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Corporate Environmental Responsibility and Firm Risk

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Abstract In this study, we examine the relation between corporate environmental responsibility (CER) and risk in U.S. public firms. We develop and test the risk-reduction, resource-constraint, and cross-industry variation hypotheses. Using an extensive U.S. sample during the 1991–2012 period, we find that for U.S. industries as a whole, CER engagement inversely affects firm risk after controlling for various firm characteristics. The result remains robust when we use firm fixed effect or an alternative measure of CER using principal component analysis or downside risk measures. To address the concern of endogeneity bias, we use a system equations approach and dynamic system generalized methods of moment regressions, and continue to find that environmentally responsible firms experience lower risk. These findings support the risk-reduction hypothesis, but not the resource-constraint hypothesis, along with the notion that the top management in U.S. firms is generally risk averse and that their CER engagement facilitates their risk management efforts. Our cross-industry analysis further reveals that the inverse CER-risk association mainly comes from the manufacturing sector, whereas in the service sector, CER tends to increase firm risk.

Keywords Corporate environmental responsibility · Corporate social responsibility · Risk reduction · Resource constraint

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Introduction

Researchers have generally found that corporate environmental responsibility (CER) is becoming an integral part of corporate social responsibility (CSR) (Mitchell et al. 1997; Gibson 2000; Kaler 2002; Crane and Matten 2004). In fact, CER is playing an increasingly important role in the corporate landscape[1] and a growing body of literature examines the reasons why companies engage in CER and how it influences financial performance (Berchicci and King 2007; Etzion 2007; Ambec and Lanoie 2008; Cai and He 2014; Jo et al. 2014). Given this increase in the importance of and emphasis on CER, we hold that examining the CER-firm risk link will shed light on the role that CER plays in firms' risk management decision making, specifically in those decisions that relate to the company's environmental choices.

Risk management can reduce firm risk by alleviating the adverse influence on firms' cash flow from expected financial, social, or environmental crises (Sharfman and

[1] For example, in a recent survey of 766 CEOs conducted by Accenture and United Nations Global Compact (UNGC), 93 % of the CEOs surveyed believe that sustainability will be critical to the future success of their businesses and 91 % report that their companies will use new technologies (e.g., renewable energy or clean technology) to address sustainability issues over the next five years (Accenture and UNGC 2010).

Fernando 2008) and/or by generating moral capital or goodwill that provide "insurance-like" protection to preserve financial performance (Godfrey 2005; Godfrey et al. 2009).[2] Although previous studies examine the empirical association between CSR and firm risk,[3] they neither sharply focus on the CER-firm risk link nor scrutinize the effects of each CER strength and concern, of the CER component, and/or of the cross-industry CER variation on firm risk. Our study aims to fill this void.

In this study, we examine the relation between U.S. firms' CER engagement and firm risk. As a company's environmental choices are a core part of its CSR and the importance of CER is still evolving both for academics and practitioners, we empirically examine whether firms with CER engagement attempt to present themselves in a positive manner to accomplish long-term CSR strategies that can ultimately reduce firm risk (the risk-reduction hypothesis). Another possibility is that firms waste valuable but limited firm resources in questionable environmental investing (the resource-constraint hypothesis). If so, the management of firms investing in environmental issues could use CER activities to build reputations for their own private benefits. Once investors determine the companies' true intentions, they could penalize them in the stock market, which may result in their CER engagement increasing firm risk. In contrast, CER initiatives may not affect firm risk at all. Which of these mutually exclusive explanations is most correct? To empirically verify the relative importance of the above competing stories, we examine the effects of aggregate- and cross-industry CER initiatives on firm risk.

Along with the acceleration of CER issues, the legitimacy of environmental investing has attracted growing attention from academics, practitioners, social and environmental activists, and policy makers. Advocates of CER typically claim that firms invest too little in it (for reviews of the literature, see Derwall et al. 2005; Guenther et al. 2006; Weber et al. 2008). They assert that firms can improve their performance by increasing investment in CER. Critics maintain that firms waste valuable resources through over-investment in CER and can enhance their performance by decreasing such investments (Brammer et al. 2006).[4] Still others claim that corporations are investing the correct amount in CER, that is, not too much and not too little, by adjusting their CER levels to maximize their financial performance (Kim and Statman 2012).

Can a firm investing in various environmental initiatives reduce firm risk by engaging in CER activities, or do investors interpret the CER engagement of those firms as risk-increasing activities? Do firms get "caught in the middle" in terms of CER (Oikonomou et al. 2014), substantiating the claim that simultaneous exhibitions of positive and negative social performance may backfire? Although the empirical CSR literature generally indicates a mild positive relation between CSR and financial performance[5] and a negative relation between CSR and firm risk, whether firms can reduce risk by investing in CER activities remains relatively less explored.

Using various econometric methods, including ordinary least square (OLS), fixed effect regressions, and principal component analysis, in addition to the various firm risk measures of CAPM beta, Fama and French market beta, standard deviation of daily stock returns, and downside risk measures, we empirically find that for all U.S. industries, firm risk is significantly and negatively associated with CER engagement after controlling for firm characteristics. To control for the endogeneity issue, we further use the simultaneous equation approach and dynamic system generalized methods of moment (GMM) following Blundell and Bond (1998) and Wintoki et al. (2012). Our main finding of a negative association between CER engagement and firm risk remains robust. Overall, our aggregate industry results support the risk-reduction hypothesis, but not the resource-constraint explanation. In the cross-industry analysis, we find evidence of risk reduction in the manufacturing sector, especially in large manufacturing industries. In the service sector, however, the resource-constraint effect seems to dominate. Although evidence of the CER-firm performance relation generally remains largely inconclusive (Molina-Azorin et al. 2009; Busch and Hoffmann 2011),[6] our study suggests an additional motive

[2] To examine the relation between the manifestation of CSR and shareholder wealth, Godfrey (2005) argues that good deeds earn chits. Specifically, he establishes the following core assertions: (1) corporate philanthropy can generate positive moral capital among communities and stakeholders, (2) moral capital can provide shareholders with "insurance-like" protection for many of a firm's idiosyncratic intangible assets, and (3) the insurance-like protection contributes to shareholder wealth.

