

Corporate Environmental Management and Credit Risk

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Abstract

This study analyzes corporate environmental management and its implications for bond investors. We provide support for the view that the credit standing of borrowing firms is influenced by legal, reputational, and regulatory risks associated with environmental incidents. Using information on the environmental profile of 582 U.S. public corporations between 1995 and 2006, we document that (i) environmental concerns are associated with a higher cost of debt financing and lower credit ratings, and (ii) proactive environmental practices are associated with a lower cost of debt. The results are robust to numerous controls for company and bond specific characteristics, alternative model specifications, and industry membership.

Key Words: Environmental risk management, Cost of debt, Credit ratings, Litigation, Regulatory risk, Reputation risk, Climate change

JEL classification: G32; G33; Q51; Q56; M49; K32

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1. Introduction

The environmental impact of businesses has been the subject of public debates ever since corporate negligence repeatedly resulted in incidents with immense damage caused to the environment and human health (e.g., the Seveso incident in 1976; Bhopal incident in 1984; Exxon Valdez spill in 1985; Brent Spar incident in 1995; and the Great Barrier Reef collision of the freighter Sheng Neng 1 as well as BP plc spill in 2010). In the wake of growing climate change concerns and recent environmental disasters, the matter is rapidly gaining unprecedented public attention, which fuels the ongoing controversy over the social responsibility of firms and the role of governments in regulating corporate behavior. With calls for stricter environmental regulations growing louder, the financial markets are wary of the often uncertain financial implications of likely regulatory interventions. To better evaluate their exposure to environmental risks, investors increasingly demand that firms assess and disclose their relative risk position to climate change.

In this paper, we investigate the credit risk implications of corporate environmental management for bond investors. Our conceptual framework is based on the view that environmental practices influence the solvency of borrowing firms by determining their exposure to legal, reputational, and regulatory risks. Firms that engage in environmental misconduct can incur costly penalties and evoke strong negative reactions from both financial and non-financial stakeholder, each of which affects their default risk and thus impairs the value of their fixed income securities. The recent BP oil spill in the Gulf of Mexico illustrates the tremendous negative impact that environmental incidents can have on the credit standing of firms. Bond investors who want to protect themselves against environmental performance related losses require a better understanding of how the different corporate environmental activities relate to credit risk, before making their decision to lend. This study aims to provide a better insight into this issue.

To test the hypothesized relation, our analysis takes advantage of the growing coverage and popularity of independent rating agencies that specialize in the evaluation of corporate environmental performance (e.g., Luck and Pilotte, 1993; Derwall, Guenster, Bauer, and Koedijk, 2005; Fisman, Heal, and Nair, 2006; Kempf and Osthoff, 2007; Statman and Glushkov, 2009). These widely used performance ratings typically combine a range of public and proprietary information to provide a comprehensive overview on the environmental management of firms. We collect data on a range of corporate environmental activities to construct aggregate measures of the firm's environmental strengths and concerns, and subsequently regress the cost of debt and credit ratings on these measures.

The results presented herein are consistent with the prediction that the environmental management of firms has value implications for bond investors. We report economically meaningful and statistically significant relations between the environmental performance measures and both, the cost of debt and credit ratings of borrowing firms. The corporate activities underlying the documented relations are mainly attributable to regulatory and climate change issues, but also to efforts to reduce environmental risk exposure, and to enhance cash flows by supplying innovative products and services with environmental benefits. Following a conservative approach, we estimate a maximum environmental performance effect on the cost of debt of up to 64 basis points per annum. Our analysis provides no evidence that the impact of environmental management is consistently higher or restricted to firms in high risk industries, but rather suggests that it is important to account for heterogeneity across these industries. Finally, we show that the relevance of environmental management concerns for bond investors has increased over the recent decade, corresponding with the view that widespread climate change concerns have heightened investors' awareness of potential regulatory changes and other associated financial risks.

Our study adds to the literature by providing comprehensive evidence that corporate environmental management is a cross-sectional determinant in the valuation of credit risk. We follow up on earlier work that reports on a credit risk effect for misrepresented environmental liabilities (Graham, Maher, and Northcut, 2001; Graham and Maher, 2006), and show that already the environmental performance of firms is reflected in the pricing of newly issued bonds in anticipation of the associated risks. Unlike similar studies that exclusively focus on environmental concerns (Schneider, 2010; Sharfman and Fernando, 2008); this paper is the first to also consider corporate activities that are directed at reducing environmental risk exposure or enhancing cash flows. Furthermore, it is the first study to investigate the hypothesized relations in a comprehensive sample across multiple industries. Finally, our work complements earlier credit risk research on lender liability (e.g., Pitchford, 1995, 2001; Boyer and Laffont, 1995, 1997; Heyes, 1996; Balkenborg, 2001; Kroszner and Strahan, 2001), by demonstrating that environmental concerns do not only constitute a meaningful risk for bank lenders, but also for investors in non-secured publicly traded debt. Our analysis benefits bond investors by contributing to an enhanced understanding of how environmental performance aspects influence the pricing of credit risk, and by providing risk managers with better guidance on where to direct their attention to.

The paper is organized as follows. Section 2 introduces the conceptual framework for our analysis. We discuss environmental management as a potential source of risk for bond

investors, and contrast our work with earlier research. Section 3 formulates testable hypotheses for the relation between environmental management and credit risk. Section 4 describes the sample selection and data sources, define the variables, and provide descriptive statistics. Section 5 presents our results and corresponding robustness tests. Section 6 concludes.

2. Conceptual Framework and Related Literature

2.1. Environmental Management and Bondholder Risk

Bond investors primarily need to concern themselves with the environmental management of borrowing firms, because of the potential liabilities that arise for businesses under the U.S. legal and regulatory framework. Firms that are held responsible for environmental violations can incur substantial clean-up costs, fines, and damage awards. These environmental liabilities do not only burden the solvency of borrowers, but according to environmental law also often subordinate the claims of their debt holders. Furthermore, if these liabilities pose a significant risk to the firm's financial viability, management can be tempted to file for strategic bankruptcy in an attempt to escape them.¹ Given that an inadequate management of environmental risks increases the likelihood of costly future liabilities, bondholders can expect a higher default risk for borrowers with poor environmental practices, and a consequently impaired value of their investments.

The potentially far-reaching legal consequences of poor environmental management are best illustrated through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).² Commonly known as Superfund, this federal law gives the Environmental Protection Agency (EPA) the authority to identify parties responsible for the pollution of sites, and compel them to bear the costs and responsibility for remediating contaminations.³ Environmental liabilities imposed under CERCLA are *retroactive, joint and several*, and *strict*: i.e., parties can be held liable for incidents that occurred before the enactment of CERCLA in 1980; if the damage is caused by multiple parties but cannot be

¹ Filing a petition for bankruptcy under Chapter 11 enables firms to reorganize their business by preventing the complete liquidation of their assets, and discharging many of their pre-petition debts. Environmental violators can attempt to exploit the existing legal ambiguity on whether environmental liabilities constitute dischargeable claims or not, in order to escape them (e.g., Greenberg and Shaw, 1991; Kishiyama, 2003).

² Other environmental laws that generate potential liabilities for businesses include the Clean Air Act; Clean Water Act; Emergency Protection and the Community Right-to-Know Act; Federal Insecticide, Fungicide, and Rodenticide Act; Marine Protection, Research, and Sanctuaries Act; Pollution Prevention Act; Resource Conservation and Recovery Act; Safe Drinking Water Act; and the Toxic Substance Control Act.

³ www.epa.gov/superfund

separated, any single party may be held liable for the entire cleanup; and no negligence is required to be held liable, only involvement at the site (e.g., as generator, transporter, operator, or owner). Moreover, if a responsible firm merges or is acquired, its environmental liabilities are generally not discharged, but carried over to the new entity.

Allegations or charges of environmental violations also have economic implications that extend beyond the direct costs of litigation. Stakeholders who take issue with socially questionable practices or fear reputational risks from being associated with an environmental scandal are likely to restrict or dissolve their relationship with the firm. A deterioration of key stakeholder relationships in turn affects the level and variation of cash flows, which influences firm value as well as raises the default risk of borrowers. Konar and Cohen (2001) report that the size of legally emitted toxic chemicals is negatively correlated with the intangible asset value of the firm. In addition, environmental offenders can experience difficulties in attaining cost-efficient funding as well as a reduction in the liquidity of their securities. Particularly banks are cautious about financing firms with poor environmental practices, because next to the risk of incurring reputation and repayment losses (McKenzie and Wolfe, 2004), a too close involvement with such clients can make them liable for environmental obligations (e.g., Pitchford, 1995, 2001; Boyer and Laffont, 1995, 1997; Heyes, 1996; Balkenborg, 2001; Kroszner and Strahan, 2001).⁴ Adding to the liquidity constraint, are the increasing public demands to limit or shun investments in firms with socially irresponsible practices, which gradually leads institutional investors to adopt environmental performance screens for their portfolios. The reluctance of investors to finance or hold securities of environmental offenders can thus require an additional risk and liquidity premium on the cost of capital for firms with questionable practices (e.g., Garber & Hammitt, 1998).

While the current environmental laws and regulations address a wide range of corporate activities, the risk of further regulatory intervention has progressively increased over the recent decades. Primary drivers of this development are the growing concerns about global climate change, and the repeated environmental disasters in which corporate neglect has resulted in immense environment damage and social costs. Whereas the climate change debate has sensitized the public to the environmental impact of business; the controversy over

⁴ Following the CERCLA Amendments in 1996, banks are liable as ‘owners or operators’ of a polluted site, if their participation in management can be established (see, e.g., *New York vs. HSBC USA, N.A.*). Although generally protected under the secured creditor exemption rule, a number of situations exist that continue to expose banks to lender liability (Ahrens and Langer, 2008). Bondholders, unlike banks, cannot be held responsible for the environmental liabilities of their borrowers. Our focus on unsecured publicly traded debt therefore makes lender liability only indirectly relevant to this study.

stricter regulation has in particular been fuelled by environmental incidents that uncover the current inability of legislators to effectively hold environmental offenders liable for the damages that they caused (e.g., Exxon Valdez spill in 1985; BP Gulf of Mexico spill in 2010).

In view of the persistent media coverage and public pressure on policy makers to implement environmental reforms, state and federal governments are expected to eventually respond by more rigorously enforcing existing environmental regulations, imposing more stringent regulations, and introducing more severe criminal and civil penalties for polluters. Although such a tightening of regulations typically targets firms in high-risk industries, borrowers in seemingly low-risk industries can increasingly constitute a credit risk as well, if they fail to recognize and manage the very environmental risks that they are exposed to. Furthermore, the higher compliance costs that generally accompany stricter regulations represent an additional drain on cash flows, which can pose a significant burden for firms that operate at minimal compliance standards. Altogether, the relevance of environmental management as a means to protect firms and their investors against legal, reputational, and regulatory risks is expected to increase over time and across industries.

