The Eco-Efficiency Premium Puzzle

Jeroen Derwall, Nadja Günster, Rob Bauer and Kees Koedijk

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Email address corresponding author	j.derwall@fbk.eur.nl
Address	Erasmus Research Institute of Management (ERIM) Rotterdam School of Management / Rotterdam School of Economics Erasmus Universiteit Rotterdam P.O. Box 1738 3000 DR Rotterdam, The Netherlands Phone: + 31 10 408 1182 Fax: + 31 10 408 9640 Email: info@erim.eur.nl Internet: www.erim.eur.nl

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Jeroen Derwall
Erasmus University Rotterdam

Nadja Günster
Erasmus University Rotterdam

Rob Bauer
ABP Investments and Maastricht University

Kees Koedijk
Erasmus University Rotterdam and CEPR

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Corresponding author:
Jeroen Derwall
Rotterdam School of Management,
Erasmus University Rotterdam,
Department of Financial Management
P.O. Box 1738
3000 DR Rotterdam,
The Netherlands
Phone: (+31) 10 4082601
Fax: (+31) 10 4089017
E-mail: j.derwall@fbk.eur.nl

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ABSTRACT

There exists a widespread consensus among mainstream academics and investors that socially responsible investing (SRI) leads to inferior, rather than superior, portfolio performance. Using Innovest's well-established corporate eco-efficiency scores, we provide evidence to the contrary. We compose two equity portfolios that differ in eco-efficiency characteristics and find that our high-ranked portfolio provided substantially higher average returns compared to its low-ranked counterpart over the period 1995-2003. Using a wide range of performance attribution techniques to address common methodological concerns, we show that this performance differential cannot be explained by differences in market sensitivity, investment style, or industry-specific components. We finally investigate whether this eco-efficiency premium puzzle withstands the inclusion of transaction costs scenarios, and evaluate how excess returns can be earned in a practical setting via a best-in-class stock selection strategy. The results remain significant under all levels of transactions costs, thus suggesting that the incremental benefits of SRI can be substantial.

Introduction

In recent decades a large number of investors have embraced the concept of socially responsible investing (SRI). Currently, nearly 12% of assets under management are invested according to ethical criteria[1]. However, despite the increasing popularity of SRI, there is an ongoing debate over whether adding an ethical dimension to the stock selection process adds value.

At the firm level it is often believed that businesses cannot resort to their financial resources to improve social or environmental performance without decreasing shareholder value. One common line of reasoning is that a firm's costs of adhering to ethical standards will translate into higher product prices, a competitive disadvantage and lower profitability (e.g. Walley and Whitehead (1994)). Alternatively, it has been argued that improved social or environmental performance can lead to enhancements in a company's input-output efficiency or generate new market opportunities. Porter and van der Linde (1995) argue that active policies to improve environmental performance can lead to a competitive advantage resulting from more cost-efficient use of resources. Therefore, if the benefits of social or environmental initiatives outweigh their costs, investors holding responsible portfolios may earn incremental financial returns.

The extent to which social or environmental screening policies truly contribute to investment returns, however, depends on financial markets' ability to factor the financial consequences of corporate social responsibility into share prices. At the investment level, there is a widespread belief that incorporating ethical criteria into investment decisions will come at the cost of poorer portfolio performance. Conventional asset pricing theory, relying on the efficient market hypothesis, posits that (a) investment portfolios deliver returns proportional to associated risk and that (b) the optimal investment portfolio is a well-diversified one. Any empirical evidence of anomalous risk-adjusted investment performance from stocks clustered by firm-specific characteristics – such as size or the book-to-market ratio, but also corporate social responsibility – should be attributable to deficiencies in the performance evaluation models that attempt to explain them. Consequently, once such methodological shortcomings are tackled, no abnormal returns should exist. These lines of reasoning suggest that socially responsible investors, inherently suffering from imposed limits to diversification, should report sub-optimal returns once employing the appropriate performance attribution framework. However, proponents of SRI typically favor an opposing stance, arguing that corporate social responsibility represents management's long-term views on how a company should perform, which may be mispriced due to 'short-term thinking' within the financial community. This stream of thought suggests SRI can be incrementally profitable over long-run horizons.

The central empirical question arising from this debate is whether corporate social or environmental responsibility is associated with financial performance. A large literature has investigated the social-financial performance link empirically by comparing the historical returns of socially responsible mutual funds with those of conventional funds or market indexes (e.g. Bauer, Koedijk and Otten (2002), Hamilton, Jo and Statman (1993), and Statman (2000)).[2] Although this approach provides useful evidence on the financial consequences of SRI in a practical context, the method has some limitations. Results from mutual fund studies might be biased due to non-quantifiable aspects such as management skill, unknown portfolio holdings and screening methods. Furthermore, mutual fund studies cannot establish whether a social or environmental responsibility premium exists given that social and conventional fund holdings are not mutually exclusive.

In this study, we avoid these difficulties by using the Innovest rating database to evaluate self-composed equity portfolios. Despite being well established in the investment community, these ratings are rarely used in empirical research. Focusing exclusively on the environmental element of social responsibility, this study investigates if a long-run premium or penalty exists for holding environmentally responsible companies. In the first part of this research, we construct two mutually exclusive portfolios with distinctive 'eco-efficiency' scores. We then apply performance attribution models to test whether any performance differential between the portfolios is significant and attributable to the environmental component. The method allows us to examine the long-term benefits of including environmental criteria in the investment process.

We explicitly attempt to overcome the performance attribution divides outlined earlier by using several elaborate performance evaluation methods. Following Carhart (1997), we evaluate our portfolios while controlling for multiple non-environmental factors known to determine stock performance. In doing so, we methodologically improve most related studies, which typically only accounted for volatility or market risk. The major benefit of our approach, as empirically confirmed by Fama and French (1993) and Carhart (1997), is that we additionally control for the presence of style tilts in stock portfolios (e.g. size, value versus growth or momentum effects). This is particularly important given mounting evidence that environmentally and socially screened portfolios in the United States tend to be more biased towards large caps and growth stocks than unscreened portfolios; see for example Bauer *et al.* (2002). Furthermore, following Geczy, Stambaugh and Levin

(2003), our study brings into attention a four-factor model augmented by factors that capture industry effects in socially responsible equity portfolios.