[3] The effect of CSR engagement on firm risk is documented by several studies including McGuire et al. (1988), Feldman et al. (1997), Orlitzky and Benjamin (2001), Husted (2005), Godfrey et al. (2009), Salama et al. (2011), and Oikonomou et al. (2012). In general, they find an inverse association between CSR and firm risk.

[4] Brammer et al. (2006) assert that environmentally responsible companies underperform if their environmental responsibilities are considered. Karnani (2012) argues that in circumstances in which financial performance and social welfare are in direct opposition, an appeal to CSR and/or CER is almost always ineffective because senior managers are unlikely to act voluntarily against shareholder interests.

[5] See the overview studies of the empirical relation between CSR engagement and financial performance (Orlitzky et al.2003; Margolis and Walsh 2003; Allouche and Laroche 2006; Beurden and Gössling 2008; Baron et al. 2011).

[6] We refer to firms' environmental concerns as CER. In their literature review article, Molina-Azorin et al. (2009) report that 21 studies obtain a positive CER-firm performance relation, whereas 11 document either an insignificant or a negative association.

underlying the adoption of environmental programs that has rarely been examined in the finance and managerial literature: managers are influenced by risk considerations in their dealings with environmental issues.

The remainder of this paper is organized as follows. First, we briefly describe the literature on which we base our hypothesis development. We then discuss the sampling and measurement of CER practices and firm risk. Following this discussion, we present the empirical results. In the final sections, we discuss the significance and limitations of this study and state our overall conclusions.

Literature Review and Hypothesis Development

CER vs. CSR vs. Corporate Sustainability (CS)

Previous studies from both academics and practitioners suggest that although CER is a subset of either the CSR or corporate sustainability (CS) fields, the emphasis on CER is still progressing. First, regarding the academic side, Montiel (2008) suggests that the current research shows a shared environmental and social concern for activities addressing environmental responsibility. Similarly, Oikonomou et al. (2012) treat environmental integrity as a specific individual CSR dimension.[7] They, however, neither sharply focus on each component of CER issues nor on the environmental strengths and concerns. Recently, the environmental dimension has been one of the greatest interests in terms of the market's attitude toward CSR (Bird et al. 2007; Wahba 2008). For instance, Klassen and McLaughlin (1996) suggest that improved financial performance is indeed a result of environmental performance. Similarly, Kassinis and Vafeas (2006) and Welford et al. (2007) find the environment to be one of the most important concerns for stakeholders in a company's CSR efforts. Wahba (2008) explores the moderating effect of financial performance on the relationship between CER and institutional investors and concludes that CER has a positive and significant effect on institutional ownership. Another perspective on a corporation's role in environmental management suggests that top management's green commitment is a factor, among others, that influences the formulation of different types of CER practices (Lee and Ball 2003).

The past decade has also seen an exponential increase in studies on CS. Despite the notable increase in scholarly interest in CS, a common definition for it is lacking. Montiel and Delgado-Ceballos (2014) conduct a literature review on CS as studied by management scholars and suggest that the CS field is still evolving, such that a consensus does not yet exist on what CS means to practitioners and academic scholars. It is largely agreed, however, among management scholars that there are three pillars of CS: profit (economic), people (social), and planet (environmental), or the three P's. Numerous quantitative studies have been conducted to analyze the correlation (if any) between economic or financial performance and social performance, fitting well within an anthropocentric paradigm. Most empirical CSR research treats social and economic performance as independent components.

Alternatively, we use an eco-centric paradigm. We argue that the economic, social, and environmental pillars are interconnected within a nested system, and that the economy is part of society, which in turn is part of the larger ecological system. The complex dimensions of sustainability should include an appropriate balance between and among environmental, social, and economic challenges. The underlying thread in the literature on CER strategy is that through a complex web of constituents, be they customers, shareholders, investors, employees, environmental activists, or other stakeholders, environmentalism is transformed from something external to the market environment to a core objective of the firm. Bansal (2005) similarly argues that because environmental, social, and economic responsibilities are complementary, the three elements must be integrated to achieve perfection. For this task, we hypothesize and test a direct CER-firm risk connection, adding to the abundant evidence on the CSR-firm risk association.

Next, with respect to practitioners and emphasizing consumers, the Shelton Group's 2013 Eco Pulse study reveals that CER is slightly more appealing than CSR. Twelve percent of Americans say a company's environmental reputation significantly influences their decision whether to buy its products. However, only 8 % list "maintain high CSR standards" as one of the three most important things companies should be doing to positively affect purchase decisions. In the business-to-business world, the Shelton Group's just-released Pulse study presents different results. Only 5 % of business decision-makers say a strong CER track record is very important in making product selection decisions, whereas 9 % say a strong CSR track record is very important (Shelton 2014). The main point is that the window remains wide open for

[7] Our study differs from Oikonomou et al. (2012) in several aspects. The first difference is that we take an extensive sample of all U.S. public firms, whereas their study focuses on S&P500 index components. We include all KLD firms to insure a wider spectrum of environmental strengths and concerns. The second difference is in model selection. Their variable of interest is CSR, whereas our variable of interest is CER. They choose a multivariate model to simultaneously embrace five different CSR dimensions, whereas we sharply focus exclusively on the environmental responsibility. Due to these major differences and other findings, our results of the CER-firm risk relationship provide additional evidence and contributions beyond Oikonomou et al. (2012).

the firm to define commitment to sustainability in a way that truly fits with the DNA of the firm's brand and market. Firms should do the homework first to understand what the market's concerns are or they risk missing launching a sustainability/responsibility communications strategy that does not resonate with their core audience.

An alternative view is to treat CSR and CER as two parallel dimensions of CS. Specifically, according to Montiel and Delgado-Ceballos (2014), management research is socially rather than environmentally focused. Appendix 1 is a reproduction of Fig. 2 in their article. It shows the number of articles published by type of journal on CSR and CER from 1995 to 2013. Appendix A suggests that in both academic management journals and specialized journals, twice as much research is published on social issues than on environmental issues. In practitioner-oriented journals, it is about the same. Although less academic interest is observed in studying environmental issues, we suggest that it is of equal importance that corporate managers identify the implications of active environmental management.

