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ENVIRONMENTAL RISK MANAGEMENT AND THE COST OF CAPITAL

MARK P. SHARFMAN[1]* and CHITRU S. FERNANDO[2]
[1] *Division of Management, Michael F. Price College of Business, The University of Oklahoma, Norman, Oklahoma, U.S.A.*
[2] *Division of Finance, Michael F. Price College of Business, The University of Oklahoma, Norman, Oklahoma, U.S.A.*

Our study of 267 U.S. firms shows that improved environmental risk management is associated with a lower cost of capital. Our findings provide an alternative perspective on the environmental-economic performance relationship, which has been dominated by the view that improvements in economic performance stem from better resource utilization. Firms also benefit from improved environmental risk management through a reduction in their cost of equity capital, a shift from equity to debt financing, and higher tax benefits associated with the ability to add debt. These findings help build better theory regarding the outcomes of strategic improvements in environmental risk management. Copyright © 2008 John Wiley & Sons, Ltd.

INTRODUCTION

The idea that a firm's environmental ('green') performance and overall economic performance are positively related (Murphy, 2002) has not always received universal acceptance within the research community. The conventional view had been that such activities represented a cost to the firm and should be minimized whenever possible. Specifically,

> *(i)nvestors view pollution control expenditures as a drain on resources that could have been invested profitably, and do not reward the companies for socially responsible behavior* (Mahapatra, 1984 : 29).

Starting in the 1970s, researchers examined the relationship by looking at various approaches to measuring both constructs (e.g., Christmann, 2000; Dowell, Hart, and Yeung, 2000; Hart and Ahuja, 1996; Russo and Fouts, 1997; Spicer, 1978). The theoretical underpinning of much of this research stems explicitly or implicitly from variants of the resource-based view (Bansal, 2005; Barney, 1991; Darnall and Edwards, 2006; Hart, 1995; Sharma and Vredenburg, 1998). In their theoretical perspectives, previous authors have argued that if the firm makes 'greener' (i.e., more efficient) use of its resources it will be more economically effective. Such 'greener' use can come from, for example, generating less pollution and waste from the resources employed, or by using fewer resources. While there have been some dissenting voices along the way (e.g., Chen and Metcalf, 1980; Mahapatra, 1984), when researchers find a positive relationship between environmental and economic performance, they generally credit it to such improved resource utilization, which in turn leads to overall increases in organizational effectiveness. We propose an additional theoretical perspective that can enrich our understanding of the environmental performance-economic performance relationship.

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*Correspondence to: Mark P. Sharfman, Division of Management, 307 W. Brooks, Rm. 206, Michael F. Price College of Business, The University of Oklahoma, Norman, OK 73019-0450, U.S.A. E-mail: msharfman@ou.edu

Most research on the environmental-economic performance relationship has been predicated on the idea that (internal) strategic environmental investments result in improved resource efficiency (Bansal and Roth, 2000; Branzei *et al*., 2004; Buysse and Verbeke, 2003). While the effects of such strategic choices are often clear even to the financial markets, internal investments are not the only phenomena that drive organizational performance. Institutional and other external factors also have a profound effect on the performance (survival) of firms (Singh, Tucker, and House, 1986). While several researchers have examined how the stock market reacts to improved environmental performance through market returns (e.g., Dowell *et al*., 2000; Gottsman and Kessler, 1998; Mahapatra, 1984), little attention has been paid to such external influences on the environmental-economic performance relationship itself. In this article we examine the capital market's response to improved environmental risk management by a firm as measured by changes in the firm's cost of capital. We posit that such improved environmental risk management improves the market's risk perception of the firm. There is evidence in the literature that investors and analysts take account of improvement in environmental risk factors when making investment decisions and recommendations (Heinkel, Kraus, and Zechner, 2001; Mackey, Mackey, and Barney, 2007). This improved perception should, in turn, cause the financial market to be willing to accept lower risk premiums on equity, or allow the firm to acquire higher levels of leverage, all of which can result in a lowered cost of capital overall. The lowering in the firm's cost of capital due to a reduction in the perceived riskiness of its cash flows (from environmental risk management) can be differentiated both conceptually and empirically from an increase in its cash flows from greater revenues and/or lowered costs due to improved resource efficiency through better environmental performance. The value of the firm can be increased due to either or both of these effects. In contrast to prior studies (e.g., Klassen and McLaughlin, 1996; Dowell *et al*., 2000) that have looked at the broad question of whether improved environmental performance increases the market value of the firm, our focus is solely on whether or not investors' risk perception of the firm changes due to environmental performance in the form of environmental risk management. This question is important because the cost of capital and return on capital are fundamental variables from the standpoint of the firm and capital markets, respectively. If the market perceives improvements in resource utilization but did not perceive changes in riskiness, the cost of capital would not change. However, if the changes in perceived riskiness lead to reduced costs of capital, the firm's overall cost base decreases while its ability to make a profit from a given level of revenue correspondingly increases.

Using risk management and institutional theories as our conceptual underpinning with a sample from the Standard and Poor's (S&P) 500, we examine whether improved environmental risk management is associated with a reduction in firms' total cost of capital. Further, we test several sub-hypotheses to decompose what drives any such reduction. Such findings should enrich theory by showing that improved environmental risk management signals the financial markets that the firm represents a less risky investment that deserves less expensive debt and lower equity risk premiums. Such lowered costs of capital should, in turn, increase the firm's overall economic performance (Scott and Pascoe, 1984) and thereby help to explain the observed positive relationship between economic and environmental performance.

Prior research

To understand where our study fits in with prior literature, we briefly examine earlier work on the general relationship between environmental and economic performance (see Murphy [2002] for an extensive review of 20 well-known studies in the area) plus what limited research has been done on the relationship between environmental performance and the cost of capital.

The general research question in this literature asks whether the investment in improved environmental performance pays off in improved economic performance. To our knowledge, the first study on this topic was by Spicer who found that '. . .for a sample [of firms] drawn from the pulp and paper industry, companies with better pollution-control records tend to have higher profitability. . .' (Spicer, 1978: 109). Chen and Metcalf (1980) showed that Spicer's (1978) results were contaminated by a variety of methodological problems, including inappropriate statistical tests, failure to control for size and the use of panel data while making longitudinal/temporal causality

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arguments. Nonetheless, Spicer's study focused attention on the question that underlay the public debate—whether environmental expenditures should be viewed as a cost or as an investment.

Several other researchers have examined this question using accounting-based dependent variables. Nehrt (1996) found that firms that invested in cleaner technologies experienced higher levels of abnormal profit growth, while the earliest adopters had the highest levels of that growth. Hart and Ahuja (1994) found that pollution reduction initiatives were positively related to several performance measures over a two-year horizon, and that the firms that made the largest improvements in environmental performance experienced the most profound economic gains. Russo and Fouts (1997) extended this body of research by examining (from a resource-based perspective) broader measures of environmental performance and their effect on return on assets. They found a strong relationship between environmental and economic performance, particularly when including the moderating role of industry growth.

Other researchers have examined the questions using market-based measures of firm performance, also with generally consistent results. For example, Cohen, Fenn, and Naimon (1995) found that a sample of theoretical investment portfolios of low pollution firms provided better returns than did similar portfolios of high pollution firms. Klassen and McLaughlin (1996) found that firms receiving strong, positive environmental publicity increased in market value, while negative publicity had the opposite effect. Hamilton (1995) found that firms suffered stock market losses after particularly negative Toxic Release Inventory (TRI) announcements. Bosch *et al*. (1998) found results similar to Hamilton (1995), that both firms who had been the target of Environmental Protection Agency (EPA) investigations and those who had appealed enforcement actions lost market value when these outcomes were announced. Dowell *et al*. (2000) determined that firms with stricter environmental management systems had higher market values as well. Essentially all of these researchers examined the relationship between environmental and economic performance from the perspective of various internal effects of improved environmental performance. This perspective begs the question as to whether there are external effects from such investments, e.g., on costs of capital—an area that according to the normative environmental management literature 'should' be affected.

Nonetheless, we found considerably less work that focused specifically on the relationship between environmental risk management and cost of capital. In the 'green' literature, one sees assertions that overall improvements in environmental risk management should lead to (among other benefits) lowered costs of capital. However, while this normative logic may be strong, the empirical support for the assertion is sparse. As far as we can determine, no prior study has examined comprehensively the relationship between overall environmental risk management and the costs of capital.