Our empirical results provide evidence suggesting that eco-efficiency relates to investment performance. We find that the high-ranked portfolio considerably outperformed its low-ranked counterpart over the period 1995-2003. Our study also shows that this performance differential cannot be attributed to differences in market sensitivity, investment style, or industry exposures. On the contrary, performance evaluation results from the multifactor framework indicate that the observed average return difference increases and becomes statistically significant after controlling for risk- and investment style bias. This performance gap widens further once industry-effects are accounted for as well. Consequently, we investigate whether the 'eco-efficiency premium' puzzle survives practical transaction costs scenarios. Using a simple best-in-class stock selection strategy, we show that this premium is large and pervasive under practical conditions.

Environmental Responsibility and Stock Returns

Over the past decades, a large body of literature has investigated the relationship between environmental and financial performance. Unfortunately, the empirical evidence to date has been inconsistent. As pointed out by Ullman (1985) and by Griffin and Mahon (1997), the conflicting results in prior research are mainly attributable to differences in methodology and in the choice of financial and environmental performance indicators. However, for studies using stock returns as a financial performance measure, Wagner (2001) identified three different categories: portfolio studies, event studies, and (multivariate) regression studies.

Portfolio studies typically compose mutually exclusive portfolios based on various corporate social performance indicators and investigate their return differences over a certain investment horizon. For instance, Diltz (1995) studied daily returns for a variety of portfolios composed on the basis of several ethical performance indicators. While many screens did not improve portfolio performance significantly, environmental screens were found to enhance stock performance significantly during the period 1989-1991. Cohen, Fenn and Konar (1997) constructed industry-balanced portfolios with different environmental responsibility characteristics to investigate the financial performance difference between low-polluter and high-polluter companies in the United States. Contrary to Diltz (1995), their findings suggest that there is neither a premium nor a penalty for investing in environmental leader companies. However, a comparison by Yamashita, Sen and Roberts (1999) of 10-year risk-adjusted returns showed that their environmentally highest ranked stocks performed significantly better than lowest ranked stocks. White (1996), furthermore, examined the performance of "green", "oatmeal" and "brown" equity portfolios. He demonstrated that the green portfolio provided a significantly positive Jensen's alpha while the other two alternatives failed to outperform the market. In addition to these studies, some literature has compared self-composed socially screened portfolios with a regular investment portfolio. Along these lines, one of Innovest's on-line research publications discusses the potential usefulness of eco-efficiency scores in making investment decisions. In this work, Blank and Daniel (2002) reported that an equal-weighted eco-efficiency enhanced portfolio delivered somewhat higher Sharpe ratios compared to the S&P500 during the period 1997-2001. Finally, Guerard (1997) used the social performance database of Kinder, Lydenberg, Domini & Co. (KLD) to conclude that portfolios derived from a socially screened investment universe did not perform differently from those obtained from an unscreened set during the period 1987-1996.

Event studies to date provide most pronounced evidence of a linkage between environmental and stock market performance. Shane and Spicer (1983) documented that companies experienced abnormal declines in stock prices two days prior to their pollution figures being reported by the Council on Economic Priorities. Moreover, on the day of publication, negative returns were significantly larger for companies with a relatively poor pollution control record than for companies with better rankings. Hamilton (1995) reported a significantly negative abnormal return for publicly traded companies following the first release of their TRI pollution figures. Consistent with previous results, Klassen and McLaughlin (1996) found evidence suggesting that positive corporate events, measured by environmental awards given to companies by third parties, are associated with positive subsequent abnormal returns. Significantly negative returns tend to follow environmental crises. Similarly, Rao (1996) reported that the performance of companies after pollution reports by the Wall Street Journal between 1989 and 1993 was significantly below their expected market adjusted returns. Only Yamashita *et al.* (1999) did not find significant stock market responses to environmental conscientiousness scores published in July 1993's Fortune Magazine.

A third category of literature primarily used regression or correlation analysis to examine whether a long-term relation exists between corporate environmental responsibility and stock performance. Taken as a whole, these studies provide only limited support for the notion of a relationship between environmental and stock market performance. Spicer (1978) documented that companies in the US pulp and paper industry with better pollution control records have a higher profitability and a lower stock beta. Chen and Metcalf (1980), on the other hand, replicated Spicer (1978) and put his findings in doubt after controlling for the impact of firm size on environmental performance. Using a nearly similar method, Mahapatra (1984) also found no evidence to support the notion that pollution control initiatives are rewarded with improved stock performance.

Most prior research, being implicitly underpinned by Sharpe's (1964) CAPM-framework, merely corrected portfolio performance or observed relationships for a single-risk factor loading. More recent evidence by Fama and French (1993) and Carhart (1997) has pointed out that a single-factor environment is insufficiently capable of explaining the cross-sectional variation in equity returns. Therefore, the relationship between environmental and financial performance observed in studies to date may have been driven by latent factors that were not considered as control variables in the research method. Surprisingly, the empirical literature addressing some of such unobserved influences is limited to non-U.S. studies. These include Thomas (2001; UK), who adds environmental policy dummies to a 2-factor model that controls for size effects in addition to market sensitivity, and Ziegler, Rennings and Schröder (2002; Europe) who control for market risk, firm size and the book-to-market effect. Both find some evidence of a positive association between environmental responsibility and stock performance.

In the remainder of this paper, we will extend prior portfolio research, particularly Blank and Daniel (2002), by considering more advanced performance attribution frameworks and a larger sample.