2.2. Related Literature

Earlier research suggests that the credit market accounts for the impact of environmental liabilities on the solvency of borrowers. Graham, Maher, and Northcut (2001) report that a firm's listing as potentially responsible party for Superfund liabilities is associated with a significant deterioration of its bond ratings. Graham and Maher (2006) confirm and extend this finding, by showing that bond ratings and bond yields are both significantly related to the number of times that a firm is named a potentially responsible party. A commonality in these studies is that they are motivated by the potential misreporting of existing Superfund liabilities: According to the environmental accounting literature, financial statements do not accurately reflect the firm's past or present environmental liabilities under the prevailing accounting standards and practices (Barth and McNichols, 1994; Gamble, Hsu, Kite, and Radtke, 1995; Barth, McNichols, and Wilson, 1997; Blacconiere and Northcut, 1997; Graham et al. 2001). Schneider (2010) discusses these accounting regulations in detail, and points to the considerable discretion that firms are granted in their reporting of environmental liabilities.⁵ The resulting understatement or omission of environmental liabilities is

⁵ More specifically, firms need not recognize a liability in a given period, if it can be argued that a reasonable estimate is not feasible. When the estimation of a liability produces a range of possible outcomes, the most likely amount is recorded. In the case that each of these estimates is equally likely, the firm is permitted to report the lowest amount.

particularly problematic for lenders, because when these obligations are finally realized, their actual values can significantly exceed the ones reported on the balance sheet, and thus cause an adverse shock to debt recovery.

Our study differs from the previous literature in that we analyze the credit risk relations for a broad range of corporate environmental activities, instead of focusing on the potential misreporting of environmental liabilities after their occurrence. Bond investors who want to protect themselves from environmental performance related losses need to identify and evaluate environmental risks prior to their decision to lend. We aim to contribute to the environmental risk assessment of borrowing firms, by providing a more comprehensive understanding of the relation between environmental management and credit risk. The paper closest to our work is that by Schneider (2010), who studies the effect of toxic emission levels on the pricing of bonds for firms in the paper and pulp or chemical industry. The author reports that higher toxic emission levels are associated with lower bond ratings and a premium on the cost of debt. Unlike Schneider, our analysis tests the credit risk effect of a comprehensive set of past and ongoing corporate environmental activities across multiple industries. Moreover, we consider the firm's efforts to reduce its exposure to environmental risk, and do not limit our focus on the impact of environmental concerns.

3. Hypotheses Development

The preceding discussion suggests that environmental performance constitutes a source of credit risk, and that the informed lender tries to anticipate associated losses through a comprehensive assessment of the borrower's environmental management prior to lending. We formally test the credit risk implications of environmental management by relating information on the firm's environmental activities to key measures of its credit standing. While fixed income investors typically focus on the downside risk of borrowers, they may also benefit from corporate initiatives that prevent environmental incidents or mitigate their consequences. Our analysis therefore distinguishes between corporate activities that increase environmental risks, and those that are directed at reducing environmental risk exposure.

Our first hypothesis regards the link between environmental concerns and credit risk. We argue that firms with poor environmental practices are more likely to default on their debt obligations, because of their higher exposure to potentially costly environmental litigation, reputational losses, and regulatory risk. Consequently, we expect that the credit market requires a compensation for this incremental risk in form of a higher cost of debt, and lower

credit ratings to reflect the lower credit standing. We derive the following hypothesis stated in alternative form:

Hypothesis 1: Firms with more environmental concerns have a higher cost of debt financing and lower credit ratings.

In contrast, a proactive engagement in environmental matters is expected to reduce the likelihood as well as consequences of environmental violations, and can serve as a signal that management is committed to a low-risk environmental strategy. Moreover, earlier research suggests that environmental management can enhance the firm's financial position by reducing costs and increasing profitability. Reinhardt (1999) argues that an engagement beyond compliance standards can improve production efficiency, increase demand from environmentally sensitive consumers, discourage stakeholder activism, and help firms to attract skilled workers. Several studies indeed confirm that strong environmental performance is associated with higher profitability and firm value (e.g., Klassen and McLaughlin, 1996; Russo and Fouts, 1997; Konar and Kohen, 2001; King and Lenox, 2002). Given these positive cash flow implications, we derive the following hypothesis on the effect of environmental engagement on credit risk:

Hypothesis 2: Firms with a more proactive environmental engagement have a lower cost of debt financing and higher credit ratings.

The preceding hypotheses both assume that environmental management equally affects the credit standing of firms across different industries. However, since firms that operate in environmentally risky industries are generally more prone to incidents, they should also form a more likely credit risk to bond investors. We thus expect that the credit risk implications of environmental management are more significant for firms in inherently risky industries:

Hypothesis 3: The link between environmental performance and credit risk is stronger for firms that operate in environmentally risky industries.

We argue that corporate environmental management affects credit risk through the associated legal, regulatory, and reputational consequences. An important factor underlying this relation is the general attention that is awarded to environmental issues, because of its role in shaping public opinion and influencing regulatory policy. Although the protection of the natural environment and human health has been an ongoing public concern for decades, it

is only since the recent climate change debate that the environmental impact of corporations has gained widespread attention from the media and public policy makers. Notable events that fall into our sample period include the third assessment report on climate change by the Intergovernmental Panel on Climate Change (IPCC) in 2001, the coming into effect of the Kyoto Protocol⁶ and initiation of the United Nations Principles for Responsible Investment (UNPRI) in 2005, and the Stern Review on the economics of climate change in 2006. Given this growing awareness of environmental concerns, we hypothesize that the risks associated with corporate environmental violations have increased over time, and with it the relevance of environmental management for bond investors.

Hypothesis 4: The impact of environmental performance on credit risk has increased over the recent decade.

4. Data

4.1. Environmental Management Performance

We construct measures for the firm's environmental management performance using data from Kinder, Lydenberg, and Domini Research & Analytics (KLD). KLD is an independent investment research company that specializes in the assessment of firms' environmental management, social performance, corporate governance standards, and product quality. It issues annual performance evaluations based on a wide variety of information, which include external surveys and ratings, corporate websites, global media publications, governmental and nongovernmental institutions, financial reports, regulatory filings, and academic studies. The resulting performance information is aggregated into the KLD *STATS* database, which covers all Standard & Poor's (S&P) 500 constituents as of 1991, the 1,000 largest publicly traded U.S. firms from 2001 to 2002, and the 3,000 largest publicly traded U.S. firms thereafter.

To rank firms according to the quality of their environmental management, we focus on the qualitative performance indicators that are contained in the *Environment* dimension of KLD *STATS*. These indicators cover the strengths and concerns that each firm in the database displays with regard to its environmental activities. We exclude the categories *Property, Plant, and Equipment* and *Ozone Depleting Chemicals* from the set of available indicators,

⁶ Although the United States is a signatory to the Kyoto Protocol, the signature is merely symbolic (i.e., non-binding), because it has neither ratified nor withdrawn from the protocol. Nevertheless, a federal objective of the current administration is to reduce greenhouse gas emissions back to 1990 levels by 2020, and an additional 80% by 2050. Next to this national objective, individual States have supplementary policies to cut emissions.

because of their limited and highly clustered observations.⁷ Table 1 provides details on the indicators that comprise our measures of environmental management performance.

*** Insert Table #1 about here ***

KLD assigns a value of zero or one to each of the indicators, which respectively denote the absence and presence of a strength or concern. We sum the individual indicators to obtain measures for the total number of environmental strengths, *ENVStrengths*, and the total number of environmental concerns, *ENVConcerns*. This approach follows our objective to distinguish between the effects of corporate activities that increase environmental risks, and those that are aimed at mitigating the same. It also controls for earlier concerns that positive and negative social actions may be both empirically and conceptually distinct constructs (Mattingly and Berman, 2006).

4.2. Credit Risk Measures

We use three distinct measures of credit risk to test the relevance of environmental management for bond investors: the cost of debt financing, bond ratings, and long-term issuer ratings. Information on the cost of debt and bond ratings are collected from the Mergent Fixed Income Securities Database (FISD), which provides data on more than 140,000 publicly offered U.S. corporate bonds, together with more than 550 bond characteristics. We perform several screens to limit confounding effects that may result from bond specific characteristics: First, we focus our analysis on unsecured corporate bonds that are either classified as senior or senior-subordinated debt. Next, we exclude bonds with option or other nonstandard components (i.e., callable, puttable, convertible, exchangeable, preferred, perpetual, asset-backed, private placements, part of unit deals, sinking fund provisions). After the matching of our credit risk measures with the test and control variables, we are left with a sample of 2,242 bonds that were issued by 582 firms in the period from 1995 to 2006. FISD reports yield spreads for 2,119 of these bonds, and bond ratings for the entire sample.

Our first dependent variable is the firm's cost of debt financing, which we define as the market quoted yield spread of newly issued bonds, *Spread*. The yield spread equals the difference between the offering yield to maturity of a bond issue and the yield to maturity of a

⁷ KLD has not passed judgment on the *Property, Plant, and Equipment* category since 1995, which leaves us with a single sample observation after database matching. The *Ozone Depleting Chemicals* category contains at most 22 observations, 15 of which are clustered around two companies.

corresponding treasury bond. Consequently, it reflects the premium that the market charges borrowers for assuming the risk that they may default on their debt obligations. We study the cost of debt in its log form, $\ln(\text{Spread})$, because of the significant positive skewness in the yield spread distribution.

The second dependent variable is credit rating that is assigned to a particular bond issue, *Bond Rating*. We use an equally weighted average of S&P and Moody's ratings to construct our bond ratings measure. In the case that only a single bond rating from either rating agency is available, we assign the full weight to this rating. To ensure a reasonable match with the issue yield spreads, we require that the distance between a bond's offering date and its rating date does not exceed 90 days, before adding a bond rating to the sample. We then recode the standard rating classifications into numerical values according to the conversion schedule in Panel A of Table A1 (Ashbaugh-Skaife, Collins, and LaFond, 2006), provided in the Appendix. The values that we assign range on a seven-point scale, where one denotes the lowest (CCC⁺-D) and seven the highest (AAA) credit rating category.

Our third dependent variable is the *Issuer Rating*, which reflects the general creditworthiness of a firm in relation to its senior unsecured obligations. We obtain S&P long-term issuer ratings from Compustat for the same period as for the other credit risk measures. After matching the data with the control variables our sample comprises 6,420 issuer ratings that were assigned to 1,094 firms. We follow the same approach as for the bond ratings to recode the Compustat rating classifications into a numerical ranking from one to seven.