In the first of only three studies we found that addressed the question in any form, Feldman, Soyka, and Ameer (1997) found positive effects on beta and stock price from improvements in environmental risk management. Due to the proprietary nature of their model, they did not provide sufficient details to replicate their methodology or to create empirical estimates, and only provided an illustration of the inferred relationship. Additionally, their focus was only on beta and the cost of equity capital, disregarding debt financing and its cost. Heinkel *et al*. (2001) developed a theoretical model to show that exclusionary investing (based on environmental performance) can induce some polluting firms to undertake reforms to voluntarily stop polluting when the cost of doing so is less than the cost of equity capital disadvantage that they would otherwise have to bear. However, these authors also disregard potential effects of environmental risk management on the availability and cost of debt financing, and other 'channels' through which environmental risk management can potentially affect the cost of capital. Furthermore, they do not validate their predictions empirically. Garber and Hammitt (1998) examined the effect on costs of equity for 73 chemical firms with identified Superfund liabilities. While they found no relationship between the liabilities and costs of equity for small firms, they were able to find a robust positive relationship for 23 large firms. However, their focus was on balance sheet liabilities identified to cover Superfund charges, a single, extreme, well-publicized balance sheet item that was quite visible to equity analysts (e.g., Campbell, Sefcik, and Soderstrom, 1998) because of the notoriety and fear that such charges evoke in the general public. Superfund liabilities are far more visible and easy to understand than other signals such as TRI reports or EPA fines. Generalized environmental risk management is a longer-term phenomenon and is neither as quantifiable nor as transparent. Therefore, it is important to determine whether the capital market is able to discern differences in environmental risk management across firms. Second, by focusing only on the cost of equity capital, Garber and Hammitt (1998) disregard the costs and tax effects of debt financing on a firm's overall cost of capital. Therefore, the question of whether and how a firm's environmental risk management influences its cost of capital remains open, and it is this question that we address in the present article.

THEORETICAL FRAMEWORK

In this section of the article we describe the theoretical linkages between a firm's environmental risk management activity and its cost of capital. A firm's cost of capital is an important determinant of its valuation for two reasons. First, the cost of capital is the expected rate of return demanded by a firm's investors for investing in the firm. The higher the rate of return demanded by a firm's investors for the capital they provide to the firm, the more costly it is for a firm to finance itself. As capital is a basic input that the firm receives, the more costly that this input is, the less chance the firm has to make a profit regardless of its level of revenues.

Second, the cost of capital is the rate that investors use to discount a firm's future cash flows. The higher the cost of capital, the lower the present value of the firm's future cash flows. Therefore, all else being equal, firms with a lower cost of capital will be more highly valued than firms with a higher cost of capital and hence more attractive to investors. Investors determine a firm's cost of capital by evaluating the riskiness of its cash flows relative to other investment opportunities that are available to them. Broadly speaking, firms are financed through either debt or equity capital. Debt capital can come from private sources (e.g., banks) or from public sources (the debt markets). In either case, the cost of debt is the applicable interest rate. (In public debt markets, investors trade debt securities just like they trade equities in a stock market.) The cost of equity is the return investors in the firm's shares expect as reflected in the stock price they are willing to pay relative to future expected cash flows. Since most publicly held firms typically finance themselves with both debt and equity, the firm's overall cost of capital is given by the weighted average of its cost of debt and equity capital, which has come to be known as the weighted average cost of capital (WACC).

In the general case of a firm with both equity and debt financing, the firm's after-tax weighted average cost of capital (r_{WACC}) (Modigliani and Miller, 1958) can be expressed as

$$r_{WACC} = \left(\frac{E}{D+E}\right) r_E + \left(\frac{D}{D+E}\right) r_D(1-T), \qquad (1)$$

where

E $=$ market value of the firm's equity;
D $=$ market value of the firm's debt;
$r_E =$ the firm's cost of equity capital;
$r_D =$ the firm's cost of debt capital; and
T $=$ the firm's rate of corporate taxation.

The firm's cost of equity capital (r_E) is equal to the expected investor return from holding the firm's equity, estimated with the Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965)

$$r_E = r_F + \beta_E(r_M - r_F), \qquad (2)$$

where

$r_F =$ the risk-free rate;
$r_M =$ the return on the market portfolio; and
$\beta_E = \dfrac{Cov(r_E, r_M)}{Var(r_M)}$ measures the firm's systematic risk.

Higher levels of environmental performance should be viewed as environmental risk management for a variety of reasons. At the most basic level, as a firm makes strategic investments that reduce emissions and pollution, it mitigates its risk of litigation either from governmental regulators or from nongovernmental stakeholders (cf. King and Shaver, 2001). This reduces both immediate risks from known hazards and future risks from currently unknown hazards. Both current (known) and future (unknown) hazards carry an uncertain level of financial impact. By reducing current or

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potential hazards, the firm reduces the number of potential claimants on its rents through fines, settlements, or other compliance/litigation costs. By reducing the number of potential claimants on its rents, more of the firm's overall economic resources can be directed strategically to dividends to stockholders, debt payments, internal investments, or acquisitions. Each of these activities is likely to be rewarded by the market in terms of improved risk perception of the company from an investment standpoint.

In general, improving a firm's environmental risk exposure (environmental risk management) can reduce its cost of capital in three ways, through both direct and indirect relationships:

1. By reducing the firm's cost of debt capital r_D;
2. By increasing the firm's debt capacity, and thereby increasing the amount of income the firm can protect from corporate taxation;
3. By reducing the firm's cost of equity capital.

We explore each of these possibilities using a series of hypotheses to determine if any or all of the three contribute to any overall relationship that may exist.

One of the earliest arguments in favor of risk management arises from the notion that risk management reduces a firm's expected costs of financial distress and thereby enhances the quality of its debt (Smith and Stulz, 1985). To understand how environmental risk management strategies could affect the cost of debt specifically, we examine the theoretical nature of debt financing. The cost of debt financing incurred by a firm is based on the assessment by the capital market (including banks, bond markets, and rating agencies) of the default risk of the firm. The level of default risk that a firm presents is a function of the uncertainty inherent in its future activities (Miller and Bromiley, 1990; Orlitzky and Benjamin, 2001). The greater the uncertainty inherent in a firm's future activities, the lower the assessed credit quality of its debt and the higher the cost of debt financing (i.e., it will have to pay higher interest rates). Undertaking environmental risk management activities by improving environmental performance can reduce the likelihood that firms will encounter extreme environmental events (e.g., Union Carbide's Bhopal disaster, the *Exxon Valdez* oil spill, or the hazardous waste dumping in the Love Canal area by Hooker Chemical) that can require heavy cash outflows arising from compensation and cleanup costs, and thereby make firms more vulnerable to bankruptcy. Environmental risk management can also reduce the vulnerability of firms to other adverse business developments that would reduce profitability, impair the firm's reputation, or reduce the value of its asset base. Additionally, while conventional financial risk management activities (e.g., using derivative securities) can sometimes be reversed by stockholders after new debt financing takes place (Smith and Stulz, 1985; Chidambaran, Fernando, and Spindt, 2001), environmental risk management investments are usually long term in nature and cannot be easily reversed. Perhaps such stability makes them more credible from the standpoint of the firm's future debt holders. If environmental risk management reduces the default risk profile that a firm presents to the debt markets, those markets should in turn reward that improved risk profile with lower required interest rates and subsequent lowered costs of debt capital. This leads to our first prediction:

Hypothesis 1: The higher the level of environmental risk management, the lower the firm's cost of debt capital for a given level of debt.

Hypothesis 1 assumes that the firm holds its level of debt fixed and benefits from increasing its level of environmental risk management by incurring a lower cost of debt capital. Alternatively, a firm may choose to take strategic advantage of its lower cost of debt by increasing the overall level of debt in its debt-equity financing mix. The firm's ability to increase its leverage by managing risks gives rise to another explanation for the linkage between environmental risk management and costs of debt capital (Leland, 1998; Stulz, 1996). Risk management can be viewed as an alternative strategic choice to employing equity capital. When the firm shifts its financing strategy from equity to debt, it shifts to the debt market the burden to bear the firm's residual risk (Stulz, 1996). As a firm increases its level of risk management, it can correspondingly shift its financing from equity to debt capital (i.e., increase its leverage) because the firm is perceived as being less risky. Leland (1998) develops a model in which a firm's optimal level of leverage rises with its level of risk management. And, consistent with these arguments, Graham and Rogers (2002) provide empirical evidence indicating a positive relationship between leverage and strategic hedging. Another benefit of raising the firm's level of debt is that higher leverage, in turn, increases the amount of income that a firm can shield from taxation. Therefore, the higher tax advantage associated with a higher level of debt reduces the after-tax cost of capital of a firm, giving managers additional incentive to add leverage by reducing the cost of borrowing even further. This discussion leads to two additional sub-hypotheses:

Hypothesis 1a: The higher the level of environmental risk management, the higher the firm's leverage.