Measuring Environmental Performance

Whereas most proxies for environmental performance represent absolute pollution levels, the concept of eco-efficiency is frequently used to measure the environmental performance of a firm in a relative sense. Eco-efficiency can be defined as the ratio of the value a company adds (e.g. by producing products) and the wastes the firm generates resulting from the creation of that value; see for instance Schaltegger, Burritt and Petersen (2003). To emphasize the difference between absolute and relative environmental performance, consider, for example, firms that operate in environmentally sensitive industries such as mining, energy, or chemicals. In absolute terms, these firms are typically labeled poor environmental performers. However, along this performance spectrum, firms facing the same environmental challenges can still do well relative to competitors and benefit from this financially.

In order to proxy for corporate eco-efficiency, we obtained rating data from Innovest Strategic Value Advisors (from hereon Innovest). The main benefits of these scores are their comprehensiveness. Using over twenty information sources, both quantitative and qualitative in nature, Innovest's analysts evaluate a company relative to its industry peers via an analytical matrix. Companies are evaluated along approximately sixty dimensions, which jointly constitute the final rating. For each of these factors, all companies receive a score between 1 and 10. As these variables are not considered equally important in the overall assessment of eco-efficiency, each factor is weighted differently. For example, a firm's environmental product development is usually considered more important than, for instance, outside certification by an NGO. The final numerical rating assigned to a company is converted into a relative score based on the total spread of scores in the sector to which the firm belongs.

To summarize, the sub-criteria can be grouped into five broader categories, addressing five fundamental types of environmental factors[3]:

- Historical liabilities: involves risk resulting from preceding actions.
- Operating risk: risk exposure from recent events.
- Sustainability and eco-efficiency risk: future risks initiated by the weakening of the company's material sources of long-term profitability and competitiveness.
- Managerial risk efficiency: the ability to handle environmental risk successfully.
- Environmentally-related strategic profit opportunities: business opportunities, such as a competitive advantage, available to the firm relative to industry peers.

While the Innovest database contains scores on more than 1200 firms globally, this paper only considers U.S. companies. The number of firms is about 180 at the end of May 1997 and increases steadily to approximately 450 at the end of May 2003. All ratings are dated for the month in which they were made available.

Empirical Analysis

Portfolio construction. We construct two mutually exclusive stock portfolios with distinctive eco-efficiency characteristics.[4] After having matched all firms in the Innovest universe with the CRSP stock database, we annually rank the companies on most recent eco-efficiency ratings.[5] Covering 30% of total capitalization, the 'high-ranked' ('low-ranked') portfolio consists of companies rated highest (lowest) by Innovest. The annual re-ranking and portfolio re-balancing occurs at the end of June. When constructing the portfolios, we take into account a one-month lag for the ranking data to avoid look-ahead bias. Companies for which no rankings were available at the rebalancing date are excluded automatically for the subsequent twelve-month period.

Because asset pricing tests require considerable data points we must manage a small-sample problem. The Innovest database contains scores merely for the period 1997-2003. In order to obtain more meaningful results we employ the July-97 ratings backwards until 1995. Since eco-efficiency ratings tend to have a low variability, we believe that extending data backwards for 2 years is acceptable.[6] As a result, end-of-month portfolio return data are observed for the period July 1995-December 2003. It is perhaps interesting to note that shortening the window of analysis to 1997-2003 does not affect the conclusions in this paper.

Table 1 presents an overview of descriptive statistics on the two portfolios. Mean returns, standard deviations and Sharpe ratios are annualized. These basic statistics suggest that the portfolio consisting of highly eco-efficient companies performed better than the eco-inefficient counterpart, even when adjusting for volatility.

[Insert Table 1]

Portfolio Performance in a CAPM-Framework. To account for differentials in the portfolios' market risk, we first measure portfolio performance via the well-established CAPM-framework. Specifically, for all portfolios we employ a (OLS) regression to estimate the model of the form:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \varepsilon_{it}, \qquad (1)$$

where

R_{it}	=	the return on portfolio i in month t,
R_{ft}	=	the one-month T-Bill rate at t,
R_m	=	the return on a value-weighted market proxy in month t,
ε_{it}	=	an error term.

The value-weighted market proxy and the risk-free rate were provided by the Kenneth French Data Library[7]. The model- β_i ('beta') is interpreted as measuring a portfolio's market risk exposure and α_i (Jensen's 'alpha') represents the average abnormal return in excess of the return on the market proxy. Hence, in this scenario it is implicitly assumed that the difference between the return on a portfolio and the return on the single-factor benchmark according to an estimated CAPM provides an accurate estimate of risk-adjusted performance.

Table 2 reports performance evaluation results obtained from the CAPM-framework. We present results for the portfolios comprising high-ranked and low-ranked firms. Since the primary focus of the research is examining the performance differential between the high-ranked portfolio and the low-ranked portfolio, we also investigate the returns on a long-short portfolio, the *difference* portfolio, which is constructed by subtracting the low-ranked portfolio returns from the returns on the high-ranked stock portfolio. The influence of environmental screening on investment performance is derived from the difference in the observed alpha between the high-ranked portfolio and the low-ranked portfolio.

[Insert Table 2]

According to the reported alpha estimates and corresponding t-statistics, both portfolios did not perform significantly different from the market proxy. Furthermore, a comparison of the betas reveals that the portfolios do not differ significantly in exposure to the market factor. The most important observation is that the alpha of the *difference* portfolio is positive (i.e. 3.05% annually), which suggests that the high-ranked portfolio provided a higher market risk-adjusted return than its low-ranked counterpart. Although being economically large, the performance difference observed under this scenario is not statistically significant.

