The Economic Value of Corporate Eco-Efficiency

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ABSTRACT

For several decades, scholars and practitioners have been intrigued by the question whether adopting environmental management policies are economically valuable to the firm. We focus on the concept of eco-efficiency and add new insights to the environmental-financial performance debate. Using a large database of monthly eco-efficiency ratings which have received little academic attention hitherto, this study provides evidence of a positive but non-linear relationship between corporate eco-efficiency and the firm’s Tobin’s q. We also demonstrate that the relation has strengthened in recent years, which may indicate that the market has responded to environmental information with a drift. While environmental winners initially did not sell at a premium relative to losers, this premium increased strongly over time. Furthermore, our study points to a clear discrepancy in operating performance between firms with high eco-efficiency ratings and those with low ratings. Environmental leaders do not have a return on assets superior to that of the control group, but laggards display significant operational underperformance. Our results have major implications for company managers, who evidently do not have to overcome a tradeoff between eco-efficiency and financial performance, and for investors, who may regard our results as an informational source for making investment decisions.
1. Introduction

Companies have long been thought of as profit-maximizing entities which are expected to engage in activities that meet the financial responsibilities of the firm. Little room existed for alternative firm performance measures concerning the contribution of the company to society as a whole and to our natural environment. However, fuelled by widely reported corporate environmental and social scandals, managers and shareholders are now increasingly showing interest in the concept of corporate social responsibility (CSR). The world’s largest institutional asset managers are publicly demonstrating their commitment to investing in companies that are deemed socially, morally and environmentally responsible.¹ In addition, several governmental organizations are increasingly considering the introduction of corporate reporting standards designed to accelerate these developments.²

In spite of the increased acceptance of corporate social responsibility principles, there exists 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 being good? Skeptics predominantly believe CSR is a vague construct that requires organizations to raise operating costs and to forego shareholder wealth (e.g. Friedman 1962, Walley and Whitehead 1994). In contrast, scholars that seem to favor CSR 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, which all could ultimately be received positively by capital markets. See, for example, Porter and van der Linde (1995), Shane (1978), and Fombrun et al. (2000).

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. Whereas 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 negative environmental performance is more than ever before being punished by law with concrete financial penalties.³ However, several scholars have stressed that the financial information content of environmental performance is not evident by itself. Among

¹ Pension funds currently showing commitment to ‘socially responsible investments’ include, for example, CalPERS in the US, Universities Supperannuation Scheme in the UK, ABP and PGGM in the Netherlands, and AP7 in Sweden.
² For instance, an amendment to the 1995 Pension Act in the UK, which was enforced in 2000, requires pension funds to disclose how they consider social and environmental issues.
others, Hart and Ahuja (1996), Russo and Fouts (1997) and King and Lenox (2002) emphasize that companies can display environmental awareness through ‘end-of-pipe’ pollution control, where emissions are simply cleaned up subsequent to the production process, but that pro-active pollution prevention techniques embedded in the firm’s production processes are more likely to increase operating efficiency and profitability.

Building on the aforementioned assertions, we focus on the concept of corporate eco-efficiency. Corporate eco-efficiency reflects the environmental governance of the firm beyond what is indicated by elementary environmental compliance and pollution control policies. Broadly, eco-efficiency can be defined as the economic value a company creates over the waste it generates resulting from the creation of that value. 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. 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 have received limited attention in the empirical literature up to this point.

One exception is a recent study on eco-efficiency, which we aim to extend along several lines. Derwall et al. (2004) composed two equity portfolios of stocks sorted on the eco-efficiency scores and assessed their performance using elaborate performance attribution models. Their results suggest that companies labeled 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 this research by examining the relationship between eco-efficiency and, respectively, firm value and firm operating performance. Close attention is paid to potentially confounding influences through the inclusion of a broad range of control variables.

In choosing firm value (Tobin’s $q$) and operating performance (return on assets) as firm financial performance criteria, this paper not only looks at multiple dimensions of financial performance but also sheds new light on the nature of the eco-efficiency premium puzzle documented in Derwall et al. (2004). 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. (2004) 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.

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3 For example, fifteen years after the widely reported Exxon Valdez oil spill drama in Alaska, a federal judge recently
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. We expect to provide additional empirical validation of an undervaluation story after having examined the degree to which eco-efficiency is factored into firm valuation measures, such as Tobin’s $q$. That is, we expect relatively undervalued companies to experience a period of upward share price correction and display a relative increase in $Q$ over time. But 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 Porter and van der Linde (1995) and Alexander and Bucholtz (1978), it can be hypothesized that eco-efficiency is a sign of production efficiency or a proxy for management skill and thus related to the firm’s operational performance.

As will be explained in more detail in the following sections, our study is important for several reasons. While most previous research has somewhat sub-optimally measured corporate environmental performance by relying on narrow or noisy proxies, this study uses a novel and rigorous dataset of scores which aim to provide a detailed assessment of corporate eco-efficiency. Second, the data we use are made available on a monthly basis, allowing us to expand previous work in terms of statistical power. Whereas most previous research has limited its attention to static, cross-sectional relationships between environmental and financial performance, we demonstrate the relevance of examining the robustness of these relations over time. Finally, previous research has differed markedly in the choice of firm financial performance measures; yet little is known about the consistency of the results so far across studies. Because differences in the choice of financial criteria may be an important source for potentially conflicting outcomes, our study also uses alternative measures of financial performance but intends to reconcile all the evidence against the background of management theories and financial theories on corporate environmental responsibility.

The remainder of the paper is organized as follows. Section 2 outlines several theoretical lines of reasoning pertaining to the link between corporate social (environmental) performance and financial performance. Section 3 gives an overview of prior related research, taking into consideration the financial variables of interest to this paper. Furthermore, this section points to several limitations encountered in the literature and highlights the contribution of this study. Section 4 describes the database used for measuring corporate eco-efficiency. In section 5, we discuss the empirical analysis. Section 5.1 relates eco-efficiency to firm value. Section 5.2 explores the relationship between corporate eco-efficiency and firm operating performance. Section 6 highlights the practical implications resulting from our findings. Finally, section 7 concludes.

imposed punitive damages of more than $4 billion on the Exxon Mobil Corporation.
2. Theoretical Debates

For several decades, the academic community has been occupied with postulating models and hypotheses relating corporate social and environmental responsibility to financial performance. Despite the growing academic attention for the CSR-financial performance relationship, management scientists and financial economists have developed their ideas in this area almost autonomously. This section intends to bridge the gaps between management and financial theories.

2.1. Management Theories

It is well known that the CSR-financial performance relationship is the source of considerable debate. Extant theories in the management literature are far from uniform and more than twenty-five years of empirical research has been unable to overcome long-lasting theoretical divides (Griffin and Mahon 1997). The roots of the debates can be traced back decades. During the 1960s, the concepts of corporate social responsibility and socially responsible investing were gaining momentum. In reply, opponents of CSR quite forcefully questioned the validity of CSR in the context of what was believed to be the purpose of the firm: maximizing shareholder wealth. In general, ‘opponents’ of the concept of CSR have raised two critical points:

- CSR is far from well defined. A view shared by many skeptics, including Milton Friedman (Friedman 1962), is that managers are unable to determine what the social responsibility of their company is. Accordingly, it is said that the only ‘responsibility’ of the firm is to engage in profitable activities. Shareholders are themselves capable of deciding whether their stock income sufficiently represents social awareness.