Hypothesis 1b: The higher the level of environmental risk management, the higher the firm's tax advantage (shield) from debt financing.

Next, environmental risk management strategies may also reduce a firm's overall cost of capital by reducing its cost of equity financing. If environmental risk management results in improved financial performance by way of a lower level of systematic risk, then the market should reward that improved performance with a lower cost of equity capital. An investor makes investments by trading off risk and return, that is, either maximizing return for a given level of systematic risk or minimizing systematic risk for a given level of return.

If environmental risk management through improved environmental performance augments overall organizational effectiveness or even just increases firm legitimacy (Deephouse, 1996; Russo, 2003) then it would follow that the more firms adopt such an approach, the higher their level of future performance and the greater the willingness of the market to invest in them. The more confidence the market has that a firm will provide high returns on invested capital (assuming equal levels of risk) or reduce the systematic risk of the investment (assuming equal levels of return), the more it will be willing to pay for the opportunity to capture those returns, thereby driving up the stock price. In the latter case, as firms increase their level of environmental risk management and become more legitimate in the eyes of potential stockholders or other stakeholders (Deephouse, 1996; Hoffman, 1999; Jennings and Zandbergen, 1995; Kassinis and Vafeas, 2002; Sharma and Henriques, 2005), according to institutional theory's arguments, the market should reward these more legitimate firms with a lower cost of equity. Thus,

Hypothesis 2: The higher the level of environmental risk management, the lower the cost of equity capital.

A reduction in the cost of equity financing by reducing the firm's systematic risk is manifested in a lowered equity beta (Feldman, Soyka, and Ameer, 1997). The firm may be able to accomplish this by implementing environmental risk management operating changes (i.e., better buffer systems—Thompson, 1967) to increase its flexibility to manage economic downturns (Stulz, 2003). For example, assume the firm changes processes to require less inputs or at least less toxic inputs. In an economic downturn, should the firm's supply chains be restricted, the firm would be less susceptible to price increases from its reduced input profile. By reducing the variability in performance, the firm likely will reduce its beta, which also should lead to lowered costs of equity capital. (See Bansal and Clelland [2004] who make a comparable argument regarding environmental performance and unsystematic risk.) Therefore, the impact of improved environmental risk management can be measured by a reduction in the value of beta:

Hypothesis 2a: The higher the level of environmental risk management, the lower the firm's non-leveraged equity beta (systematic risk).

A second explanation for the relationship between environmental risk management and the cost of equity capital stems from the types of investors 'green' firms attract. In the Heinkel *et al.* (2001) model with two investor classes, 'green' and 'non-green,' the authors showed how 'green' investors will only invest in firms with good environmental risk management (i.e., more legitimate firms) while 'non-green' investors are indifferent about environmental risk management and will not necessarily invest in 'green' firms. Therefore, firms with poor environmental risk management will have a higher cost of equity capital because fewer people will buy their shares (cf. Mackey *et al*., 2007). Further, Merton (1987) develops a model of capital market equilibrium with incomplete information in which the firm's cost of equity declines as its investor base expands. In the context of Merton

(1987), it is possible that firms engaging in higher levels of environmental risk management will gain more visibility and positive publicity in the media, thereby attracting more investors (Bansal, 2005). Heinkel *et al*. (2001) and the Social Investment Forum (2003) estimate that approximately 10 to 11 percent of all assets under management in the United States are invested after applying ethical or environmental screens, implying that a significant subset of investors intentionally include good environmental performers in their portfolios. This increase in the number of shareholders will increase the firm's share price and decrease its cost of equity. Hence, we would once again expect the cost of equity capital to be negatively related to environmental risk management; in this case due to firms with better environmental risk management having a more dispersed ownership (i.e., more shareholders). Therefore,

> *Hypothesis 2b: The higher the level of environmental risk management, the more dispersed the firm's share ownership.*

Finally, a third explanation for why the cost of equity financing might be reduced can be found in the benefits of the firm being monitored by institutional investors who own its shares. Under this line of reasoning, if firms strategically manage their environmental risks, it is possible that this activity will gain them legitimacy even with 'non-green' institutional investors and increase the investment by institutional investors in the firm's shares. As widely documented in the literature, institutional investors actively monitor the performance of the firms they invest in, and such monitoring can lead to a variety of benefits for the firm (Allen, Bernardo, and Welch, 2000; Carleton, Nelson, and Weisbach, 1998; Gillan and Starks, 2000; D'Mello, Schlingemann and Subramaniam, 2003: Fernando, Gatchev, and Spindt, 2007; Shleifer and Vishny, 1986; Smith, 1996). McConnell and Servaes (1990) show specifically that institutional ownership and firm value are positively related. A key argument in this literature is that firms with a higher concentration of institutional owners will benefit from a lower cost of capital/higher performance. Additionally, in the particular case of environmental risk management, it is possible that even 'non-green' institutional owners will attempt to steer given firms away from taking undue risks (Heinkel *et al*., 2001) and hence will stay away from firms that are poor environmental performers. If so, we would expect to find a positive relationship between institutional ownership and environmental risk management, such that environmental risk management has an indirect effect on the cost of equity capital through institutional share ownership. This leads to our next hypothesis:

> *Hypothesis 2c: The higher the level of environmental risk management, the higher the percentage of institutional share owners.*

The above hypotheses combined imply a single omnibus prediction that improved environmental risk management will lower the firm's weighted average cost of capital as in Equation 1. This leads to our final hypothesis.

> *Hypothesis 3: The higher the level of environmental risk management, the lower the firm's weighted average cost of capital (WACC).*

The analysis that we present in the following sections investigates each of our predictions that link cost of capital components to environmental risk management and our omnibus prediction in Hypothesis 3 that links the overall weighted average cost of capital to environmental risk management. We summarize the model in Figure 1.

METHODOLOGY

Sample and datasets

To test our hypotheses, we required a dataset of firms that met two criteria: (1) Firms had to be large enough to be traded publicly and able to access the capital markets regularly to enable an accurate estimate of their costs of capital; plus (2) have a meaningful and transparent environmental management function to enable measurement of their environmental risk management. The S&P 500 dataset meets these criteria as it represents a cross section of the largest publicly held firms in the United States, and has been used in other studies in the area (e.g., Dowell *et al*., 2000; Hart and Ahuja, 1996).

We used two different datasets to create our environmental risk management measure. First, we obtained access to the United States EPA TRI data

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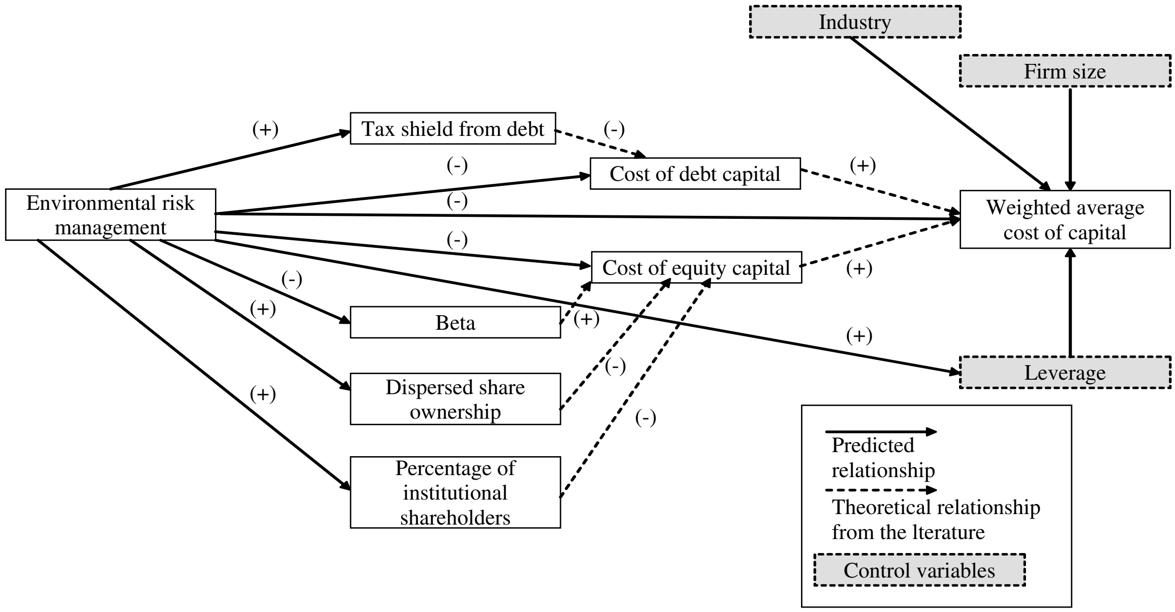