As DiBartoleo and Kurtz (1999) provide evidence suggesting that sector exposures considerably drive SRI portfolio returns, we additionally investigated whether our results tend to be industry-sensitive. We test for industry sensitivity using an approach similar to Pastor and Stambaugh (2002), and Jones and Shanken (2004). This approach, previously applied on socially responsible mutual fund returns by Geczy, Stambaugh and Levin (2003), involves the construction of a factor model composed of the excess market return and three industry factors orthogonal to the primary factor. In order to derive these regressors, a principal components analysis is performed on the portion of Fama and French's 30 excess industry-sorted portfolio returns that cannot be explained by the single-factor model (i.e. the model's intercept and the residual series). Subsequently, the first three components are taken to complement the single-factor model by capturing most remaining industry return variation. The resultant model is of the form:

$$R_{it} - R_{ft} = \alpha_i + \beta_{0i}(R_{mt} - R_{ft}) + \beta_{1\text{-}3i}\, IP_{1\text{-}3t} + \varepsilon_{it}, \qquad (2)$$

where

$IP_{1\text{-}3t}$ = three factors (principal components) capturing industry effects,

After having performed the regression described above we obtained industry bias-free alpha estimates. The results are reported in the final row of Table 2. Notice that Table 2 does not report loadings on the industry-adjustment variables, as these coefficients are more difficult to interpret. The return on the zero-investment portfolio after industry-adjustment increases to 3.82% per annum, indicating that the performance estimates reported previously were adversely affected by industry exposures. The model intercept remains insignificant nonetheless.

Performance in a Multifactor Framework. In spite of the widespread use of the single-factor performance model, it has been repeatedly argued that the model is insufficiently capable of explaining the cross-section of expected stock returns. Fama and French (1993) empirically established the inefficiency of the CAPM-framework and introduced a three-factor model that includes the factors SMB and HML in addition to excess market return. Essentially, SMB represents a 'small-versus-large' cap return spread and HML is defined as the return on a 'value-versus-growth' stock portfolio. Although the benefits of the 3-factor model are nowadays acknowledged, the model is subject to further improvement. Examining persistence in U.S. mutual fund performance, Carhart (1997) demonstrated that the 3-factor model fails to explain the Jegadeesh and Titman (1993) momentum strategy and proposed the addition of a momentum factor to existing performance models.

For the reasons mentioned above, this section analyzes the historical monthly return distribution of the two portfolios by means of the multifactor performance model by Carhart (1997). In using three additional control variables, we mitigate potentially severe biases resulting from the presence of style tilts in stock portfolios (e.g. size, value versus growth or momentum effects).[8] This is particularly important given mounting evidence that the returns on style investment strategies account for a considerable portion of SRI-portfolio performance; see for example Bauer *et al.* (2002) and Gregory, Matatko and Luther (1997). To further adjust average returns for industry effects, we extend the industry-adjustment routine explained earlier to a multivariate setting by analyzing the residuals derived from a regression of Fama and French's industry-sorted portfolio returns on the four factors.

Formally, the approach to performance assessment entails estimation of the following equations:

$$R_{it} - R_{ft} = \alpha_i + \beta_{0i}(R_{mt} - R_{ft}) + \beta_{1i}\,SMB_t + \beta_{2i}\,HML_t + \beta_{3i}\,MOM_t + \varepsilon_{it}, \tag{3}$$

where

SMB_t = the return difference between a small cap portfolio and a large cap portfolio in month t,

HML_t = the return difference between a value (high B/M) portfolio and a growth (low B/M) portfolio in month t,

MOM_t = the return difference between a portfolio of past 12-month winners and a portfolio of past 12-month losers in month t,

and

$$R_{it} - R_{ft} = \alpha_i + \beta_{0i}(R_{mt} - R_{ft}) + \beta_{1i}SMB_t + \beta_{2i}HML_t + \beta_{3i}MOM_t + \beta_{4\text{-}6i}IP_{1\text{-}3t} + \varepsilon_{it} \qquad (4)$$

SMB and HML were obtained from the Kenneth French Data Library. The momentum factor (MOM) was provided by Carhart.

Table 3 reports performance estimates resulting from estimation of the four-factor model (equation 3). Compared to the results in the previous section, the table displays several prominent differences. First, the adjusted R-squared from the models has increased as compared to the adjusted R-squared values reported in the previous section. This observation confirms the incremental explanatory power of a multivariate framework. Second, notice that the high-ranked portfolio earned a large and significant average factor-adjusted return equal to 3.98 per annum, whereas the low-ranked portfolio performed poorly. Third, factor loadings on the additional determinants SMB, HML and MOM are generally significant. For both the high-ranked portfolio and the low-ranked portfolio, we observe a significantly negative coefficient on SMB, which implies a bias towards large capitalization stocks. Factor loadings on HML suggest the high-ranked portfolio was somewhat growth stock-oriented during the examined period, whereas the low-ranked portfolio was significantly tilted towards value stocks. We also observe a rather counterintuitive loading on MOM. The significantly negative coefficients on the momentum factor, suggesting that both companies with a relatively bad and those with good historical stock performance record tend to have relatively poor eco-efficiency rankings, seem counterintuitive at first glance. Since prior related studies revealed evidence of a positive relation between financial performance and subsequent social performance (Chung, Eneroth and Schneeweis (2003) for instance) we expected the high-ranked portfolio to be positively related to the momentum factor.

[Insert Table 3]

Results with regard to the *difference* portfolio show that the performance differential between the two portfolios equals 5.06% per annum after adjusting for multiple factor loadings. This difference is also significant at the 10% cut-off level, and almost significant at the 5% level. As for the factor loadings, the results confirm the conjecture that there are significant differences in styles or risk sensitivities between the two extreme portfolios. In line with the outcomes within the CAPM-framework, the two portfolios do not significantly differ in exposure to market risk. Only with respect to HML the *difference* portfolio exhibits a significant factor exposure.

The final two rows in Table 3 report coefficients and corresponding t-statistics estimated using the seven-factor model that additionally controls for industry tilts (equation 4). Once industry effects are taken into account, the difference in performance between the high-ranked portfolio and the low-ranked portfolio increases mildly to 6.04% per annum and becomes statistically significant at the 5% level. Perhaps remarkably, differences in factor loadings between the two portfolios also become more pronounced after removing industry effects. We observe significant differences in market sensitivity and exposure with respect to SMB and HML.

However, it should be noted that the logical interpretation of performance evaluation results can be overly driven by various parameters in the measurement process that have been specified exogenously. Continuing with the analysis of industry-adjusted returns, we therefore also 'endogenize' some of these parameters by considering alternative portfolio construction methodologies and return calculations. Empirical results of the robustness checks are reported in Table 4.