- CSR is expensive and decreases shareholder value. At least partially due to the problem of determining the social responsibility of businesses, a common critique to CSR addresses the financial dangers of adopting corporate social responsibility principles. Several critics have stressed that CSR initiatives inherently demand significant portions of a company’s financial resources, whereas their potential financial benefits are mostly visible in the distant future, provided these benefits are evident at all (e.g. Walley and Whitehead 1994, Henderson 2002).
In brief, the main concern expressed by CSR skeptics is that the bulk of costs associated with corporate social performance improvements are likely to outweigh the financial benefits, which makes the CSR doctrine inconsistent with the principles of shareholder wealth maximization.

In contrast, a sizable number of CSR ‘proponents’ have put forward a wide range of advantages to corporate social responsibility. Their line of reasoning is that organizations can generate significant goodwill and new market opportunities by displaying social and environmental awareness (e.g. Porter and Van der Linde 1995, Hart and Ahuja 1996, Russo and Fouts 1997, Fombrun et al. 2000). However, there is a growing belief that the economic benefits depend on the nature of environmental performance. Increasingly, it has been argued that advantages resulting from simple social and environmental compliance with regulatory requirements are not a primary source of competitive advantage. For example, simple 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. Real benefits to organizations are likely to come from more rigorous (i.e. pro-active) forms of environmental performance that require changes in production and manufacturing processes as well as a forward-looking management style (Hart and Ahuja 1996, Russo and Fouts 1997 and Dowell et al. 2000). Hillman and Keim (2001) add that CSR initiatives can pay off, so long as these efforts are in the interest of the company’s primary stakeholders who bear some form of risk by being financially involved with the company. 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 signals labor conditions, socially responsible companies gain a competitive advantage by improving their ability to attract high quantities of high-quality human resources. Apart from human resource benefits, others have mentioned the possibility that reputational advantages result into sales benefits because customers may be sensitive to social issues; see for instance Vandermerwe and Oliff (1990), and Russo and Fouts (1997). Similarly, reputation increases may affect relationships with potential suppliers and lenders.

- CSR can proxy for management skills. As also mentioned by Bowman and Haire (1975) and Alexander and Buchholz (1978), another assertion is that corporate social and environmental performance reflects management quality. For instance, it can be argued

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4 Empirical evidence by Turban and Greening (1996) strongly supports this line of reasoning.
that a structural and dedicated CSR policy inherently requires commitment to CSR among and between all levels of the firm as well as a forward-thinking, long-term oriented management (Shrivastava 1995).

- CSR may 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.

Taken as a whole, it has been argued repeatedly that firms which commit to social, moral and environmental concerns may reap tangible and intangible benefits, which suggests that CSR does not weaken but strengthen the firm’s ‘bottom line’ performance.

2.2. Financial Theories

Increasingly - and now more than ever before - financial market participants have been showing attention for CSR. Institutional investors are demonstrating their interest in the concepts CSR and socially responsible investing (SRI) as a means to fulfilling their social and their financial obligations. Analogous to these developments, financial economists have put forward theoretical frameworks that either support or reject the validity of CSR from an investor perspective by relying on established asset pricing theories. These theories, as outlined in all modern finance textbooks, center around the risk-return paradigm. In capital markets theory, investors are typically considered rational and have some degree of risk aversion. Rational investors seek to gain the highest rate of return given a certain level of investment risk. For example, if holding asset A instead of B requires investors to bear a higher risk, then investors expect a financial compensation for this risk differential between A and B expressed by a differential return between A and B. The risk-expected return paradigm, accordingly, says that the market values an asset so that its expected return is a function of its risk.

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5 Recent estimates by the Social Investment Forum (2003) suggest the market for ‘socially responsible investments’ (SRI - i.e. investments in socially responsible corporations) currently covers approximately 12% of the market as a whole.

6 Moskowitz (1972) is regarded as one of the initiators of SRI.

7 See, for example, Sharpe (1964), Lintner (1965) and Mossin (1966).
The risk-return paradigm is important because it highlights that managerial perspectives towards CSR are merely one part of the story. While 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) return to stockholders. Whether investors benefit from holding stocks of socially responsible companies, depends on how the investment community perceives CSR. As also pointed out by Hamilton et al. (1993), 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. In a rational market this implies that CSR is not tied to investment risk. 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 non-responsive firms, all other things equal.8

- Contrary to the first hypothesis, the second hypothesis predicts that investors do value CSR. As also suggested by Spicer (1978) and Shane and Spicer (1983), a plausible line of reasoning is that firms with a strong social or environmental performance record may gain investor trust and are regarded as less risky investments compared to those performing poorly on these performance spectra. In the risk-return framework, the notion that social and environmental leaders are less risky investments than 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. Note that if capital markets incorporate information related to CSR efficiently, we can assume that expected returns on stocks fairly compensate for 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 for example Heinkel et al (2001).

- Finally, a 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 where investors underestimate the possibility that

8 There is another hypothesis, which is not directly related to the other three hypotheses, suggesting that the financial community should be critical towards the concept of socially responsible investing. It is said that socially responsible
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, stocks of socially responsible companies can be undervalued (overvalued) relative to those of less socially responsible companies and produce higher (lower) risk-adjusted returns.

What also becomes apparent is that, from a theoretical point of view, one can argue both sides as to whether CSR adds or exhausts economic value. Ultimately, this question is an empirical one. The following section discusses empirical evidence to date.

3. Literature review

3.1. Prior evidence

Researchers have long sought for compelling empirical evidence on the environmental-financial performance link. The extant literature in this area is discussed thoroughly in Griffin and Mahon (1997) and in Ullman (1985), amongst others. Their discussions point to the methodological inconsistencies across studies, which makes the literature incomparable and the evidence inconclusive. In this section, we limit ourselves to reviewing research related to financial variables of interest to this study: stock returns, firm value measured by Tobin’s q, and return on assets.

The empirical literature relating the environmental component of CSR to stock performance can easily be summarized into three subsets: (a) event studies exploring the immediate effects of social or environmental performance proxies on short-term stock price variability, (b) cross-sectional regression analyses attempting to establish a longer-term relationship between CSR and stock returns, and (c) portfolio studies investigating the benefits of embedding CSR into investment decisions.