Figure 1. Conceptual model

through the Investor Responsibility Research Center (IRRC)[1]. The TRI data are reported by firms to comply with EPA regulations about the use, emission, or disposal of over 600 toxic substances. The use of TRI data has come under criticism (e.g., Toffel and Marshall, 2004) because of questions about (among other issues) firm reporting accuracy, the data's inability to account for relative toxicity, and the fact that firms sometimes report estimates as opposed to actual emissions. Regardless of the complaints, the TRI still is the most widely examined set of measures of firms' environmental activity (Toffel and Marshall, 2004). This extensive use occurs because it is the broadest and most objective dataset available. As an additional indicator of environmental risk management we used the environmental scores from the Kinder, Lydenberg, Domini & Co., Inc. (KLD) social performance dataset[2]. The use of the KLD measure allowed us to triangulate between two very different approaches to measuring environmental risk management. KLD is a financial advisor who provides social screening of firms to clients via its reports and socially screened mutual funds. These data too have come under criticism because, for example, they were developed atheoretically (Sharfman, 1996) and are non-normal because of the scoring system (Mattingly and Berman, 2006). However, Graves and Waddock (1994) suggested that the KLD data is the best single source of social and environmental performance data because

> *The group doing the rating consists of knowledgeable individuals not affiliated with any of the rated companies or with researchers performing studies. Thus, this firm's scaling process provides unique access to a wide range of consistently rated firms across a number of important social performance attributes* (Graves and Waddock, 1994 : 1039).

Measures

The first dependent variable used in our analysis was each firm's WACC derived as in Equation 1 above. The cost of equity capital is estimated using the CAPM (Sharpe, 1964; Lintner, 1965), which equates the cost of equity of a firm to the risk-free interest rate plus the firm's beta times the market risk premium. The cost of debt is the firm's marginal cost of borrowing and is based on estimates from the Bloomberg Financial dataset[3]. The risk free rate (Rf) is the return an investor can earn on an essentially risk-free investment. Following convention, we used as our risk-free rate the 10-year U.S. Treasury bond rate of 4.79 percent, which was the rate at the beginning of this

[1] Received directly from the IRRC in April of 2004.
[2] Received directly from KLD in July of 2004.
[3] Received directly from Bloomberg in May of 2004.

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analysis according to Bloomberg. Beta (β) is the covariance of the market's return with the individual company's common stock return divided by the market's variance. We used an annual beta computed by Research Insight[4] for each company that we found in the COMPUSTAT database (WRDS, 2007). The weight of equity (We) is found by using the total market capitalization, divided by debt plus market capitalization. Market capitalization is the product of the value of one share of stock times the number of shares outstanding. The weight of debt (Wd) is found by summing all debt issues of the firm, divided by the total of that debt plus market capitalization. Market capitalization, the weight of debt, and the tax rate data came from the Bloomberg Financial database. We set the risk premium (Rp) at 5.6 percent based on the Fama and French (2002) estimate of average returns over the period 1872–2000. Throughout the paper we refer to this as WACC-1.

To reduce the possibility of error in our WACC measure, we estimated it using three other methods and then created a factor score from the alternative approaches. First, the Bloomberg database provides its own estimate of each firm's WACC. While calculated using the same formula as the one we used, the key differences between our WACC-1 measure and Bloomberg's WACC are that Bloomberg uses a beta calculated weekly as opposed to COMPUSTAT's annual beta, and they use their own, firm-specific estimate of the risk premium rather than using the Fama and French (2002) average. As the cost of equity will be affected heavily by the beta value used, we also used the Bloomberg estimate of WACC (WACC-2). Further, because the cost of equity is highly sensitive to the risk premium, we recalculated WACC-1 based on the Bloomberg, firm-specific risk premium (WACC-3). Finally, to reduce further any potential effect of error in the measurement of WACC, we conducted a factor analysis using a varimax rotation on WACC-1, WACC-2, and WACC-3. We extracted a single factor that accounted for 91 percent of the variance in the three measures suggesting a confirmatory factor analysis was not necessary. Using the loadings from the factor analysis we constructed a factor score from the factor weights times the original values. We call the factor score WACC-4 and estimated our equations using that measure and WACC-1.[5]

We estimated WACC using the multiple methods we describe above as an attempt to limit measurement error. While we report the results from the equations using the WACC-1 and the aggregate WACC-4 dependent variables, it should be noted that the WACC-1 results are the ones we discuss throughout the paper because they are the most consistent with how WACC has been estimated in prior literature. For cost of equity, we rely primarily on our estimate (COE-1). However, in our cost of equity regressions, we employ both our estimate and the Bloomberg estimate of this value (COE-2).

We also used independent theoretical and control variables in our analysis. The theoretical variable is the measure of environmental risk management. From the variety of ways previous researchers (e.g., Dowell *et al*., 2000; Klassen and McLaughlin, 1996; Russo and Fouts, 1997) have measured environmental risk management, and in view of its multifaceted nature, we believed it necessary to use multiple environmental risk management indicators. We selected indicators that would be widely available to the financial markets as well as those representing both more quantitative and more qualitative assessments. Such an approach allows us to triangulate on the elusive notion of environmental risk management and to demonstrate convergent validity in the measure (Campbell and Fiske, 1959). For the quantitative measures we selected data elements from the TRI data as compiled by the IRRC. Once the IRRC collects the TRI data from the EPA, they then standardize the values by dividing them by domestic revenues for the firm. This produces scaled environmental risk management measures that are comparable across firms. The IRRC collects 25 TRI data elements; however only four of them provide enough observations to allow us to conduct a meaningful analysis. These four elements were total TRI emissions (TRI-TOTAL), total TRI emissions treated on site to reduce their toxicity (TRI-TREAT), total TRI emissions reused or recycled on-site for energy (TRI-ERR) and total waste generation including TRI emissions (WASTE-GEN). We standardized each of the first three measures by WASTE-GEN to see what percentage of the firm's overall waste generation was being closely monitored (i.e., by public disclosure) through the TRI (ST-TRITO),

[4] Received directly from Standard and Poor's in September of 2006.

[5] The factor analysis results are available from the first author.

what percentage of the firm's discharges were being treated to reduce their toxicity (ST-TRITR), and what percentage was being recycled for energy (ST-TRIEN).

For a qualitative assessment of environmental risk management we turned to the environmental evaluations provided by KLD. As we mentioned above, KLD is a social investment and screening firm whose evaluations are used widely within the financial services industry. KLD evaluates the membership of the S&P 500 along a wide range of social performance indicators. Specifically KLD examines seven 'strength' and seven 'concern' environmental dimensions ranging from the extent to which the firm engages in pollution prevention programs or uses alternative fuels to the firm's use of ozone depleting chemicals or its generation of hazardous wastes. To calculate our KLD score we averaged the strengths and the concerns separately. In past literature, (see Sharfman, 1996 for a review) authors kept the metric consistent by subtracting the average concern score from the average strength score. Unfortunately there is a flaw in the assumption that each strength category and each concern category are equal. As such, the assumption implied in adding or subtracting them, that one is adding or subtracting equals, is not empirically verifiable. Therefore, consistent with Mattingly and Berman (2006) we created a separate average strength (KLD-ENVST) and concern (KLD-ENVCO) score for each firm.

We further examined whether the various environmental risk management indicators could be combined into a single scale. As we had no theoretical rationale as to how to combine the measures other than their face validity, we could not conduct a confirmatory factor analysis. Instead we ran an exploratory factor analysis using z-scores of the five measures. Using a varimax rotation we were able to extract a factor common to the ST-TRITO, ST-TRITR, and KLD-ENVST variables. This factor was the only one with an eigenvalue over 1.00 that had no cross loadings among observables, plus it accounted for 43 percent of the variance in these data. We used the SPSS (statistical analysis software) factor score from these three indicators as our measure of environmental risk management.

Because any cost of capital effects would be the result of prior environmental risk management, it was also necessary to determine whether more than one year of lagged environmental risk management data was necessary for our analysis. Using 2002 as our reference year (t), we estimated our models using data from 1999 (t_{-3}) to 2001 (t_{-1}) as well as the average values from 2000–2002 to see if any other lag in this data was appropriate. We obtained meaningful results only with the data from 2001 (a one-year lag) so we used those values in our analysis. We should note that list-wise deletion due to missing data resulted in a final sample of 267.

