The Economic Value of Corporate Eco-Efficiency

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ABSTRACT

This study adds new insights to the long-running corporate environmental-financial performance debate by focusing on the concept of eco-efficiency. Using a new database of eco-efficiency ratings, we document a positive but asymmetrical relation between eco-efficiency and a firm's Tobin's *q*. Moreover, our results suggest that the market's valuation of environmental performance has been time variant, which may indicate that the market incorporates environmental information with a drift. Although environmental leaders initially did not sell at a premium relative to laggards, the premium has increased significantly over time. Finally, we report that eco-efficiency relates to operating performance. Environmental leaders do not have a return on assets superior to that of the control group, but laggards display significant operational underperformance. The results suggest that company managers do not face a tradeoff between eco-efficiency and financial performance, and that investors can use environmental information for investment decisions.

Key words: *Corporate Social Responsibility, Eco-Efficiency, Shareholder value, Firm Value, Firm Operating Performance, Management Policies, Capital Markets*
JEL Classification: G1, G3, M14

INTRODUCTION

Fuelled by widely reported corporate environmental and social scandals, managers and shareholders are now showing heightened interest in the concept of corporate social responsibility (CSR). Some of the world's largest institutional asset managers, for example, those at CalPERS in the U.S., Universities Superannuation Scheme in the UK, ABP and PGGM in the Netherlands, and AP7 in Sweden, are publicly demonstrating their commitment to investing in companies that are deemed socially, morally, and environmentally responsible.

In addition, several governmental organizations are considering the introduction of corporate reporting standards designed to accelerate these developments. For instance, an amendment to the 1995 Pension Act in the UK, which was created in 2000, requires pension funds to disclose how they consider social and environmental issues.

In spite of greater acceptance of corporate social responsibility principles, there is a long-running debate on whether managers should incorporate CSR policies into their tactical and strategic decisions. One intriguing question has been the source of this great controversy: Can a firm do well while doing good? Most skeptics believe CSR is a vague construct that requires organizations to raise operating costs and to give up shareholder wealth (e.g., Walley and Whitehead, 1994). In contrast, scholars such as Fombrun et al. (2000), Porter and van der Linde (1995), and Spicer (1978) posit that corporate social responsibly initiatives can lead to reputational advantages, improvements in investors' trust in the company, more efficient use of resources, and new market opportunities, all of which could ultimately be perceived positively by capital markets.

Corporate environmental performance is considered an important component of the CSR construct, and its potential usefulness as a forward-looking measure of firm financial performance has gained acceptance, both in the literature and in practice. Although the assessment of the CSR-financial performance relationship relies heavily on qualitative data and subjective interpretation, the financial impact of environmental governance is easier to assess *a priori*, particularly now that the law punishes negative environmental performance with concrete financial penalties more than ever before. For example, 15 years after the widely reported Exxon Valdez oil spill drama in Alaska, a federal judge recently imposed punitive damages of more than $4 billion on the Exxon Mobil Corporation.

However, several scholars have stressed that the financial information content of environmental performance is not evident by itself. Among others, Hart and Ahuja (1996), King and Lenox (2002), and Russo and Fouts (1997) emphasize that companies can display environmental awareness through "end-of-pipe" pollution control, where companies clean up emissions subsequent to the production process, but that proactive pollution prevention techniques embedded in the firm's production processes are more likely to increase operating efficiency and profitability.

Building on these assertions, we focus on the concept of corporate eco-efficiency, a concept that reflects the environmental governance of the firm beyond that which is indicated by elementary environmental compliance and pollution control policies. Broadly, we can define eco-efficiency as creating more value with fewer environmental resources resulting in less environmental impact (for example, less pollution or natural resource exhaustion).

Using a comprehensive database of firm-level eco-efficiency scores produced by Innovest Strategic Value Advisors, we examine the relationship between corporate eco-efficiency and financial performance while taking into account several financial performance measures. The eco-efficiency data we use are made available on a monthly basis, allowing us to exploit statistical power. Further, we demonstrate the relevance of examining the robustness of the relation between eco-efficiency and financial performance over time. Although the eco-efficiency scores we study are based on multidimensional research and are now monitored by some of the world's largest institutional investors, the data are new and have not yet received much attention in the empirical literature.

One exception is a recent study on eco-efficiency, which we aim to extend along several lines. Derwall et al. (2005) compose two equity portfolios of stocks sorted on the eco-efficiency scores and assess their performance using elaborate performance attribution models. Their results suggest that companies labeled the most eco-efficient significantly outperformed their least eco-efficient counterparts by approximately 6% per annum over the period 1995-2003. Their findings are anomalous in the sense that neither differences in portfolio risk nor differences in investment style and sector exposure can explain the observed return differential. Our study complements their research by examining the relationship between eco-efficiency and, respectively, firm value and firm operating performance. We pay close attention to potentially confounding influences by including a broad range of control variables.

In choosing firm value (Tobin's *q*) and operating performance (Return on Assets (ROA)) as financial performance criteria, we do not only look at several dimensions of financial performance but also shed new light on the nature of the eco-efficiency premium puzzle documented in Derwall et al. (2005). Conventional financial-markets theory states that assets are priced efficiently so that their expected returns reflect a fair compensation for associated investment risk. Because Derwall et al. (2005) document realized returns of eco-efficient companies that are not entirely consistent with popular expected return models that incorporate market-wide risk factors, their evidence is difficult to reconcile with the risk-return paradigm. Their results may be interpreted as evidence that information related to eco-efficiency is value-relevant, but incorporated slowly into a company's stock price.

After examining the degree to which eco-efficiency is factored into firm valuation measures, such as Tobin's q, we provide additional empirical validation for an undervaluation story. That is, relatively undervalued companies experience a period of upward share price correction and display a relative increase in Q over time. Even if capital markets do not value eco-efficiency directly, the influence of eco-efficiency on financial performance may be realized through alternative channels of transmission. In the tradition of Alexander and Buchholz (1978), and Porter and van der Linde (1995), we can hypothesize that eco-efficiency is a sign of production efficiency or a proxy for management skill, and therefore related to the firm's operational performance. This possibility is our primary motivation for considering operating performance measures as well.

The paper is organized as follows. Section 2 gives an overview of prior related research, taking into consideration the financial variables of interest to this paper. This section also notes several limitations encountered in the literature and highlights the contribution of this study. Section 3 outlines several theoretical lines of reasoning pertaining to the link between corporate social (environmental) performance and financial performance. Section 4 describes the database we use for measuring corporate eco-efficiency. In section 5, we discuss the empirical analysis. Section 6 concludes.

LITERATURE REVIEW

Researchers have long sought empirical evidence on the environmental-financial performance link. However, studies on CSR are well documented, but not well structured. Griffin and Mahon (1997) and Ullman (1985), among others, discuss this literature and point out that methodological inconsistencies across studies make most evidence incomparable and inconclusive. In this section, we review prior research while keeping in mind the financial variables central to this study: stock returns, firm value measured by Tobin's q, and return on assets (ROA).

Prior Evidence

The empirical literature relating the environmental component of CSR to stock performance separates into three subsets: event studies that explore the immediate effects of social or environmental performance proxies on short-term stock price variability; cross-sectional regression analyses that attempt to establish a longer-term relationship between CSR and stock returns; and portfolio studies that investigate the benefits of embedding CSR into investment decisions.

To date, event studies provide the best evidence of a link between environmental and stock market performance. This body of research, which includes studies by Hamilton (1995), Klassen and McLaughlin (1996), and Shane and Spicer (1983) suggests that although environmental pollution figures generally tend to have an influence on stock market performance, there is also an asymmetrical stock return sensitivity to environmental news. For example, Klassen and McLaughlin (1996) find evidence suggesting that a stock price increase following positive environmental information about the firm is less strong than a price decline in response to negative news.

A second group of studies uses regression or correlation analysis to explore long-term relationships between corporate environmental responsibility and stock returns. These studies provide mixed support for the notion of a relationship between environmental performance and shareholder value. Spicer (1978) reports that those companies in the U.S. pulp and paper industry that have better pollution control records have higher profitability figures and lower stock betas, but both Chen and Metcalf (1980) and Mahapatra (1984) fail to confirm the idea that pollution control initiatives are rewarded with improved stock performance. More consistent evidence pertains to markets outside the United States, for which Thomas (2001; UK) and Ziegler et al. (2002; Europe) document moderate evidence of a positive relationship between environmental performance and stock returns. Portfolio research typically involves a comparison of average risk-adjusted returns between two or more mutually exclusive portfolios. These portfolios are constructed using a company characteristic as a discriminating factor. Portfolios are usually evaluated by using a performance attribution model that controls for common intervening factors known to influence portfolio performance.