4.3. Control Variables

Our credit risk analysis incorporates two sets of control variables, which account for borrower and bond characteristics that previous studies have identified as cross-sectional determinants of credit risk (e.g., Ashbaugh-Skaife et al. , 2006; Bradley, Chen, Dallas, and Snyderwine, 2008; Bhojraj and Sengupta, 2003; Cremers, Nair, and Wei, 2007). Table A2 in the appendix lists the control variables, together with their definitions and predicted credit risk relations.

The first set of control variables comprises bond issuer characteristics, which we collect from Compustat. *Leverage* is the financial leverage of the firm, defined as the ratio of its total liabilities to total assets. *Size* measures firm size, and is defined as the natural logarithm of the firm's total assets. *Capital Intensity* equals the ratio of fixed assets to total assets. *Interest Coverage* is the interest coverage ratio, defined as operating income before depreciation divided by interest expense. *ROA* measures the accounting return on assets, and is defined as

the ratio of net income before extraordinary items to total assets. *Loss* is an indicator variable that equals one if a firm's net income before extraordinary items is negative in the current and prior fiscal year. A recurring negative net income can be an indicator for financial distress.

The second set of control variables accounts for bond issue specific characteristics, which we obtain from Mergent FISD. *TTM* is the time-to-maturity of a bond, measured in years. *Issue Size* equals the size of a bond issue, measured as the natural logarithm of its offering amount. The expected relation between the issue size of a bond and its default risk is ambiguous. Large debt issues are generally associated with higher liquidity, and thus expected to reduce the issue yield spread. However, large debt obligations also imply a higher default probability for the bond issuer, and higher expected absolute loss for the bondholder. *Subordinate* is an indicator variable that equals one if a bond's order of repayment classifies as senior-subordinated.⁸ *Speculative* is an indicator variable that equals one if a bond issue has a speculative credit grade, i.e., its bond rating is below BBB⁻ (S&P) or Baa³ (Moody's). Firms whose credit status is downgraded to speculative grade generally experience a significant markup in their cost of debt financing, due to the reduced liquidity of their debt securities and higher default risk that accompany this downgrade.

We introduce a modified bond rating, *BRmod*, as additional control variable for the cost of debt analysis. *BRmod* is defined as the residual of a bond rating regression on *ENV_{Strengths}* and *ENV_{Concerns}*. This approach follows a procedure that is frequently used in earlier studies on the cost of debt, to place an orthogonality condition on *Bond Rating* with respect to environmental management information (see, e.g., Datta, Iskandar-Datta, and Patel, 1999; Anderson, Mansi, and Reeb, 2003; Klock, Mansi, and Maxwell, 2005; Ortiz-Molina, 2006; Goss and Roberts, 2009; Schneider, 2010). We include the modified bond rating to control for additional credit risk determinants that are missing from our set of control variables, while accounting for the fact that credit rating agencies scrutinize borrowing firms for environmental liabilities (Standard & Poor's, 2008).

4.4. Descriptive Statistics

In Table 2, we summarize the sample distribution of our credit risk measures across industries. The observations are allocated into industry classifications according to the debt issuer's membership in a major SIC division. The majority of observations is concentrated in

⁸ This definition applies for the cost of debt and bond rating analyses. In the issuer rating analysis, *Subordinated* denotes an indicator variable that equals one if a firm has subordinated debt (data80) in its capital structure, and zero otherwise.

the *Manufacturing* division (41-45%),⁹ or *Transportation, Communication, Electric, Gas, and Sanitary Services* division (18-20%).

*** Insert Table #2 about here ***

We present summary statistics on our regression variables in Table 3.¹⁰ The logarithmic variables *ln(Spread)*, *Size*, and *Issue Size* are reported in real values to facilitate interpretation. To ensure that the significance of our results is not driven by extreme outliers, we winsorize all continuous variables at the one percent level.

*** Insert Table #3 about here ***

An inspection of the bond statistics confirms that our sample is economically meaningful and representative. The median *Spread* equals 120 basis points, and shows considerable sample variation with a standard deviation of 105 basis points and a range of 9.42%. The median *Bond Rating* equals BBB⁺/Baa³, and 13% of all bond ratings are rated below investment grade. Only 2% of the bonds classify as debt issues whose seniority is denoted senior-subordinated. The median issue size of the bonds is \$300 million, and their median maturity is ten years. The bond issuer statistics show that the firms in our sample are relatively large and highly levered. Their median *Size* is reported at about \$12.54 billion (total assets), and their median *Leverage* at 69%. However, both measures show considerable variation within the sample. The median *Issuer Rating* for the bond issuing firms is BBB⁺, which is consistent with the presented bond rating statistics.

The data shows no signs of multicollinearity in correlation as well as variance inflation factor (VIF) tests.

⁹ These percentage numbers refer to the bond issue sample and issuer ratings sample, respectively.

¹⁰ The presented summary statistics are based on the bond issue sample. Corresponding summary statistics for our issuer ratings sample are excluded for brevity, but available on request.

5. Empirical Analysis

5.1. Environmental Management and the Cost of Debt

In the first step of our analysis, we regress the cost of debt on our measures of environmental management performance and the two sets of control variables. The general model for the cost of debt financing has the form:

$$\ln(\text{Spread}) = f(\text{ENV}, \text{Issuer Characteristics}, \text{Issue Characteristics}) \quad (1)$$

where *ENV* represents a vector of environmental performance measures that capture the firm's environmental management strengths and concerns (*ENV_{Strengths}*; *ENV_{Concerns}*), while *Issuer Characteristics* and *Issue Characteristics* denote the sets of corresponding control variables. Throughout our analysis, all regression models control for year fixed effects and industry fixed effects (2-digit SIC codes). We estimate the cost of debt model using pooled OLS regressions, and assess the significance of the coefficient estimates using robust standard errors that are clustered at the industry level (2-digit SIC codes). The clustering of errors assumes that observations are independent across industries, but not necessarily independent within industries. Not correcting standard errors for correlation within clusters can result in exaggerated *t*-statistics (Petersen, 2009). Given its minimal assumptions about the correlation structure of the error term, the clustering method is likely to provide the most conservative standard errors.

*** Insert Table #4 about here ***

Table 4 reports multivariate regression results for the cost of debt analysis. Column (1a) summarizes the outcomes for our basic model, which only comprises the sets of control variables. In Column (1b), we present the findings for the general model. Column (1c) contains the results for the most comprehensive model specification, which adds the modified bond rating as a control for additional credit risk determinants. Our confidence in the model's fit is supported by the adjusted R²s, which range between 0.70 and 0.74. Moreover, the control variables have coefficients that are statistically significant in almost all cases, and signs that correspond with their predicted relations across all model specifications.

The regression results support our hypotheses that environmental management is a value relevant determinant of bond prices. The general model reports a negative and statistically

significant factor loading on $ENV_{Strengths}$, and a positive and statistically significant factor loading on $ENV_{Concerns}$. Extending the model with BR_{mod} further increases the statistical significance of both coefficients. Our findings illustrate that borrowers who engage in environmentally risky activities are charged a premium on their cost of debt financing, which substantiates earlier evidence that the credit market is sensitive to environmental liabilities. Furthermore, they show that firms with proactive environmental engagement enjoy a lower cost of debt financing.

To assess the economic significance of our findings, we estimate the expected change in the cost of debt given a one standard deviation change in the environmental performance measures. We calculate that a standard deviation increase in $ENV_{Strengths}$ corresponds with a reduction in the yield spread by 6 basis point, while a standard deviation increase in $ENV_{Concerns}$ is associated with an increase of the yield spread by 5 basis points. We arrive at these estimates by calculating standardized coefficients for $ENV_{Strengths}$ (-0.0487) and $ENV_{concerns}$ (0.0411) based on the most comprehensive model specification. Since the cost of debt is in log-form, a standard deviation change in $ENV_{Strengths}$ or $ENV_{concerns}$ translates into a 4.87% and 4.11% change in *Spread*, respectively. Using the median *Spread* as reference point, we infer our final estimates after rounding. The maximum impact of a combined change in our environmental performance measures on the annual cost of debt is estimated at 64 basis points, or 53% of the \$3.6 million annual median interest expense that is payable in excess of the Treasury benchmark rate.

5.2. Environmental Management and Credit Ratings

We conduct additional tests on the relevance of environmental management for credit risk, by studying the link between our environmental performance measures and credit ratings. Our first set of regressions assesses the link with bond ratings. The general model takes the form:

$$Bond\ Rating = f(ENV, Issuer\ Characteristics, Issue\ Characteristics) \quad (2)$$

where *Bond Rating* is the credit rating assigned to a specific bond issue of a firm, and the control variables are defined almost identically to those in the cost of debt analysis. We exclude *Speculative* and BR_{mod} from the set of issue specific control variables, since their information content derives from the dependent variable. To account for the ordinal nature of the credit ratings, we perform ordered probit regressions on the pooled bond ratings sample to

obtain coefficient estimates and corresponding z-statistics. Panel A of Table 5 reports the regression output for the bond ratings analysis.

*** Insert Table #5 about here ***

The coefficients of the control variables are again mostly statistically significant, and have signs that are consistent with prior studies. The time-to-maturity variable forms the only exception, with a coefficient that contradicts its predicted sign, but although this outcome is unexpected, our study is not the first to observe this relation (see Bhojraj and Sengupta, 2003). More importantly, the results for the environmental performance measures are again consistent with our first two hypotheses: The general model specification produces a positive and statistically significant coefficient for $ENV_{Strengths}$, and a negative and statistically significant coefficient for $ENV_{Concerns}$. Consequently, firms with better environmental management capabilities or activities are more likely to receive a higher bond rating, while firms with more environmental concerns are associated with lower bond ratings.

To corroborate our evidence on the link between environmental management and credit ratings, we study a supplementary sample of long-term issuer ratings. The general model for the issuer ratings takes the form:

$$Issuer\ Rating = f(ENV, Issuer\ Characteristics) \quad (3)$$

The issuer rating analysis only incorporates control variables that capture firm specific characteristics, given that the dependent variable reflects the general creditworthiness of a rated entity, rather than that of a particular bond issue. The *Subordinated* variable is accordingly redefined as an indicator variable that equals one if the firm has subordinated debt in its capital structure, and zero otherwise.

Panel B of Table 5 summarizes the results for the issuer ratings regressions. The coefficients of the control variables have their expected signs and are mostly statistically significant. The coefficients of $ENV_{Strengths}$ and $ENV_{Concerns}$ are generally consistent with the bond rating results, although only the measure for environmental management concerns achieves statistical significance. This finding is indicative that information related to environmental concerns plays a more prominent role for rating agencies when assessing the general creditworthiness of borrowers.