We also required measures for shareholder concentration and the percentage of institutional owners. For our indicator of shareholder concentration we used the total number of shareholders at the close of 2002. The logic here is that the higher the number of shareholders, the less concentrated the shares. We used the published percentage of institutional holders at the same point as a measure as well. Both the number of shareholders and the percentage of institutional holders came from COMPUSTAT's Research Insight database.

In terms of control variables, our review of the cost of capital literature suggests that the three constructs most likely to affect any sample of firms' costs of capital are firm financial leverage, industry membership, and firm size (Gebhardt, Lee, and Swaminathan, 2001). Additionally, controlling for industry and size differences is also important to rule out a spurious correlation between environmental risk management and cost of capital that would stem from these differences. For example, it is possible that different industries may have systematically different costs of capital and levels of environmental exposure/environmental risk management, causing a spurious correlation. With regard to size, we know from Bansal (2005) that larger firms are more likely to engage in environmental management because they attract more stakeholder attention and have more resources generally. As such, we believed it particularly important to control for both size and industry.

Our first control variable is the firm's level of financial leverage, since leverage affects cost of capital in multiple ways. Consistent with our market-based perspective, we used the firm's level of long-term debt as reported in COMPUSTAT, standardized by market capitalization. Financial leverage is also a theoretical variable in the test of Hypothesis 1a.

The question of whether industry membership is a valid control variable is an empirical one. Gebhardt *et al.* (2001) found industry effects on cost of capital in their study looking at all publicly held firms. With a sample less than three percent of the size of Gebhardt *et al.* (2001), it was ill-advised to assume that there would be an industry effect and categorize industries in some way to test for such an assumed effect. However, it is important that we assess industry effects because different industries might have systematically different costs of capital and levels of environmental exposure/environmental risk management, leading to a spurious correlation between environmental risk management and WACC. There are a variety of ways to assess industry effects. Often authors use either the Standard Industrial Classification (SIC) or the North American Industry Classification System (NAICS) code that identifies each firm's primary industry as a categorical variable. Unfortunately, because of the size of our dataset and the number of two-digit SIC codes (gathered from COMPUSTAT) represented in the sample (39), adding the appropriate number of dummy variables was not practical. Various methods exist for coding such a large number of industry codes into a manageable set (Amburgey and Miner 1992). However, we worried that if we did not use the classes as originally distributed, we would not be able to rule out the explanation that the coding method itself led to any detected result rather than it being a bona fide industry membership effect. As such, we treated the question of an industry effect as an empirical one so that we could determine if indeed there was an effect in this sample. So using the two-digit codes we ran an analysis of variance (ANOVA) with WACC-1 as the dependent variable and the two-digit SIC codes as the independent variable. Missing data reduced this sample to 331. There was a significant effect, so we ran a post hoc analysis using Dunnett's T^3 test (Toothaker, 1992) to determine which SIC code groups were different. This analysis is more likely to find differences among groups (be less conservative) as it does not assume equal variances across cells. In this analysis, six two-digit groups were not homogeneous with the other groups so we created a dummy variable with the homogeneous groups in one category and the nonhomogeneous groups in the other. This resulted in 129 firms in the nonhomogeneous group and 202 in the homogeneous group and we used this dummy variable in the analysis we describe below. Our approach allows us to identify in advance where differences lie and to include such differences explicitly in our analysis. By doing so, we have parsed out any industry effect on cost of capital in a rigorous and conservative way.

Finally, given that larger firms are more likely to engage in environmental risk management (Bansal, 2005) because they attract more stakeholder attention, have more resources generally, and have lower costs of capital (Gebhardt *et al.*, 2001); we included a measure of size in our analysis. Because we are working with financial market measures in the cost of capital variables, we selected the Bloomberg Financial database's measure of market capitalization as our size measure. While revenue, employee, and asset-based measures for size are quite common, market capitalization is the measure with which financial market analysts likely would work. Given that the measure is highly skewed, we conducted a natural logarithmic transformation on it before using it in our analysis. This reduced the skewness to conventional levels (cf. Muthen and Kaplan, 1985).

RESULTS

Tables 1 and 2 present the correlations and descriptive statistics, respectively, for the key variables in our study. Even though there was no obvious reason to suspect that our results might be affected by linear dependencies across the independent variables, we ran a colinearity diagnostic for each equation. The VIF statistics for each independent variable were at or only slightly above 1.0 (Neter, Wasserman, and Kutner, 1985), providing evidence that no variable caused undue influence on the results because of multicolinearity.

We analyzed the data using hierarchical regression because of the need to assess the marginal predictive contribution of our theoretical variables over and above that of the control variables. Table 3 presents the results of the test of Hypothesis 1, which predicts a negative relationship between the cost of debt capital and environmental risk management. In the analysis, this hypothesis is not supported. Our results suggest a significant positive relation between the cost of debt and environmental risk management, even after controlling for size, leverage, and industry effects. As we predict, the cost of debt decreases significantly with size and increases significantly with leverage. As one can see, while the control variables account for 4.2 percent of the variance

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Table 1. Correlations

	WACC-1	Cost of equity-1	Cost of debt	Beta	Financial leverage	Log-market capitalization	Number of shareholders	Institutional percentage
Cost of equity-1	0.857 **							
N	330							
Cost of debt	−0.290 **	−0.168 **						
N	330	330						
Beta	0.857 **	0.959 **	−0.168 **					
N	330	335	330					
Financial leverage	−0.307 **	0.034	0.170 **	0.034				
N	330	335	330	335				
Log-market capitalization	−0.193 **	−0.281 **	−0.114 *	−0.281 **	−0.056			
N	330	335	330	335	335			
Number of shareholders	−0.074	−0.104(+)	−0.128 *	−0.104	0.002	0.888 **		
N	269	274	269	274	274	274		
Institutional percentage	0.002	−0.021	0.038	−0.021	−0.034	−0.119 *	−0.084	
N	269	274	269	274	274	274	274	
Environmental risk management	−0.200 **	−0.142 *	0.220 **	−0.142 *	0.140 *	0.150 *	0.192 **	−0.188 **
N	268	271	268	271	271	271	270	270

** Correlation is significant at the 0.01 level (two-tailed).
* Correlation is significant at the 0.05 level (two-tailed).
+ Correlation is significant at the 0.10 level (two-tailed).

Table 2. Descriptive statistics

	N	Mean	Std. dev.
WACC-1	330	0.09	0.04
Cost of equity-1	335	0.10	0.05
Cost of debt	330	0.04	0.01
Beta	335	0.96	0.81
Financial leverage	335	0.61	1.25
Log-market cap	336	8.88	1.15
Number of shareholders (in thousands)	274	426.47	227.78
Institutional holders percentage	274	65.58	16.61
Environmental risk management	546	0.00	1.00

in the cost of debt, the environmental risk management indicator adds an additional five percent. Because leverage also increases with environmental risk management (see below), it is possible that we are unable to control properly for the effect of leverage on the cost of debt. We examined possible nonlinearities in the cost of debt-leverage relation, but the significant positive relationship between cost of debt and environmental risk management persists, so the result appears robust. Note that we conducted this analysis with a before tax estimate of the cost of debt. As a firm's effective cost of debt is affected by its marginal tax rate, we reestimated this equation with the cost of debt adjusted for the firm's marginal tax rate. The coefficient for environmental risk management was significant at a similar level and in the same direction but accounted for a bit less variance.

To test Hypothesis 1a, which predicts that improved environmental risk management would allow the firm to increase its leverage thereby increasing the potential tax benefit of debt financing, we use the financial leverage measure as the dependent variable and regress the remaining control variables plus the environmental risk management variables on it. As we see in Table 4, the control variables account for one percent of the variance in financial leverage, and the environmental risk management scale accounts for 1.6 percent of additional explained variance. The coefficient for the environmental risk management indicator is in the correct direction and significant (at $p < 0.05$), providing support for Hypothesis 1a. Therefore, firms with better environmental risk management benefit by being able to carry higher levels of debt.