Here, we focus exclusively on the environmental management strengths and concerns, regarding the relationship between firm activities and the natural environment, and carefully examine whether proactive environmental management facilitates risk management. The literature supports the risk-reduction effect of CSR (e.g., Jo and Na 2012). However, the implication of a CSR-risk connection should not be extended directly to the CER-risk nexus, given the very distinctive interests of social and environment dimensions and the growing importance of CER.[8]

Hypothesis Development

As we previously discussed, CER is an important subset of CSR. Thus, we begin by reviewing the CSR-risk literature and to connect CER with the risks sustained by entire U.S. industries. Numerous scholars assert that CSR is beneficial not only to society, but also to firms themselves (Carroll 1998; Porter and Kramer 2002). The benefits of CSR engagement may come from various sources, including increases in shareholder wealth through insurance-like protection, improved risk management, market appeal to customers by strategic approach, improved transparency, and easier access to the financial market. Some, if not all, of these factors may also lead to a reduced risk for firms investing in environmental issues.

[8] To illustrate, we borrow from Montiel and Delgado-Ceballos (2014) to summarize the different items used to measure the social versus environmental dimensions in the literature and secondary resources. The summary is included in Appendix 2.

First, Godfrey (2005) argues that moral capital can provide shareholders with "insurance-like" protection for a firm's relationship-based intangible assets. Godfrey et al. (2009) further examine the essential portions of the 'insurance-like' protection of CSR activities. They extend the risk management model by theorizing that some types of CSR activities are more likely to create goodwill and offer insurance-like protection than other types. Using an event study, they empirically show that participation in institutional CSR activities—those aimed at a firm's stakeholders and/or society at large—provides an "insurance-like" benefit. To the extent that CER initiatives create goodwill and provide the insurance-like protection established by Godfrey (2005) and Godfrey et al. (2009), a firm's CER engagement can reduce firm risk.

Second, there is a view that moral managers use CSR as a way to improve information transparency, strategies, and philanthropy, and to eventually reduce firm risk (Jensen and Meckling 1976). Wood (1991) maintains that the principle of managerial discretion recognizes managers as moral actors who are obliged to exercise their actions toward socially responsible outcomes. Moral managers can also take CSR engagement as a strategic investment (Porter and Kramer 2006, 2011; Cai et al. 2012). To the extent that firms with CER engagement are more likely to disclose their CER activities (similar to the CSR study of Dhaliwal et al. 2011), firms investing in CER activities consequently become more transparent. Accordingly, higher levels of transparency reduce the informational asymmetries between the firms and investors, thus mitigating the perceived firm risk.

Third, there is a view that CSR engagement makes financial constraints less serious and provides easier access to financial markets. Cheng et al. (2014) argue that firms with better CSR performance face lower capital constraints. They attribute this negative relation between CSR performance and capital constraints to improved stakeholder engagement (Choi and Wang 2009; Jo and Harjoto 2011, 2012) that increases mutual trust and cooperation while reducing potential agency costs by pushing managers to adopt a long-term rather than a short-term orientation. If CER engagement also eases financial constraints (thus far uninvestigated) and reduces conflicts of interest between managers and environmental activists, then CER investing may also reduce firm risk. Similarly, Sharfman and Fernando (2008) specifically focus on environmental risk management and suggest that improved environmental risk management is negatively related to cost of capital. Their findings suggest that firms benefit from improved environmental risk management through a reduction in their cost of equity capital. Several other recent studies also find that CSR engagement can lower firms' cost of equity capital (e.g., Chava 2010; El Ghoul et al. 2011; Dhaliwal et al. 2011) and cost of debt (e.g., Chava 2011; Goss and

Roberts 2011). As the reduced cost of capital may be the outcome of reduced risk, these findings may help to build better theory regarding the outcomes of strategic environmental improvements in risk management.

In short, managers' choice of CER initiatives can reduce firm risk by providing insurance-like protection, providing market appeal to customers by improving information transparency, and/or by providing easier access to financial markets. In summary, we expect the following:

Hypothesis 1 Under the risk-reduction hypothesis, there is a negative association between CER engagement and firm risk.

Clearly, an alternative scenario could be that both the public and consumers see firms' efforts in investing in CER initiatives as a waste of valuable but limited firm resources, and their efforts ultimately fall flat or backfire. Does it really pay to be good or does the pursuit of CER entail financial detriment? Barnett and Salomom (2006) maintain that if a mutual fund implements strict CSR criteria that exclude firms, industries, or sectors from its portfolio, then that mutual fund may be unable to adequately diversify. Without sufficient diversification, the fund is exposed to additional risk for a given level of return and, by definition, incurs additional risk and a loss in risk-adjusted financial returns. Barnett and Salomom (2012) further readdress the long-standing debate over the relationship between CSR and corporate financial performance (CFP). For decades, scholars have sought to determine whether CSR and CFP are positively or negatively associated. Milton Friedman is the traditional straw man in the CSR-CFP literature. Friedman (1970) sees CSR as an agency problem in which managers misallocate shareholder wealth to pursue a social mission of their choice. He argues that firms ought to do no more than abide by the letter of the law, lest the additional costs associated with social spending place firms at a competitive disadvantage. To the extent that CER is an important subset of CSR and the additional risk negatively affects CFP, managers' pursuit of their desired environmental missions degrade firms' ability to maximize shareholder wealth. Therefore, the CER-firm risk nexus could be positively associated.[9]

Alternatively, firms may get "caught in the middle" in terms of CSR (Oikonomou et al. 2014), which may substantiate the claim that simultaneous exhibitions of positive and negative social performance may backfire. Oikonomou et al. (2014) suggest that "it is commonplace for firms to exhibit both positive and negative indicators of CSR: say, a firm makes sizable donations to wildlife charities but is also associated with environmental degradation. In such cases, stakeholders must weigh good against bad in order to form a judgment of whether the firm is socially responsible, which raises the question: How do stakeholders judge CSR in light of such a mixed picture, and condition their behavior accordingly? More specifically, does the good offset the bad, or is misconduct viewed as diagnostic of irresponsibility? Are negative indicators more dimly viewed if accompanied by evidence that the company has otherwise simultaneously sought to demonstrate, erroneously and cynically it may now seem, some creditable degree of CSR?"