5.3. Analyzing the Effect of Individual Environmental Performance Activities

To enhance our understanding of the link between environmental management and credit risk, we disaggregate both environmental performance measures and regress their underlying factors on the credit risk proxies. Since the environmental activities within each performance measure are partially correlated, we first orthogonalize them with respect to each other to document their separate effects. Table 6 summarizes the regression results for the most comprehensive model specifications. We do not report on the control variables for brevity.

*** Insert Table #6 about here ***

The coefficients on the environmental performance categories generally show their expected sign. Among the tested performance strengths, the categories *Beneficial Products*, *Clean Energy*, and *Other Strength* load statistically significant. For the performance concerns, we document significant coefficients on all categories. However, the categories that are most consistently associated with the different credit risk measures are *Regulatory Problems*, *Substantial Emissions*, and *Climate Change*. The only unexpected outcome is the negative and significant loading on *Recycling* in the issuer ratings regression, which is however not sustained in further tests.

The presented evidence corresponds with the idea that climate change related issues and regulatory concerns are linked to a higher expected default risk of firms. Moreover, our analysis suggests that the better credit standing which we observe for firms with proactive environmental activities is not only linked to a reduction in environmental risk exposure, but also appears to be associated with an improvement in cash flows.

5.4. High-Risk Industries

The credit market is expected to be particularly sensitive to the environmental performance of borrowers in inherently risky industries, because of their higher susceptibility to environmental violations and the associated costs. To test this hypothesis, we extend the credit risk models with two interaction variables that combine our measures of environmental performance with an indicator variable, *HighRisk*, which denotes whether or not a firm operates in an environmentally risky industry. Using SIC codes, we identify 92 firms in the following high risk industries: paper and allied products (2600), chemicals and allied products (2800, 5160, 5161, 5169), petroleum refining (2910, 2911, 2900), primary metal (3300), and

mining (1000, 1200). Our selection is guided by earlier environmental performance studies (e.g., Cormier and Magnan, 1997). Since credit rating agencies account for industry specific risks in their evaluations, we perform the cost of debt regressions with and without the modified bond rating, to control that *BRmod* does not assume part of the predicted effect.

*** Insert Table 7 about here ***

The results in Table 7 do not lend support to the hypothesized relation. The coefficients of the interaction variables are statistically insignificant in nearly all cases, which gives rise to the conclusion that there is no incremental effect of environmental management performance on the credit standing of inherently risky firms.¹¹

An alternative explanation for the observed outcome is provided by earlier studies that point to the presence of considerable heterogeneity among environmentally risky industries (Cormier and Magnan, 1997; Schneider, 2010). Since *HighRisk* fails to take account of this heterogeneity, the interaction terms may inaccurately identify the predicted empirical relations. To test for this possibility, we separately analyze the two high-risk industries with the most available sample observations: the paper and allied products industry (19 firms), and the chemicals and allied products industry (40 firms).¹² We respectively create two new interaction variables that either combine our environmental performance measures with an indicator variable for the paper and allied products industry, *P&A*; or chemicals and allied products industry, *C&A*. The regression results for the paper and allied products industry are reported in Table 8.

*** Insert Table #8 about here ***

In line with the existing evidence (Cormier and Magnan, 1997; Schneider, 2010), we find that the credit market is particular sensitive to the environmental concerns of firms in the paper and allied products industry. The coefficients on the interaction variable $ENV_{Concerns} * P\&A$ are both economically and statistically significant across regression models.

¹¹ An analysis of a more comprehensive set of risky industries produces very similar results. This extended set adds the following sectors to *HighRisk*: printing, publishing, and allied industries (2700); rubber and miscellaneous plastics products (3000); electronic and other electric equipment (3600); miscellaneous manufacturing industries (3900); textile mill products (2200); industrial machinery and equipment (5084); and lumber and wood products – except furniture (2400). We also test our general regression models on the sample subsets, and find that $ENV_{Strengths}$ and $ENV_{Concerns}$ generally load consistent with our main results.

¹² The complementary issuer ratings analysis covers 27 firms in the paper and allied products industry, and 84 firms in the chemicals and allied products industry, respectively.

The cost of debt regressions suggest that credit rating agencies consider industry-specific risks other than but correlated with the factors comprised in $ENV_{Concerns}$, since the respective interaction term only assumes the predicted sign after excluding BR_{mod} . Given that $ENV_{Concerns}$ partially incorporates the same information sources as previous studies, these findings may in themselves not be surprising. Perhaps more interestingly, the coefficients on $ENV_{Strengths} * P\&A$ are in general economically and statistically significant, which implies that activities aimed at reducing environmental risk exposure improve the credit standing of firms in this high-risk industry. The basic environmental performance measures have their predicted signs and remain generally significant.

The regression results for the chemicals and allied products industry are less conclusive.¹³ While the outcomes for the basic environmental performance measures are very similar to those in the preceding analyses, we find no consistent evidence on an incremental effect for chemical firms. Altogether, our findings correspond with earlier conjectures that environmentally risky industries are fairly heterogeneous, and one should exercise care when pooling them for analysis. The outcomes for the tested industries may be explained by the varying degree of homogeneity among firms in both industries. Business operations in the paper and allied products industry are arguably more homogenous than that of firms in the chemicals and allied products industry (Schneider, 2010).

5.4. Change in the Relevance of Environmental Management Over Time

We argue that the relevance of corporate environmental management has increased over the recent years, as a result of the growing climate change concerns and investors' awareness of the associated regulatory risks. To test this hypothesis for bond investors, we split our sample into two periods from 1995-2001 and 2002-2006, and repeat our main analyses for both sub-periods. Our selection is motivated by the distinction between the pre and post dot-com bubble periods. During the boom phase of the IT economy, environmental concerns are expected to have played a subordinated role in financial markets. In contrast, the subsequent period includes or follows shortly after a number of influential climate change initiative and publications that drew considerable attention to the issue.

Table 9 summarizes the credit risk effect of environmental management over time. Panel A reports on regression results for the period from 1995 to 2001, and Panel B on those for the

¹³ The respective regression results are excluded for brevity, but are readily available on request.

period from 2002 to 2006. For brevity, we do not show the coefficients on the control variables.

*** Insert Table #9 about here ***

The results suggest that the relevance of environmental management for credit risk has indeed increased over time, and that this increase is mainly attributable to impact of environmental concerns. Panel A only shows a significant relation for $ENV_{Strengths}$ in the cost of debt regression, which supports the view that the credit market only assigned little value to corporate environmental concerns prior to the dot-com bubble. The subsequent period reports significant factor loadings on $ENV_{Concerns}$ across all credit models, which corresponds with the hypothesis that investors are increasingly concerned about the financial implications of climate change. $ENV_{Strengths}$ continues to only load significantly in the cost of debt regression, although its economical and statistical significance diminish. From 2002 to 2006, a standard deviation increase in $ENV_{Strengths}$ corresponded with a reduction in the yield spread by 5 basis point, whereas a standard deviation increase in $ENV_{Concerns}$ was associated with an increase in the yield spread by 10 basis points.

5.5. Robustness Checks

5.5.1. Aggregate Environmental Management Performance

Our analysis up to this point focuses on environmental management strengths and concerns as separate constructs. This approach differs from most of the earlier studies that rely on data from KLD, and combine both groups of performance indicators to construct aggregate performance measures (see, e.g., Graves and Waddock, 1994; Waddock and Graves, 1997; Johnson and Greening, 1999; Kane et al., 2005; Fisman et al., 2006; Kempf and Osthoff, 2007; and Statman and Glushkov, 2009). To consider this alternative, we calculate a measure for the firm's aggregate environmental performance, ENV_{Total} , by subtracting $ENV_{Concerns}$ from $ENV_{Strengths}$. A higher score on ENV_{Total} suggests that a firm displays a better general environmental performance, and vice versa. We repeat our main analyses using the aggregate performance measure, and summarize the outcomes in Table 10.

*** Insert Table #10 about here ***

The regression results closely align with our earlier findings: ENV_{Total} has a statistically significant coefficient in all credit risk models, and the signs suggest that a better general environmental performance is associated with an enhanced credit standing of the firm.

5.5.2. Ordinary Yield Spreads

We log-transform our measure for the cost of debt financing, $\ln(Spread)$, to account for the considerable skewness in yield spreads. To verify that our results are not sensitive to this adjustment, we repeat our cost of debt analysis using the ordinary yield spread, $Spread$.

*** Insert Table #11 about here ***

Table 11 shows that the regression outcomes are very similar to those for $\ln(Spread)$. The coefficients on the environmental performance measures are statistically significant, and their economic magnitude comparable in size: A one standard deviation change in $ENV_{Strengths}$ corresponds with a 7 basis point reduction in the cost of debt; and a one standard deviation change in $ENV_{Concerns}$ is associated with a 6 basis point increase in the cost of debt.

5.5.3. Marginal Effects Analysis for Credit Ratings

Interpreting the ordered probit coefficients in the credit ratings analyses is unfortunately not straightforward: While the factor loadings enable us to infer the odds of being assigned into a higher (or lower) credit rating category given a change in an independent variable, they do not provide information on how the effect is distributed across the different credit rating categories. More specifically, judging only by the sign of the coefficient, it is not possible to infer whether the signs of the marginal effects are internally consistent. To enhance our understanding of the link between environmental management information and credit ratings, we complement our ordered probit regressions with marginal effects analyses. The marginal effects predict how a change in a variable translates into the probability of observing a particular bond rating outcome, while holding the other explanatory variables fixed at their mean. Table 12 reports results for our bond rating analysis:

*** Insert Table #12 about here ***

The marginal effects show that an increase in *ENV_{Strengths}* significantly decreases the probability of receiving a bond rating of “BBB” or lower, while increasing the probability of being rated “A” or higher. By contrast, an increase in *ENV_{Concerns}* significantly decreases the probability of being rated “A” or higher, and increases the probability of receiving a rating of “BBB” or lower.

Table 13 reports marginal effects for the issuer rating analysis, which are generally consistent with those of the bond ratings. A change in *ENV_{Concerns}* significantly decreases the firm’s probability of receiving a long-term issuer rating of “BBB” or higher, while increasing the probability of being rated “BB” or lower.

*** Insert Table #13 about here ***

Taken as a whole, the marginal effects lend support to our earlier conclusions on the ordered probit regressions. Environmental management performance, and especially corporate activities that increase environmental risks, are significantly and consistently associated with the credit ratings of firms.

5.5.4. Credit Relevance of Environmental Performance Categories in More Recent Years

Our preceding analysis suggests that corporate environmental management has become increasingly relevant for bond investors over the recent years. To identify which environmental activities drive the observed relations in the latter half of our sample period, we analyze their impact on credit risk during the years from 2002 to 2006. Table 14 summarizes the regression results.