Table 3. Hypothesis 1: Cost of debt regression results

Stage	Variable	Cost of debt Standardized coefficients	
		Beta	*t* value and significance level
1	(Constant)		7.629(***)
	Financial leverage	0.162	2.671(**)
	Log-market capitalization	−0.116	−1.914
	Industry	−0.017	−0.286
Initial R-squared		R-squared	F value and significance level
		0.042	3.89(**)
2	(Constant)		8.179
	Financial leverage	0.132	2.225(*)
	Log-market capitalization	−0.162	−2.679(**)
	Industry	0.045	0.736
	Environmental risk management	0.238	3.813(***)
Test of the change in R-squared		R-squared change	F value and significance level of the R-squared change
		0.05	14.54(***)
Total R-squared		0.093	

*** Coefficient is significant at the 0.001 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).
* Coefficient is significant at the 0.05 level (two-tailed).

Table 4. Hypothesis 1A: Leverage regression results

Stage	Variable	Cost of debt Standardized coefficients	
		Beta	*t* value and significance level
1	(Constant)		1.806
	Log-market capitalization	−0.022	−0.363
	Industry	−0.094	−1.536
Initial R-squared		R-squared	F value and significance level
		0.010	1.337
2	(Constant)		1.989(*)
	Log-market capitalization	−0.047	−0.751
	Industry	−0.058	−0.917
	Environmental risk management	0.132	2.079(*)
Test of the change in R-squared		R-squared change	F value and significance level of the R-squared change
		0.016	4.321(*)[6]
Total R-squared		0.026	

*** Coefficient is significant at the 0.001 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).
* Coefficient is significant at the 0.05 level (two-tailed).

To test for a positive relation between the level of environmental risk management and the firm's tax advantage from debt financing as predicted by Hypothesis 1b, we first compute the tax reduction (TR) associated with debt financing as TR = tax rate*cost of debt*leverage. We then regress TR on environmental risk management, using market capitalization and industry as our control variables (see Table 5). We find support for Hypothesis 1b, with the environmental risk management coefficient being positive and significant. Thus, firms that undertake a higher level of environmental risk management reap higher tax benefits arising from debt financing.

[6]The overall F statistic for the final equation is 2.343 which is significant at p = 0.073

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Table 5. Hypothesis 1B: Tax advantage from debt financing regression results

Stage	Variable	Tax advantage Standardized coefficients	
		Beta	t value and significance level
1	(Constant)		2.801(**)
	Log-market capitalization	−0.083	−1.353
	Industry	−0.128	−2.091(*)
Initial R-squared		R-squared	F value and significance level
		0.026	3.53(*)
2	(Constant)		2.982(**)
	Log-market capitalization	−0.106	−1.713
	Industry	−0.094	−1.479
	Environmental risk management	0.124	1.955(*)[7]
Test of the change in R-squared		R-squared change	F value and significance level of the R-squared change
		0.014	3.823(*)[8]
Total R-squared		0.040	

*** Coefficient is significant at the 0.001 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).
* Coefficient is significant at the 0.05 level (two-tailed).

While our tests of Hypothesis 1 indicate that the cost of debt increases with environmental risk management, the results for Hypothesis 1b indicate that this cost increase may be offset by the higher level of tax reduction associated with environmental risk management, driven by the combination of higher leverage and higher cost of debt. Therefore, it is important to check how the after-tax cost of debt, that is, the cost of debt net of associated tax offsets, relates to environmental risk management. We address this question by substituting the after-tax cost of debt for the dependent variable in Table 3 and then repeating the regression (see Table 6). Notwithstanding the higher debt-related tax advantage associated with environmental risk management, the net cost of debt continues to be positively and significantly related to environmental risk management and Hypothesis 1 continues to be unsupported.

In our examination of Hypothesis 2, which predicts that improved environmental risk management will lead to reduced costs of equity capital, we estimate the equations for both versions of our cost of equity measure. Regardless of the approach, (see Table 7) the control variables account for a significant amount of variance (14.7% for COE-1 and 10.3% for COE-2). The environmental risk management measure also adds a significant amount of variance (2.6% in each case). In both equations the coefficients for the indicator are in the correct direction and significant. Hence, Hypothesis 2 is supported.

To examine further the cost of equity results through the three sub-hypotheses, we first test whether beta is affected by environmental risk management (see Hypothesis 2a). In Table 8, we see that the control variables account for 10.3 percent of explained variance, while the environmental risk management measure adds 2.6 percent. The coefficient for the environmental risk management indicator is in the correct direction and is significant, so Hypothesis 2a is supported. As we can see from Equation 2, beta and the cost of equity measures are, by definition, linearly related. Therefore, if environmental risk management leads to a lower beta it also leads to a lower cost of equity (Feldman, *et al.*, 1997).

To test Hypothesis 2b's prediction concerning improved environmental risk management leading to lower share ownership concentration (more dispersion), which in turn should lead to a reduced cost of equity capital, we use the number of shareholders at the end of the target year as our measure of share dispersion. In this analysis (see Table 9) we see the vast majority of variance in the number of shareholders accounted for by the size

[7] P = 0.052
[8] P = 0.052

Table 6. Hypothesis 1B: After tax cost of debt regression results

Stage	Variable	Cost of debt Standardized coefficients	
		Beta	*t* value and significance level
1	(Constant)		5.498(***)
	Financial leverage	0.124	2.030 (*)
	Log-market capitalization	−0.066	−1.084
	Industry	−0.061	−0.984
Initial R-squared		R-squared	F value and significance level
		0.026	2.39(+)
2	(Constant)		5.924 (***)
	Financial leverage	0.098	1.620
	Log-market capitalization	−0.107	−1.747 (+)
	Industry	−0.004	−0.071
	Environmental risk management	0.212	3.351 (**)
Test of the change in R-squared		R-squared change	F value and significance level of the R-squared change
		0.04	11.23(**)
Total R-squared		0.066	

*** Coefficient is significant at the 0.001 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).
* Coefficient is significant at the 0.05 level (two-tailed).
+ Coefficient is significant at the 0.10 level (two-tailed).

Table 7. Hypothesis 2: Cost of equity-1 and cost of equity-2 regression results

Stage	Variable	COE-1 Standardized coefficients		COE-2 Standardized coefficients	
		Beta	*t* value and significance level	Beta	*t* value and significance level
1	(Constant)		9.651(***)		9.913(***)
	Financial leverage	0.023	0.401	0.003	0.050
	Log-market capitalization	−0.262	−4.575(***)	−0.242	−4.142(***)
	Industry	−0.244	−4.233(***)	−0.182	−3.101(**)
Initial R-squared		R-squared	F value and significance level	R-squared	F value and significance level
		0.147	15.132	0.103	10.225(***)
2	(Constant)		9.428(***)		9.710(***)
	Financial leverage	0.044	0.775	0.023	0.404
	Log-market capitalization	−0.229	−3.975(***)	−0.210	−3.576(***)
	Industry	−0.289	−4.907(***)	−0.226	−3.770(***)
	Environmental risk management	−0.172	−2.887(**)	−0.170	−2.805(**)
Test of the change in R-squared		R-squared change	F value and significance level of the R-squared change	R-squared change	F value and significance level of the R-squared change
		0.026	8.332(**)	0.026	7.87(**)
Total R-squared		0.173		0.129	

*** Coefficient is significant at the 0.001 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).
* Coefficient is significant at the 0.05 level (two-tailed).

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Table 8. Hypothesis 2A: Equity beta regression results

Stage	Variable	Equity beta Standardized coefficients	
		Beta	t value and significance level
1	(Constant)		7.600(***)
	Financial leverage	0.003	0.050
	Log-market capitalization	−0.242	−4.142(***)
	Industry	−0.182	−3.101(**)
Initial R-squared		R-squared	F value and significance level
		0.103	10.225
2	(Constant)		7.379(***)
	Financial leverage	0.023	0.404
	Log-market capitalization	−0.210	−3.576(***)
	Industry	−0.226	−3.770(***)
	Environmental risk management	−0.170	−2.805(**)
Test of the change in R-squared		R-squared change	F value and significance level of the R-squared change
		0.026	7.87(**)
Total R-squared		0.129	

*** Coefficient is significant at the 0.001 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).
* Coefficient is significant at the 0.05 level (two-tailed).