Event studies to date have provided most pronounced evidence of a linkage between environmental and stock market performance. This body of research, including Shane and Spicer (1983), Hamilton (1995), and Klassen and McLaughlin (1996), suggests that while environmental pollution figures generally tend to have an influence on stock market performance, there also exists an asymmetrical stock return sensitivity to environmental news. For example, Klassen and McLaughlin (1996) found 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 body of literature has employed regression or correlation analysis to explore long-term relationships between corporate environmental responsibility and stock returns. Taken as a whole, these studies provide mixed support for the notion of a relationship between environmental performance and shareholder value. Spicer (1978) reported that companies in the US pulp and paper industry with better pollution control records have higher profitability figures and lower stock betas, but both Chen and Metcalf (1980) and Mahapatra (1984) failed to confirm that pollution control initiatives are rewarded with improved stock performance. Interestingly, 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, which are constructed using a company characteristic as a discriminating factor. Portfolio research typically involves a comparison of average risk-adjusted returns between two or more mutually exclusive portfolios, which are constructed using a company characteristic as a discriminating factor. Portfolios are usually evaluated by means of 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, 1998), remarkably little research has applied environmental firm characteristics as a discriminating variable. Among the few exceptions, research by Cohen et al. (1997) suggests there is neither a premium nor a penalty for investing in environmental leader companies. White (1996), on the other hand, found that his ‘green’ portfolio provided a significantly positive market-risk adjusted return while ‘brown’ and ‘oatmeal’ portfolios did not. Finally, recent research by Derwall et al. (2004), using enhanced performance evaluation techniques, suggests that eco-efficient companies jointly provided anomalously positive equity returns relative to their less-eco efficient peers over the period 1995-2003.

Evidence on potential linkages between environmental performance and firm value is addressed in a relatively recent strand of research. Generally, the evidence is uniform and points to a positive and significant relationship between environmental management policies and Tobin’s $q$. Dowell, Hart and Yeung (2000) allocated multinational firms in their U.S. sample into three groups: (a) firms which default internationally to (less stringent) local environmental standards, (b) companies applying U.S. environmental standards on an international scale, and (c)

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9 An alternative approach involves a comparison between the returns of socially responsible mutual funds and those of a matched sample of conventional funds or conventional equity indexes; see for instance Hamilton et al. (1993), Statman (2000) and Bauer et al. (2004). However, when investigating a ‘pure’ association between CSR and equity returns these studies introduce bias in the sense that socially responsible fund holdings and conventional fund holdings are far from mutually exclusive.
firms adopting more stringent standards than required by U.S. law. Their results suggest that firms which adopt higher, more stringent, environmental criteria have a higher firm valuation than those who employ less stringent ones. These findings are consistent with Konar and Cohen (2001), who suggest that firms disposing relatively smaller amounts of toxic chemicals, and those being confronted with fewer or no environmental lawsuits, tend to have a higher \( Q \). King and Lenox (2002) further expanded previous research by making an attempt to disentangle 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 has relied on operating performance measures, predominantly using accounting data.\(^{10}\) 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 and deserve some attention. Considerable interest has been shown in the company’s return on assets (ROA) as a dependent variable, primarily because ROA is one of the broadest measures of firm operating performance. Freedman and Jaggi (1988), for example, investigated the relation between environmental pollution disclosure and several accounting-based performance indicators but found little evidence to support the conjecture that a clear-cut and significant association exists. However, McGuire et al. (1988) documented 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), in addition, reported 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 pollution prevention, but not pollution treatment, causes higher return on assets.

### 3.2. 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. The present paper intends to overcome several methodological limitations that are often encountered in the empirical literature. Broadly, our enhancements pertain to the following areas.

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\(^{10}\) For a detailed overview the reader is referred to Ullman (1985) and Griffin and Mahon (1997).
First, we seek to overcome 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 vast majority of related literature has relied on measures that either lack sufficient depth and detail or, alternatively, are too noisy in order to be fully capable of measuring corporate social or environmental performance. In addition, as underscored by Konar and Cohen (2001), most previous research has studied data that only point towards historical performance. Extensively employed proxies for environmental performance include the data from the Council on Economic Priorities (e.g. Shane and Spicer 1983), the toxic release data reported to the Economic Protection Agency (e.g. Konar and Cohen 2001, King and Lennox 2002), and some corporate reputation indexes (McGuire et al. 1998). In contrast, this study builds on the concept of eco-efficiency, which is a more strictly defined construct and quantifiable via Innovest’s eco-efficiency rating methodology. As will be explained in following sections, the rating is not only intended to reflect historical environmental performance but also aims to identify future environmental risks and opportunities. Despite the benefits of this broad measure, the eco-efficiency score we use has received little attention in the literature to date.

Our second contribution is methodological of nature. The environmental data observed in the literature hitherto is typically available annually (e.g. Dowell et al. 2000). In addition, some studies have limited their exploration into cross-sectional relationships to one specific point in time (for example, Konar and Cohen 2001). The ratings examined 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 have differed remarkably in the choice of corporate financial performance criteria, thereby underlining that determining the appropriate financial performance measure is the subject of considerable debate. While all of the aforementioned empirical work is undoubtedly important and innovative, remarkably little attention has been paid to whether the results from these studies are truly coherent. For instance, the evidence by Dowell et al. (2000), Konar and Cohen (2001) and King and Lennox (2002), suggesting that environmental

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11 From a theoretical perspective, it can be argued that stock return data are preferred over accounting-based data, because accounting reports are much more sensitive to managers’ latitude. However, stock return data contain considerable idiosyncratic noise and are occasionally driven by confounding influences, such as stock market crashes. Firm valuation measures such as Tobin’s Q are incrementally informative, being capable of capturing both the tangible and the intangible value of the company, but do not specifically address the internal (operational) efficiency of the company. The strengths and limitations of these variables point to the incremental relevance of firm operating performance measures, for which a whole host of candidate proxies exist (see for example Barber and Lyon 1996).
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 conventional asset pricing theory holds, lower risk implies a relatively lower expected return on stocks of companies that perform well environmentally. However, as also shown in the previous section, recent evidence points to an abnormal positive stock return differential between environmental leaders and laggards, which 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 thus to overcome potential inconsistencies in the results across the different analyses.

4. Data

4.1. Eco-Efficiency Data

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

We will focus on eco-efficiency. Formally, 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). A less formal explanation is given by Dowell et al. (2000: 1062), who interpret eco-efficiency as the ability of companies to minimize pollution by improving the production and manufacturing process. This form of environmental responsibility thus represents pro-active environmental management, concentrating on environmental performance yielded by 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 typically 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 benefit from this financially.

We explore empirical relationships between eco-efficiency and several dimensions of corporate financial performance using eco-efficiency scores developed by Innovest Strategic Value Advisors (hereafter referred to as ‘Innovest’). The Innovest data have received little attention in previous research and, therefore, allow us to provide the reader new evidence. One of the main strengths of this database is its 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 (sub)score. 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 certification by a third party that is devoted to promoting environmental awareness. 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.