[Insert Table 4]

In the first row of the table, we report the outcome of estimating the seven-factor model using equal-weighted industry-adjusted portfolio returns, instead of value-weighted returns. The performance gap between the high-ranked portfolio and its low-ranked counterpart narrows to 2.17%, indicating that alpha relies more on large caps than on small caps. However, portfolio construction based on equal weighting is uncommon in practice.

Continuing with the analysis of value-weighted industry-adjusted returns, we furthermore find that the results are somewhat sensitive to changes in portfolio formation. Rows 2 and 3 in Table 4, reporting the results of using size deciles of 20% and 40% of total capitalization respectively, reveal different outcomes compared to the initial scenario. If we use 20% quintiles, thereby increasing the distinction in environmental performance between the portfolios, the performance gap widens to 8.60%. On the other hand, if we construct portfolios covering 40% of total market value, then the performance difference reduces to 4.69%. In both cases, however, the excess return remains significant from both an economic and a statistical perspective.

Finally, we computed alphas for portfolios only comprising stocks from environmentally sensitive industries (e.g. electric utilities, chemistry, metal and mining, paper and forest products, aerospace and defense, petroleum). The last row in Table 4 shows that the industry-adjusted performance differential reduces to 4.47% but remains statistically significant at the 5% level. Nonetheless, this observation is rather remarkable and counterintuitive, given that environmental responsibility and compliance expenditures in these industries are usually substantial.

Overall, we find that companies performing relatively well along environmental dimensions collectively provide superior returns. The average return on the zero-investment strategy is economically large and statistically significant on a risk-, style-, and industry-neutral basis. In terms of statistical significance, the premium estimate is reasonably robust to variations in methodology. Therefore, the results as a whole corroborate the notion that there are benefits to environmentally responsible investing.

Our findings, however, also call for an important discussion. Given that efforts to correct for investment style and industry bias fail to explain the observed performance differential, a logical question concerns the nature of the eco-efficiency premium. Is the observed performance gap attributable to latent risk factors or due to mispricing? Many so-called anomalies, such as the size effect (Banz, 1981), the value premium (Fama and French, 1993), and the momentum anomaly (Jegadeesh and Titman, 1993) have been subject to considerable debate. A vast majority of scholars suggest most return anomalies can be interpreted as proxies for various forms of risk – see for example (Fama and French, 1993, Vassalou and Xing, 2004, and Pastor and Stambaugh, 2003) – while others attribute the observed effects to market inefficiencies (e.g. Lakonishok, Schleifer and Vishny, 1994, or Haugen and Baker, 1996). Contrary to these well-documented return premia, however, the eco-efficiency premium is difficult to explain within the well-known risk-return paradigm.[9] We also find it difficult to attribute the results to deficiencies in the performance attribution analysis, as our results are robust to, if not strengthened by, the inclusion of factors that control for investment risk, investment style and severe industry effects.

Accordingly, the alternative explanation - in spirit similar to Lakonishok et al. (1994) and Haugen and Baker (1996) - is that our findings are due to the market's inability to price eco-efficiency in an efficient manner. This interpretation could also explain the smaller magnitude of the eco-efficiency premium observed within environmentally sensitive industries. In environmentally sensitive sectors, where eco-efficiency is arguably a significant driver of future corporate performance, investors are more likely to factor environment-related information into investment decisions. In sectors where the benefits of eco-efficiency are less obvious, corporate eco-efficiency information may be priced inappropriately by financial markets.

Practical Implications: a Best-in-Class Strategy.

Previous sections showed that a portfolio comprising stocks of high-ranked firms outperformed its low-ranked counterpart after adjusting return for market risk, investment style and industry effects. However, obtaining evidence by adjusting returns *after the fact* may not be very useful from an investor's perspective. In this section, we therefore outline the economic implications of our findings by demonstrating how one can construct an environmentally responsible investment portfolio under practical conditions. To take into account our evidence that industry tilts influence portfolio performance greatly, we construct a SRI-portfolio based on 'best-in-class' analysis, an approach that is commonly applied in the socially responsible investment industry.

We first identify 12 industries using Fama and French's industry classification scheme[10]. In each of our twelve industry groups all companies in our data set are first ranked on the eco-efficiency scores. Within each industry, we then construct a value-weighted portfolio of high-ranked stocks and a portfolio of low-ranked stocks. As a general rule the two portfolios are equal in size, namely 30% of total capitalization, and mutually exclusive. Occasionally, however, when the number of companies within an industry is limited, firms are assigned to both the high-ranked group and the low-ranked alternative. This is done in order to maintain a balance in the portfolios' asset size. Based on the ratio of total industry capitalization to total market value of all firms in the NYSE-AMEX-Nasdaq universe, we compute twelve industry weights. We finally assign these weights to our sub-portfolios in order to obtain a best-in-class portfolio and a worst-in-class portfolio.

Summary statistics on the strategies are reported in table 5. The best-in-class portfolio, having earned an annual return of 13.07% in the absence of transactions costs, outperformed the worst-in-class portfolio, which paid an average return of 9.88%. Corresponding Sharpe ratios indicate that the performance difference persists after adjusting for volatility. Notice that our worst-in-class portfolio comprises more companies and exhibits a higher turnover compared to the best-in-class portfolio.

[Insert Table 5]

Figure 1 displays the cumulative return over time for the two strategies. While the cumulative performance difference between the high-ranked portfolio and the low-ranked portfolio is substantial at the end of the observation period, i.e. approximately 66%, the return gap widened predominantly during the second half of the observation window.