Some firms in controversial industries, i.e., alcohol, tobacco, and gambling, use CER neither as a long-term strategy to adapt their core business nor as a continuous effort to reduce their negative effect and unfavorable public perception. Thus, the attempts of firms damaging the environment to counter their sinfulness through CER activities may backfire because the public and consumers see the action as a waste of valuable resources. We label this alternative argument the "resource-constraint" hypothesis. If it is valid, we predict that investors who eventually realize certain firms' true intentions of resource waste will penalize those companies in the stock market, such that CER engagement increases firm risk.[10]

Hypothesis 2 Under the resource-constraint hypothesis, there is a positive association between CER engagement and firm risk.

The null hypothesis predicts no relation between CER investing and firm risk. The underlying rationale for this conjecture is that as CER investing activities are relatively easy for investors to understand and analyze, the analysis should be reflected immediately in the current stock price, such that no relationship is observed between the CER investing and firm risk. Which of our mutually exclusive hypotheses is correct? Because which hypothesis has greater validity is an open empirical question, we examine the effect of CER engagement on firm risk using empirical data observations in the following sections.

Thus far, we have pondered the relation between CER and firm risk for entire industries. Next, we consider the potential

[9] Despite his terse dismissal of CSR as "hypocritical window-dressing," Friedman (1970) does nonetheless acknowledge that a firm's investment in CSR could "make it easier to attract desirable employees … may reduce the wage bill or lessen losses from pilferage and sabotage or have other worthwhile effects." In noting that CSR can generate valuable goodwill for firms, he thus provides a basis for the counter-argument of stakeholder theorists that CSR and CFP are positively related.

[10] Alternatively, to comply with the increasingly rigorous environmental laws and regulations, firms should expand CER investments to improve environmental management and performance, shrinking firm profitability. For instance, firms should use costly environmental technologies and/or equipment to prevent and control pollution. This additional and costly CER investment may not bring returns in the short term, or even in the long term, and therefore may increase firm risk. Unfortunately, the KLD Stats database does not provide the absolute dollar amount of CER investment. Thus, it is difficult to directly examine the validity of the CER-cost argument.

cross-industry variation in the CER-firm risk nexus. Although there is a comparative dearth of academic work on the cross-industry variation in the CER-firm risk link, there is some literature on the cross-industry analysis of the CSR-firm performance association, from which we can indirectly gain accumulated wisdom. In particular, Baron et al. (2011) disaggregate the industries and indicate that CFP is positively correlated with CSR for firms in consumer markets and negatively correlated for those in industrial markets. They suggest that in consumer markets, CSR increases in CFP, whereas CSR decreases in CFP in industrial markets. Servaes and Tamayo (2013) suggest that CSR and firm value are positively related for firms with high customer awareness, as proxied by advertising expenditures, whereas for firms with low customer awareness, the relation is either negative or insignificant. In addition, they find that the effect of awareness on the value-CSR relation is reversed for firms with a poor prior reputation as corporate citizens. This evidence is consistent with the view that CSR activities can add value to the firm, but only under certain conditions. Salama et al. (2011) examine the relationship between corporate community and environmental responsibility (CCER) and firm risk in the British context and show that a company's CCER is inversely related to its systematic financial risk. They suggest that future investigations look at individual industries, speculating that the CCER–risk relationship may be much stronger for oil companies than retailers, for example.

Given the lack of previous academic studies on the CER-firm risk link across industries, however, we speculate that CER initiatives and policies help reduce firm risk for manufacturing industries that damage the environment. We also consider that CER initiatives and policies may backfire and increase firm risk in pure service industries that do not harm the environment, as CER initiatives are costly and take time to implement. For the remaining industries other than manufacturing or services, we consider the CER-risk association to be irrelevant. We label this the "cross-industry variation" hypothesis.

Hypothesis 3 Under the cross-industry variation hypothesis, there is (a) a negative CER-firm risk association for manufacturing industry firms; (b) a positive CER-firm risk association for service industry firms; and (c) an insignificant CER-firm risk association for other industries categorized as neither manufacturing related nor service related.

Data and Measurement

Data

We take a sample from the Kinder, Lydenberg, and Domini Stats database (KLD) from 1991 to 2012 to measure the CER. During this period, the KLD evaluates each firm annually in seven major CSR categories, community relations, corporate governance, diversity, employee relations, environment, human rights, and products.[11] In each CSR category, a company is assigned a rating indicator (zero or one) for a possible "strength" (positive CSR characteristic) it possesses, or a possible "concern" (negative CSR characteristic) in which it could engage.[12] Altogether (i.e., over all seven CSR categories), the KLD lists approximately 80 "strength" and "concern" indicators. Before 2001, the KLD covered about 650 firms in the S&P 500 index or the Domini 400 social index. In 2001, the KLD sample expanded to include around 1,100 firms in the S&P 500 index, the Domini 400 social index, or the Russell 1,000 (and Russell 2,000) indices. In 2002, the KLD sample expanded again to around 3,100 firms. The KLD reports are issued on December 31 of each year.

In Appendix 3, we explain in detail how in its environmental category, the KLD rates a company on 10 "strength" dimensions and 11 "concern" dimensions. The environmental "strengths" are the firm's initiatives that benefit the environment, whereas the environmental "concerns" are the firm's activities that harm the environment. The KLD environmental strength ratings are based on whether the firm provides environmentally "beneficial products and services," has strong "pollution prevention" programs, relies on "recycling" for its raw materials, uses "clean energy" sources, etc. The KLD's environmental concern ratings are based on whether the firm has "hazardous waste" liabilities, has "regulatory problems" related to fines or civil penalties paid for violating environmental laws, produces "ozone-depleting chemicals," has "substantial emissions" of toxic chemicals, produces "agricultural chemicals" such as pesticides or chemical fertilizers, derives substantial revenue from selling or using fuels that contribute to "climate change," etc.

The dataset from the KLD database is merged with the Compustat and Center for Research in Security Prices (CRSP) databases for the financial information, stock prices, and volatilities. After matching across all three databases and accounting for lags and changes in CER and financial variables, the combined dataset consists of 23,000 firm-year observations from 1991 to 2012 (see Table 2).[13]

[11] The KLD also has exclusionary screens, such as alcohol, gambling, military, nuclear power, and tobacco, which differ from the inclusive screens in that only concern ratings, no strength ratings, are assigned. We only make use of the inclusive screens in our tests. In some CER studies (Cai and He 2014), "nuclear power" is also included because radioactive waste is harmful to the environment.