The sub-criteria can be grouped into five broader categories, which address five fundamental types of environmental factors. The first component of the score, referred to as ‘historical liabilities’, concerns the risks (and opportunities) a firm faces resulting from past environmental behavior. Amongst other things, this category covers superfund liabilities, state and hazardous waste sites, and toxic torts. A second, contemporaneous component that is called ‘operating risk’ addresses risk exposures arising from events that are more recent. This includes, for example, toxic emissions, product risk liabilities, waste discharges, and supply chain management risk. The third category, 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. Within this category, assessments are being made on energy intensity, energy efficiency, the durability and recyclability of the product life cycle, but also on the extent to which companies are exposed to changes in consumer values. The fourth element of the score covers ‘managerial risk efficiency’. Largely, this category assesses the ability of the company to manage environmental risks successfully as indicated by several sub-indicators (e.g. the quality of supply chain management, environmental audit/accounting capacity, the strength of environmental management systems, training capacity). A final component, classified as ‘environmentally-related strategic profit opportunities’, factors business prospects into the eco-efficiency assessment routine. One of the primary objectives of the latter
category is to identify 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 ratings are intended to embody both ex post (i.e. historical and current) and ex ante (i.e. forward-looking) dimensions of corporate eco-efficiency. The scores cover the period December 1996-December 2002. This paper considers firms listed on the U.S. stock markets. As we also use various financial data, we matched the Innovest database to the CRSP U.S. Stock database and to the Compustat U.S. Research database. The resultant 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.

[Table 1: Summary Statistics]

We converted Innovest’s seven non-numerical ratings into numerical eco-efficiency scores, where highest-ranked firms have a rating equal to 6 and lowest-ranked firms have a value of 0. Table 1 gives some brief statistics on the eco-efficiency scores over time. These statistics are merely descriptive and serve as some background for the analyses that follow. The results are displayed for four particular dates. Notice that the last date we display is September 2002 due to the nature of the financial data, which are reported on a quarterly basis (i.e. fourth-quarter financial measures will be regressed on eco-efficiency scores that are dated September). The average rating decreased over the period 1996-2002 from 3.04 to 2.66. The median rating is equal to 3 in all periods. The standard deviation varied 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 received an eco-efficiency score below 3 increased more strongly compared to the number of firms that have a score of 4 or higher. The number of firms in the sample increases sizably over time. Our data set includes scores about 154 companies at the end of December 1996 and scores about 409 firms at the end of September 2002.

12 Matching occurred by ticker, company name and CUSIP number.
4.2. Financial Data

Our objective is to investigate 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. The usefulness of \( Q \) in measuring the value of a company is well established. Broadly, Tobin’s \( q \) is defined as the market value of the firm divided by the replacement value of the firm’s assets. In line with Kaplan and Zingales (1997), we compute the market value of assets 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. The replacement value is represented by the book value of assets. 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 Erickson and White (2001), 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 it has been shown that recent sales growth is positively related to company valuation (e.g. Hirsch (1991)), we include past two-year sales growth as a control variable. Furthermore, related work, including Konar and Cohen (2001), Dowell et al. (2000) and King and Lenox (2002), 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.\(^\text{13}\) 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 computed the difference between the first trading day and the respective date of the analysis. Since the database “Exshare”, from which the first trading days were retrieved, was established in November 1984 we lack information before 1984. If firms were founded before this date, it is still assumed that foundation occurred in 1984. Finally, we consider a dummy variable that is equal to unity if the firm is listed on the NASDAQ Stock Exchange and zero otherwise. The dummy controls for atypically high Tobin’s \( q \) values of NASDAQ firms, which may have occurred during the stock market hype of the nineties. All variables other than AGE were constructed using data from Compustat.

Subsequently, we explore the connection between eco-efficiency and operating performance. Our primary interest is in a broad measure of operating performance that addresses profitability and efficiency. Following related research, we measure operating performance.

\(^{13}\) Konar and Cohen (2001) scale R&D expenditure by sales while 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 used both
performance by the company’s return on assets. Our set of control variables is largely consistent with Waddock and Graves (1997). We control for the influence of firm size, the firm’s riskiness and R&D expenditures. Size is measured by the firm’s total assets and by total assets. Risk is represented by the debt-to-asset ratio. All variables are formed using data from Compustat.\footnote{Specific Compustat data definitions and data item numbers are available upon request.}

To give an impression of the distribution of $Q$ and of ROA, Table 2 reports some descriptive statistics pertaining to four specific dates in time. A brief visual inspection indicates that there is some non-normality in the data. Particularly $Q$ 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. This can also be seen by differences in the cross-sectional median $Q$ and the mean $Q$ over time. The median value for Tobin’s $q$ remained quite time invariant but mean Tobin’s $q$ values where much higher during the boom and bust of the technology markets. 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. Moreover, we consider a dummy variable capturing potentially extreme Tobin’s $q$ values for companies listed on the Nasdaq Stock Exchange.

5. Empirical Analysis

5.1. Eco-Efficiency and Firm Value

Previous studies, using alternative environmental performance measures, have provided evidence in support of the conjecture that corporate environmental performance is associated with firm value; see for example Dowell et al. (2000) and Konar and Cohen (2001). There are two reasons why we would expect corporate eco-efficiency to influence firm valuation. First, as also suggested by previous work, it can be argued that the firm’s environmental governance affects its reputation and improves investors’ trust (Russo and Fouts 1997, Spicer 1978, Shane and Spicer 1983). Accordingly, investors perceive companies that do well on the eco-efficiency spectrum as less
risky relative to less eco-efficient firms and associate eco-efficient firms with a lower discount rate, a higher discounted value, and a lower expected stock return. Our expectation, thus, is that the most eco-efficient companies have higher (discounted) values compared to the least eco-efficient firms. Second, it can be expected that recent evidence by Derwall et al. (2004), reporting 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 that increases over time. To test both lines of reasoning, this section investigates the relationship between corporate eco-efficiency and firm value.

Using a standard application of the Fama-Macbeth (1973) procedure, we estimate quarterly the following cross-sectional models:15

\[
Q_{it} = \alpha_i + \beta_1 \text{ECO}_{it} + \gamma_{it} \mathbf{X}_{it} + \epsilon_{it}, \quad (1)
\]

\[
Q_{it} = \alpha_i + \beta_0 \text{ECO HIGH}_{it} + \beta_1 \text{ECO LOW}_{it} + \gamma_{it} \mathbf{X}_{it} + \epsilon_{it}, \quad (2)
\]

\(Q_{it}\) denotes Tobin’s \(q\) for firm \(i\) at \(t\) and \(\text{ECO}_{it}\) in model (1) represents the eco-efficiency rating of firm \(i\) in quarter \(t\). \(\mathbf{X}_{it}\) is a vector of control variables and \(\gamma\) denotes a vector of coefficients. In model (2), \(\text{ECO}_{it}\) is replaced by 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. (2004). More specifically, \(\text{ECO HIGH}_{it}\) (\(\text{ECO LOW}_{it}\)) is equal to unity if firm \(i\) is rated 5 or 6 (0 or 1) and zero otherwise.16 Because we consider several model specifications, \(\mathbf{X}_{it}\) contains permutations of the following candidate regressors: the firm’s 2-year sales growth (\(\text{SG}_{it}\)) at \(t\), firm age (\(\text{AGE}_{it}\)), the ratio of R&D expenditure to sales (\(\text{RD/SALES}_{it}\)), the book value of total assets (\(\text{SIZE}_{it}\)), an interaction term between sales growth and R&D spending (\(\text{RD*SG}_{it}\)), advertising expenses scaled by sales (\(\text{ADV/SALES}_{it}\)) and, lastly, the dummy variable for NASDAQ companies (\(\text{NASDUM}\)). From the 24 quarterly regressions, performed over the period January 1997 - December 2002, we compute time-series averages of the cross-sectional coefficient estimates. Subsequently, corresponding t-statistics are computed 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

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15 At first glance, a plausible alternative to our approach would be a pooled regression that allows for fixed effects and time effects. However, we rejected this setup due to a lack of variability in the eco-efficiency data.