Despite the popularity of this approach in the mainstream asset pricing literature (e.g., Fama and French, 1993), remarkably little research has applied environmental firm characteristics as a discerning variable. Among the few exceptions, research by Cohen et al. (1997) suggests that there is neither a premium nor a penalty for investing in environmental leader companies. On the other hand, White (1996) finds that his "green" portfolio provides a significantly positive market-risk adjusted return, while "brown" and "oatmeal" portfolios do not. Recent research by Derwall et al. (2005), who use enhanced performance evaluation techniques, suggests that eco-efficient companies jointly provide anomalously positive equity returns relative to their less-eco efficient peers over the period 1995-2003.

A relatively recent strand of research addresses the evidence on potential links between environmental performance and firm value. Generally, the evidence is uniform and points to a positive and significant relationship between environmental management policies and Tobin's q. Dowell et al. (2000) separate multinational firms in their U.S. sample into three groups: firms that default internationally to (less stringent) local environmental standards; companies that apply U.S. environmental standards on an international scale; and firms that adopt more stringent standards than those required by U.S. law. Their results suggest that firms that adopt higher, more stringent environmental criteria have a higher firm valuation than those that use less stringent ones.

These findings are consistent with Konar and Cohen (2001), who suggest that firms that are disposing of relatively smaller amounts of toxic chemicals, and those that are confronted with fewer or no environmental lawsuits, tend to have a higher *Q*. King and Lenox (2002) further expand previous research by disentangling the emissions of a large number of U.S. firms into sub-aggregates. The important conclusion from their work is that waste prevention and future firm value are positively associated, but that pollution reduction efforts by other means, such as "end-of-pipe" pollution treatment, do not affect Tobin's *q*.

Another massive body of research relies on operating performance measures, predominantly using accounting data.[1] Not surprisingly, the results from this research are somewhat dependent on the choice of operating performance measure. A few empirical studies are of particular concern to our work. Considerable interest has been shown in the company's return on assets as a dependent variable, primarily because ROA is one of the broadest measures of firm operating performance. For example, Freedman and Jaggi (1988) investigate the relation between environmental pollution disclosure and several accounting-based performance indicators but find little evidence to support the conjecture that there is a clear-cut and significant association. However, McGuire et al. (1988) show that, contrary to alternative measures in their study, ROA does correlate with their corporate social performance index. Russo and Fouts (1997) complement previous work, suggesting that environmental performance is positively connected with ROA but also that this association is more pronounced for high-growth industries. Hart and Ahuja (1996) and Waddock and Graves (1997) also report that several financial measures, including ROA, relate significantly to environmental performance indicators, but express some doubts regarding the direction of causality. In a more recent study, King and Lennox (2002) suggest that pollution prevention, but not pollution treatment, causes higher return on assets.

Contribution to Existing Literature

While the research up to this point seems overwhelming at first glance, a substantial part of the evidence should be interpreted with caution. Our goal in this paper is to overcome several methodological limitations that are often encountered in the empirical literature. Broadly, our enhancements pertain to the following areas.

First, we address the problem of choosing an appropriate proxy for environmental performance. Corporate social (environmental) responsibility is a broad construct that can only be assessed with multidimensional indicators. As also suggested by Waddock and Graves (1997), the majority of related literature relies on measures that either lack sufficient depth and detail or, alternatively, are too noisy to be fully capable of measuring corporate social or environmental performance. In addition, as

[1] For a detailed overview the reader is referred to Griffin and Mahon (1997) and Ullman (1985).

underscored by Konar and Cohen (2001), most previous research analyzes data that only point towards historical performance.

In contrast, our study builds on the concept of eco-efficiency, which is a more strictly defined construct and can be quantified by using Innovest's eco-efficiency rating methodology. As we explain, the rating is not only intended to reflect historical environmental performance, but also to identify future environmental risks and opportunities.

Our second contribution is methodological. The environmental data noted in the literature hitherto is typically available annually (e.g., Dowell et al., 2000). In addition, some studies have limited their exploration of cross-sectional relationships to one specific point in time (for example, Konar and Cohen, 2001). The ratings we examine in this study are available on a monthly basis and span more than six years, which allows for an evaluation of relationships over time. Using a variant of the two-step modeling approach introduced by Fama and MacBeth (1973), we are able to exploit the richness of information contained by both cross-sectional and time-series dimensions of the data.

Third, previous studies differ remarkably in the choice of corporate financial performance criteria, which underlines the fact that determining the appropriate financial performance measure is the subject of considerable debate. Since both market-based as well as accounting-based measures have their specific strengths and weaknesses, we apply both measures to ensure that our results are reliable and consistent.

Finally, researchers have paid little attention to whether the results of previous studies are truly coherent. For instance, the evidence by Dowell et al. (2000), King and Lennox (2002), and Konar and Cohen (2001), which suggests that environmental governance is positively related to Tobin's *q*, is consistent with the assertion that environmental performance translates into improvements in reputation, an increase in investor trust, a decrease in investor risk, and a lower cost of capital associated with environmental leaders. Provided that conventional asset-pricing theory holds, lower risk implies a relatively lower expected return on stocks of companies that perform well environmentally. However, recent evidence points to an abnormal positive stock return differential between environmental leaders and laggards. This evidence is difficult to reconcile with the risk-return paradigm. Apart from exploring the relationships between eco-efficiency and multiple dimensions of financial performance, our objective is to overcome potential inconsistencies in the results across the different analyses.

THEORETICAL DEBATES

For several decades, the academic community has postulated models and hypotheses that relate corporate social and environmental responsibility to financial performance, mostly with the intention to provide a framework that aligns CSR with shareholder value creation. Despite the growing academic attention on the CSR-financial performance relationship, management scientists and financial economists have developed their ideas in this area almost autonomously. Corporate management theories up to this point discuss many benefits to CSR, but leave unexplained questions that are critically relevant to shareholders of socially and environmentally responsible companies. Modern investment theories fill that gap. In this section, we discuss both corporate management and financial theories, which jointly lay the groundwork for our empirical research.

Management Theories

The CSR-financial performance relationship is the source of considerable debate. Theories in the management literature are far from uniform and, as pointed out by Griffin and Mahon (1997), more than 25 years of empirical research has been unable to overcome long-lasting theoretical divides.

The roots of the debates go back decades. During the 1960s, the concepts of corporate social responsibility and socially responsible investing were gaining momentum. However, opponents of CSR quite forcefully questioned the validity of CSR in the context of what they believed is the purpose of the firm: maximizing shareholder wealth. In general, opponents of the concept of CSR raise two critical points:

- CSR is far from well defined. A view shared by many skeptics, including Friedman (1962), is that managers are unable to determine what the social responsibility of their company is. Many managers believe that the only responsibility of the firm is to engage in profitable activities. Shareholders themselves are capable of deciding whether their stock income sufficiently represents social awareness.
- CSR is expensive and decreases shareholder value. At least partly because of the problem of determining the social responsibility of businesses, a common criticism of CSR cites the financial dangers of adopting corporate social responsibility principles. Several critics stress that CSR initiatives inherently demand significant portions of a company's financial resources, but the potential financial benefits of such initiatives are mostly in the distant future, if these benefits are evident at all (e.g., Henderson, 2002; Walley and Whitehead, 1994).

In brief, the main concern expressed by CSR skeptics is that the costs associated with corporate social performance improvements are likely to outweigh the financial benefits, which makes the CSR thinking inconsistent with the principles of shareholder wealth maximization.

In contrast, a sizable number of CSR proponents have put forward a long list of the advantages to corporate social responsibility. Their reasoning is that organizations can generate significant goodwill and new market opportunities by displaying social and environmental awareness (e.g., Fombrun et al., 2000; Hart and Ahuja, 1996; Porter and Van der Linde, 1995; Russo and Fouts, 1997). However, there is a growing belief that the economic benefits depend on the nature of environmental performance. More and more often, researchers argue that the advantages resulting from social and environmental compliance with regulatory requirements are not a primary source of competitive advantage. For example, the mere fact of environmental compliance hardly allows a company to distinguish itself from its competitors, because most intra-industry peers are affected by compliance in a similar way. As pointed out by Dowell et al. (2000), Hart and Ahuja (1996), and Russo and Fouts (1997), real benefits to organizations are likely to come from more rigorous (i.e., proactive) forms of environmental performance that require both changes in production and manufacturing processes and a forward-looking management style. Hillman and Keim (2001) add that CSR initiatives can pay off, as long as these efforts are in the interest of the company's primary stakeholders.