[12] The KLD conducts its annual evaluation based on various sources, such as surveys, financial reports, mainstream media, government documents, etc.

[13] The KLD compiles information on CSR beginning in 1991. The initial sample size of the KLD is 38,058 firm-year observations during the 1991–2012 period. After matching the KLD data with the

The actual samples used in the regression analyses are slightly different, as the data availability of the variables varies across different regression models.

Measurement

For the robustness of our findings, we use two independent measures of CER and three independent measures of firm risk as the main variables in testing. We also use a battery of control variables in different models to isolate the relationship between CER and firm risk from other factors. The definitions and constructions of all of the variables are explained in detail in Table 1.

CER Measures

We use the KLD data to construct our measure of environmental responsibility. The KLD data have been extensively used in the literature to measure CSR. Although other CSR studies focus on all or most of the categories covered by the KLD, we focus on a single CSR category—the environment—and exclusively use the ratings in this category to measure CER. Following Cai et al. (2012), we use the net environmental strength (ENV_NET) as an environmental measure. ENV_NET is simply calculated as the number of environmental strengths minus the number of environmental concerns.

The simple measure of ENV_NET suffers from the drawback of incomparability, as the numbers of the KLD environmental strength and concern indicators vary considerably each year. To address this concern, we apply a second measure of CER. We construct an aggregate environmental index (ENV_IDX) of a firm by aggregating its ratings in the KLD environmental category, in a similar way as that used by Jo and Harjoto (2011, 2012) to calculate the aggregate CSR index. Specifically, we measure CER by scaling the individual firm strength and concern scores by the total number of strength and concerns in each year. Letting EN^{ijt} be the indicator variable of environment for firm i for strength j in year t, letting EN^{ikt} be the indicator variable of environment for firm i for concern k in year t, and letting EN^{jt} (EN^{kt}) be the total number of KLD environmental strengths (concerns) in year t, the environmental index EN^{it} of firm i in year t is

$$EN^{it} = \frac{\sum_j EN^{ijt} - \sum_k EN^{ikt}}{EN^{jt} + EN^{kt}}. \quad (1)$$

In short, our environmental index (ENV_IDX) is the ratio of the net environmental strengths (numerator), divided by the sum of the numbers of environmental strengths and concerns (denominator).

Firm Risk Measures

To ensure that our test results are not sensitive to the choice of risk measures, we measure the firm risk by both market risk and total risk. Modern portfolio theory states that only systematic risk matters in asset pricing, whereas idiosyncratic risk, which can be diversified away, is not priced (Markowitz 1952). Building on the work of Markowitz, asset pricing models have been developed in finance to determine a theoretically appropriate required rate of return on an asset. The most notable of these is the capital asset pricing model (CAPM) introduced by Sharpe (1964), Lintner (1965), and Mossin (1966). Following this tradition, we first use CAPM beta to measure firm risk.[14]

Second, observing that value and small cap stocks outperform markets on a regular basis, Fama and French (1992, 1996) develop a three-factor model that expands on the CAPM by adding size and value factors.[15] The three-factor model has replaced CAPM as the most widely accepted explanation of stock prices in aggregate and investor returns, and is applied extensively in both academia and practice for understanding portfolio performance, measuring the effect of active management, portfolio construction, and estimating future returns. Considering its popularity and influence, we use Fama–French market factor beta as a second measure of firm risk. We use a four-factor extension (Carhart 1997) of the Fama–French three-factor model that includes a momentum factor. Momentum in a stock is described as the tendency for the stock price to continue rising if it is going up and to continue declining if it is going down. We control for risk with the four Carhart (1997) risk premium factors and analyze the excess return using the following regression model:

Footnote 13 continued
Compustat database, we obtain a combined sample of 31,033 firm-year observations. The first six characters of CUSIP (including leading zeroes) identify the issuer and the last two identify the issue itself. The CUSIP identifier may change for a security if its name or capital structure changes. We use the 6-digit issuer number to merge COMPUSTAT and CRSP. After matching across all three databases, the size of the combined sample is approximately 25,800 firm-year observations from 1991 to 2012. When we take the lagged variables, our final sample is reduced to 23,000 firm-year observations.

[14] CAPM beta measures a firm's systematic risk relative to the risk of the stock market in general, i.e., the market portfolio.

[15] CAPM uses only one variable to describe the returns of a portfolio or stock with the returns of the market as a whole. In contrast, the Fama–French model uses three variables. Fama and French start with the observation that two classes of stocks tend to do better than the market as a whole, (i) small caps and (ii) stocks with a high book-to-market ratio (customarily called value stocks, contrasted with growth stocks). They then add two factors to CAPM to reflect a portfolio's exposure to these two classes.

Table 1 Variable description

Variables	Definitions
CAPM_BETA	CAPM Beta of individual stocks in current year, based on daily stock returns. (*Source: CRSP*)
FF4_MKT_BETA	Fama and French four-factor Model market beta of individual stocks in current year, based on daily stock returns. (*Source: CRSP*)
DEVRET	Standard deviation of daily stock returns for current year. (*source: CRSP*)
E_BETA	Following Estrada (2002) to define the downside beta-risk (E_beta), where R_i (R_m) is security i's (the market's) excess return, and $\mu_i(\mu_m)$ is security's average excess return(average market excess return). (*Source: CRSP*) $\beta_{im}^{D} = \frac{E[\min(R_i-\mu_i,0)\min(R_m-\mu_m,0)]}{E[\min(R_m-\mu_m,0)]^2}$
SLPM	Second-order lower partial moment defined by negative deviations of the returns realized in relation (R_{it}) to the average return(μ_i).(*Source: CRSP*)
ENV_IDX	(Sum of all environment strength items for firm i at year t minus the sum of all environment concern items for firm i at year t) divided by (total maximum possible number of environment strength items during year plus total maximum possible number of environment concern items at year t) (*source: KLD*)
ENV_NET	Net score of KLD ratings in the environmental category, measured as the number of strengths minus the number of concerns (*source: KLD*)
ENV_PCA	Equals first principal component of environment strengths minus first principal component of environment concern items.(*source: KLD*)
ENV_STR	The number of environment strengths (*source: KLD*)
ENV_CON	The number of environment concerns (*source: KLD*)
Firm control variables	
LOGTA	Log of total asset (*source: COMPUSTAT*)
MBR	Measured by market value of equity divided by book value of equity (*source: COMPUSTAT*)
CAPEXA	Capital expenditure expense divided by total assets (*source: COMPUSTAT*)
SALEG	Sales growth rate from t-1 to t (*source: COMPUSTAT*)
DEBTR	Long-term debt divided by total asset (*source: COMPUSTAT*)
ROA	Operating income after depreciation divided by total assets (*source: COMPUSTAT*)
CHG_ROA	Change in ROA in current year (*source: COMPUSTAT*)
RNDR	R&D expense divided by total sales (*source: COMPUSTAT*)
ADVR	Advertising expense divided by total sales (*source: COMPUSTAT*)
GOV	Net score of KLD ratings in the governance category, measured as the number of strengths minus the number of concerns. (*source: KLD*)
MNCs	Dummy variable of one if the firm is a multinational corporations (Using Compustat's IDBFLAG variable to identify the multinational corporations) and zero otherwise (*source: COMPUSTAT*)