16 We also replicated the portfolio construction method of Derwall et al. (2004) and evaluated the returns on our high-ranked and low-ranked portfolio over the period Dec. 1996-Dec. 2002 using Carhart’s (1997) performance attribution model. Our results corroborate their results and are not reported here.
median $Q$, $Q$ in logs, and a trimmed $Q$ as a regressant.\footnote{The primary motivation for considering Tobin’s $q$ relative to industry averages is that $Q$ is known to vary} Trimming mitigates the effect of potential outliers in Tobin’s $q$. We adopted the trimming approach of Collins et al. (1997) and removed observations using the 0.995 percentile and the 0.005 percentile as upper and lower boundaries.

[Insert Table 3: Fama-Macbeth Regressions for Tobin’s $q$]

The results for the main model specifications are shown in Table 3. The left panel 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 (SG, 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 relationship with firm value. The observation most relevant to our study is that under all scenarios the coefficient on the main variable of interest, eco-efficiency ($ECO_i$), is positive and statistically significant at the 1% level. Our estimates of $\beta_1$ in equation (1) are 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, it is important to note that neither industry-adjustment nor trimming of Tobin’s $q$ has effect on the coefficient estimates, which are highly 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.

The right panel in Table 3 adds to the understanding of the observed positive association between ECO and $Q$, reporting the results of replacing $ECO_i$ by the dummy variables ECO HIGH$_i$ and ECO LOW$_i$ (equation (2)). Contrary to previous findings, these results are suggestive of a non-linear relationship between eco-efficiency and $Q$. Specifically, there is no compelling evidence that eco-efficient companies have a higher $Q$ relative to the remainder of the reference sample. The coefficient on ECO HIGH$_i$ is not significant at the conventional levels. In contrast, all coefficient estimates for ECO LOW$_i$ are negative and significant at the 1% level, thereby pointing out 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.
In order to evaluate the robustness of the documented relationships even further, we estimated additional models that include different sets of control variables. Table 4 presents the outcomes for these alternative specifications. For reasons of comparison, the initial results pertaining to equations (1) and (2) are imported 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 (RD*SG). Second, since Konar and Cohen (2001) present evidence that advertising expenses might be related to firm value, another model contains the firm’s advertising expenses scaled by sales (ADV/SALES). The last alternative specification augments the first model by the NASDAQ dummy. In the left panel, 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 by ECO HIGH and ECO LOW are given in the right panel of Table 4 and are in support of previous observations. In three scenarios, the reported coefficients underline that eco-efficient companies do not have a higher $Q$ relative to the reference group while the least eco-efficient firms have a Tobin’s $q$ that is significantly lower compared to the remainder of companies in the sample. Interestingly, the coefficients on ECO and ECO HIGH increase in magnitude when the control set includes advertising (ADV/SALES) as a determinant instead of the interaction between R&D and sales growth (RD*SG). However, because limited availability of (cross-sectional) advertising data induces a small sample problem, the results under the third set of control variables should be interpreted with caution.

A positive (though potentially non-linear) 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 observed association between Tobin’s $q$ and eco-efficiency has not been reconciled with the evidence by Derwall et al. (2004) that eco-efficient stock portfolios have earned 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

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18 We estimated model 2 as well as 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 upon request.
firms are deemed less risky. After adjustment for these risk differences, there should be no abnormal difference in return. Under the hypothesis that the market reacts to eco-efficiency with a drift, however, firms can be under- or overvalued and risk-adjusted portfolio returns can be anomalous.

We now exploit the attractive features of the Tobin’s $q$ measure and of the Fama-Macbeth regression technique to shed more light on the nature of the large return differential documented in Derwall et al. (2004). Their stock portfolio of eco-efficient firms earned 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 $q$ with respect to corporate eco-efficiency allows for an investigation into 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, reporting regression results for Tobin’s $q$ broken up into two sub-samples, confirms our expectations. Time-series average coefficients are displayed for the period 1997-1999 and 2000-2002, respectively. The sub-sample results indicate a strong time variation in the coefficients on ECO HIGH$_i$ and on ECO LOW$_i$. The coefficient on ECO LOW is -0.42 and significant (at the 1% level) in the first period and -0.20 but insignificant in the second period. The coefficient on ECO HIGH underwent a stronger upswing, being -0.24 and significant in the first period and 0.21 and significant in the second period. Thus, whereas the least eco-efficient firms did not undergo a substantial change in valuation over time, eco-efficient companies witnessed a stronger upward shift in their value across sub-sample periods. In Figure 1, we report differences between the quarterly estimates of the cross-sectional coefficients on the two dummy variables ($\beta_0 - \beta_1$) in equation (2). The upward sloping trend line in Figure 1 tells a similar story: while eco-efficient firms were not selling at a sizeable relative premium at the beginning of the sample period, the premium increased 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.
The patterns indicated by Table 5 and Figure 1 are consistent with recent evidence of abnormal returns on stocks of eco-efficient companies, as an abnormal return differential would explain relative differences in $Q$ across periods. The results are also supportive of 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, where stocks of eco-efficient companies were initially undervalued and, subsequently, underwent a price correction. Investors adjusted downwards the expected stock returns and the cost-of-capital associated with environmental leaders. Accordingly, the value of eco-efficient companies was driven upwards. While the expected returns of these firms were driven downwards, the upward trend in firm valuation generated positive realized returns.

The results we find over time can also be harmonized with, for example, the event study results of Klassen and McLaughlin (1996). Their study documents significant negative abnormal returns in response to negative environmental events and relatively smaller abnormal returns following positive events. Of course, our findings differ from theirs - and are in line with the results of Derwall et al. (2004) - 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) may 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 be in conflict with the notion that markets are efficient, this study is not the first to document that some information is incorporated slowly into stock prices. For example, there is evidence that stock repurchases (Ikenberry et al. 1995) and dividend omissions (Michaely et al. 1995), all of which are arguably more concrete events than environmental events, have a post-event drift.