Table 9. Hypothesis 2B: Shareholder concentration regression results

Stage	Variable	Shareholder concentration (number of shareholders) Standardized coefficients	
		Beta	t Value and Significance Level
1	(Constant)		−22.516(***)
	Financial leverage	0.028	1.001
	Log-market capitalization	0.893	31.719 (***)
	Industry	−0.021	−0.739
Initial R-squared		R-squared	F value and significance level
		0.793	338.82(***)
2	(Constant)		−22.323(***)
	Financial leverage	0.021	0.760
	Log-market capitalization	0.883	30.909(***)
	Industry	−0.007	−0.223
	Environmental risk management	0.055	1.873(+)
Test of the change in R-squared		R-squared change	F value and significance level of the R-squared change
		0.003	3.508 (+)
Total R-squared		0.795	

*** Coefficient is significant at the 0.001 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).
* Coefficient is significant at the 0.05 level (two-tailed).
+ Coefficient is significant at the 0.10 level (two-tailed).

control variable (79.3%). Because of the massive amount of variance explained by the market capitalization variable, the environmental risk management indicator only added 0.3 percent additional explained variance. Nonetheless, in the equation the coefficient for environmental risk management is in the correct direction but only significant at $p < 0.10$. However, when we reestimate this equation without the market capitalization control variable, the environmental risk management coefficient is in the correct direction and significant at $p < 0.001$. In addition, the variable adds

4.9 percent additional variance. As size is so powerfully related to share ownership and so modestly related to environmental risk management ($r = 0.15$), it appears to have a suppressor effect on the relationship between the two. This set of analyses then suggests that as firms improve environmental risk management, their share ownership becomes more dispersed, thus supporting Hypothesis 2b and the conjecture in Heinkel *et al*. (2001) and Mackey *et al*. (2007) of exclusionary environmental investing.

We are also able to provide modest support for the prediction that higher levels of share ownership dispersion lead to lower costs of equity. As the reader can see from Table 1, the correlation between the number of shareholders and COE-1 is in the correct direction, although it is significant only at $p < 0.10$. A correlation analysis between the number of shareholders and COE-2 provides a stronger relationship with a correlation of $r = -0.13$ with $p < 0.05$.

Our test of Hypothesis 2c does not yield significant results. While the control variables again account for 6.4 percent of the variance in the institutional holders percentage and the environmental risk management scale accounts for an additional 1.3 percent of the variance (see Table 10), the coefficient on the measure was negative (the opposite of our prediction) and only marginally significant ($p < 0.10$). However, the correlation between the institutional percentage variable and COE is not significant. Therefore, Hypothesis 2c is not supported.

Table 11 presents the results of the test of Hypothesis 3, which predicts that better environmental risk management would result in a lower weighted average cost of capital (WACC). This hypothesis is supported regardless of the WACC measure. For WACC-1, the control variables are all significant. WACC decreases with size as would be expected. WACC also decreases with leverage, which suggests a significant tax advantage of using higher levels of debt. We also observe a significant industry effect. The control variables account for 16.9 percent of the variance in costs of capital and the environmental risk management measure accounts for an additional 3.4 percent for an overall explained variance of 20.3 percent. The coefficient on the environmental risk management indicator is in the correct direction and the indicator's t statistic reaches conventional significance levels ($p < 0.05$). In the WACC-4 regression, the overall level of explained variance is 23.4 percent with the environmental risk management indicator accounting for 2.3 percent additional significant explained variance. The sign on the environmental risk management indicator is in the predicted direction and is significant. Thus, improved environmental risk

Table 10. Hypothesis 2C: Institutional holdings regression results

Stage	Variable	Institutional holdings percentage Standardized coefficients	
		Beta	t Value and significance level
1	(Constant)		9.475(***)
	Financial leverage	−0.019	−0.315
	Log-market capitalization	−0.142	−2.378(**)
	Industry	0.226	3.757(***)
Initial R-squared		R-squared	F value and significance level
		0.064	6.063(**)
2	(Constant)		9.283
	Financial leverage	−0.004	−0.068
	Log-market capitalization	−0.120	−1.971(*)
	Industry	0.194	3.131(**)
	Environmental risk management	−0.122	−1.943(+)
Test of the change in R-squared		R-squared change	F value and significance level of the R-squared change
		0.013	3.775(+)
Total R-squared		0.077	

*** Coefficient is significant at the 0.001 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).
* Coefficient is significant at the 0.05 level (two-tailed).
+ Coefficient is significant at the 0.10 level (two-tailed).

Table 11. Hypothesis 3: WACC regression results

Stage	Variable	WACC-1 standardized coefficients		WACC-4 Standardized coefficients	
		Beta	t value and significance level	Beta	t value and significance level
1	(Constant)		8.961(***)		5.102(***)
	Financial leverage	−0.332	−5.892(***)	−0.377	−6.864(***)
	Log-market capitalization	−0.177	−3.129(**)	−0.206	−3.743(***)
	Industry	−0.188	−3.312(**)	−0.187	−3.378(**)
Initial R-squared		R-squared	F value and significance level	R-squared	F value and significance level
		0.169	17.95 (***)	0.211	23.50(***)
2	(Constant)		8.731(***)		4.844(***)
	Financial leverage	−0.308	−5.525(***)	−0.357	−6.532(***)
	Log-market capitalization	−0.139	−2.463(*)	−0.175	−3.157(**)
	Industry	−0.240	−4.147(***)	−0.230	−4.054(***)
	Environmental risk management	−0.196	−3.346(**)	−0.162	−2.827(**)
Test of the change in R-squared		R-squared change	F value and significance level of the R-squared change	R-squared change	F value and significance level of the R-squared change
		0.034	16.79(***)	0.023	20.09(***)
Total R-squared		0.203		0.234	

*** Coefficient is significant at the 0.001 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).
* Coefficient is significant at the 0.05 level (two-tailed).

management is associated with decreased WACC, after controlling for size, leverage, and industry effects.

DISCUSSION

The purpose of this article is to examine an additional theoretical perspective to explain the growing consensus in the literature concerning the positive relationship between firm environmental and economic performance. Using arguments developed out of risk management and institutional theories, we propose an external explanation for the improved economic performance previous authors have found. As we argue, improved environmental risk management is theoretically synonymous with strategic risk management. The strategic choices that lead to improvements in environmental risk management make the firm less risky, that is, there are fewer potential claimants on its assets/rents through potential litigation or compliance costs. In addition, we predict that the marketplace would reward the firm's improved risk posture through lowered costs of debt and equity capital. Finally, we examine complementary theoretical arguments as to why the firm would experience improvements in the cost of debt and equity capital when it undertakes environmental risk management.

Our key contribution is that we are able to find strong support for the basic prediction of this article—that firms that develop a strategy to improve their risk management through improved environmental performance reduce their weighted average cost of capital regardless of the way in which we estimate WACC. Our second set of contributions comes from the examination of several arguments to see if we could determine why we find support for our omnibus prediction. We first hypothesize a beneficial impact of environmental risk management on the firm's cost of debt, but obtain results contrary to prediction. Higher levels of environmental risk management, although permitting firms to carry more debt, increase the cost

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of debt capital. While this cost increase is partially offset by higher tax benefits, the net result is still the same. There are three alternative explanations for this contrarian result. First, it may be the case that the debt markets continue to see even strategic investments in environmental risk management beyond that necessary for compliance as inefficient and punish firms who engage in such behavior. Another perspective suggested by our data arises from our observation that high levels of environmental risk management are positively related to leverage. As the firm reduces its environmental risk profile through improved environmental risk management, debt markets appear to be more willing to provide debt financing, which can improve overall organizational performance. Such increases in leverage also increase the cost of debt capital, and it is possible that we are unable to separate the effect on the cost of debt of higher leverage from that of higher environmental risk management. Also, the increased leverage and decreased cost of capital may be key drivers in the overall improvement in economic performance that firms with strong environmental risk management experience. Finally, of the over $2 trillion in socially invested assets, less than one percent is in corporate debt instruments and very little of that is screened on environmental risks. As such, given that institutional debt holders evaluate things strictly on current risk, firms making long-term investments in environmental risk management may be seen as more risky in the short term. Also, given that there is very little demand for debt from socially screening investors, there would be little or no resulting upward price pressure (cf. Mackey *et al*., 2007).

We also carry out a comprehensive examination of the relation between cost of equity and environmental risk management. The results for our regressions on the costs of equity measures show that the markets amply reward increased environmental risk management by reducing the firm's cost of equity capital. As expected from CAPM theory, the negative relationship between environmental risk management and costs of equity is confirmed by the observed decrease in beta. As the firm lowers its systematic risk profile through improved environmental risk management, it experiences less volatility in its performance, and the market appears to reward such behavior with lower costs of equity capital and, by implication, a lower WACC.

We decompose the cost of equity relationship further through the application of risk management theories about the effects of improved environmental risk management on both share ownership concentration and institutional ownership. We were able to confirm that firms with more dispersion in the number of shareholders experienced lower costs of equity capital, and that improved environmental risk management increases the dispersion of shares as more individual investors wish to acquire the stock of less environmentally risky firms (Mackey *et al*., 2007). We also predict that good environmental performers should become more attractive to institutional holders resulting in more concentration. However, as we show in our results, improved environmental risk management leads to lower levels of institutional holders, but there is no relationship between the level of institutional holdings and the cost of equity capital.