Conditional on these lines of reasoning, specific arguments in favor of CSR include:

- CSR is associated with reputational benefits. Several scholars suggest that adopting corporate social responsibility policies may lead to improvements in the firm's image (e.g., Davis, 1973). Because the firm's social performance record can proxy for labor conditions, socially responsible companies gain a competitive advantage by improving their ability to attract high-quality employees. Empirical evidence by Turban and Greening (1996) strongly supports this line of reasoning. Apart from human-resource benefits, other researchers, for instance, Vandermerwe and Oliff (1990), and Russo and Fouts (1997), mention the possibility that reputational advantages result into sales benefits, because customers may be sensitive to social issues. Similarly, reputational increases may affect relationships with potential suppliers and lenders.
- CSR can also serve as a proxy for management skills. Alexander and Buchholz (1978) and Bowman and Haire (1975) suggest that corporate social and environmental performance reflects management quality. A structural and dedicated CSR policy might inherently require commitment to CSR among and between all levels of the firm as well as a forward-thinking, long-term-oriented management as outlined by Shrivastava (1995).
- CSR may also reflect (technological) innovativeness. For example, Porter and van der Linde (1995) argue that poor environmental performance is a sign of the firm's operational inefficiency, which ultimately leads to competitive disadvantages. In addition, the resource-based view towards environmental governance, as outlined by Russo and Fouts (1997), says

that a proactive environmental policy within the firm ultimately requires a structural change in production and service delivery processes. This redesign involves the development, acquisition, and implementation of new technologies and may lead to economic advantages vis-à-vis competitors.

What becomes apparent is that from a theoretical point of view, we can argue both sides as to whether CSR adds or exhausts economic value.

Financial Theories

Now, more than ever before, financial-market participants have been paying attention to CSR. Institutional investors are demonstrating their interest in the concepts CSR and socially responsible investing (SRI) as a means of fulfilling their social and financial obligations. Recent estimates by the Social Investment Forum (2003) suggest that the market for socially responsible investments currently covers approximately 12% of the market as a whole.

Analogous to these developments, financial economists, starting with Moskowitz (1972), have put forward theoretical frameworks that either support or reject the validity of CSR from an investor perspective. These frameworks rely on established asset pricing theories which center around the risk-return paradigm.

The risk-return paradigm is important because it highlights that managerial perspectives towards CSR are only one part of the story. Although there is a tendency among management scholars to believe that firms are doing well by engaging in activities that increase their (intangible) value, financial theories add important insights on benefits from such activities in terms of risk-adjusted returns to stockholders. Whether investors benefit from holding stocks of socially responsible companies depends on how the investment community perceives CSR.

Hamilton et al. (1993) note that financial markets may respond to corporate social responsibility information in three different ways:

- One hypothesis says that the market does not value corporate social responsibility. If CSR is not a priced factor in the market, then investors do not expect (portfolios of) socially and environmentally responsive companies to deliver stock returns different from nonresponsive firms, all else equal.
- Contrary to the first hypothesis, the second hypothesis predicts that investors do value CSR. For instance, Shane and Spicer (1983) and Spicer (1978) suggest that firms with a strong social or environmental performance record may gain investor trust and might, accordingly, be regarded as less risky investments compared to those that perform poorly on these performance spectra. In the risk-return framework, the notion that social and environmental

leaders are less risky investments than are laggards implies that investors demand a lower (expected) return on these firms' stocks, and that these companies have a relatively lower cost-of capital. Because investors assign a lower discount rate to expected future cash flows of socially responsive companies, these firms have a higher value. We note that if capital markets incorporate information related to CSR efficiently, we can assume that expected returns on stocks compensate investors fairly for the associated risk, and that risk-adjusted stock returns are consistent with an equilibrium setting. For a theoretical model that allows socially responsible investors to influence the stock price and the cost-of-capital of a firm, see, e.g., Heinkel et al. (2001).

- The third hypothesis raises the possibility that the paradigm is violated in practice, suggesting that the market does not price CSR efficiently. As an example, Hamilton et al. (1993) mention a scenario in which investors underestimate the possibility that negative information will emerge about companies that are typically considered controversial from an ethical perspective, such as companies operating in the oil sector. Under this hypothesis, the stocks of socially responsible companies can be undervalued (overvalued) relative to those of less socially responsible companies and produce higher (lower) risk-adjusted returns.

These scenarios show that, whether CSR increases shareholder value depends on how financial markets perceive CSR. Ultimately, the question is an empirical one.

DATA

Eco-Efficiency Data

Among both managers and scholars, there is no consensus as to precisely what constitutes the social or environmental responsibility of the firm. Traditional proxies for environmental performance, such as environmental reports by third-party organizations, typically rely on news concerning absolute pollution levels. However, these indicators of environmental responsibility address merely a single dimension of a company's environmental performance and usually reflect historical environmental events.

We focus on eco-efficiency. As noted earlier, we define a firm's eco-efficiency as the ability to create more value while using fewer environmental resources, such as water, air, oil, coal and other limited natural endowments. Obviously, what specifically constitutes eco-efficiency strongly depends on the specific production processes and, thus, the industry the firm belongs to, as outlined below. Dowell et al. (2000) interpret eco-efficiency as the ability of companies to minimize pollution by improving the production and manufacturing process. This form of environmental responsibility represents proactive environmental management, one which concentrates on good environmental performance from changes in operational efficiency, rather than by adopting standards for pollution control at the "end of the pipe."

Eco-efficiency usually measures the environmental performance of a firm in a relative sense. To understand 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 usually regarded as poor environmental performers. However, at the intra-industry level, firms facing the same environmental challenges can still do well relative to competitors, and can benefit from this financially.

We explore empirical relationships between eco-efficiency and several dimensions of corporate financial performance. To do so, we use eco-efficiency scores developed by Innovest Strategic Value Advisors. Since the Innovest data have received little attention in previous research, by using Innovest's data we can provide new evidence.

One of the main strengths of this database is its comprehensiveness. Using over 20 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 by more than 60 criteria, which jointly constitute the final rating. For each of these factors, all companies receive a (sub)score. As these variables are not considered equally important in the overall assessment of eco-efficiency, each factor is weighted differently. For example, Innovest analysts consider a firm's environmental product development as more important than certification by a third party that is devoted to promoting environmental awareness. The final numerical rating analysts assign to a company is converted into a relative score based on the total spread of scores in the sector to which the firm belongs.

The eco-efficiency score reflects environmental performance in five fundamental areas. The first broad area covers historical liabilities, which concern the risks (and opportunities) a firm faces in consequence of past environmental behavior. Among other things, this category covers superfund liabilities, state and hazardous waste sites, and toxic torts. A second component represents contemporaneous operating risk, addressing risk exposures from events that are more recent. This category includes, for example, toxic emissions, product risk liabilities, waste discharges, and supply-chain management risk. The third area, which can be labeled "sustainability and eco-efficiency risk," pertains to the weakening of a firm's material sources of long-term profitability and competitiveness, and the potential future risks initiated by this development. This area spans energy intensity, energy efficiency, the durability and recyclability of the product life cycle, but also the extent to which companies are exposed to changes in consumer values. The fourth area covered by the score concerns managerial risk efficiency. This category represents the ability of the company to manage environmental risks successfully, as can be witnessed from, e.g., the quality of supply chain management, environmental audit/accounting capacity, the strength of environmental management systems, training capacity. The last dimension involves business prospects resulting from eco-efficiency, such as the degree to which businesses can reap future competitive advantages from environmentally driven market trends and profit opportunities provided that the company's management has well-developed eco-efficiency policies.

From this brief overview, it becomes apparent that Innovest's eco-efficiency measure is intended to embody both *ex post* (i.e., historical and current) and *ex ante* (i.e., forward-looking) dimensions of corporate eco-efficiency.

In this paper, we consider firms listed on the U.S. stock markets. As we also use various financial data, we match the Innovest database to the CRSP U.S. stock database and to the Compustat U.S. Research database. We match by ticker, company name, and CUSIP number. The resulting data set is survivor-bias-free in the sense that it includes not only firms that were covered by Innovest recently, but also those which disappeared over time, for instance, due to merger or bankruptcy. Further details on the financial data will be given in the appropriate sections.