This table gives the definition and description of each variable used in the analysis. The top panel lists the main variables of interest, including 5 measures of firm risk, e.g., CAPM beta, Fama–French market factor beta, volatility, Downside beta and Second-order lower partial moment, and 3 measures of corporate environmental responsibility, e.g., the aggregate environmental index, the net environmental strength, and the net first principle component of environmental strength. All control variables are listed in the bottom panel

$$R_{it} - R_{ft} = \alpha + \beta MKTRF_t + \beta_{HML} HML_t + \beta_{SMB} SMB_t + \beta_{MOM} MOM_t + \varepsilon_{it}, \quad (2)$$

where R_{it} is the return on stock i in month t, R_{ft} is the risk-free rate of return taken from the Wharton Research Data Services (WRDS). Fama and French factors, α is an interpretation that captures the excess return (or abnormal risk-adjusted return), and $MKTRF_t$, HML_t, SMB_t, and MOM_t are the returns on the market, value, size, and momentum factors obtained from WRDS, respectively.

An increasing number of recent studies provides evidence against classic asset pricing theory and suggests that idiosyncratic risk matters (e.g., Goyal and Santa-Clara 2003; Fu 2009). In this sense, total risk should be a better measure of firm risk than beta. Total risk is composed of both market risk and firm-specific idiosyncratic risk. The total risk of an investment is typically measured by the variance or, more commonly, the standard deviation of its daily return (Ross et al. 2011). Thus, in addition to the CAPM beta and the Fama–French market factor beta, we measure firm risk by its stock volatility as our third risk measure.

We estimate risk measures using daily returns over a 12-month horizon. First, using daily stock returns we gain a sufficiently large number of observations to obtain more accurate estimates. Second, market risk is time varying, as

Fama and French (1997), Lewellen and Nagel (2006), and Ang and Chen (2007) all note. Thus, betas over a long horizon can be noisy, prompting Ang et al. (2006) and Fama and French (2006) to advocate estimating betas using an annual horizon. As a robustness check, we also estimate risk using monthly returns over a longer horizon (i.e., 24 or 36 months). The results (unreported) remain qualitatively the same.[16]

Other Control Variables

To further control firm characteristics in our CER-risk relation, we follow previous CSR-risk (Jo and Na 2012) and CSR studies (Jo and Harjoto 2011, 2012; Servaes and Tamayo 2013; Harjoto and Jo 2014) to add a list of control variables to our model. The control variables include firm size either by total assets (LOGTA) or by market value of equity (MVE), growth opportunities by market-to-book value of equity (MBR), investment opportunities by capital expenditure expense divided by total assets (CAPEXP), research and development (R&D) expenses divided by total sales (RNDR) and advertising expenses divided by total sales (ADVR) following Servaes and Tamayo (2013), sales growth (SALEG), firm profitability measured by return on assets (ROA) and the change in ROA following Jo and Kim (2007) and Jo et al. (2007), and debt structure by long-term debt divided by total assets (DEBTR). In addition, we control for the effect of corporate governance using the net score of KLD ratings in the governance category (GOV).[17] We control for the effect of multinational corporations (MNCs), because MNCs tend to be more diversified and decentralized and thus are exposed to higher risk. We include an MNC dummy of one if the firm has a Compustat IDBFLAG variable of foreign sales, and zero otherwise.

Empirical Results

Descriptive Statistics and Univariate Results

We first present an overview of our sample. There are 23,000 firm-year observations during the 1991–2012 period. The number of firms increases from only a few hundred at the beginning to over 3000 by the end of our sample period due to the expanding coverage of the KLD database.

Table 2 provides some descriptive statistics for the variables used in our analyses. All of the continuous variables are winsorized at the 1st and 99th percentiles. As this table shows, the average of total risk measure, DEVRET, for our sample is 0.4428 and the median volatility is 0.3928. In terms of market risk, the mean (median) CAPM beta is 1.1808 (1.1353) with a standard deviation of 0.5016. Our alternative measure of market risk, the Fama–French market factor beta, has a slightly lower value of 1.0626 (1.0383) for the mean (median). In our tests, we use three measures for CER. Net environmental strength, ENV_NET, is negative on average and ranges from −5 to 5. The negative average indicates that firms have more environmental concerns than strengths on average. The other two CER measures, ENV_IDX and ENV_PCA, also have negative means and range from negative to positive. In addition to a wide range, standard deviation is also high for all three CER measures, suggesting that our sample consists of a wide cross section of firms across the CER spectrum. Moving on to control variables, the mean log size and market-to-book ratio of our sample firms are 7.2532 and 3.1802, respectively. The average (median) ROA is 0.1110 (0.1168), suggesting that the firms in our sample are profitable. Of the firms in our sample, 7.47 % are multinational corporations. The mean KLD governance score is −0.2426, indicating that on average the firms have more KLD concerns than strengths under corporate governance. To proxy for firm size, we use either the log book value, LOG_TA, or the log market value, LOG_MVE. We adjust the book value to account for the difference in time.[18] The statistics of all of the other control variables are also reported in Table 2, with each variable defined in Table 1.