Overall, our findings suggest that information related to corporate eco-efficiency is valued by the market, but also that the association between eco-efficiency and Tobin’s $q$ is potentially non-linear: the least-eco efficient firms have lower $Q$ values but eco-efficient firms do not have $Q$ values that are significantly higher compared to the remainder of the firms in our sample. We also find a strong increase in $Q$ over time for eco-efficient companies relative to their least eco-efficient counterparts, keeping other variables of influence equal. The nature of the time-varying association can be debated. Given recent evidence pointing to abnormal returns on stock portfolios consisting eco-efficient firms, a plausible interpretation is that the strong upward trend in the value of eco-efficient companies reflects a period of correction. The adjustment involves a downward correction by investors of expected returns on stocks of eco-efficient firms and high realized returns. At the very least, the results suggest the market has displayed increased interest
in information about the environmental performance of the firm. This could imply that the observed non-linearity in the relationship between eco-efficiency and Tobin’s $q$ is temporary.

**5.3. Eco-efficiency and Return on Assets**

The previous section of this paper focused on market-based firm valuation measures to establish associations between corporate eco-efficiency and financial performance. In this section, we follow another large management and accounting literature which has focused on the relationship between corporate environmental performance and firm operating performance. Our primary interest is in a broad measure of operating performance that addresses profitability and efficiency. 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, *ceteris paribus*.

The multivariate model operationalized by Waddock and Graves (1997) is largely followed. Our main specifications are of the form:

\[
\text{ROA}_i = \alpha_i + \beta_1 \text{ECO}_i + \gamma_i \text{X}_i + \varepsilon_i, \quad (3)
\]

\[
\text{ROA}_i = \alpha_i + \beta_{0i} \text{ECO HIGH}_i + \beta_{1i} \text{ECO LOW}_i + \gamma_i \text{X}_i + \varepsilon_i, \quad (4)
\]

where ROA$_i$ denotes return on assets. We consider modeling both ROA and the firm’s ROA relative to the industry median ROA. ECO$_i$ in model (3) is the firm’s eco-efficiency score. In specification (4), the absolute eco-efficiency score ECO$_i$ is replaced by two dummy variables which specify whether firm $i$ was the most or the least eco-efficient. ECO HIGH$_i$ (ECO LOW$_i$) is equal to 1 if firm $i$ is rated 5 or 6 (0 or 1) at $t$ and zero otherwise. X$_i$ is a vector of control variables and $\gamma$ 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 by total assets (SIZE$_i$) and by total sales (SALES$_i$), the debt-to-asset ratio (D/A$_i$), and R&D expenditures (R&D$_i$). Using a variant of the Fama-Macbeth (1973) method, as outlined earlier, 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: Fama-MacBeth Regressions for ROA]
Table 6 reports the time series mean coefficients and corresponding t-statistics. Notice that variations in respectively, the dependent variable, the control variables, and the eco-efficiency variable are allowed for. Several important observations can be made. 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. As for the coefficients on the eco-efficiency variables, we find estimates that are consistent with those reported in the previous section. The left panel of Table 6 reports coefficients on the eco-efficiency score. ECO has a coefficient that is positive and significant at the 1% level. Further, as shown by the supplementary results from estimating alternative specifications, the observed relation between eco-efficiency and ROA is robust to changes in the set of control variables. The results of replacing ECO by ECO HIGH and ECO LOW, as given in the right panel of Table 6, point to an asymmetry in the positive relation between eco-efficiency and operating performance. Under all specifications, the estimated coefficient on ECO HIGH is positive but not significant at the standard levels. All coefficient estimates for ECO LOW, on the other hand, are negative and significant at the 1% level. In other words, highest ranked firms that are deemed eco-efficient do not display 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.

Overall, the results in this section show no particular inconsistencies with those of the previous section, pointing to a positive but non-linear association between corporate eco-efficiency and return on assets. While firms that are deemed eco-efficient do not display superior operating performance in comparison to the remainder of companies, firms with the lowest eco-efficiency ratings experience significant operational underperformance. Existing concerns that a pro-active environmental management policy exhausts the firm’s performance seem to be exaggerated.

6. Discussion of Implications

The empirical results presented in this paper have important practical implications. In spite of many competing opinions, our findings evidently suggest that the decision to pursue an environmentally aware management style does not come at the expense of a weaker ‘bottom line performance’. On the contrary, we can quite confidently assert that firms can prevent financial
disadvantages resulting from being devoted to environmental matters. The financial implications can be internal, but also external to the firm.

The internal implications have consequences for managers. Our findings are supportive of the conjecture that being eco-inefficient induces resource inefficiency and operating underperformance. Existing concerns among CSR critics that pro-active environmental governance affects the firm’s financial resources negatively are not supported by our results. Moreover, as shown by our Tobin’s \( q \) research, we find that the capital market has increasingly assigned value to corporate environmental performance. While the evidence presented in this paper should motivate businesses to be environmentally conscientious, several issues require further attention. First, it can be expected that managers are generally cautious to adopt rigorous environmental performance policies in the absence of solid evidence demonstrating the channels of transmission from eco-efficiency to firm operating efficiency. Attempts to unravel the complex relationships underlying the broad link between the ecological and financial element of the company would be an important avenue for further research, although we acknowledge this is a notoriously difficult task. Second, attention should be given to motivating managers to commit to environmental governance. As an example, financial incentives could serve as a practical means of persuasion.

Our results, furthermore, have important implications for several stakeholders external to the firm, showing that the interests of shareholders and those of other parties are not necessarily in conflict. Our findings support the conjecture of a win-win situation, where eco-efficiency can lead not only to social benefits but also to improved shareholder wealth. Thus, because adding an environmental dimension to share price valuation approaches appears to be incrementally valuable from a financial perspective, shareholders - and investors in general – are well advised to look beyond conventional approaches to evaluating firm management quality and assessing the future prospects of businesses.

Finally, as our work suggests that shareholders’ interests are not at stake if eco-efficiency policies are implemented forcefully, the role of the government in promoting environmental awareness deserves attention. An interesting direction for future research would be to look at the value of governmental organizations in providing tangible guidelines to long-term environmental governance as well as to environmental investing.
7. Conclusion

Are managerial efforts to improve and maintain a strong environmental performance record associated with financial benefits? This study has provided new answers to this pervasive question. Focusing on the concept of eco-efficiency, our research covers 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 document 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 non-linear relationship between eco-efficiency and firm valuation as measured by Tobin’s \( q \). Firms that are deemed most eco-efficient did not have consistently higher values compared to the control group, but the least eco-efficient companies had values that were 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 time-varying sensitivities of firm value with respect to the eco-efficiency scores points out that environmental winner companies initially did not trade at a premium relative to losers, but that the premium increased strongly over time. This explanation could imply that the asymmetry in the relationship between eco-efficiency and Tobin’s \( q \) is only 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 by suggesting that shares of eco-efficient firms were initially undervalued but have witnessed an upward price correction. At the very least, Tobin’s \( q \) regression results suggest that the market has assigned more value-relevance to environmental information about firms in recent times.

Our study also points to a clear 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 display significant operational underperformance. Our findings, thus, strongly reject the notion expressed by CSR skeptics that the benefits of adopting a strong environmental policy are unlikely to outweigh the costs.

