
2001	0.0353	0.0594	0.0280	0.0417	0.0263	0.0273	0.0165	0.0237
2002	0.0225	0.0228	0.0174	0.0198	0.0181	0.0265	0.0221	0.0235
2003	0.0322	0.0264	0.0136	0.0164	0.0104	0.0151	0.0129	0.0089
2004	0.0147	0.0189	0.0140	0.0093	0.0110	0.0108	0.0095	0.0062
2005	0.0228	0.0116	0.0119	0.0125	0.0106	0.0129	0.0071	0.0103
2006	0.0258	0.0126	0.0078	0.0168	0.0083	0.0120	0.0114	0.0094
2007	0.0245	0.0116	0.0080	0.0076	0.0113	0.0155	0.0124	0.0110
2008	0.0314	0.0270	0.0237	0.0206	0.0166	0.0297	0.0184	0.0208
MEAN 96-00	0.0260	0.0265	0.0194	0.0250	0.0199	0.0239	0.0207	0.0194
<i>t</i> _value	6.40	5.55	6.30	4.05	4.01	5.17	3.57	4.71
MEAN 01-08	0.0262	0.0238	0.0156	0.0181	0.0141	0.0187	0.0138	0.0142
<i>t</i> _value	5.80	2.61	5.64	2.99	5.06	5.14	6.20	4.02
MEAN 96-08	0.0261	0.0248	0.0170	0.0207	0.0163	0.0207	0.0165	0.0162
<i>t</i> _value	8.21	3.99	8.30	4.83	5.89	7.25	5.40	6.11

Table 2 and Table 3 suggest that tracking errors generally decrease as the number of stocks in the portfolio rises. Compared to the unrestricted index portfolio, the socially responsible index portfolio does better with semi-tracking error, which is consistent with many previous studies that find that SRI performs better than non-SRI during most of the

years covered. Although tracking error differences exist between unrestricted and socially responsible screened index tracking portfolios, the differences are small, and not strictly uniform with socially responsible screened index portfolios; they track the target index better occasionally, although in most cases a matched unrestricted portfolio tracks better.

Table 3

Semi-Tracking Error of Market Capitalization Weighted Portfolios

Table 3 includes semi-tracking errors of our index portfolios that target to track the S&P 500 Index. We consider different sizes of index portfolios, of 25, 50, 75 and 100 stocks in the portfolios. For a specific portfolio size, we place side by side the semi-tracking errors of an unrestricted index portfolio and a socially responsible screened index portfolio. All the index portfolios are market capitalization weighted. Semi-tracking error takes tracking error into consideration only when the portfolio underperforms the target index. For the two sub periods and the whole period, we also include t _statistic to test whether the mean semi-tracking error is significantly different from zero.

q	25		50		75		100	
	sTE	SR-sTE	sTE	SR-sTE	sTE	SR-sTE	sTE	SR-sTE
1996	0.0200	0.0130	0.0131	0.0020	0.0045	0.0012	0.0031	0.0019
1997	0.0118	0.0096	0.0091	0.0106	0.0082	0.0059	0.0013	0.0073
1998	0.0149	0.0128	0.0040	0.0078	0.0044	0.0084	0.0059	0.0029
1999	0.0218	0.0135	0.0149	0.0040	0.0087	0.0127	0.0069	0.0100
2000	0.0225	0.0088	0.0157	0.0148	0.0211	0.0161	0.0020	0.0036
2001	0.0142	0.0126	0.0181	0.0050	0.0096	0.0018	0.0067	0.0023
2002	0.0143	0.0107	0.0050	0.0067	0.0131	0.0091	0.0103	0.0068
2003	0.0189	0.0033	0.0082	0.0086	0.0084	0.0044	0.0044	0.0054
2004	0.0071	0.0150	0.0133	0.0038	0.0056	0.0051	0.0044	0.0029
2005	0.0156	0.0101	0.0060	0.0064	0.0064	0.0064	0.0008	0.0056
2006	0.0056	0.0101	0.0043	0.0073	0.0039	0.0082	0.0011	0.0014
2007	0.0035	0.0102	0.0034	0.0073	0.0063	0.0025	0.0027	0.0056
2008	0.0056	0.0217	0.0026	0.0112	0.0111	0.0059	0.0047	0.0067
MEAN 96-00	0.0182	0.0116	0.0114	0.0078	0.0094	0.0088	0.0038	0.0051
t _value	3.88	3.46	3.78	2.41	1.50	1.95	2.30	2.63
MEAN 01-08	0.0106	0.0117	0.0076	0.0071	0.0080	0.0054	0.0044	0.0046
t _value	3.36	3.52	3.80	3.53	3.64	2.88	2.31	3.49
MEAN 96-08	0.0135	0.0116	0.0090	0.0074	0.0086	0.0067	0.0042	0.0048
t _value	5.05	4.75	5.33	4.02	2.71	2.81	3.04	4.27