To explore CER's potential effect on firm risk, we first conduct simple regressions to regress risk on the lagged CER variable. The results are included in Table 3. We find that CER relates to risk inversely and significantly across the various specifications in Table 3, suggesting that a corporation with greater environmental responsibility tends to have lower risk in its stock price. Overall, Table 3 provides evidence for a negative association between CER and risk. However, these results are tempered by the systematic differences that exist in a list of other firm characteristics between low- and high-risk firms. Thus, the results from our simple regressions are to be interpreted with caution. Considering that firm risk is significantly affected by its industry association and the considerable

[16] In addition, we use the second-order lower partial moment and downside betas for our robustness check in the additional tests section.

[17] Our main results remain intact when we control for corporate governance by the independent board proportion or by the G-Index established by Gompers et al. (2003) from the RiskMetrics database.

[18] The book value and market value are not necessarily consistent, so we use both as a proxy for firm size when testing robustness.

Table 2 Descriptive statistics

Variable	Observation	Mean	SD	Min	Median	Max
CAPM_BETA	23,000	1.1808	0.5016	0.1558	1.1353	2.6511
FF_MKT_BETA	23,000	1.0629	0.3899	0.1063	1.0383	2.1680
DEVRET	23,000	0.4428	0.2156	0.1430	0.3928	1.2423
E_BETA	23,000	1.0382	0.4572	0.1201	0.9969	2.3821
SLPM	23,000	0.2589	0.1254	0.0832	0.2304	0.712
ENV_NET	23,000	−0.0211	0.7840	−5.0000	0.0000	5.0000
ENV_IDX	23,000	−0.0023	0.0619	−0.4545	0.0000	0.3846
ENV_PCA	23,000	−0.0028	1.5230	−6.1087	−0.0357	5.7320
ENV_STR	23,000	0.2223	0.6337	0.0000	0.0000	5.0000
ENV_CON	23,000	0.2591	0.7170	0.0000	0.0000	6.0000
LOGTA	23,000	6.8278	1.7329	3.2867	6.7391	11.3614
LOGMVE	23,000	7.2532	1.5893	4.0630	7.1008	11.6413
MBR	23,000	3.1802	3.2057	0.4716	2.1782	21.2016
CAPEXA	23,000	0.0480	0.0535	0.0000	0.0321	0.2984
RNDR	23,000	0.0941	0.3790	0.0000	0.0000	3.1894
ADVR	23,000	0.0108	0.0251	0.0000	0.0000	0.1502
DEBTR	23,000	0.1656	0.1631	0.0000	0.1292	0.6616
ROA	23,000	0.1110	0.1212	−0.4371	0.1168	0.4109
CHG_ROA	23,000	−0.0012	0.0612	−0.2523	0.0005	0.2367
SALEG	23,000	0.1198	0.2706	−0.5296	0.0821	1.4647
GOV	23,000	−0.2426	0.7235	−4.0000	0.0000	3.0000
MNCs	23,000	0.0747	0.2630	0.0000	0.0000	1.0000

This table displays descriptive statistics for the variables. The sample is merged across 3 databases, KLD, CRSP, and COMPUSTAT over the period 1991–2012. Mean, standard deviation, median, minimum, and maximum of each variable is reported. The definition of each variable is provided in Table 1

Table 3 The relation between CER and firm risk

Variables	(1) CAPM_BETA	(2) FF_MKT_BETA	(3) DEVRET	(4) CAPM_BETA	(5) FF_MKT_BETA	(6) DEVRET
ENV_NET ($t-1$)	−0.0174*** (−4.989)	−0.0145*** (−4.946)	−0.0075*** (−5.524)			
ENV_IDX ($t-1$)				−0.1897*** (−4.358)	−0.1745*** (−4.763)	−0.0830*** (−4.909)
Constant	1.2682*** (102.676)	1.0314*** (102.636)	0.4308*** (92.860)	1.2683*** (102.672)	1.0315*** (102.644)	0.4308*** (92.854)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22,990	22,990	22,988	22,990	22,990	22,988
R^2	0.258	0.117	0.421	0.258	0.117	0.421
Adj R^2	0.255	0.114	0.419	0.255	0.114	0.419

This table gives the simple OLS regressions for the sample over the period of 1991–2012. The main independent variable is the net environmental strength (ENV_NET) in column (1)–(3), while the aggregate environmental index (ENV_IDX) is the variable of interest in column (4)–(6). The industry dummy is assigned according to the 2 digits of the SIC code. Variables are winsorized at 1 and 99 %. Robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level, respectively

amount of time variation involved, we include both year and industry dummies in the remaining tests. We provide more comprehensive analyses to test this relation in the following sections.

Multivariate Tests

We estimate the following baseline empirical model to analyze the relation between CER and firm risk. To ensure that environmental responsibility is the cause but not the consequence, we use the lagged value of ENV_IDX or the lagged value of ENV_NET in the model. Except for the net governance strength calculated from the KLD, the control variables are taken at the beginning of the period. Industry (two-digit SIC code) and year fixed effects are included in the regressions to control for any unobserved industry characteristics or macroeconomic shocks that could simultaneously drive CER performance and firm risk.[19]

$$\begin{aligned} Firm\_Risk_t = {} & \alpha + \beta_1 ENV\_NET_{t-1}(or ENV\_IDX_{t-1}) \\ & + \beta_2 LOG\_TA_{t-1}(or LOG\_MVE_{t-1}) \\ & + \beta_3 MBR_{t-1} + \beta_4 CAPXA_{t-1} + \beta_5 RNDR_{t-1} \\ & + \beta_6 ADVR_{t-1} + \beta_7 ROA_{t-1} + \beta_8 DEBTR_{t-1} \\ & + \beta_9 SALEG_{t-1} + \beta_{10} CHG\_ROA_{t-1} \\ & + \beta_{11} GOV_t + \beta_{12} MNCs + \beta_{13} YearDummy \\ & + \beta_{14} IndustryDummy + \mu_{t.} \end{aligned} \quad (3)$$

As the literature identifies the various determinants of firm risk, it is possible that CER affects risk through other factors. To mitigate concerns about omitted variable bias, we control for a large set of covariates of firm risk suggested in the literature to study the incremental influence of CER engagement on risk. Specifically, as previously discussed, we control for firm size (LOG_TA or LOG_MVE), market-to-book ratio (MBR), return on assets (ROA), change in ROA (CHG_ROA), capital expenditure ratio (CAPEXA), debt ratio (DEBTR), sales growth (SALEG), R&D expense ratio (RNDR), advertising expense ratio (ADVR), KLD net governance strength (GOV), and multinational corporations (MNCs). Detailed variable definitions are provided in Table 1.