[Insert Table 1 about here: Summary statistics on eco-efficiency data]

We convert Innovest's seven non-numerical ratings into numerical eco-efficiency scores. We assign highest-ranked firms a rating equal to six and lowest-ranked firms a value of zero.

Table 1 gives some brief statistics on the eco-efficiency scores over time. These statistics are merely descriptive and serve only as some background for the analyses that follow.

The table shows results for four particular dates. We note that due to the nature of the financial data, the last date is September 2002, because such data are reported on a quarterly basis (i.e., we regress fourth-quarter financial measures on eco-efficiency scores that are dated September). Over the period 1996-2002, the average rating decreases from 3.04 to 2.66. The median rating is equal to three in all periods. The standard deviation varies only mildly over time.

The table also reports the frequency of the eco-efficiency score broken up into seven categories. Statistics on the number of firms within each rating category explain the decrease in average eco-efficiency rating. The number of firms that receive an eco-efficiency score below three increases more strongly compared to the number of firms that have a score of four or higher.

The number of firms in the sample increases considerably over time. Our data set includes scores for about 154 companies at the end of December 1996 and scores for about 409 firms at the end of September 2002.

Financial Data

To accomplish our objective of investigating the association between eco-efficiency and several dimensions of corporate financial performance, we first turn our attention to the role of eco-efficiency in firm valuation, using the Tobin's *q* measure. Following Kaplan and Zingales (1997), we compute *Q* as the market value of assets divided by the book value of assets. The market value of assets is defined as the sum of the book value of assets and the market value of common stock outstanding minus the sum of the book value of common stock and balance sheet deferred taxes. Although there are more sophisticated approaches to computing *Q*, we use the most efficient approximation to ensure sufficient data availability throughout our sample period. Further, as shown by Perfect and Wiles (1994), and by Chung and Pruitt (1994), this proxy for *Q* is highly correlated with estimates that are more complex.

Our analysis accounts for potentially confounding influences. Because researchers such as Hirsch (1991) show that recent sales growth is positively related to company valuation, we include past two-year sales growth as a control variable. Furthermore, related work, including Dowell et al. (2000), King and Lenox (2002), and Konar and Cohen (2001), suggests that firm value is positively related to R & D expenses. To parse out this relationship, our control set contains research and development expenses scaled by sales as an additional explanatory variable.[2] To condition on differences in firm size we use the book value of total assets.

Following Konar and Cohen (2001), we also include firm age. As an approximation of the firm's age, we compute the difference between the first trading day and the respective date of the analysis. Since the database "Exshare," from which we retrieve the first trading days, was established in November 1984, we lack information before 1984. If firms were founded before this date, we still assume that founding occurred in 1984.

Finally, we consider a dummy variable that is equal to unity if the firm is listed on the Nasdaq exchange and zero otherwise. The dummy controls for atypically high Tobin's *q* values of Nasdaq firms that may have occurred during the stock market hype of the late nineties. We construct all variables other than AGE using data from Compustat.

Next, we explore the connection between eco-efficiency and operating performance. Our primary interest is in a broad measure of operating performance that addresses both profitability and efficiency. Inspired by Barber and Lyon (1996), we measure operating performance by the company's return on assets. Our set of control variables is similar to Waddock and Graves (1997). We control for

[2] Konar and Cohen (2001) scale R&D expenditure by sales. Dowell et al (2000) and King and Lenox (2002) scale R&D expenditures by the book value of total assets. To ensure the robustness of our results, we use both scaling methods. Results using the book value of total assets instead of sales are nearly identical and are available from the authors.

the influence of firm size and the firm's riskiness. We measure size by the firm's total assets and by total sales. The debt-to-asset ratio represents risk. We use data from Compustat to construct all variables.

[Insert Table 2 about here: Summary statistics for financial data]

To show the distribution of *Q* and ROA, Table 2 reports some descriptive statistics pertaining to four specific dates. We can see that there is some non-normality in the data. *Q* has a distribution that is peaked and leptokurtic, as indicated by the high values for skewness and kurtosis. Arguably, the stock market fad of 2000 plays an important role in explaining the long right tail in the *Q* data. Further, we observe differences in the cross-sectional median *Q* and the mean *Q* over time. The median values for Tobin's *q* remain time invariant but mean Tobin's *q* values are much higher during the technology market's boom and bust period. Median and mean values for ROA do not display such a large discrepancy, being largely similar in value and time invariant.

We alleviate potential problems associated with non-normality by doing robustness tests after having industry-adjusted, taken in logs, and trimmed the data, respectively. We also consider a dummy variable that captures potentially extreme Tobin's *q* values for companies listed on the Nasdaq Stock Exchange.

EMPIRICAL ANALYSIS

Eco-Efficiency and Firm Value

There are two reasons why we would expect corporate eco-efficiency to influence firm valuation. First, as also suggested by previous work we could argue that the firm's environmental governance affects its reputation and improves investors' trust. Thus, investors would perceive companies that do well on the eco-efficiency spectrum as less risky relative to less eco-efficient firms. Investors would associate eco-efficient firms with relatively lower expected returns, a lower discount rate, and a higher discounted value. Our expectation is that the most eco-efficient companies have higher discounted values compared to the least eco-efficient firms. Second, we could expect that recent evidence by Derwall et al. (2005), who report abnormal risk-adjusted stock returns for portfolios consisting of eco-efficient companies, translates into a differential in firm valuation between the most eco-efficient companies and their least eco-efficient counterparts, and that this difference increases over time. The hypothesis central to this section can be stated as follows:

H_1: Eco-efficiency is positively associated with firm value. Companies with a high eco-efficiency rating have a higher value than do companies with a lower rating.

Cross-sectional analysis is most suitable for testing H_1.[3] Since our data are longitudinal in nature, periodical regressions can be performed. Using a standard application of the Fama-MacBeth (1973) procedure, we estimate quarterly the following cross-sectional models:

$$Q_{it} = \alpha_i + \beta_1 \, Eco\text{-}Efficiency_{it} + \boldsymbol{\gamma_{it}} \boldsymbol{X_{it}} + \varepsilon_{it}, \quad (1)$$

$$Q_{\mathrm{it}} = \alpha_i + \beta_0 \, High\ Eco\text{-}Efficiency_{it} + \beta_1 Low\ Eco\text{-}Efficiency_{it} + \boldsymbol{\gamma_{it}} \boldsymbol{X_{it}} + \varepsilon_{it}, \quad (2)$$

In model (1), Q_{it} denotes Tobin's *q* for firm i in quarter t and $\text{Eco-Efficiency}_{\mathrm{it}}$ represents the eco-efficiency rating of firm i at t. $\boldsymbol{X_{it}}$ is a vector of control variables and $\boldsymbol{\gamma}$ denotes a vector of coefficients. In model (2), we replace $\text{Eco-Efficiency}_{\mathrm{it}}$ with two dummy variables that indicate whether firm i is eligible for inclusion in a high-ranked portfolio or a low-ranked portfolio similar to that of Derwall et al. (2005). The variable "High $\text{Eco-Efficiency}_{\mathrm{it}}$"("Low $\text{Eco-Efficiency}_{\mathrm{it}}$") is equal to unity if firm i is rated five or six (zero or one), and zero otherwise.

Because we consider several model specifications, $\boldsymbol{X_{it}}$ contains permutations of the following candidate regressors: the firm's two-year sales growth, firm age, the ratio of R&D expenditure to sales, firms size measured by the book value of total assets, an interaction term between sales growth and R&D spending, advertising expenses scaled by sales, and the dummy variable for Nasdaq companies. From the 24 quarterly regressions, performed over the period January 1997 to December 2002, we compute time-series averages of the cross-sectional coefficient estimates. Subsequently, we compute corresponding *t*-statistics by using standard errors from the time-series parameters. We also allow for some variation in the dependent variable by repeating the estimation of (1) and (2) using, respectively, an industry-adjusted *Q* (*Q* minus the industry median *Q*), *Q* in logs, and a trimmed *Q* as a regressant. Trimming mitigates the effect of potential outliers in Tobin's *q*. We adopt the trimming approach of Collins et al. (1997) and remove observations, using the 0.995 percentile and the 0.005 percentile as upper and lower boundaries.

[Insert Table 3 about here: Fama-MacBeth (1973) regressions for Tobin's *q*]

[3] At first glance, a plausible alternative to our approach could be a pooled model estimation that allows for fixed effects and time-specific events. However, this setup is not feasible due to a lack of variability in the eco-efficiency scores. Using a large pool of generally time-invariant ratings leads to highly exaggerated *t*-statistics in panel data models.