[Insert Figure 1]

Table 6 reports performance evaluation results using the CAPM-framework, as indicated by equation (1).[11] On a market risk-adjusted basis the best-in-class portfolio earned an average annualized return equal to 2.46%. The worst-in-class portfolio underperformed, earning a return of -1.09%. The alpha computed for the *difference* portfolio is 3.55%, which is significant at the 10% level. Moreover, the difference in performance between the two portfolios is robust to the introduction of transaction costs. In fact, an increase in transaction costs leads to a widening of the return gap, most probably because the worst-in-class portfolio suffers from a higher turnover rate compared to the best-in-class strategy. For example, in the 200bp-scenario the best-in-class portfolio outperforms the worst-in-class strategy by 3.82% on a market risk-adjusted basis. Notice that this performance difference resembles the one reported previously in Table 2.

[Insert Table 6]

Table 7 reports the outcomes of performing the multivariate performance attribution analysis using equation (3). As expected, the results are generally more pronounced after controlling for style bias. In the absence of transaction costs, the best-in-class portfolio delivers an annualized alpha of

4.15%. The alpha is statistically significant at the 5% level. The worst-in-class portfolio, on the other hand, clearly displays inferior performance. Its four-factor alpha is approximately -1.80%. Accordingly, the alpha computed for the *difference* portfolio is 5.96%, which is significant at the 5% level. Once again, it is interesting to note that this performance estimate is nearly similar to that reported in Table 3 in the previous section.

[Insert Table 7]

In the presence of transaction costs, the excess return on the best-in-class portfolio remains statistically significant. For instance, even in the 200bp-scenario we find that the annualized alpha of the best-in-class portfolio is still large, i.e. 3.43%, and statistically significant at the 10% level. Unsurprisingly, the factor-adjusted return on the *difference* portfolio is statistically significant at the 5% level in all transaction costs scenarios. Our results therefore strongly suggest that the eco-efficiency premium is exploitable in a practical setting.

Concluding Remarks

The majority of academics and investors, relying on standard portfolio theory, have been reluctant to embrace the socially responsible investing doctrine. In spite of the widespread skeptical attitude towards SRI, we present evidence that a stock portfolio consisting of companies labeled 'most eco-efficient' sizably outperformed its 'less eco-efficient' counterpart over the period 1995-2003. Using several enhanced performance attribution models to overcome methodological concerns, we show that the observed performance difference cannot be explained by differences in market sensitivity, investment style, or extreme industry tilts. Even in the presence of transaction costs, a simple best-in-class stock selection strategy historically earned a higher risk-adjusted return of 6% compared to a worst-in-class portfolio. Overall, our findings suggest that the benefits of considering environmental criteria in the investment process can be substantial.

Our results are puzzling in the sense that it is difficult to explain the observed performance differential using conventional asset pricing theory, and particularly the well-established return-risk paradigm. The fact that common risk factors fail to account fully for the observed results raises the possibility of a mispricing story. However, testing a mispricing hypothesis is beyond the scope of this paper. We leave our findings open to interpretation and encourage future research to concentrate on longer time-series data and to present complementary evidence from different countries.

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Table 1. Descriptive Statistics on the Extreme Portfolios

The high-ranked portfolio consists of stocks of firms with the highest eco-efficiency ratings. The low-ranked portfolio comprises companies with the lowest eco-efficiency scores. The Sharpe ratio is the ratio of the mean excess return to the standard deviation of return. The mean return, the standard deviation and the Sharpe ratio are annualized. Sample period: 1995:07 – 2003:12

Portfolio	Mean Return	Std. Dev.	Sharpe	Maximum	Minimum
High-Ranked Companies	12.20	17.82	0.46	13.06	-12.86
Low-Ranked Companies	8.87	17.01	0.28	9.95	-11.48

Table 2. Empirical Results 1-Factor Regressions

This table reports the results of estimating CAPM-based regression models. For all portfolios we estimated the model formally defined by equation (1):

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \varepsilon_{it}, \qquad (1)$$

where $R_{it} - R_{ft}$ denotes the return on the portfolio in excess of the risk-free rate and $R_{mt} - R_{ft}$ is the excess return on the market portfolio. The *difference* portfolio is constructed by subtracting low-ranked portfolio returns from the returns on the high-ranked stock portfolio. The final row displays the results of estimating the difference in industry-adjusted return using three additional regressors obtained via a principal components analysis:

$$R_{it} - R_{ft} = \alpha_i + \beta_{0i}(R_{mt} - R_{ft}) + \beta_{1\text{-}3i}\, IP_{1\text{-}3t} + \varepsilon_{it}, \qquad (2)$$

See Pastor and Stambaugh (2002). Coefficients on $IP_{1\text{-}3t}$ are not reported. T-statistics (in brackets) are derived from Newey-West (1987) heteroskedasticity and autocorrelation consistent standard errors. Sample period: 1995:07 – 2003:12. Alphas are are in annualized percentages.

Portfolio	α	$(R_m - R_{ft})$	adj. Rsq.
High-Ranked Companies	1.29	0.94***	0.82
	(0.51)	(22.62)	
Low-Ranked Companies	-1.76	0.91***	0.83
	(-0.86)	(15.87)	
Difference	3.05	0.04	0.00
	(1.09)	(0.66)	
Industry-Adjusted Difference	3.82	0.03	0.00
	(1.42)	(0.39)	

* *significant at 10% level*

** *significant at 5% level*

*** *significant at 1% level*

Table 3. Multifactor Regression Results

This table reports empirical results corresponding to the multifactor regressions formally defined by equation (2):

$$R_{it} - R_{ft} \quad = \quad \alpha i + \beta_{0i}(R_{mt} - R_{ft}) + \beta_{1i}\, SMB_t + \beta_{2i}\, HML_t + \beta_{3i}\, MOM_t + \varepsilon_{it}, \qquad (3)$$

$R_{mt} - R_{ft}$ represents the returns on the market proxy in excess of the risk-free rate, SMB denotes the difference in return between a small cap portfolio and a large cap portfolio, HML denotes the return spread between a value portfolio and a growth portfolio and MOM is the return difference between a prior 12-month winner portfolio and a prior 12-month loser portfolio. The *difference* portfolio is constructed by subtracting low-ranked portfolio returns from the returns on the high-ranked stock portfolio. The final row displays the results of comparing portfolio returns after adding 3 industry-adjustment factors to the four-factor model:

$$R_{it} - R_{ft} \quad = \quad \alpha i + \beta_{0i}(R_{mt} - R_{ft}) + \beta_{1i}\, SMB_t + \beta_{2i}\, HML_t + \beta_{3i}\, MOM_t + \beta_{4\text{-}6i}\, IP_{4\text{-}6t} + \varepsilon_{it}, \qquad (4)$$

See Pastor and Stambaugh (2002). Coefficients on $IP_{4\text{-}6t}$ are not reported. T-statistics (in brackets) are derived from Newey-West (1987) heteroskedasticity and autocorrelation consistent standard errors. Sample period: 1995:07 – 2003:12. Alphas are annualized percentages.