Overall, the results of this paper have implications for managers and for investors. Evidently, managers have little reason to worry that an environmental policy is in conflict 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 facilitates them in
generating 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?
References


Table 1. Summary Statistics on Eco-Efficiency Scores
Reported are summary statistics for eco-efficiency scores observed at the end of 1996, 1998, 2000 and 2002, respectively. The table includes the mean eco-efficiency score, the median score, the standard deviation of the score, and the number of firms with a given score. The final column gives changes in these values over the beginning and the end of the sample period.

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<th>Eco-Efficiency Ratings</th>
<th>Dec-96</th>
<th>Dec-98</th>
<th>Dec-00</th>
<th>Sept-02</th>
<th>Change (2002-1996)</th>
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<td></td>
<td></td>
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Table 2. Summary Statistics on Tobin’s $q$ and ROA

Reported are summary statistics for Tobin’s $q$ and return on assets (ROA) observed at, respectively, the first quarter of 1997, the first quarter of 1999, the first quarter of 2001, and the last quarter of 2002. The table includes the cross-sectional mean, the median, the standard deviation, skewness and kurtosis.

<table>
<thead>
<tr>
<th></th>
<th>1997 Q1</th>
<th>1999 Q1</th>
<th>2001 Q1</th>
<th>2002 Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tobin’s $q$</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean $Q$</td>
<td>1.74</td>
<td>2.40</td>
<td>2.21</td>
<td>1.82</td>
</tr>
<tr>
<td>Median $Q$</td>
<td>1.46</td>
<td>1.64</td>
<td>1.57</td>
<td>1.40</td>
</tr>
<tr>
<td>St. Deviation</td>
<td>1.01</td>
<td>2.19</td>
<td>1.67</td>
<td>1.23</td>
</tr>
<tr>
<td>Skewness</td>
<td>2.87</td>
<td>3.54</td>
<td>2.33</td>
<td>3.08</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>14.54</td>
<td>20.77</td>
<td>9.80</td>
<td>17.70</td>
</tr>
<tr>
<td><strong>ROA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ROA</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Median ROA</td>
<td>0.04</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>St. Deviation</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.08</td>
<td>0.51</td>
<td>0.38</td>
<td>0.45</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>5.60</td>
<td>3.66</td>
<td>5.90</td>
<td>4.93</td>
</tr>
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</table>
Table 3. Eco-Efficiency and Firm Value: Fama-MacBeth Regressions
This table reports the results of running quarterly Fama-Macbeth regressions of firm value on a set of independent variables. For each variable we report the time-series mean coefficient and the corresponding t-statistic (in parentheses). We use four different dependent variables: regular Q, industry-adjusted Q, log(Q), and trimmed Q. Equation (1) includes the firms’ eco-efficiency scores as an independent variable Equation (2) contains two dummy variables that indicate whether firm i has a rating equal to or higher than 5 (ECO HIGH), or equal to or lower than 1 (ECO LOW) at t. The control variables are: 2-year sales growth (SG), firm age (AGE), R&D expenses scaled by sales (RD/SALES), and book value of total assets (SIZE). Sample period: 1997-Q1 – 2002-Q4.

<table>
<thead>
<tr>
<th></th>
<th>Equation (1)</th>
<th></th>
<th>Equation (2)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q</td>
<td>Ind.-Adj. Q</td>
<td>log (Q)</td>
<td>trimmed Q</td>
</tr>
<tr>
<td>Intercept</td>
<td>1.62***</td>
<td>-0.08</td>
<td>0.38***</td>
<td>1.58***</td>
</tr>
<tr>
<td></td>
<td>(9.48)</td>
<td>(-0.41)</td>
<td>(7.30)</td>
<td>(10.66)</td>
</tr>
<tr>
<td>ECO</td>
<td>0.07***</td>
<td>0.06***</td>
<td>0.03***</td>
<td>0.07***</td>
</tr>
<tr>
<td></td>
<td>(5.63)</td>
<td>(6.98)</td>
<td>(6.38)</td>
<td>(5.71)</td>
</tr>
<tr>
<td>ECO LOW</td>
<td>-0.31***</td>
<td>-0.32***</td>
<td>-0.10***</td>
<td>-0.32***</td>
</tr>
<tr>
<td></td>
<td>(-3.52)</td>
<td>(-4.34)</td>
<td>(-4.43)</td>
<td>(-3.88)</td>
</tr>
<tr>
<td>ECO HIGH</td>
<td>-0.02</td>
<td>-0.03</td>
<td>0.02</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(-0.27)</td>
<td>(-0.43)</td>
<td>(1.66)</td>
<td>(-0.27)</td>
</tr>
<tr>
<td>SG</td>
<td>1.51***</td>
<td>1.28***</td>
<td>0.37***</td>
<td>1.41***</td>
</tr>
<tr>
<td></td>
<td>(6.40)</td>
<td>(5.18)</td>
<td>(8.72)</td>
<td>(6.15)</td>
</tr>
<tr>
<td>AGE</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.01*</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(-0.19)</td>
<td>(-0.35)</td>
<td>(1.92)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>R &amp; D / Sales</td>
<td>11.34***</td>
<td>4.59***</td>
<td>3.03***</td>
<td>11.06**</td>
</tr>
<tr>
<td></td>
<td>(6.53)</td>
<td>(5.39)</td>
<td>(7.78)</td>
<td>(6.62)</td>
</tr>
<tr>
<td>SIZE</td>
<td>-3.34 E-6***</td>
<td>-1.43 E-6***</td>
<td>-1.27 E-6***</td>
<td>-3.21 E-6***</td>
</tr>
<tr>
<td></td>
<td>(-21.23)</td>
<td>(-11.13)</td>
<td>(-20.22)</td>
<td>(-19.89)</td>
</tr>
</tbody>
</table>

* significant at 10% level
** significant at 5% level
*** significant at 1% level
Table 4. Eco-Efficiency and Firm Value: Robustness Checks

This table reports the results of running quarterly Fama-Macbeth regressions of firm value (regular Tobin’s $q$) on different sets of independent variables. For each variable we report the time-series mean coefficient and the corresponding t-statistic (in parentheses). The results of using control set 1 is imported from table 2. Control set 2 additionally includes a variable describing the interaction between R&D expenditures and sales growth (RD*SG). Control set 3 includes advertising scaled by sales (ADV/SALES) instead of RD*SG. Control set 4 includes a dummy indicating a listing on the NASDAQ stock exchange (NASDUM). The results in the right panel differ from those in the left panel in that the variable ECO is replaced by two dummy variables which indicate whether firm $i$ has a rating equal to or higher than 5 (ECO HIGH), or equal to or lower than 1 (ECO LOW). Sample period: 1997-Q1 – 2002-Q4.