Table 3 shows the results for the main model specifications. Panel A of Table 3 reports the results of estimating equation (1). The first column of this panel reports the results of a regression based on a standard, unmodified *Q*. The additional columns present the results of using, respectively, industry-adjusted *Q* (*Q* minus the industry median *Q*), *Q* in logs, and trimmed *Q*. Taken as a whole, regardless of the choice of the dependent variable, the coefficients on most control variables (sales growth, R&D / sales and size) are highly significant and carry signs that are consistent with *a priori* expectations and with previous research. The only exception is the age variable, for which we observe no significant relation to firm value.

The observation most relevant to our study is that under all scenarios, the coefficient on the main variable of interest, Eco-Efficiency$_{it}$, is positive and statistically significant at the 1% level. Our estimate of β_1 in equation (1) is approximately 0.08 when *Q* is the dependent variable. The coefficient decreases somewhat due to rescaling when *Q* is taken in log, but remains highly significant. Furthermore, we note that neither industry adjustment nor trimming of Tobin's *q* affects the coefficient estimates, which are similar across the different specifications. The latter observation is important because it suggests our results are not driven by outliers arising from, for instance, the stock market crash of 2000. Overall, these parameter estimates support H_1.

Panel B of Table 3, adds to understanding the positive association between ECO and *Q*. The panel reports the outcomes of replacing Eco-Efficiency$_{it}$ with the dummy variables High Eco-Efficiency$_{it}$ and Low Eco-Efficiency$_{it}$ (equation (2)). The results are partially in support of H_1. Contrary to previous findings, these results suggest an asymmetrical relationship between eco-efficiency and *Q*. There is no compelling evidence that eco-efficient companies have a higher *Q* relative to the remainder of the reference sample. The coefficient on High Eco-Efficiency$_{it}$ is not significant at the conventional levels. In contrast, all coefficient estimates for Low Eco-Efficiency$_{it}$ are negative and significant at the 1% level. This result shows that less eco-efficient companies had a lower *Q* over the studied period. Therefore, these results suggest that eco-efficiency is not associated with a positive valuation, but that eco-inefficiency is punished by a lower valuation.

[Insert Table 4 about here: robustness tests]

To evaluate the robustness of the relationships even further, we estimate additional models that include different sets of control variables. Table 4 presents the outcomes for these alternative specifications.

For reasons of comparison, we import the initial results pertaining to equations (1) and (2) from the previous table. One alternative model augments the first set of control variables by an interaction term between sales growth and R&D spending. Second, since Konar and Cohen (2001) show that advertising expenses might be related to firm value, another model contains the firm's advertising expenses scaled by sales.[4] The last alternative specification augments the first model by the Nasdaq dummy.

In panel A the results show that even in the presence of additional control variables, the sensitivity of *Q* with respect to the eco-efficiency score remains positive and significant at the 1% level. The results of replacing Eco-Efficiency$_{it}$ with High Eco-Efficiency$_{it}$ and Low Eco-Efficiency$_{it}$ are given in Panel B of Table 4 (labeled "Equation 2"), and support our previous observations.

In three scenarios, the reported coefficients underline that eco-efficient companies do not have a higher *Q* relative to the reference group, but the least eco-efficient firms have a Tobin's *q* that is significantly lower compared to the remainder of companies in the sample. We are interested to find that the coefficients on Eco-Efficiency$_{it}$ and High Eco-Efficiency$_{it}$ increase in magnitude when the control set includes advertising as a determinant instead of the interaction between R&D and sales growth. However, because limited availability of (cross-sectional) advertising data induces a small sample problem, the results that we find under the third set of control variables should be interpreted with caution.

To assess the economic significance of eco-efficiency, we can estimate how much a firm would enjoy an increase in valuation resulting from a unit increase in eco-efficiency ranking. Table 4, panel A, suggests that the impact of a one-point increase in eco-efficiency ranking on Tobin's *q* amounts to 0.07, *ceteris paribus*, which is approximately 3.4 percent of the average *Q* we observe for all firms in the sample. To address the asymmetrical influence, we can estimate how much loss in *Q* a firm would prevent by avoiding a low eco-efficiency ranking. Panel B suggests that the loss avoidance amounts to about 0.30, which is almost 15 percent of the average Tobin's *q* value.

A positive (though potentially asymmetrical) relation between eco-efficiency and firm value is consistent with the notion that eco-efficiency is a "priced" factor, i.e., that investors drive up the value of environmental leaders by lowering their expected stock return and their cost-of-capital. However, up to this point, the association between Tobin's *q* and eco-efficiency does not reconcile with the evidence by Derwall et al. (2005) that eco-efficient stock portfolios earn abnormal annual returns relative to their least-efficient counterparts. Their results raise the possibility that the market has undervalued eco-efficient firms relative to less eco-efficient companies. In an equilibrium setting, the expected returns on a group of eco-efficient companies can be lower than the returns on a group of less-eco efficient companies because eco-efficient firms are deemed less risky. After adjustment for these risk

[4] We estimated both model 2 and model 3 while also scaling R&D expenditures and advertising expenditures by the book value of total assets instead of by sales. The results are qualitatively similar and available on request.

differences, there should be no abnormal difference in return. However, under the hypothesis that the market reacts to eco-efficiency with a drift, firms can be under- or overvalued and risk-adjusted portfolio returns can be anomalous.

[Insert Table 5 about here: sub-sample regressions]

[Insert Figure 1 about here : differences between coefficients on high and low eco-efficiency]

To shed more light on the nature of the large return differential documented in Derwall et al. (2005), we exploit the attractive features of the Tobin's *q* measure and of the Fama-MacBeth (1973) regression technique.

The Derwall et al. (2005) stock portfolio of eco-efficient firms earns an average abnormal return of approximately 6% per annum after accounting for the portfolio's risk, its style tilts, and sector exposures. In contrast, their portfolio of least eco-efficient companies earned no significant abnormal return. Examination of time-varying sensitivities of Tobin's *q* for corporate eco-efficiency allows us to investigate whether the superior stock performance associated with eco-efficiency is at least partially reflected in a higher valuation over time for eco-efficient companies relative to their eco-inefficient counterparts. Based on the evidence from the stock portfolios, we would expect the abnormal returns associated with eco-efficient firms to induce an upward trend in their Tobin's *q* values through time.

Table 5, which reports regression results for Tobin's *q* broken up into two subsamples, confirms our expectations. The table shows time-series average coefficients for the 1997-1999 and 2000-2002 periods, respectively. The subsample results indicate a strong time variation in the coefficients on High $\text{Eco-Efficiency}_{it}$ and Low $\text{Eco-Efficiency}_{it}$. The coefficient on the low eco-efficiency dummy is -0.42 and significant (at the 1% level) in the first period and -0.2 but insignificant in the second period. The coefficient on the high eco-efficiency dummy undergoes a stronger upswing, from -0.24 (which is significant at 1%) in the first period to 0.21 (which is significant at 5%) in the second period. Thus, although the least eco-efficient firms do not undergo a substantial change in valuation over time, eco-efficient companies have a stronger upward shift in their value across subsample periods.

In Figure 1a, we report differences between the quarterly estimates of the cross-sectional coefficients on the two dummy variables (β_0 High Eco-Efficiency - β_1 Low Eco-Efficiency) in equation (2). The upward-sloping trend line in Figure 1 tells a story similar to the subsample results: although eco-efficient firms are not selling at a sizeable relative premium at the beginning of the sample period, the premium increases throughout the sample period. The slope of the trend line is 0.034 and the corresponding *t*-statistic is 1.94, indicating that the upward rise is statistically significant below the 10% level. Equally important is the economic interpretation of the trend. The slope coefficient, once translated into an annual average, indicates that the value of eco-efficient firms rises by approximately 6% of the average Tobin's *q*. This percentage strongly resembles the abnormal returns outlined in Derwall et al. (2005).

The patterns shown by Table 5 and Figure 1 are consistent with recent evidence of abnormal returns on stocks of eco-efficient companies, since an abnormal return differential would explain relative differences in *Q* across periods. The results also support the idea that the anomalously positive average return on the eco-efficient portfolio is attributable to some form of pricing inefficiency. The positive trend in relative firm valuation may represent a period of adjustment, when stocks of eco-efficient companies are initially undervalued and, subsequently, undergo a price correction. Investors adjust downwards the expected stock returns and the cost-of-capital associated with environmental leaders. Accordingly, the value of eco-efficient companies was driven upwards. The expected returns of these firms were driven downwards, but the upward trend in firm valuation generated positive realized returns.