Portfolio	α	$(R_m - R_{ft})$	SMB	HML	MOM	adj. Rsq.
High-Ranked Companies	3.98*	0.90***	-0.22***	-0.08	-0.10***	0.87
	(1.93)	(25.02)	(-4.30)	(-1.16)	(-5.99)	
Low-Ranked Companies	-1.08	0.95***	-0.15***	0.11**	-0.08***	0.88
	(-0.55)	(19.09)	(-3.70)	(2.29)	(-2.62)	
Difference	5.06*	-0.05	-0.07	-0.19**	-0.02	0.01
	(1.86)	(-0.80)	(-0.95)	(-2.20)	(-0.43)	
Industry-Adjusted Difference	6.04**	-0.20*	-0.14*	-0.30**	-0.01	0.01
	(2.38)	(-1.79)	(-1.87)	(-2.18)	(-0.18)	

* *significant at 10% level*

** *significant at 5% level*

*** *significant at 1% level*

Table 4. Robustness Analysis: Results under Alternative Methodologies

The table reports the results of performing regression (4) when applying some changes to various parameters in the methodology. The first row presents the difference in alpha estimates between the high-ranked portfolio and the low-ranked portfolio derived from industry-adjusted equal-weighted portfolio returns. The second and third row reports the results of changing the size of the upper (lower) deciles of the portfolios to 20% and 40% of total capitalization respectively. Finally, the last row reports the industry-adjusted performance difference when only companies belonging to environmentally sensitive industries are considered. T-statistics (in brackets) are derived from Newey-West (1987) heteroskedasticity and autocorrelation consistent standard errors. Sample period: 1995:07 – 2003:12. Alphas are annualized percentages.

	α	$(R_m - R_{ft})$	SMB	HML	MOM	adj. Rsq.
<u>*Equal – Weighting*</u>						
Industry-adjusted Difference portfolio	2.17	-0.10	-0.15***	-0.12*	-0.01	0.18
	(1.11)	(-1.08)	(-3.33)	(-1.75)	(-0.41)	
<u>*20% portfolios*</u>						
Industry-adjusted Difference portfolio	8.60***	-0.21	-0.09	-0.23	0.01	-0.04
	(2.83)	(-1.40)	(-1.21)	(-1.36)	(0.28)	
<u>*40% portfolios*</u>						
Industry-adjusted Difference portfolio	4.69**	-0.31**	-0.22***	-0.28**	0.01	0.06
	(2.40)	(-2.62)	(-3.41)	(-1.98)	(0.51)	
<u>*Sensitive sectors only*</u>						
Industry-adjusted Difference portfolio	4.47**	-0.17**	-0.14***	-0.24**	0.09***	0.15
	(2.07)	(-2.25)	(-2.72)	(-2.60)	(3.77)	

* *significant at 10% level*

** *significant at 5% level*

*** *significant at 1% level*

Table 5. Descriptive Statistics: Best-in-Class vs. Worst-in-Class Portfolio

The table reports summary statistics on the two extreme portfolios. The best-in-class (worst-in-class) portfolio comprises firms having the highest (lowest) eco-efficiency score in each industry group. The Sharpe ratio is the ratio of the mean excess return to the standard deviation of return.The mean return, the standard deviation and the Sharpe ratio are annualized. Sample period: 1995:07 – 2003:12

	Mean	StDev	Sharpe	Avg. Turnover	Avg # firms
Best-in-Class Portfolio	13.07	17.23	0.53	19.67%	88
Worst-in-Class Portfolio	9.88	18.04	0.33	28.65%	163

Table 6. Market risk-adjusted Returns under Different Transactions Costs Scenarios

The table reports the results of performing regression (1) under various levels of transactions costs (roundtrip). Alphas and betas are presented for the best-in-class portfolio and for the worst-in-class portfolio under the zero transaction costs scenario. Alphas under higher transaction costs scenarios are reported in the final four columns. Alphas are annualized percentages. T-statistics (in brackets) are derived from Newey-West (1987) heteroskedasticity and autocorrelation consistent standard errors. Sample period: 1995:07 – 2003:12.

	α (0bp tc)	Rm-Rf	Adj. Rsq	α (50 bp tc)	α (100 bp tc)	α (150 bp)	α (200bp tc)
Best-in-Class Portfolio	2.46	0.91***	0.83	2.30	2.15	2.00	1.85
	(1.15)	(20.78)		(1.07)	(1.00)	(0.93)	(0.86)
Worst-in-Class Portfolio	-1.09	0.96	0.84	-1.31	-1.54	-1.76	-1.98
	(-0.44)	(19.96)		(-0.53)	(-0.62)	(-0.71)	(-0.79)
Difference	3.55*	-0.05	0.00	3.62*	3.69*	3.76*	3.82*
	(1.85)	(-1.20)		(1.88)	(1.91)	(1.94)	(1..97)

* *significant at 10% level*

** *significant at 5% level*

*** *significant at 1% level*

Table 7. Multifactor-adjusted Returns under Different Transactions Costs Scenarios

The table reports the results of performing regression (3) under various levels of transactions costs (roundtrip). Four-factor alphas are presented for the best-in-class portfolio and for the worst-in-class portfolio under the zero transaction costs scenario. Alphas under higher transaction costs scenarios are reported in the final four columns. Alphas are annualized percentages. T-statistics (in brackets) are derived from Newey-West (1987) heteroskedasticity and autocorrelation consistent standard errors. Sample period: 1995:07 – 2003:12.