*** Insert Table #14 about here ***

The results are consistent with our earlier finding that the economic and statistical significance of environmental concerns has increased for bond investors over recent years, while that for environmental engagement has diminished. The environmental activities that drive the credit risk of firms continue to be the same as in our earlier analysis, although the previously significant *Clean Energy* and *Other Strength* categories only continue to be significant in the cost of debt analysis.

5.5.5. Additional Tests

As an additional robustness check, we test the sensitivity of the main results to the clustering of standard errors at different levels (e.g., firm, year, industry and year), and confirm that our findings are robust to these modifications. Next, environmental performance studies in multi-industry settings generally face the concern that empirical outcomes may be driven by inter-industry differences (e.g., Cormier and Magnan, 1997; Clarkson et al., 2004). We control for such industry effects by including 2-digit SIC code indicator variables into our analysis, while clustering the standard errors of the coefficients accordingly. To account for concerns about the low representation in some of the 2-digit SIC code industries, we repeat our analysis with industry fixed effects based on SIC division level codes. The significance of our findings slightly increases following this adjustment.

6. Conclusion

This paper reports comprehensive evidence that the environmental management of public corporations has credit risk implications for bond investors. The fundamental hypothesis underlying our analysis is that environmental practices affect the solvency of borrowing firms, by determining their exposure to potentially costly legal, reputational, and regulatory risks. We construct aggregate measures for the environmental strengths and concerns of firms, and test their relation with the yield spread of newly issued bonds, bond ratings, and long-term issuer ratings.

Our analysis shows that firms with environmental concerns pay a premium on the cost of debt financing and have lower credit ratings assigned to them. The corporate activities that underlie this relation are mainly related to regulatory and climate change issues. In contrast, firms with a proactive environmental engagement are charged a lower cost of debt, and there is evidence on a weak link to higher credit ratings. Particularly the supply of innovative products and services with environmental benefits, and the firm's efforts to reduce its impact on climate change and air pollution through the use of clean energy, energy efficiency, or its commitment to climate-friendly policies and practices, are associated with lower bond spreads. We find no evidence in support of the view that the stated relations are consistently stronger for firms in high-risk industries. However, our results indicate that environmental management practices have become increasingly relevant to bond investors over the recent decade. These outcomes are robust to controls for numerous credit risk determinants, varying model specifications, and industry membership.

The findings of this study extend earlier research by showing that the credit market does not only respond to the potential misreporting of existing environmental liabilities, but also prices the environmental management of borrowing firms in anticipation of associated losses. We present the first evidence that a proactive environmental engagement of firms is associated with a lower credit risk. However, since this relation is primarily reflected in bond prices, it may indicate that credit rating agencies do not yet fully account for this effect. The results are consistent with the view that the regulatory implications of climate change have sensitized lenders to the downside risk of poor environmental practices. Furthermore, we show that an assessment of past and ongoing corporate environmental activities enhances the accuracy in the pricing of corporate bond issues, by enabling bond investors to evaluate the risk of environmental performance related losses. Our findings contribute to a better understanding of how corporate environmental activities affect the credit standing of firms, and provide risk managers with improved guidance on where to focus their attention.

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Table 1

Measures of Environmental Management Performance

This table lists the performance indicators that we use to construct our measures of environmental management performance. Information on these qualitative indicators is collected from the *Environment* dimension in the KLD STATS database. Panel A reports the performance strength indicators for this dimension, and Panel B reports its performance concern indicators. If a firm displays a related environmental strength or concern, KLD assigns a value of zero or one to the corresponding indicator, where zero denotes “no concern/strength” and one denotes a “concern/strength”. We sum each group of indicators to respectively construct an aggregate measure for the firm’s environmental management strengths, $ENV_{Strengths}$, and concerns, $ENV_{Concerns}$.

Panel A: Performance Strength Indicators, $ENV_{Strengths}$	
<i>Beneficial Products and Services</i>	The company derives substantial revenues from innovative remediation products, environmental services, or products with environmental benefits. (The term “environmental service” excludes services with questionable environmental effects, such as landfills, incinerators, waste-to-energy plants, and deep injection wells.)
<i>Pollution Prevention</i>	The company has notably strong pollution prevention programs including both emissions reductions and toxic-use reduction programs.
<i>Recycling</i>	The company either is a substantial user of recycled materials as raw materials in its manufacturing processes, or a major factor in the recycling industry.
<i>Clean Energy</i>	The company has taken significant measures to reduce its impact on climate change and air pollution through use of renewable energy and clean fuels or through energy efficiency. The company has demonstrated a commitment to promoting climate-friendly policies and practices outside its own operations.
<i>Other Strength</i>	The company has demonstrated a superior commitment to management systems, voluntary programs, or other environmentally proactive activities.
Panel B: Performance Concern Indicators, $ENV_{Concerns}$	
<i>Hazardous Waste</i>	The company’s liabilities for hazardous waste sites exceed \$50 million, or the company has recently paid substantial fines or civil penalties for waste management violations.
<i>Regulatory Problems</i>	The company has recently paid substantial fines or civil penalties for violations of air, water, or other environmental regulations, or it has a pattern of regulatory controversies under the Clean Air Act, Clean Water Act or other major environmental regulations.
<i>Substantial Emissions</i>	The company’s legal emissions of toxic chemicals (as defined by and reported to the EPA) from individual plants into the air and water are among the highest of the companies followed by KLD.
<i>Agricultural Chemicals</i>	The company is a substantial producer of agricultural chemicals, i.e., pesticides or chemical fertilizers.
<i>Climate Change</i>	The company derives substantial revenues from the sale of coal or oil and its derivative fuel products, or the company derives substantial revenues indirectly from the combustion of coal or oil and its derivative fuel products. Such companies include electric utilities, transportation companies with fleets of vehicles, auto and truck manufacturers, and other transportation equipment companies. In 1999, KLD added the climate Change Concern.
<i>Other Concern</i>	The company has been involved in an environmental controversy that is not covered by other KLD ratings.

Table 2
Industry Distribution

This table summarizes the industry distribution of our credit risk samples. The sample observations are allocated to industry classifications according to their membership in a major SIC division.

<i>SIC Division</i>	<i>Cost of Debt</i>	<i>Bond Rating</i>	<i>Issuer Rating</i>
Agriculture, Forestry, Fishing	0.05 %	0.04 %	0.21 %
Mining	3.88 %	4.06 %	5.14 %
Construction	2.34 %	2.25 %	1.44 %
Manufacturing	41.66 %	40.84 %	45.01 %
Transportation, Communication, Electric, Gas, Sanitary services	19.34 %	19.56 %	17.94 %
Wholesale Trade	2.34 %	2.25 %	2.58 %
Retail Trade	7.61 %	7.95 %	7.79 %
Finance, Insurance, Real estate Services	13.03 %	13.86 %	9.74 %
Nonclassifiable establishment	0.19 %	0.22 %	0.48 %
<i># Observations</i>	<i>2,119</i>	<i>2,242</i>	<i>6,447</i>

Table 3
Descriptive Statistics

This table provides summary statistics of the test variables for a sample of 2,242 bond issues over the period from 1995 to 2006. Note that log-transformed variables are reported in real values to facilitate their interpretation (i.e., $\ln(\text{Spread})$, Size , Issue Size). Spread is the issue yield spread expressed in basis points, defined as the difference between a bond issue's offering yield and the yield of its Treasury benchmark. $ENV_{\text{Strengths}}$ and ENV_{Concerns} respectively denote the sum of a firm's environmental management strengths and concerns. ENV_{Total} equals the difference between $ENV_{\text{Strengths}}$ and ENV_{Concerns} , and is a proxy for the firm's aggregate environmental performance. Bond Rating is the issue-specific credit rating, defined as the average S&P and Moody's rating assigned to a particular bond issue. Issuer Rating is the S&P long-term domestic issuer rating. Leverage is defined as the ratio of total liabilities to total assets; Size measures firm size, defined as the natural logarithm of total assets; Capital Intensity is the ratio of fixed assets to total assets; Interest Coverage is a solvency ratio expressed as multiple, defined as operating income before depreciation divided by interest expense; ROA is defined as the ratio of income before extraordinary items to total assets; Loss is an indicator variable that equals 1 if a firm's net income before extraordinary items is negative in the current and prior fiscal year. TTM is the bond issue's time to maturity stated in years; Issue Size is the bond issue's dollar denomination, defined as the natural logarithm of its initially offered par value; Subordinate is an indicator variable that equals 1 if the bond issue is denoted senior-subordinated; Speculative is defined as an indicator variable that equals 1 for bond issues that are assigned a speculative-grade credit rating. All continuous variables are winsorized at the 1st and 99th percentile.

Variable	# Obs.	Mean	Std. Dev.	Median	Min	Max
<i>Environmental Performance</i>						
ENV _{Strengths}	2,242	0.30	0.59	0	0	4
ENV _{Concerns}	2,242	0.67	1.06	0	0	5
ENV _{Total}	2,242	-0.37	1.07	0	-4	4
<i>Credit Risk Measures</i>						
Spread (in bp)	2,119	149.85	104.59	120	3	945
Bond Rating	2,242	4.41	0.93	4	1	7
Issuer Rating	6,420	3.73	1.18	4	1	7
<i>Issuer Specific Controls</i>						
Leverage (%)	2,242	69.38	15.18	68.62	36.08	123.09
Size (in BM\$)	2,242	39.21	93.63	12.54	0.28	979.41
Capital Intensity (%)	2,242	57.64	40.28	53.82	0.06	174.85
Interest Coverage	2,242	9.17	8.99	6.21	-1.51	45.96
ROA (%)	2,242	4.23	4.59	3.64	-21.73	15.76
Loss	2,242	0.03	0.18	0	0	1
<i>Issue Specific Controls</i>						
Subordinated	2,242	0.02	0.15	0	0	1
TTM (in years)	2,242	12.50	11.85	10	0.25	100
Issue Size (in MM\$)	2,242	438.66	399.14	300	10	2,500
Speculative	2,242	0.13	0.34	0	0	1

Table 4
Cost of Debt Regressions

This table shows the effect of environmental management performance on the cost of debt financing. We regress the log-transformed yield spread ($\ln(\text{Spread})$) on measures of environmental management performance ($ENV_{Strengths}$, $ENV_{Concerns}$), and an array of issuer and issue control variables. The general model is extended with a modified bond rating variable (BR_{mod}) that is orthogonal to the environmental performance measures, to account for credit relevant information that is not captured by our control variables but incorporated by credit rating agencies. All models include year and industry fixed effects (2-digit SIC codes), and estimate standard errors that are clustered at the industry level (2-digit SIC codes). Robust t -statistics are reported in parentheses below the coefficients.