Figure 1b presents slopes for two subsamples, where the subperiods are determined by technology stock market crash of February/March 2000. In both subsamples, the eco-efficiency premium increased over time. This trend in relative valuation supports Derwall et al. (2005), who find that eco-efficient stocks earned anomalously high returns both before and after the crash.

The results over time also support the event study results of Klassen and McLaughin (1996). They find significant negative abnormal returns in response to negative environmental events and relatively smaller abnormal returns following positive events. Our findings augment theirs, and are in line with the results of Derwall et al. (2005), by showing that abnormal stock returns can be expected beyond a short-run event period. In light of our findings, the evidence of Klassen and McLaughlin (1996) might suggest that the market reacts attentive to negative environmental news but incorporates positive environmental information with a drift. Although finding that environmental information is priced gradually seems to contradict the notion that markets are efficient, our study is not the first to show that some information is incorporated slowly into stock prices. For example, there is evidence that stock repurchases (Ikenberry et al., 1995) and dividend omissions (e.g., Michaely et al., 1995), all of which are arguably more concrete events than environmental events, have a post-event drift.

Essentially, two important messages emerge from the findings discussed so far. First, the evidence that the market's valuation of eco-efficiency has strengthened over the long run may indicate that the observed asymmetry in the relation between eco-efficiency and Tobin's *q* is a temporary phenomenon. Second, we observe short-term variation in the market's response to environmental performance which is consistent with recent evidence of abnormal returns on stock portfolios of eco-efficient firms. This time-varying pattern may indicate that the value of eco-efficiency is not well understood by capital markets, allowing investors to exploit temporary mispricing of corporate environmental performance criteria. At the very least, our results suggest the market shows increased interest in information about the environmental management of the firm.

Eco-efficiency and Return on Assets

The resource-based view towards environmental performance, as interpreted by Hart and Ahuja (1996) and Russo and Fouts (1997), suggests that only pro-active environmental governance is a source of financial benefit. Even though this form of policy involves a structural change in production processes and an innovative management, these intensive demands lie at the core of a firm's competitive advantage. Examples of such benefits for a firm include production efficiency gains and reputation advantages deemed critical for attracting skilled workers and increasing sales, all of which can be unique to the firm and difficult to attain by competitors. Empirical work by Russo and Fouts (1997) indicates that the resources-based perspective is useful for understanding the economic value of environmental performance, suggesting that pollution prevention relates positively to operating performance. Since our eco-efficiency data closely coincides with the resource-based perspective in that it represents pro-active environmental management, we use this section to explore the link between eco-efficiency and operating performance.

Our primary interest is in a broad measure of operating performance that addresses profitability and efficiency. Therefore, we follow the management and accounting literature that focuses on the relation between corporate environmental performance and firm operating performance. In line with several related studies, we choose the company's return on assets (ROA) as the dependent variable. The objective here is to investigate whether eco-efficiency significantly influences ROA, all else equal. The hypothesis can be stated as follows:

> *H_2: Eco-efficiency is positively associated with return on assets. Companies with a high eco-efficiency rating have a higher ROA compared to companies with a lower rating.*

We follow the multivariate model of Waddock and Graves (1997) to test H_2. Our main specifications take the form:

$$ROA_{it} = \alpha_i + \beta_1 Eco\text{-}Efficiency_{it} + \boldsymbol{\gamma_{it}} \boldsymbol{X_{it}} + \varepsilon_{it}, \quad (3)$$

$$ROA_{it} = \alpha_i + \beta_0 High\ Eco\text{-}Efficiency_{it} + \beta_1 Low\text{-}Eco\text{-}Efficiency_{it} + \boldsymbol{\gamma_{it}} \boldsymbol{X_{it}} + \varepsilon_{it}, \quad (4)$$

where ROA_{it} denotes return on assets. We consider modeling both ROA and the firm's ROA relative to the industry median ROA. Eco-Efficiency$_{it}$ in model (3) is the firm's eco-efficiency score. In specification (4), we replace the absolute eco-efficiency score with two dummy variables that specify whether firm i is the most or the least eco-efficient. High Eco-Efficiency$_{it}$ (Low Eco-Efficiency$_{it}$) is equal to one if firm i is rated five or six (zero or one) at t, and zero otherwise. $\boldsymbol{X_{it}}$ is a vector of control variables and $\boldsymbol{\gamma}$ is a vector of coefficients. As in the previous section, we allow for permutations of the regressors. Candidate control variables include the firm's size measured either by total assets or by total sales, and the debt-to-asset ratio. Using a variant of the Fama-MacBeth (1973) method, we perform quarterly regressions of the company's ROA on a set of independent variables and compute time-series averages of the cross-sectional coefficients.

[Insert Table 6 about here: Fama-MacBeth (1973) regressions for ROA]

Table 6 reports the time series mean coefficients and corresponding *t*-statistics. We note that we allow for variations in the dependent variable, the control variables, and the eco-efficiency variable, respectively.

We make several important observations. First, the coefficient estimates for all control variables are consistent with those reported by Waddock and Graves (1997) and statistically significant at the usual cut-off levels. For the coefficients on the eco-efficiency variables, we find estimates that are consistent with those reported in the previous section. Table 6, panel A, reports coefficients on the eco-efficiency score. ECO_{it} has a coefficient that is positive and significant at the 1% level, which supports H_2. Further, as shown by the supplementary results from estimating alternative specifications, the relation between eco-efficiency and ROA is robust to changes in the set of control variables. The results of replacing Eco-Efficiency$_{it}$ with High Eco-Efficiency$_{it}$ and Low Eco-Efficiency$_{it}$, partially support H_2. Panel B of Table 6 points to an asymmetry in the positive relation between eco-efficiency and operating performance. Under all specifications, the estimated coefficient on the high eco-efficiency dummy is positive but not significant at the standard levels. On the other hand, all coefficient estimates for the low eco-efficiency dummy are negative and significant at the 1% level. In other words, the highest-ranked firms that are deemed eco-efficient do not show a significant operational outperformance compared to the control group, but the lowest-ranked companies have an ROA that is significantly lower than that of the remainder of sample.

From an economic perspective, eco-efficiency relates sizably to operating performance. The increase in absolute ROA resulting from a one-point rise in eco-efficiency ranking is estimated at of $0.08E^{-2}$, *ceteris paribus*, which is equivalent to 2.1 percent the sample average ROA we observe in

Table 2. In order to address the asymmetrical influence of eco-efficiency on operating performance, we can estimate how much loss in ROA a firm would prevent by avoiding a low eco-efficiency ranking. Panel B points out that the loss prevention amounts to about $0.39E^{-2}$, which is more than 10 percent of the average ROA.

CONCLUSION

Can corporate environmental management align with the economic objectives of a firm? This study provides new answers to this question. Focusing on the concept of eco-efficiency, we perform an extensive analysis on the relation between corporate eco-efficiency and several dimensions of financial performance. Using a large database containing monthly scores for the period December 1996 - December 2002, we find evidence suggesting that the virtues of a strong corporate eco-efficiency policy can be significant from a financial perspective.

Our study provides new evidence of a positive but potentially asymmetrical relation between eco-efficiency and firm valuation as measured by Tobin's q. Firms that are deemed most eco-efficient do not have consistently higher values compared to the control group, but the least eco-efficient companies have values that are significantly lower compared to those of the remainder of the sample. Our results are robust to variations in the choice of control variables and insensitive to industry-adjustment.

However, an exploration into the time-varying sensitivities of firm value with respect to the eco-efficiency scores shows that environmental winner companies initially did not trade at a premium relative to losers, but that the premium increases strongly over time. This explanation could imply that the asymmetry in the relationship between eco-efficiency and Tobin's q is temporary. The observed upward trend in relative firm valuation also offers an explanation for recent evidence of abnormal returns on companies regarded as most eco-efficient. This trend suggests that shares of eco-efficient firms are initially undervalued but later experience an upward price correction. At the very least, Tobin's q regression results suggest that these days, the market assigns more value-relevance to environmental information about firms.

Our study also points to a discrepancy in operating performance between firms with high eco-efficiency ratings and those with low ratings. Firms that are deemed eco-efficient do not have a return on assets superior to that of the control group, but the least eco-efficient firms show significant operational underperformance. Thus, our findings strongly reject the notion expressed by CSR skeptics, that the benefits of adopting a strong environmental policy are unlikely to outweigh the costs.