<table>
<thead>
<tr>
<th>Equation (1)</th>
<th>Equation (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Set 1</strong></td>
<td><strong>Control Set 2</strong></td>
</tr>
<tr>
<td><strong>Intercept</strong></td>
<td>1.62***</td>
</tr>
<tr>
<td></td>
<td>(9.48)</td>
</tr>
<tr>
<td><strong>ECO</strong></td>
<td>0.07***</td>
</tr>
<tr>
<td></td>
<td>(5.63)</td>
</tr>
<tr>
<td><strong>ECO LOW</strong></td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(-0.27)</td>
</tr>
<tr>
<td><strong>ECO HIGH</strong></td>
<td>1.49***</td>
</tr>
<tr>
<td><strong>SG</strong></td>
<td>1.51***</td>
</tr>
<tr>
<td></td>
<td>(6.40)</td>
</tr>
<tr>
<td><strong>AGE</strong></td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(-0.19)</td>
</tr>
<tr>
<td><strong>RD/SALES</strong></td>
<td>11.34***</td>
</tr>
<tr>
<td><strong>SIZE</strong></td>
<td>-3.34 E-6***</td>
</tr>
<tr>
<td></td>
<td>(-21.23)</td>
</tr>
<tr>
<td><strong>RD*SG</strong></td>
<td>1.52 E-3***</td>
</tr>
<tr>
<td></td>
<td>(2.96)</td>
</tr>
<tr>
<td><strong>NASDAQ</strong></td>
<td>12.24***</td>
</tr>
<tr>
<td></td>
<td>(5.78)</td>
</tr>
</tbody>
</table>

*** significant at 1% level
** significant at 5% level
Table 5. Eco-Efficiency and Firm Value: Sub-Sample Regressions
This table reports the results of sub-sample estimations of (2) using Tobin’s g and using control set 1 (see table 4). For each variable, we report the time-series mean coefficient and the corresponding t-statistic (in parentheses). The two dummy variables ECO HIGH and ECO LOW indicate whether firm i has a rating equal to or higher than 5 (ECO HIGH), or equal to or lower than 1 (ECO LOW). The sub-sample periods are 1997-Q1 – 1999-Q4 and 2000-Q1 – 2002-Q4.

<table>
<thead>
<tr>
<th>Coefficients for Model (2) with Q as regressant</th>
<th>Period 1</th>
<th>Period 2</th>
<th>Complete Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.36***</td>
<td>2.27***</td>
<td>1.81***</td>
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<tr>
<td></td>
<td>(5.89)</td>
<td>(14.78)</td>
<td>(11.07)</td>
</tr>
<tr>
<td>ECO LOW</td>
<td>-0.42***</td>
<td>-0.20</td>
<td>-0.31***</td>
</tr>
<tr>
<td></td>
<td>(-3.51)</td>
<td>(-1.53)</td>
<td>(-3.52)</td>
</tr>
<tr>
<td>ECO HIGH</td>
<td>-0.24***</td>
<td>0.21**</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(-6.36)</td>
<td>(2.25)</td>
<td>(-0.27)</td>
</tr>
<tr>
<td>SG</td>
<td>1.62***</td>
<td>1.36**</td>
<td>1.49***</td>
</tr>
<tr>
<td></td>
<td>(8.86)</td>
<td>(2.97)</td>
<td>(6.26)</td>
</tr>
<tr>
<td>AGE</td>
<td>0.04*</td>
<td>-0.03</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(2.02)</td>
<td>(-1.27)</td>
<td>(-0.27)</td>
</tr>
<tr>
<td>R &amp; D / Sales</td>
<td>14.09***</td>
<td>8.46**</td>
<td>11.27***</td>
</tr>
<tr>
<td></td>
<td>(8.84)</td>
<td>(2.95)</td>
<td>(6.71)</td>
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<tr>
<td>SIZE</td>
<td>-2.83E-6</td>
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<td>-3.21E-6</td>
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<tr>
<td></td>
<td>(-15.65)</td>
<td>(-14.49)</td>
<td>(-19.16)</td>
</tr>
</tbody>
</table>

* significant at 10% level
** significant at 5% level
*** significant at 1% level
Table 6. Eco-Efficiency and Return on Assets (ROA): Fama-MacBeth Regressions

This table reports the results of running Fama-Macbeth regressions of the firm’s return on assets (ROA) on a set of independent variables, as indicated by equation (3; left panel) and (4; right panel). For each variable, we report the time-series mean coefficient and the corresponding t-statistic (in parentheses). Each panel gives regression outcomes for four different specifications. The first two models in each panel include total assets (SIZE), and debt-to-assets (DEBT/ASSETS) as control variables but include, respectively, ROA and industry-adjusted ROA as the dependent variable. The last two columns in each panel report the results of using an alternative set of control variables, where SIZE is replaced by SALES. All coefficients are multiplied by 100. Sample period: 1997-Q1 – 2002-Q4.

<table>
<thead>
<tr>
<th></th>
<th>Equation (3)</th>
<th>Equation (4)</th>
</tr>
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<tr>
<td></td>
<td>ROA</td>
<td>ROA</td>
</tr>
<tr>
<td>Intercept</td>
<td>4.43***</td>
<td>0.22***</td>
</tr>
<tr>
<td></td>
<td>(24.17)</td>
<td>(3.26)</td>
</tr>
<tr>
<td>ECO</td>
<td>0.08***</td>
<td>0.08***</td>
</tr>
<tr>
<td></td>
<td>(5.80)</td>
<td>(4.97)</td>
</tr>
<tr>
<td>ECO LOW</td>
<td>-0.39***</td>
<td>-0.39***</td>
</tr>
<tr>
<td></td>
<td>(-7.53)</td>
<td>(-7.91)</td>
</tr>
<tr>
<td>ECO HIGH</td>
<td>0.07</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.87)</td>
<td>(0.19)</td>
</tr>
<tr>
<td>SIZE</td>
<td>-5.11 E-6 ***</td>
<td>-2.71 E-6 ***</td>
</tr>
<tr>
<td></td>
<td>(-9.91)</td>
<td>(-4.77)</td>
</tr>
<tr>
<td>DEBT / ASSETS</td>
<td>-3.93***</td>
<td>-2.92***</td>
</tr>
<tr>
<td></td>
<td>(-6.88)</td>
<td>(-5.99)</td>
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<tr>
<td>SALES</td>
<td>-7.00 E-6 *</td>
<td>-9.62 E-6 *</td>
</tr>
<tr>
<td></td>
<td>(-1.56)</td>
<td>(-2.00)</td>
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</tbody>
</table>

* significant at 10% level  
** significant at 5% level  
*** significant at 1% level
Each quarter we estimated equation (2): $Q_t = \alpha_i + \beta_0 \text{ECO HIGH}_t + \beta_1 \text{ECO LOW}_t + \gamma X_t + \varepsilon_t$. Figure 1 gives differences between $\beta_0$ and $\beta_1$ over time and a linear trend. The results of the regression of $\beta_0 - \beta_1$ on time and a constant term are given at the bottom right the figure. T-statistics are given in parentheses and are derived from Newey-West Heteroskedasticity and Autocorrelation Consistent (HAC) Standard Errors.