	(1a)	(1b)	(1c)
$ENV_{Strengths}$		-0.0387** (-2.06)	-0.0839*** (-4.79)
$ENV_{Concerns}$		0.0491*** (2.91)	0.0388*** (3.04)
BR_{mod}			-0.3259*** (-14.15)
Leverage	0.0040*** (3.25)	0.0038*** (3.14)	0.0031** (2.52)
Size	-0.1327*** (-8.82)	-0.1427*** (-9.30)	-0.0693*** (-3.97)
Capital Intensity	-0.0010** (-2.06)	-0.0011* (-1.83)	-0.0001 (-0.17)
Interest Coverage	-0.0066** (-2.09)	-0.0065** (-2.12)	-0.0025 (-1.12)
ROA	-0.0248*** (-6.20)	-0.0248*** (-6.71)	-0.0159*** (-5.17)
Loss	0.1569*** (3.68)	0.1578*** (3.71)	0.1216* (1.70)
Subordinated	0.1964** (2.53)	0.1974*** (2.64)	0.2008*** (2.89)
TTM	0.0098*** (8.52)	0.0097*** (8.50)	0.0096*** (9.31)
Issue size	0.0220 (0.82)	0.0207 (0.80)	0.0300 (1.07)
Speculative	0.5936*** (13.07)	0.5961*** (13.00)	
<i>Year Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Industry Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Adj. R ²	0.70	0.70	0.74
# Observations	2,119	2,119	2,068

* p<0.1, ** p<0.05, *** p<0.01

Table 5
Credit Ratings Regressions

This table summarizes the effect of environmental management performance on credit ratings. Panel A reports results for ordered probit regressions of equally weighted S&P and Moody's bond ratings (*Bond Rating*) on measures of environmental management performance ($ENV_{Strengths}$, $ENV_{Concerns}$), and an array of issuer and issue specific control variables. Panel B reports results for ordered probit regressions of S&P long-term domestic issuer ratings (*Issuer Rating*) on the same environmental performance measures, and a set of issuer specific control variables. All models include year and industry fixed effects (2-digit SIC codes), and estimate standard errors that are clustered at the industry level (2-digit SIC codes). Robust *t*-statistics are reported in parentheses below the coefficients.

	<i>Panel A: Bond Ratings</i>		<i>Panel B: Issuer Ratings</i>	
	<i>(2a)</i>	<i>(2b)</i>	<i>(3a)</i>	<i>(3b)</i>
$ENV_{Strengths}$		0.1622* (1.93)		0.0745 (1.48)
$ENV_{Concerns}$		-0.1925** (-2.18)		-0.1458** (-2.09)
Leverage	-0.0169 *** (-3.93)	-0.0165*** (-3.90)	-0.0106*** (-3.76)	-0.0104*** (-3.69)
Size	0.5708*** (4.68)	0.6164*** (5.99)	0.5329*** (8.67)	0.5584*** (10.10)
Capital Intensity	0.0067*** (3.21)	0.0069*** (3.19)	0.0041 *** (3.19)	0.0046*** (3.49)
Interest Coverage	0.0321** (2.29)	0.0323** (2.31)	0.0007 (0.59)	0.0006 (0.51)
ROA	0.0739*** (3.88)	0.0746*** (4.23)	0.0565*** (10.65)	0.0567*** (10.83)
Loss	-0.9782*** (-4.14)	-0.9814*** (-4.02)	-0.3809*** (-5.18)	-0.3914*** (-5.40)
Subordinated	-1.2784*** (-4.27)	-1.2924*** (-4.45)	-0.3634*** (-4.27)	-0.3543*** (-4.26)
TTM	0.0061** (1.99)	0.0068** (2.31)		
Issue size	-0.0028 (-0.05)	0.0002 (0.00)		
<i>Year Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Industry Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Pseudo R ²	0.33	0.34	0.23	0.23
# Observations	2,242	2,242	6,420	6,420

* p<0.1, ** p<0.05, *** p<0.01

Table 6

Credit Risk Implications of Environmental Performance Activities

This table summarizes the effect of individual environmental performance factors on credit risk. We decompose our measures of environmental management performance ($ENV_{Strengths}$, $ENV_{Concerns}$), and test the effect of their components on the cost of debt financing and credit ratings. To account for correlation within each of the performance measures, we orthogonalize the environmental activities with respect to each other. The control variables are not reported for brevity. All models control for year and industry fixed effects (2-digit SIC codes), and estimate standard errors that are clustered at the industry level (2-digit SIC code). Robust *t*-statistics are reported in parentheses below the coefficients.

	<i>ln(Spread)</i>	<i>Bond Rating</i>	<i>Issuer Rating</i>
$ENV_{Strengths}$			
Beneficial Products	-0.1900*** (-3.47)	0.0393 (0.15)	0.3550*** (4.08)
Pollution Prevention	0.0023 (0.03)	0.2461 (0.68)	0.1898 (0.85)
Recycling	-0.1257 (-1.45)	-0.0118 (-0.04)	-0.3450* (-1.72)
Clean Energy	-0.0704*** (-2.62)	0.2721** (2.08)	0.1207 (0.42)
Other Strength	-0.1856** (-2.00)	0.2888* (1.88)	-0.1082 (-0.72)
$ENV_{Concerns}$			
Hazardous Waste	0.0197 (0.43)	-0.4161 (-1.37)	-0.3515* (-1.90)
Regulatory Problems	0.1339** (2.15)	-0.5917* (-1.95)	-0.6784*** (-3.11)
Substantial Emissions	0.1478** (2.46)	-0.5933 (-1.59)	-0.4252** (-2.33)
Agricultural Chemicals	0.0794** (2.21)	-0.4475 (-1.34)	0.0022 (0.01)
Climate Change	0.1395*** (2.86)	-0.6838* (-1.73)	-0.5341** (-2.02)
Other Concern	0.1697*** (4.05)	-0.1842 (-0.74)	0.1668 (0.59)
<i>Year Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Industry Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Adj. R ² / Pseudo R ²	0.72	0.35	0.26
# Observations	1,545	1,674	5,291

Table 7

Environmental Performance and Credit Risk: High-Risk Industries

This table reports the effect of environmental management performance on credit risk for firms that operate in industries with intrinsically higher environmental risk. We regress the cost of debt and credit ratings on measures of environmental management performance ($ENV_{Strengths}$, $ENV_{Concerns}$) and respective interaction terms ($ENV_{Strengths} * HighRisk$, $ENV_{Concerns} * HighRisk$), while controlling for issuer and issue specific control variables. *HighRisk* denotes an indicator variable that equals one if a firm operates in the paper and allied products, chemicals and allied products, petroleum refining, primary metal industry, or mining sector; and otherwise zero. All models include year and industry fixed effects (2-digit SIC codes), and estimate standard errors that are clustered at the industry level (2-digit SIC codes). Robust *t*-statistics are reported in parentheses below the coefficients.

	<i>ln(Spread)</i>	<i>ln(Spread)</i>	<i>Bond Rating</i>	<i>Issuer Rating</i>
$ENV_{Strengths}$	-0.0811*** (-4.24)	-0.0297 (-1.11)	0.1289 (1.21)	0.0017 (0.03)
$ENV_{Concerns}$	0.0474*** (3.02)	0.0578*** (2.58)	-0.2026* (-1.72)	-0.1341 (-1.19)
$ENV_{Strengths} * HighRisk$	-0.0144 (-0.38)	-0.0278 (-0.55)	0.1348 (0.96)	0.2074** (2.44)
$ENV_{Concerns} * HighRisk$	-0.0208 (-1.18)	-0.0285 (-0.88)	0.0060 (0.03)	-0.0170 (-0.12)
<i>HighRisk</i>	-0.1971*** (-2.81)	-0.1912* (-1.88)	0.1792 (0.30)	-0.7395 (-1.50)
<i>BRmod</i>	-0.3255*** (-14.04)			
<i>Leverage</i>	0.0030** (2.43)	0.0056*** (3.51)	-0.0163*** (-3.76)	-0.0103*** (-3.67)
<i>Size</i>	-0.0691*** (-3.99)	-0.1767*** (-11.96)	0.6168*** (5.99)	0.5609*** (10.04)
<i>Capital Intensity</i>	-0.0001 (-0.11)	-0.0014** (-2.21)	0.0069*** (3.11)	0.0047*** (3.51)
<i>Interest Coverage</i>	-0.0025 (-1.11)	-0.0078** (-2.42)	0.0323** (2.31)	0.0007 (0.52)
<i>ROA</i>	-0.0161*** (-5.20)	-0.0285*** (-5.67)	0.0750*** (4.30)	0.0567*** (11.09)
<i>Loss</i>	0.1250* (1.72)	0.2957*** (6.63)	-0.9851*** (-4.03)	-0.3863*** (-5.37)
<i>Subordinated</i>	0.2008*** (2.88)	0.4748*** (4.45)	-1.2917*** (-4.44)	-0.3562*** (-4.28)
<i>Issue size</i>	0.0096*** (9.27)	0.0086*** (6.45)	0.0070** (2.34)	
<i>TTM</i>	0.0287 (1.03)	0.0280 (0.99)	0.0016 (0.03)	
<i>Year Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Industry Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Adj. R ² / Pseudo R ²	0.74	0.64	0.34	0.23
# Observations	2,068	2,119	2,242	6,420

* p<0.1, ** p<0.05, *** p<0.01

Table 8

Environmental Performance and Credit Risk: Pulp & Allied Products Industry

This table reports on the effect of environmental management performance on credit risk for firms that operate in the environmental risky paper and allied products sector. We regress the cost of debt and credit ratings on measures of environmental management performance ($ENV_{Strengths}$, $ENV_{Concerns}$) and respective interaction terms ($ENV_{Strengths} * P\&A$, $ENV_{Concerns} * P\&A$), while controlling for issuer and issue specific control variables. $P\&A$ is an indicator variable that equals one if a firm operates in the paper and allied products sector, and otherwise zero. All models control for year fixed effects, and estimate standard errors that are clustered at the industry level (2-digit SIC code). Robust t -statistics are reported in parentheses below the coefficients.