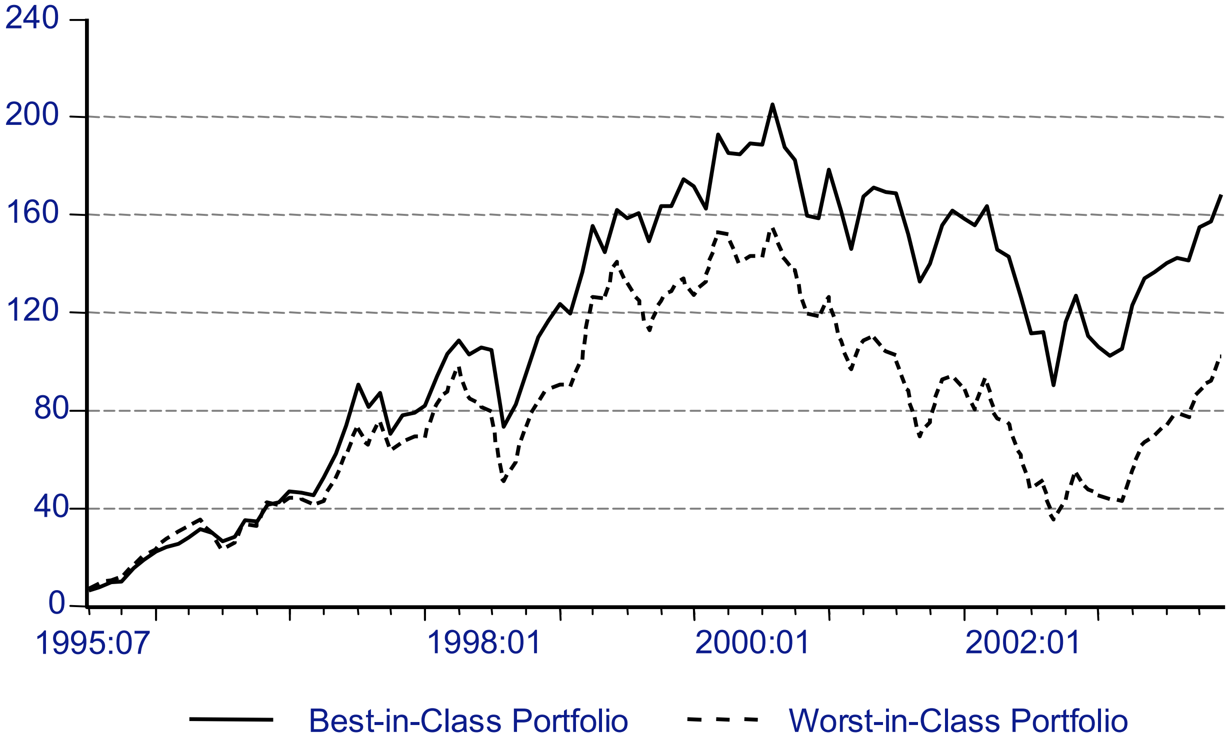
	α (0bp tc)	Rm-Rf	SMB	HML	MOM	Adj. Rsq	α (50 bp tc)	α (100 bp tc)	α (150 bp)	α (200bp tc)
Best-in-Class Portfolio	4.15**	0.92***	-0.19***	0.02	-0.09***	0.88	3.97**	3.79*	3.61*	3.43*
	(2.11)	(24.15)	(-4.14)	(0.26)	(-5.31)		(2.02)	(1.92)	(1.82)	(1.72)
Worst-in-Class Portfolio	-1.81	1.03***	0.04	0.23***	-0.08***	0.86	-2.06	-2.31	-2.56	-2.8
	(-0.77)	(27.49)	(0.93)	(4.59)	(-2.86)		(-0.88)	(-0.98)	(-1.09)	(-1.20)
Difference	5.96**	-0.12***	-0.23***	-0.22***	-0.01	0.17	6.02**	6.10**	6.16**	6.23**
	(2.54)	(-3.02)	(-3.82)	(-3.52)	(-0.20)		(2.56)	(2.58)	(2.60)	(2.62)

* *significant at 10% level*

** *significant at 5% level*

*** *significant at 1% level*

Figure 1: Cumulative Return %



Notes

[1] See Social Investment Forum (2001).
[2] Other literature on the performance of U.S. SRI mutual Funds and/or SRI indexes includes Hamilton, Jo, and Statman (1993), Sauer (1997), and Geczy, Stambaugh and Levin (2003).
[2] Source: Innovest (2003)
[3] It should be noted that the sorting approach proposed in this study does not allow for an explicit judgment on the direction of causality between environmental and financial variables. We are merely concerned with the long-term benefits of incorporating environmental criteria into the investment process.
[4] Matching occurred by ticker, company name and CUSIP number. Since the CRSP database is survivor-bias free we are able to analyze the returns for firms that disappeared during the sample period, e.g. due to merger or bankruptcy.
[6] We are aware that this procedure potentially introduces look-ahead bias. However, the ratings' variability is extremely low, and the results of using the 'real-time' period 1997-2003 are similar to those reported in the paper. These results are available upon request.
[7] Available on: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
[8] Although there is an ongoing discussion about whether these additional factors proxy for risk, we will have no perception on the subject but merely use the factor mimicking portfolio returns as control variables in the performance estimation process.
[9] Strictly speaking, this means the returns to our strategy can be interpreted as an anomaly instead of a premium.
[10] Companies were assigned to one of the following industries: Consumer Durables, Consumer Non-Durables, Manufacturing, Energy, Chemical, Business Equipment, Telephone and Television, Utilities, Shops, Health, Money/Finance, and all remaining.
[11] As best-in-class and worst-in-class strategies are industry-neutral of nature, we do not consider model (4).

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