According to the t -statistics in Table 2 and Table 3, we are able to tell that the socially responsible portfolios tend to track S&P 500 better when the portfolios are small (with 25 or 50 stocks). When we have more stocks in the portfolio, e.g. 75 or 100, the unrestricted portfolios track the market index better than the socially-screened ones as indicated by the smaller t -values. No matter which portfolio tracks S&P 500 better, unrestricted portfolios or socially screened portfolios, the tracking errors are significantly different from zero in most t -values. Clearly the numbers decline markedly from Tracking Error (Table 2) to Semi/Downside Tracking Error (Table 3). Thus the deviation from tracked index return to some extent appears to be due to upside deviations. To assess the relative magnitude of upside and downside tracking error, we quantify monthly upside and downside squared deviations separately.

Table 4

Upside and Downside Tracking Error

Table 4 separates the upside and downside tracking errors for each index tracking portfolio (unrestricted and socially responsible screened, different portfolio sizes). The numbers reported are the average squared deviation for upside or downside deviations. In the last column, two-sample t -test is included to test the difference in mean between upside deviation and downside deviation.

	q	Mean Squared Deviation (%)		
		Upside	Downside	Difference
Unrestricted	25	4.98	2.21	2.77 **
	50	2.24	1.08	1.16 ***
	75	2.46	0.93	1.53 ***
	100	3.10	0.24	2.86 ***
Socially	25	6.09	1.52	4.57 ***
	50	4.74	0.65	4.09 ***
	75	4.28	0.62	3.66 ***
Responsible	100	2.89	0.29	2.60 ***

******, and ******* represent significance level of 5% and 1%, respectively⁷.

The detailed comparison is conducted for alternative portfolio specifications and results are included in Table 4. In Table 4, upside deviations always overtake the corresponding downside deviations. Also, the difference is consistently considerably positive based on the one-sided non-parametric Wilcoxon test. Thus, we conclude that the tracking errors presented in Table 2 are mostly due to upside tracking error when index portfolio outperforms the target index. Additionally, we deduce from Table 4 that upside deviations outweigh downside deviations to a larger degree for socially responsible portfolios relative to unrestricted portfolios. Again, this is consistent with the fact that SRI outperforms in most of the time horizon under consideration.

To assess further the effect of imposing a socially responsible constraint on index tracking, we conduct two sided Wilcoxon to test the null hypothesis of no difference in tracking performance between Unrestricted and SR screened index tracking portfolios. We perform the Wilcoxon hypothesis test by using 156 monthly squared deviation or semi-squared deviation numbers for each index portfolio. The associated p-values from approximate *t* tests are reported in Table 5.

Table 5

Wilcoxon Test of Tracking Performance difference between unrestricted and SR screened market capitalization weighted index portfolios (P-Values)

Here in Table 5, non-parametric test (Wilcoxon test) is performed to test the difference in tracking error/semi-tracking error between unrestricted portfolio and socially responsible screened portfolio for different portfolio sizes. Detailed tracking error/semi-tracking error numbers are included in Table 2/Table 3. Numbers reported in Table 5 are the resulted p-values from the non-parametric tests.

⁷ The significance level is not sensitive to whether normal approximation or *t* approximation is applied in the test.

q	25	50	75	100
Tracking Error	0.6827	0.9715	0.1431	0.3077
Semi-Tracking Error	0.9069	0.1036	0.2259	0.1580

We fail to reject the null in almost all cases except that with 50 stocks portfolios, the difference with semi-tracking error is marginally significant, which suggests that with 50 stock portfolios, the SR screened portfolio demonstrates a semi-tracking error that is marginally (significantly) lower than that from unrestricted index portfolio.

Setting the tracking error issue to one side, investors also would be concerned with the performance of the unrestricted and socially responsible portfolios. We calculate annualized geometric mean returns for each year and for each portfolio. The return numbers are all dividend-adjusted. The results are reported in Table 6.