	$\ln(\text{Spread})$	$\ln(\text{Spread})$	Bond Rating	Issuer Rating
$ENV_{Strengths}$	-0.0761*** (-4.64)	-0.0285 (-1.24)	0.1616* (1.76)	0.0709 (1.28)
$ENV_{Concerns}$	0.0421*** (3.31)	0.0437** (2.31)	-0.1522* (-1.70)	-0.1334* (-1.81)
$ENV_{Strengths} * P\&A$	-0.1330*** (-7.37)	-0.1464*** (-5.41)	0.0692 (0.72)	0.1210* (1.82)
$ENV_{Concerns} * P\&A$	-0.0291* (-1.91)	0.0557*** (2.57)	-0.6163*** (-4.74)	-0.2354*** (-2.72)
P&A	-1.0938*** (-15.62)	-1.2937*** (-25.55)	1.0499*** (5.51)	-0.4527** (-2.14)
BRmod	-0.3273*** (-13.96)			
Leverage	0.0031** (2.51)	0.0057*** (3.61)	-0.0168*** (-3.87)	-0.0104*** (-3.69)
Size	-0.0690*** (-3.89)	-0.1777*** (-11.72)	0.6238*** (5.85)	0.5593*** (10.05)
Capital Intensity	-0.0001 (-0.18)	-0.0015** (-2.30)	0.0071*** (3.24)	0.0046*** (3.47)
Interest Coverage	-0.0024 (-1.08)	-0.0078** (-2.42)	0.0327** (2.32)	0.0007 (0.52)
ROA	-0.0162*** (-5.31)	-0.0284*** (-5.66)	0.0731*** (4.16)	0.0566*** (10.84)
Loss	0.1150 (1.64)	0.2889*** (6.68)	-1.0205*** (-4.34)	-0.3901*** (-5.40)
Subordinated	0.2013*** (2.89)	0.4778*** (4.50)	-1.2986*** (-4.45)	-0.3598*** (-4.30)
Issue size	0.0095*** (9.22)	0.0086*** (6.42)	0.0068** (2.28)	
TTM	0.0288 (1.03)	0.0287 (1.02)	-0.0007 (-0.01)	
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Adj. R ² / Pseudo R ²	0.74	0.64	0.34	0.23
# Observations	2,068	2,119	2,242	6,420

* p≤0.1, ** p≤0.05, *** p≤0.01

Table 9**Credit Risk Implications of Environmental Management Over Time**

This table shows the effect of environmental management performance on credit risk over different time periods. We split our sample into two periods: Panel A summarizes regression results for the 1995 to 2001 period. Panel B reports the respective regression results for the period from 2002 to 2006. All regression results are based on the comprehensive model specifications, while we do not report on the control variables for brevity. We control for year and industry fixed effects (2-digit SIC codes), and estimate standard errors that are clustered at the industry level (2-digit SIC code). Robust *t*-statistics are reported in parentheses below the coefficients.

Panel A: 1995 – 2001 Period

	<i>ln(Spread)</i>	<i>Bond Rating</i>	<i>Issuer Rating</i>
ENV _{Strengths}	-0.1266*** (-2.87)	0.2105 (1.28)	0.0571 (0.71)
ENV _{Concerns}	-0.0084 (-0.29)	-0.1479 (-1.42)	-0.0794 (-0.87)
<i>Year Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Industry Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Adj. R ² / Pseudo R ²	0.52	0.33	0.17
#Observations	1,114	1,195	2,323

* p≤0.1, ** p≤0.05, *** p≤0.01

Panel B: 2002 – 2006 Period

	<i>ln(Spread)</i>	<i>Bond Rating</i>	<i>Issuer Rating</i>
ENV _{Strengths}	-0.0251* (-1.70)	0.1480 (0.98)	0.0651 (0.77)
ENV _{Concerns}	0.0852*** (3.99)	-0.2285** (-2.34)	-0.2147*** (-3.86)
<i>Year Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Industry Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Adj. R ² / Pseudo R ²	0.68	0.35	0.26
#Observations	954	1,047	4,097

* p≤0.1, ** p≤0.05, *** p≤0.01

Table 10**Aggregate Environmental Performance and Credit Risk**

This table presents regression results for the effect of firms' aggregate environmental management performance (ENV_{Total}) on measures of their credit risk. We implement pooled OLS regressions for the cost of debt, and ordered probit models for the credit ratings. All models include year and industry fixed effects (2-digit SIC codes). Standard errors are clustered at the industry level (2-digit SIC codes). Robust t -statistics are reported in parentheses below the coefficients.

	$\ln(Spread)$	<i>Bond Rating</i>	<i>Issuer Rating</i>
ENV_{Total}	-0.0459*** (-5.39)	0.1826** (2.55)	0.1239*** (2.85)
BRmod	-0.3257*** (-14.13)		
Leverage	0.0031** (2.52)	-0.0165*** (-3.90)	-0.0104*** (-3.69)
Size	-0.0712*** (-4.02)	0.6112*** (5.79)	0.5485*** (9.10)
Capital Intensity	-0.0002 (-0.23)	0.0068*** (3.20)	0.0044*** (3.44)
Interest Coverage	-0.0025 (-1.10)	0.0323 (2.33)	0.0007 (0.53)
ROA	-0.0159*** (-5.13)	0.0747*** (4.22)	0.0566*** (10.81)
Loss	0.1204* (1.67)	-0.9851*** (-4.03)	-0.3885*** (-5.37)
Subordinated	0.2006*** (2.89)	-1.2932*** (-4.45)	-0.3517*** (-4.17)
TTM	0.0096*** (9.32)	0.0067** (2.29)	
Issue size	0.0302 (1.07)	0.0005 (0.01)	
<i>Year Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Industry Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Adj. R ² / Pseudo R ²	0.74	0.34	0.23
# Observations	2,068	2,242	6,420

*** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$

Table 11

Cost of Debt Regressions – Ordinary Yield Spreads

This table shows the effect of environmental management performance on the cost of debt financing, using ordinary yield spreads (*Spread*). We regress *Spread* on measures of environmental management performance ($ENV_{Strengths}$, $ENV_{Concerns}$, ENV_{Total}), and an array of issuer and issue control variables. The general model is extended with a modified bond rating variable (*BRmod*) that is orthogonal to the environmental performance measures, to account for credit relevant information that is not captured by our control variables but incorporated by credit rating agencies. All models include year and industry fixed effects (2-digit SIC codes), and estimate standard errors that are clustered at the industry level (2-digit SIC codes). Robust *t*-statistics are reported in parentheses below the coefficients.

	<i>Spread</i>			
	<i>(I.b)</i>	<i>(I.c)</i>	<i>(II.b)</i>	<i>(II.c)</i>
$ENV_{Strengths}$	-5.0513 <i>(-1.29)</i>	-11.8094*** <i>(-3.50)</i>		
$ENV_{Concerns}$	8.0024*** <i>(3.03)</i>	5.9395*** <i>(3.04)</i>		
ENV_{Total}			-7.0636*** <i>(-3.79)</i>	-6.6796*** <i>(-4.23)</i>
BRmod		-50.8564*** <i>(-10.33)</i>		-50.8462*** <i>(-10.25)</i>
Leverage	0.6577*** <i>(3.33)</i>	0.6358*** <i>(2.65)</i>	0.6588*** <i>(3.34)</i>	0.6358*** <i>(2.65)</i>
Size	-20.5046*** <i>(-9.05)</i>	-10.6958*** <i>(-3.83)</i>	-20.0081*** <i>(-8.96)</i>	-10.7771*** <i>(-3.66)</i>
Capital Intensity	-0.1402 <i>(-1.20)</i>	-0.0045 <i>(-0.03)</i>	-0.1284 <i>(-1.12)</i>	-0.0063 <i>(-0.04)</i>
Interest Coverage	-0.1644 <i>(-0.42)</i>	0.3796 <i>(0.92)</i>	-0.1727 <i>(-0.44)</i>	0.3807 <i>(0.91)</i>
ROA	-4.4906*** <i>(-6.05)</i>	-3.3897*** <i>(-4.14)</i>	-4.4957*** <i>(-6.08)</i>	-3.3890*** <i>(-4.15)</i>
Loss	56.6136*** <i>(3.76)</i>	58.2921*** <i>(2.82)</i>	56.9658*** <i>(3.76)</i>	58.2429*** <i>(2.80)</i>
Subordinated	84.5209*** <i>(3.52)</i>	96.0295*** <i>(3.88)</i>	84.6533*** <i>(3.50)</i>	96.0194*** <i>(3.88)</i>
TTM	0.9805*** <i>(7.52)</i>	0.9235*** <i>(7.97)</i>	0.9865*** <i>(7.70)</i>	0.9226*** <i>(8.12)</i>
Issue size	1.6182 <i>(0.42)</i>	3.9196 <i>(1.09)</i>	1.5460 <i>(0.39)</i>	3.9300 <i>(1.09)</i>
Speculative	121.6828*** <i>(11.69)</i>		121.6626*** <i>(11.60)</i>	
<i>Year Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Industry Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Adj. R ²	0.62	0.61	0.62	0.61
# Observations	2,148	2,093	2,148	2,093

* p≤0.1, ** p≤0.05, *** p≤0.01

Table 12

Marginal Effects Analysis - Bond Ratings

This tables reports the marginal effects for the bond rating analysis. The marginal effects estimate the probability of a firm being ranked in a particular bond rating category (AAA, AA, AA, BBB, BB, B, or CCC-D) given a change in an explanatory variable, while holding the explanatory variables fixed at their mean. T-statistics are reported in parentheses below the coefficients.

	CCC-D	B	BB	BBB	A	AA	AAA
ENV _{Strengths}	0.0000 (-0.54)	-0.0004 (-1.18)	-0.0106* (-1.87)	-0.0526* (-1.92)	0.0585* (1.94)	0.0050 (1.63)	0.0001 (0.79)
ENV _{Concerns}	0.0000 (0.54)	0.0004 (1.12)	0.0126** (2.00)	0.0625** (2.18)	-0.0695** (-2.20)	-0.0060* (-1.72)	-0.0001 (-0.86)
Leverage	0.0000 (0.63)	0.0000* (1.67)	0.0011*** (3.51)	0.0053*** (3.73)	-0.0059*** (-3.77)	-0.000***5 (-3.22)	0.0000 (-0.94)
Size	0.0000 (-0.66)	-0.0013* (-1.66)	-0.0403*** (-5.40)	-0.2001*** (-5.29)	0.2224*** (5.47)	0.0191*** (4.50)	0.0002 (0.96)
Capital Intensity	0.0000 (-0.60)	0.0000 (-1.43)	-0.0005*** (-3.47)	-0.0023*** (-3.02)	0.0025*** (3.15)	0.0002** (2.57)	0.0000 (1.05)
Interest Coverage	0.0000 (-0.63)	-0.0001* (-1.71)	-0.0021** (-2.47)	-0.0105** (-2.22)	0.0116** (2.25)	0.0010** (2.56)	0.0000 (0.92)
ROA	0.0000 (-0.63)	-0.0002 (-1.37)	-0.0049*** (-3.47)	-0.0242*** (-4.11)	0.0269*** (4.17)	0.0023*** (2.83)	0.0000 (0.91)
Loss ⁺	0.0001 (0.52)	0.0107 (1.12)	0.1366** (2.43)	0.1633*** (7.98)	-0.2983*** (-5.98)	-0.0123*** (-2.97)	-0.0001 (-0.86)
Subordinated ⁺	0.0003 (0.64)	0.0239 (1.17)	0.2151** (2.53)	0.1253** (2.03)	-0.3517*** (-8.06)	-0.0127*** (-3.12)	-0.0001 (-0.85)
Time-to-maturity	0.0000 (-0.55)	0.0000 (-1.15)	-0.0004** (-1.97)	-0.0022** (-2.34)	0.0025** (2.35)	0.0002* (1.65)	0.0000 (0.89)
Issue size	0.0000 (0.00)	0.0000 (0.00)	0.0000 (0.00)	-0.0001 (0.00)	0.0001 (0.00)	0.0000 (0.00)	0.0000 (0.00)

*** p≤0.01, ** p≤0.05, * p≤0.1

⁺ dy/dx is for a discrete change of dummy variable from 0 to 1

Table 13**Marginal Effects Analysis - Issuer Ratings**

This tables reports the marginal effects for the issuer rating analysis. The marginal effects estimate the probability of a firm being ranked in a particular bond rating category (AAA, AA, AA, BBB, BB, B, or CCC-D) given a change in an explanatory variable, while holding the explanatory variables fixed at their mean. T-statistics are reported in parentheses below the coefficients.