The key implication of these results is that if improved environmental risk management leads to decreases in WACC in one period, then this lowered cost of capital will lead to improved overall economic performance in later periods (e.g., Scott and Pascoe, 1984). Like any input, if firms can decrease the costs of the capital they use, they have the opportunity to gain higher margins or use margins/pricing as a more effective strategic weapon. It is important to remember that the effect on economic performance is lagged. In this study we find effects from 2001 environmental risk management on 2002 WACC. As we discuss below, we examine the effect of 2002 WACC on 2002 economic performance and find a nontrivial negative relationship as one would predict. However we find no direct effect from 2001 environmental risk management on 2002 economic performance. As such, in this sample, WACC mediates the effect of environmental risk management on economic performance.

When one examines our results in the context of the earlier literature, several key advancements are evident. First, we argue that in addition to the internal efficiency effects of investments in environmental performance that have been the focus of most prior work in the area, there are external reactions to such investments by both retail and institutional investors. Our results support this position and show that the effects of such investments are much wider than previously theorized. Second, our results help clarify why environmental performance and economic performance have been linked in previous work. Because investments in environmental risk management lead to WACC reductions, the firm's cost basis is reduced, and hence profits will be larger for any given income level. Because of these results, we can add an institutional explanation to the resource-based view type arguments that have been proposed as theoretical justifications of the linkage. Finally, our results also support the position taken by those normative articles that argue that managers 'should' improve environmental risk management because by doing so they will, among other things, lower the firm's cost of capital.

Possible alternative explanations for the results

The development of strong theory from empirical results rests in part on the elimination of alternative explanations for one's findings (Stinchcombe, 1968). We address the potential for alternative explanations of our results in two ways. First, the use of hierarchical regression allows us to determine the marginal effect of our theoretical variables after any effects of the control variables that prior literature indicated should have an effect on cost of capital. Two of the control variables, size and industry, also have been shown in prior literature to predict environmental performance, so their inclusion is doubly important as we try to rule out any spurious relationships through the use of these controls. Our use of a lagged design is a strength because it helps rule out the alternative explanation that any relationship between environmental risk management and WACC is coincidental based on single-year data collection.

In addition to design strategies, we examined empirically some additional alternative explanations proposed by our thoughtful reviewers. The first argument was that the markets are not rewarding improved environmental risk management, but rather simply recognizing better economic performance that has often been associated with improved environmental performance. If the market was rewarding improved resource utilization rather than lower risk with lower WACC, then we would expect that higher levels of environmental risk management in year t would be associated with both lower WACC and higher economic performance in t_{+1}. To examine this question we looked at six 2002 firm-specific economic performance indicators for our dataset. We did a lagged analysis for the economic-environmental performance link to be consistent with our environmental risk management-WACC analysis. We correlated our 2001 environmental risk management measure and the 2002 performance measures. In none of these cases did we detect a significant correlation. There is a strong ($r = -0.42$, $p < 0.001$) negative (and predictable) relationship between 2002 WACC and 2002 economic performance. However, we find no support for the idea that the lower cost of capital comes from the markets simply rewarding improved overall firm effectiveness arising from better environmental performance.

We also carried out further alternative explanation analyses to examine whether other firm risk issues (e.g., product or management/governance concerns) might be the source of the WACC relationships. KLD has a set of product concerns criteria that includes safety and marketing (i.e., social) problems, etc., plus a set of corporate governance concerns that includes accounting problems, transparency issues, and political accountability. We reestimated the environmental risk management—WACC regression twice—first adding the product concerns score and then in a second analysis adding the corporate governance concerns variable as controls. In both cases, while these variables did have a significant relationship with WACC, the coefficient and its significance level for environmental risk management stayed the same while the overall level of explained variance remained very close. Specifically, in the product concerns variable equation, all that changed was that some of the explained variance from the other control variables and a very small amount (0.5%) of variance explained by environmental risk management shifted to the product concerns control variable. Note the product concerns variable was significant when entered by itself but becomes nonsignificant in the latter stages. While product issues seem to have an effect on WACC they do not detract from the relationship we identified between WACC and environmental risk management. In terms of the management/corporate governance variable, it added a small amount of additional explained variance and the overall level of explained variance increased a bit as well. The variance explained by environmental risk management declined modestly (0.7%) but the direction and significance level of its coefficient were identical. While unmeasured causes are critical issues in any analysis, the design choices and additional analyses we conducted give us confidence that our results are robust.[9]

Future research

As with most research, the results from this study open as many new areas of inquiry as they answer, with two questions being the most intriguing. The most obvious future research implication is the further examination of the cost of debt findings. Given how strong the cost of equity and WACC relationships were, the fact that the cost of debt result is opposite is intriguing. While clearly debt markets look at risk differently than do equity markets, we would like to examine further why the relationships we found are opposite of prediction and contrary to the cost of equity results.

A second interesting question stems from the fact that these results were from U.S. firms. In markets where the pressure for firms to improve their environmental risk management is potentially stronger (e.g., Europe and Australia) both from regulation and from societal pressure, do these results hold? Specifically, we would predict that the equity results would be similar, but would the cost of debt results change in more environmentally sensitive locations?

Implications for managers

These results have implications for managers making strategic financial choices. Like all strategic investments, those that firms make to improve their environmental risk management have a cost that must be offset by commensurate benefits. In calculating the benefits of such investments, our results suggest that managers can also include the potential for reductions in costs of capital—particularly those who finance primarily with equity. Given that we know from previous literature that improved environmental performance leads to increases in market value, the cost of equity changes we identified should have far-reaching financial strategy effects.

For those firms whose strategy is to finance with debt, our results are informative as well. While investing in environmental risk management leads to higher costs of debt, the firms that do so are able to carry higher levels of leverage and are able to reap more tax benefits from debt financing. Depending on the specifics of the financing strategy a manager chooses, the positive effects of investments in environmental risk management may outweigh the increases in the cost of debt. Particularly for managers under strong pressure from competitive or institutional sources to make environmental risk management changes, the increases in the cost of debt may be simply short-term costs that must be absorbed for the longer-term gains that environmental improvements may generate (e.g., with stakeholders or regulators). In any case, our results provide managers with more complete information with which to make their strategic financial choices.

Potential limitations

There are two key elements to these analyses that may be seen as limiting the robustness or generalizability of the results. First, concerns might be raised about our measure of environmental risk management. The TRI and KLD data are limited in their ability to reflect environmental risk management accurately. While the measures are subject to industry differences (among other problems) we limit the potential problems from either data source first by using them in concert (i.e., triangulating on environmental risk management with two types of indicators) and by including industry differences explicitly.

Second, it could be argued that structural equations modeling (SEM) might have provided a more rigorous test of the model. However, using SEM was not appropriate for two reasons. First, the relationships between firm size and number of shareholders, plus those among beta, cost of equity and WACC are so large that when using them all in a structural equation, massive colinearity is unavoidable. Such colinearity causes uncorrectable instability in SEM equations. By estimating hierarchical regressions on the different paths in the model, the colinearity problems can be avoided or addressed directly. Secondly, because in this analysis we were interested in the marginal contribution of the theoretical variables over any variance explained by the control variables, hierarchical regression was again more appropriate.

[9] The specifics of these additional analyses are available from the first author.

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CONCLUSION

This article's main contribution is that overall, firms that develop a strategy that improves their total risk management through better environmental risk management are rewarded by the financial markets for their efforts. The main driver for this relationship comes from the resultant reduction in the cost of equity, particularly through the lowering of the volatility of the firm's stock as measured by beta. There is also some limited effect on the cost of equity capital due to the fact that more individuals purchase the high environmental performer's stock, further driving down the cost of equity capital. While increased environmental risk management seems to increase the cost of debt capital, it does so by allowing the firm to take on increased leverage, thereby increasing the tax subsidies resulting from debt financing and potentially improving the firm's overall economic performance. Our results suggest that in addition to the improved resource utilization that comes with improved environmental risk management, such actions are legitimated (rewarded) by the equity markets and, in some ways, by the debt markets as well. These findings help us build a better theoretical understanding of the outcomes of strategic choices to improve environmental risk management. Not only does an improved environmental risk management strategy result in resource efficiencies, but it also has a payoff in terms of the market's perception of the risk profile of the firm and helps explain why better environmental performers are also better financial performers.

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