Table 6

Annualized Mean Returns of Market Capitalization Weighted Portfolios

Table 6 includes annualized geometric mean returns of our index portfolios that target to track the S&P 500 Index. We consider different sizes of index portfolios, of 25, 50, 75 and 100 stocks in the portfolios. For a specific portfolio size, we place side by side the annualized geometric mean returns of an unrestricted index portfolio and a socially responsible screened index portfolio. All the index portfolios are market capitalization weighted.

q	25		50		75		100	
	AR	SR-AR	AR	SR-AR	AR	SR-AR	AR	SR-AR
1996	0.1233	0.2277	0.2921	0.4040	0.2398	0.3992	0.3121	0.3080
1997	0.3817	0.4065	0.3183	0.4473	0.4382	0.4295	0.5084	0.4118
1998	0.3253	0.4077	0.4355	0.4004	0.4566	0.5829	0.4157	0.4591
1999	0.1599	0.3250	0.2590	0.4109	0.3281	0.2876	0.4557	0.2834
2000	0.0067	0.1197	-0.0718	0.1654	0.1195	0.0497	0.2605	0.2334
2001	0.0398	0.2294	-0.0976	0.1794	0.0280	0.1047	-0.0329	0.0426
2002	-0.1981	-0.1473	-0.1162	-0.1231	-0.2019	-0.0765	-0.1371	-0.1577
2003	0.3634	0.5855	0.3146	0.3644	0.2697	0.4220	0.3808	0.2991
2004	0.1506	0.1129	0.0047	0.1582	0.1662	0.1542	0.1539	0.1516
2005	0.0393	0.0090	0.0832	0.0849	0.0381	0.0745	0.1150	0.0562
2006	0.3166	0.1297	0.1805	0.2202	0.1930	0.1524	0.2448	0.2257
2007	0.2465	0.0012	0.0772	0.0196	0.1013	0.1938	0.1210	0.0805
2008	-0.2329	-0.3745	-0.2380	-0.3232	-0.3436	-0.2119	-0.2719	-0.2729
1996-2000	0.1915	0.2925	0.2337	0.3615	0.3103	0.3374	0.3874	0.3365
2001-2008	0.0695	0.0353	0.0126	0.0514	0.0106	0.0871	0.0525	0.0369
1996-2008	0.1149	0.1275	0.0925	0.1613	0.1167	0.1773	0.1705	0.1432

From this performance table (Table 6), comparing the two index portfolios, socially responsible index portfolios seem to perform better when the portfolio size is small ($q=25$, $q=50$, or $q=75$), especially during earlier years, prior to 2004. When the portfolio contains 100 stocks, the unrestricted portfolio outperforms the socially screened portfolio, especially during more recent years. The results on 100-stock portfolios are in tune with recent studies finding that SRI underperforms in recent years. Note, however, that these are period specific results, which may have little or no predictive value.

To assess the significance level of such performance difference, we conduct one-sided Wilcoxon to test the null hypothesis of no difference in returns between Unrestricted and SR screened index tracking portfolios. Here, we use the 156 monthly return numbers to conduct the hypothesis test, and the alternative hypothesis is that SR

screened index portfolios generate higher returns than unrestricted index portfolios. The resulted p-values are reported in Table 7 and they are from approximated t tests.

Table 7

Wilcoxon Test of Return difference between unrestricted and SR screened market capitalization weighted index portfolios (P-Values)

Here in Table 7, a non-parametric test (Wilcoxon test) is performed to test the difference in returns between unrestricted index-tracking portfolio and socially responsible screened index-tracking portfolio for different portfolio sizes. More details on returns are included in Table 6. Numbers reported in Table 7 are the resulted p-values from the non-parametric tests.

q	25	50	75	100
Return	0.4733	0.1684	0.2611	0.3207

As reported in Table 7, the SR screened index portfolio doesn't perform statistically better than unrestricted counterpart. This finding is consistent with many previous studies that SRI outperforms non-SRI, but the performance difference is not statistically significant⁸.

5. Conclusions

We study the opportunity cost of socially responsible index investing. Others have examined the return performance of socially responsible mutual funds or the return performance of self-constructed socially responsible portfolios. The results of such studies may not be representative of the future since performance tends to be heavily time dependent. In certain time periods when the basic energy industry is strong, for example,

⁸ For robustness, we consider an alternative weighting scheme, equally weighting. With equally weighting, we assign a weight of $1/q$ to each of the q stocks ($q=25, 50, 75,$ and 100) in the portfolio. Specific results are omitted in the draft for space concern. Tracking errors of equally weighted portfolios are generally greater than those of market capitalization weighted portfolios. Regardless of which portfolio tracks S&P 500 index better, unrestricted or screened, the differences always are statistically insignificant.

SRI may perform below par, while when technology or other green industries are strong, SRI may do better. Accordingly, we explore SRI opportunity cost by a variable which is independent of the business/investment cycle: tracking error. Index tracking is an important part of investment business. In 2005, index funds held more than \$1.5 trillion under management. The rise of index-oriented Exchange Traded Funds (ETFs) coupled with the many quasi closet indexers add significantly to the total. Many investors choose to believe in passive investing with lower fees of most index funds.

Our results suggest that index investors still are able to track a broad market index effectively even if they impose a SRI screening. In other words, SRI screening appears to do little or no harm to index investors in terms of tracking error.

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