	CCC-D	B	BB	BBB	A	AA	AAA
ENV _{Strengths}	0.0000 (-1.31)	-0.0105 (-1.50)	-0.0180 (-1.45)	0.0089 (1.38)	0.0183 (1.52)	0.0013 (1.31)	0.0001 (1.23)
ENV _{Concerns}	0.0001 (1.06)	0.0206* (1.89)	0.0353** (2.18)	-0.0175** (-2.15)	-0.0358** (-2.04)	-0.0025 (-1.63)	-0.0002 (-1.09)
Leverage	0.0000 (1.29)	0.0015*** (3.69)	0.0025*** (3.47)	-0.0012*** (-3.18)	-0.0025*** (-3.75)	-0.0002*** (-2.64)	0.0000 (-1.52)
Size	-0.0004 (-1.31)	-0.0789*** (-8.71)	-0.1352*** (-7.36)	0.0670*** (5.31)	0.1369*** (11.83)	0.0096*** (3.24)	0.0009 (1.45)
Capital Intensity	0.0000 (-1.10)	-0.0006*** (-3.45)	-0.0011*** (-3.31)	0.0005*** (3.19)	0.0011*** (3.43)	0.0001** (2.56)	0.0000 (1.26)
Interest Coverage	0.0000 (-0.53)	-0.0001 (-0.50)	-0.0002 (-0.51)	0.0001 (0.51)	0.0002 (0.51)	0.0000 (0.49)	0.0000 (0.44)
ROA	0.0000 (-1.30)	-0.0080*** (-6.26)	-0.0137*** (-9.93)	0.0068*** (6.60)	0.0139*** (9.82)	0.0010*** (2.94)	0.0001 (1.40)
Loss [†]	0.0005 (1.13)	0.0697*** (4.85)	0.0841*** (5.06)	-0.0669*** (-3.93)	-0.0824*** (-5.97)	-0.0046*** (-3.31)	-0.0004 (-1.34)
Subordinated [†]	0.0004 (1.22)	0.0584*** (3.79)	0.0799*** (4.17)	-0.0545*** (-3.42)	-0.0790*** (-4.39)	-0.0048*** (-3.13)	-0.0004 (-1.47)

*** p≤0.01, ** p≤0.05, * p≤0.1

[†] dy/dx is for a discrete change of dummy variable from 0 to 1

Table 14

Credit Risk Implications of Environmental Performance Activities (2002-2006)

This table summarizes the effect of individual environmental performance factors on credit risk during the 2002-2006 period. We decompose our measures of environmental management performance ($ENV_{Strengths}$, $ENV_{Concerns}$), and test the relation of their components with the cost of debt financing and credit ratings. To account for correlation within each of the performance measures, we orthogonalize the individual environmental activities with respect to each other. The control variables are not reported for brevity. All models control for year and industry fixed effects (2-digit SIC codes), and estimate standard errors that are clustered at the industry level (2-digit SIC code). Robust *t*-statistics are reported in parentheses below the coefficients.

	<i>ln(Spread)</i>	<i>Spread</i>	<i>Bond Rating</i>	<i>Issuer Rating</i>
$ENV_{Strengths}$				
Beneficial Products	-0.0980** (-2.23)	-6.5204 (-0.47)	0.2182 (0.55)	0.4114*** (3.82)
Pollution Prevention	0.0279 (0.32)	10.2347 (0.64)	0.3726 (0.66)	0.2844 (1.12)
Recycling	-0.0485 (-0.47)	-3.0209 (-0.15)	-0.0831 (-0.23)	-0.2507 (-1.13)
Clean Energy	-0.0886** (-2.35)	-18.9682*** (-2.74)	0.1408 (0.67)	0.1358 (0.46)
Other Strength	-0.2292*** (-2.97)	-29.0479** (-2.01)	0.4299 (1.47)	-0.0985 (-0.51)
$ENV_{Concerns}$				
Hazardous Waste	0.0671 (0.99)	9.0009 (0.76)	-0.3009 (-0.83)	-0.4675*** (-2.72)
Regulatory Problems	0.2009*** (2.73)	41.7625*** (3.51)	-0.4808 (-1.09)	-0.8118*** (-3.85)
Substantial Emissions	0.2274*** (2.85)	38.9302*** (2.73)	-0.9263** (-2.07)	-0.5972*** (-3.16)
Agricultural Chemicals	0.0466 (0.80)	-10.5366 (-0.79)	-0.1232 (-0.67)	-0.1982 (-1.05)
Climate Change	0.2332*** (3.09)	56.2877*** (5.99)	-0.7896** (-1.99)	-0.5860** (-2.36)
Other Concern	0.1291*** (2.47)	9.9276 (1.01)	-0.1122 (-0.29)	0.0687 (0.23)
<i>Year Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Industry Fixed Effects</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Adj. R ² / Pseudo R ²	0.74	0.53	0.37	0.28
# Observations	963	984	1,674	5,291

* p≤0.1, ** p≤0.05, *** p≤0.01

Appendix

Table A1

Recoding Credit Rating Classifications

We standardize the bond and issuer rating classifications according to the rating schedule presented in Panel A. We base *Bond Rating* on equally weighted Moody's and S&P bond issue ratings collected from Mergent FISD (Columns 1 and 2), and *Issuer Rating* on S&P's long-term domestic issuer ratings as compiled by Compustat (Column 3). Column 4 lists the S&P and Moody's ratings, which we collapse into seven categories ranging from one (lowest creditworthiness) to seven (highest creditworthiness). This approach follows Ashbaugh-Skaife et al. (2006). Debt to which we assign a rating category of one to three (i.e. below BBB-) constitutes speculative grade debt, and that between four and seven represents investment grade debt. Panel B presents summary statistics of the recoded *Bond Rating* and *Issuer Rating* distributions.

Panel A: Recoding Schedule for Rating Classifications				
<i>Moody's Rating</i>	<i>S&P Rating</i>	<i>Compustat (data280)</i>	<i>Assigned Rating Code</i>	<i>Rating Grade</i>
Aaa	AAA	2	7	Investment
Aa1	AA+	4	6	Investment
Aa2	AA	5	6	Investment
Aa3	AA-	6	6	Investment
A1	A+	7	5	Investment
A2	A	8	5	Investment
A3	A-	9	5	Investment
Baa1	BBB+	10	4	Investment
Baa2	BBB	11	4	Investment
Baa3	BBB-	12	4	Investment
B1	BB+	13	3	Speculative
B2	BB	14	3	Speculative
B3	BB-	15	3	Speculative
B	B+	16	2	Speculative
B2	B	17	2	Speculative
B3	B-	18	2	Speculative
Caa1	CCC+	19	1	Speculative
Caa2	CCC	20	1	Speculative
Caa3	CCC-	21	1	Speculative
Ca	CC	23	1	Speculative
C	D, SD	27, 29	1	Speculative

Panel B: Distributions of Bond and Issuer Ratings		
<i>Assigned Rating Code</i>	<i>Bond Rating</i>	<i>Issuer Rating</i>
7 (AAA)	1.41 %	0.75 %
6 (AA ⁺ to AA ⁻)	8.34 %	16.94 %
5 (A ⁺ to A ⁻)	36.47 %	26.85 %
4 (BBB ⁺ to BBB ⁻)	40.44 %	29.17 %
3 (BB ⁺ to BB ⁻)	10.11 %	21.96 %
2 (B ⁺ to B ⁻)	2.78 %	3.25 %
1 (CCC ⁺ to D)	0.44 %	1.08 %
<i># Observations</i>	2,256	5,568

Table A2
Variable Definitions & Relations

This table describes the variables that we use in our analysis. Column 1 reports the variable categories, names, and data sources. Column 2 lists their predicted relations with the dependent variables, the *Cost of Debt* financing and credit ratings (*Bond Rating*, *Issuer Rating*), respectively. Column 3 provides variable definitions, and Column 4 denotes the data items or categories used within each data source.

Variables	Predicted Sign <i>Cost of Debt / Credit Ratings</i>	Definition	Data Items
<i>Environmental Performance Rating (KLD Stats)</i>			
ENV _{Strengths}	- / +	Sum of environmental performance <i>strengths</i>	'Environment' dimension
ENV _{Concerns}	+ / -	Sum of environmental performance <i>concerns</i>	'Environment' dimension
ENV _{Total}	+ / -	Aggregate environmental performance, i.e., difference between ENV _{Strengths} and ENV _{Concerns} .	'Environment' dimension
<i>Credit Issuer Specific Controls (Compustat North America)</i>			
Leverage	+ / -	Total liabilities / total assets	(data181 / data6) * 100
Size	- / +	Natural logarithm of total assets.	ln(data6)
Capital Intensity	- / +	Gross property, plant & equipment / total assets	(data7 / data6) * 100
Interest Coverage	- / +	Operating income before depreciation / interest expense	data13 / (data15 or data339)
Return on Assets	- / +	Income before extraordinary items / total assets	(data18 / data6) * 100
Loss	+ / -	Equal to one if the net income before extraordinary items is negative in current and prior fiscal year, otherwise zero.	data18
<i>Credit Issue Specific Controls (Mergent FISD)</i>			
TTM	+ / -	Time-to-maturity, the time until expiration of the bond contract.	offering_date ; maturity
Issue Size	?	Natural logarithm of the par value of debt originally issued.	offering_amt
Subordinated	+ / -	Equal to one if the seniority of a bond issue classifies as senior-subordinated, otherwise zero. In the issuer rating analysis, equal to one if the firm has subordinated debt, otherwise zero.	security_level or Compustat data80
Speculative	+ / -	Equal to one if the credit rating of a bond issue is below investment grade (i.e., lower than BBB- or Baa3), otherwise zero.	Rating
BRmod	- /	Bond rating that is orthogonalized with respect to ENV _{Strengths} and ENV _{Concerns} .	Rating