We believe the results of this paper have implications for both managers and investors. Evidently, managers have little reason to worry that an environmental policy conflicts with the company's primary financial objectives. Investors may interpret our results as evidence that corporate environmental performance is a potential source of information that helps them generate superior excess returns. As for these excess returns, an important avenue for further research would be to look at the endurance of the observed upward trend in the value of eco-efficient firms.

Although we have asserted that the observed patterns in Tobin's *q* reflect a correction for undervaluation of eco-efficient companies, we are forced to leave some important questions unexplained. Will these patterns persist in the future? What does this imply about future returns to shareholders?

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TABLE 1
Summary Statistics on Eco-Efficiency Scores

	Dec.-96	Dec.-98	Dec.-00	Sept.-02	*Change (2002-1996)*
Eco-Efficiency Ratings					
Mean Rating	3.04	2.82	2.71	2.64	*-0.40*
Median Rating	3	3	3	3	*0.00*
Standard Deviation	1.80	1.94	1.88	1.79	*-0.01*
Number of Companies					
Eco-Efficiency = 0	19	46	79	66	*47*
Eco-Efficiency = 1	13	39	54	56	*43*
Eco-Efficiency = 2	28	39	63	63	*35*
Eco-Efficiency = 3	28	43	102	97	*69*
Eco-Efficiency = 4	27	46	64	59	*32*
Eco-Efficiency = 5	27	37	45	37	*10*
Eco-Efficiency = 6	12	28	42	31	*19*
Total	154	278	449	409	*255*

The table summarizes the mean eco-efficiency and median scores, the standard deviation of the score, and the number of firms with a given score, observed at the end of 1996, 1998, 2000, and 2002, respectively. The *Change* column gives changes in these values over the beginning and the end of the sample period.

TABLE 2
Summary Statistics on Tobin's *q* and ROA

	1997 Q1	1999 Q1	2001 Q1	2002 Q4
Tobin's q				
Mean *Q*	1.74	2.40	2.21	1.82
Median *Q*	1.46	1.64	1.57	1.40
Standard Deviation	1.01	2.19	1.67	1.23
Skewness	2.87	3.54	2.33	3.08
Kurtosis	14.54	20.77	9.80	17.70
Return on Assets				
Mean ROA	0.04	0.04	0.04	0.03
Median ROA	0.04	0.04	0.03	0.03
Standard Deviation	0.02	0.02	0.03	0.03
Skewness	0.08	0.51	0.38	0.45
Kurtosis	5.60	3.66	5.90	4.93

Cross-sectional statistics are reported for the first quarter of, respectively, 1997, 1999, and 2001, and the last quarter of 2002.

TABLE 3
Eco-Efficiency and Firm Value (Tobin's *q*): Fama-MacBeth (1973) Regressions

	Fama-MacBeth (1973) Time-series Average Coefficients							
	Panel A: Equation (1)				Panel B: Equation (2)			
	Q	Ind.-Adj. *Q*	log (*Q*)	Trimmed *Q*	*Q*	Ind.-Adj. *Q*	log(*Q*)	Trimmed *Q*
Intercept	1.62***	-0.08	0.38***	1.58***	1.81***	0.12	0.45***	1.79***
	(9.48)	(-0.41)	(7.30)	(10.66)	(11.07)	(0.61)	(9.39)	(12.10)
Eco-Efficiency	0.07***	0.06***	0.03***	0.07***				
	(5.63)	(6.98)	(6.38)	(5.71)				
Low Eco-Efficiency					-0.31***	-0.32***	-0.10***	-0.32***
					(-3.52)	(-4.34)	(-4.43)	(-3.88)
High Eco-Efficiency					-0.02	-0.03	0.02	-0.02
					(-0.27)	(-0.43)	(1.66)	(-0.27)
Sales Growth	1.51***	1.28***	0.37***	1.41***	1.49***	1.26***	0.36***	1.39***
	(6.40)	(5.18)	(8.72)	(6.15)	(6.26)	(5.05)	(8.60)	(6.00)
Firm Age	-2.46E^{-3}	-0.01	0.01*	6.89E^{-4}	-0.02	1.53E^{-3}	0.01**	0.01
	(-0.19)	(-0.35)	(1.92)	(0.06)	(-0.27)	(0.09)	(2.22)	(0.61)
R & D / Sales	11.34***	4.59***	3.03***	11.06**	11.27***	4.48***	3.02***	11.01***
	(6.83)	(5.39)	(7.78)	(6.62)	(6.71)	(5.16)	(7.77)	(6.50)
Firm Size	-3.34 E^{-6}***	-1.43 E^{-6} ***	-1.27 E^{-6}***	-3.21 E^{-6} ***	-3.21 E^{-6}***	-1.31 E^{-6}***	-1.25 E^{-6} ***	-3.11 E^{-6}***
	(-21.23)	(-11.13)	(-20.22)	(-19.89)	(-19.16)	(-11.19)	(-18.24)	(-18.90)

The table reports the Fama-MacBeth (1973) time-series mean coefficient and the corresponding *t*-statistic (in parentheses). Note: Low Eco-Efficiency = 1 if firm ranked ≤ 1. High-Eco-Efficiency =1 if firm ranked ≥ 5. Ind.-adj. *Q* is the industry-adjusted *Q*. Sample period: 1997-Q1 – 2002-Q4.
* significant at 10% level
** significant at 5% level
*** significant at 1% level

TABLE 4
Eco-Efficiency and Firm Value: Robustness Checks

	Fama-MacBeth (1973)Time-series Average Coefficients							
	Panel A: Equation (1)				Panel B: Equation (2)			
	Q	*Q*	*Q*	*Q*	*Q*	*Q*	*Q*	*Q*
Intercept	1.62***	1.65***	0.98***	1.55***	1.81***	1.84***	1.36***	1.71***
	(9.48)	(9.77)	(4.75)	(9.81)	(11.07)	(11.30)	(6.32)	(11.37)
Eco-Efficiency	0.07***	0.07***	0.12***	0.06***				
	(5.63)	(5.66)	(6.14)	(5.70)				
Low Eco-Efficiency					-0.31***	-0.29***	-0.35***	-0.24**
					(-3.52)	(-3.41)	(-3.45)	(-2.76)
High Eco-Efficiency					-0.02	0.01	0.39***	0.04
					(-0.27)	(0.08)	(3.59)	(0.56)
Sales Growth	1.51***	1.43***	1.70***	1.38***	1.49***	1.41***	1.68***	1.36***
	(6.40)	(6.15)	(5.53)	(6.68)	(6.26)	(5.97)	(5.65)	(6.55)
Firm Age	-2.46E^{-3}	-4.59E^{-3}	0.04***	-2.80E^{-6}	-0.02	-2.35E^{-3}	0.04***	0.01
	(-0.19)	(-0.36)	(3.31)	(0.14)	(-0.27)	(0.16)	(2.82)	0.59
R&D / Sales	11.34***	11.15***	5.08***	9.19***	11.27***	11.11***	4.85***	9.20***
	(6.83)	(6.79)	(5.53)	(6.50)	(6.71)	(6.66)	(5.13)	(6.43)
Firm Size	-3.34 E^{-6} ***	-3.31 E^{-6} ***	-4.70 E^{-6} ***	-2.80 E^{-6} ***	-3.21 E^{-6} ***	-3.18 E^{-6} ***	-5.10 E^{-6} ***	-2.70 E^{-6} ***
	(-21.23)	(-15.78)	(-19.87)	(-25.24)	(-19.16)	(-15.36)	(-19.17)	(-23.22)
R&D*Sales Growth		1.52 E^{-3} ***				1.49 E^{-3} ***		
		(2.96)				(3.00)		
Nasdaq Firm Dummy				1.56***				1.54***
				(7.62)				(7.36)
Advertising / Sales			12.24***				11.68***	
			(5.78)				(5.71)	

The table reports the Fama-MacBeth (1973) time-series mean coefficient and the corresponding *t*-statistic (in parentheses). Note: Low Eco-Efficiency = 1 if firm ranked ≤ 1. High-Eco-Efficiency =1 if firm ranked ≥ 5. Sample period: 1997-Q1 – 2002-Q4.

*** significant at 1% level

** significant at 5% level

TABLE 5
Eco-Efficiency and Firm Value: Subsample Regressions

	Coefficients for Model (2) with *Q* as regressant		
	Period 1	Period 2	Complete Sample
Intercept	1.36***	2.27***	1.81***
	(5.89)	(14.78)	(11.07)
Low Eco-Efficiency	-0.42***	-0.20	-0.31***
	(-3.51)	(-1.53)	(-3.52)
High Eco-Efficiency	-0.24***	0.21**	-0.02
	(-6.36)	(2.25)	(-0.27)
Sales Growth	1.62***	1.36***	1.49***
	(8.86)	(2.97)	(6.26)
Firm Age	0.04*	-0.03	-0.02
	(2.02)	(-1.27)	(-0.27)
R & D / Sales	14.09***	8.46**	11.27***
	(8.84)	(2.95)	(6.71)
Firm Size	$-2.83E^{-6}$***	$-3.59E^{-6}$***	$-3.21E^{-6}$***
	(-15.65)	(-14.49)	(-19.16)

Reported are the Fama-MacBeth (1973) time-series mean coefficients and the *t*-statistics (in parentheses). Note: The results pertain to sub-sample estimations of (2). Low Eco-Efficiency = 1 if firm ranked ≤ 1. High-Eco-Efficiency =1 if firm ranked ≥ 5. The subsample periods are 1997-Q1 – 1999-Q4 and 2000-Q1 – 2002-Q4.

* significant at 10% level
** significant at 5% level
*** significant at 1% level

TABLE 6
Eco-Efficiency and Return on Assets (ROA): Fama-MacBeth (1973) Regressions

	Fama-MacBeth (1973)Time-series Average Coefficients							
	Panel A: Equation (3)				Panel B: Equation (4)			
	ROA	Ind.-Adj. ROA	ROA	Ind.-Adj. ROA	ROA	Ind.- adj. ROA	ROA	Ind.- adj. ROA
Intercept	4.43***	0.22***	4.40***	0.22***	4.77***	0.56***	4.71***	0.55***
	(24.17)	(3.26)	(23.66)	(3.23)	(25.03)	(7.66)	(24.10)	(7.30)
Eco-Efficiency	0.08***	0.08***	0.07***	0.08***				
	(5.80)	(4.97)	(5.28)	(4.88)				
Low Eco-Efficiency					-0.39***	-0.39***	-0.37***	-0.38***
					(-7.53)	(-7.91)	(-6.72)	(-7.69)
High Eco-Efficiency					0.07	0.01	0.06	0.01
					(0.87)	(0.19)	(0.69)	(0.10)
Firm Size	-5.11 E^{-6} ***	-2.71 E^{-6} ***			-4.98 E^{-6} ***	-2.62 E^{-6} ***		
	(-9.91)	(-4.77)			(-8.98)	(-4.64)		
Debt / Assets	-3.93***	-2.29***	-3.99***	-2.34***	-3.99***	-2.33***	-4.04***	-2.39***
	(-6.88)	(-5.99)	(-6.97)	(-6.00)	(-6.84)	(-5.95)	(-6.93)	(-5.95)
Sales			-7.00 E^{-6}	-9.62 E^{-6} *			-8.44 E^{-6}	-6.36 E^{-6} *
			(-1.56)	(-2.00)			(-1.35)	(-1.74)

The table reports the Fama-MacBeth (1973) time-series mean coefficient and the corresponding *t*-statistic (in parentheses). Note: Low Eco-Efficiency = 1 if firm ranked ≤ 1. High-Eco-Efficiency =1 if firm ranked ≥ 5. The coefficients are multiplied by 100. Ind-Adj. ROA is industry-adjusted return on assets. The sample period is 1997-Q1 – 2002-Q4.
* significant at 10% level
** significant at 5% level
*** significant at 1% level

Figure 1a. Differences between time-varying coefficients on High and Low Eco-Efficiency

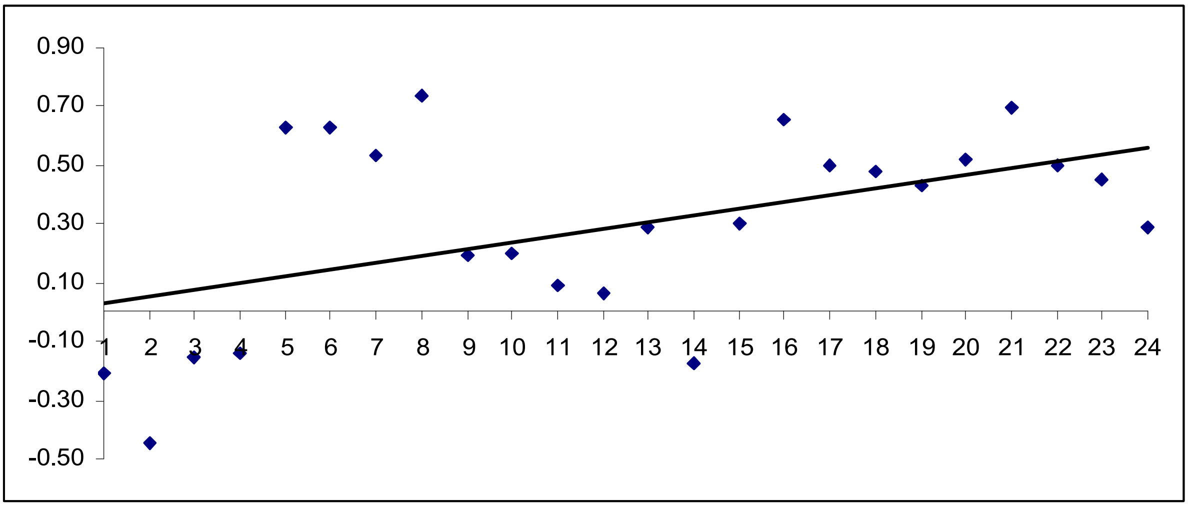
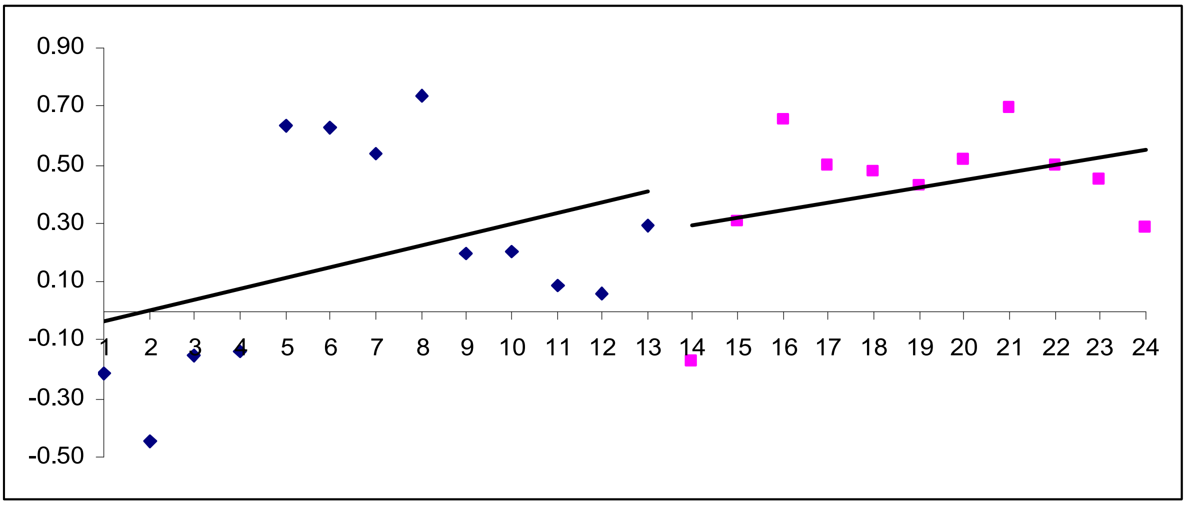


Figure 1b. Sub-period trends: 1st quarter 1997- 1st quarter 2000 and 2nd quarter 2000 – 4th quarter 2002



Reported is the difference between β_0 and β_1 for each quarterly estimation of (2): $Q_{it} = \alpha_i + \beta_0$ High Eco-Efficiency$_{it}$ + β_1 Low Eco-Efficiency$_{it}$ + γ_{it} X_{it} + ε_{it},. Figure 1a gives differences between β_0 and β_1 over time and a linear trend. The slope of the trend line in 1a is 0.034 and its *t*-statistic (derived from Newey-West (1987) heteroskedasticity and autocorrelation consistent standard errors) is 1.94. Figure 1b displays trends estimated over sub-periods.