Table 4 presents the results of the multivariate regressions. The R-square values are enhanced in Table 4 compared to Table 3, thus the control variables do add more power to the regression model to explain the firm risk. The coefficients are generally consistent with expectations, e.g., larger firms have lower risk, firms with lower market-to-book ratios have lower risk, etc. In addition, out of all of the control variables, the firm features of larger value, lower MBR, lower CAPEXA, higher ROA, lower DEBTR, lower SALEG, and non-multinational corporation seem to be associated with lower risk.

Nevertheless, the coefficients on CER remain negative and significant in the presence of all of the control variables in all specifications. The relation between CER and firm risk is also economically significant. For instance, according to the estimates in model (1) of Panel A of Table 4, a one standard deviation increase in ENV_NET decreases CAPM beta by 1.08 % of its unconditional mean. As a result, we argue that on top of all of the existing determinants of risk, the firm-level environmental responsibility is a relatively less explored factor that contributes to the risk reduction of a company's stock.

We conduct further multivariate tests to substantiate our findings regarding the negative relation between CER and risk. In particular, we use an alternative measure of CER based on principal component analysis as a robustness check of the baseline result.

CER Measurement by Principle Component Analysis

We observe in Appendix C that there are multiple dimensions in both environmental strength and environmental concern in the KLD database. Using either the net environmental scores, ENV_NET, or the aggregate environmental index, ENV_IDX, as the CER measure, we assume the same weight (or degree of importance) for each individual environmental strength or concern. This assumption may not hold true for everyone, simply due to different perceptions. For example, some people may believe that water management problems are a much larger environmental concern than supply chain management issues. One alternative is to let the "data tell" using principal component analysis, which assigns different weights to different strength or concern dimensions. We use principal component analysis to construct another CER measure, ENV_PCA, which equals the first principal component of the strength minus the first principle component of the concern. Table 5 presents the results with the independent variable of ENV_PCA. Our negative CER-risk association based on ENV_PCA is retained. In addition, we include firm fixed effects in our model to control for unobserved time-invariant firm characteristics.

Fixed Effect Regressions

Thus far, we have used year and industry dummies to control for the influence of year and industry on firm risk. In most studies, controlling for year and industry is considered adequate for testing using panel data. However, we consider it worthwhile to further run the firm fixed effects regression to account for time-invariant firm unobserved characteristics. Our data are panel data, which are also called cross-sectional time-series data. We apply a fixed effects model to focus only on the time-series information. Statistically, a fixed effects model is a reasonable method for panel data that provides consistent estimators.

By controlling for firm fixed effects, we essentially explore how changes in risk vary with changes in CER within the same firm. Table 6 presents the results of our analysis using a fixed effects method based on the assumption that the unobservable individual effects known to be correlated

[19] Using Fama and French's (1997) information on 48 industries to construct the industry dummy gives similar, if not stronger, results.

Table 4 The relation between CER and firm risk with control variables

Variables	(1) CAPM_BETA	(2) CAPM_BETA	(3) FF_MKT_BETA	(4) DEVRET	(5) DEVRET
Panel A. CER measured by the net environmental score (ENV_NET)					
ENV_NET $(t-1)$	−0.0162*** (−2.796)	−0.0130** (−2.270)	−0.0144*** (−3.141)	−0.0062*** (−3.392)	−0.0031* (−1.719)
LOG_TA $(t-1)$	−0.0317*** (−8.201)			−0.0386*** (−29.633)	
LOG_MVE $(t-1)$		−0.0422*** (−10.794)			−0.0461*** (−34.690)
MBR $(t-1)$	0.0061*** (3.408)	0.0108*** (5.958)		0.0003 (0.534)	0.0057*** (9.840)
CAPEXA $(t-1)$	0.9248*** (8.647)	0.9390*** (8.837)	0.5323*** (6.528)	0.3245*** (8.017)	0.3505*** (8.893)
RNDR $(t-1)$	0.0061 (0.372)	0.0197 (1.231)	0.0155 (1.266)	0.0037 (0.696)	0.0205*** (3.986)
ADVR $(t-1)$	−0.3737* (−1.654)	−0.3384 (−1.496)	−0.5596*** (−3.252)	0.1799*** (2.711)	0.2162*** (3.367)
ROA $(t-1)$	−0.6775*** (−11.996)	−0.5776*** (−10.134)	−0.3890*** (−9.260)	−0.4287*** (−21.856)	−0.3250*** (−17.200)
DEBTR $(t-1)$	0.1591*** (4.500)	0.1009*** (2.955)	0.1078*** (4.281)	0.1057*** (8.569)	0.0329*** (2.871)
SALEG $(t-1)$	0.0132 (0.966)	0.0213 (1.565)	0.0015 (0.140)	0.0344*** (7.200)	0.0441*** (9.405)
CHG_ROA $(t-1)$	0.3863*** (6.592)	0.3592*** (6.140)	0.2958*** (5.949)	0.0364* (1.724)	0.0094 (0.457)
GOV $(t-1)$	−0.0049 (−0.784)	−0.0104* (−1.659)	0.0098** (2.031)	−0.0052** (−2.499)	−0.0089*** (−4.323)
MNCS	0.0704*** (3.053)	0.0846*** (3.671)	0.0156 (0.934)	0.0330*** (4.752)	0.0433*** (6.286)
Constant	1.4832*** (47.666)	1.5373*** (49.540)	1.0559*** (65.589)	0.6997*** (66.422)	0.7343*** (69.507)
Year dummy	YES	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES	YES
Observations	22,971	22,971	22,971	22,969	22,969
R^2	0.297	0.302	0.136	0.553	0.572
Adj. R^2	0.294	0.299	0.132	0.551	0.570
Panel B. CER measured by the aggregate environmental index (ENV_IDX)					
ENV_IDX $(t-1)$	−0.1824** (−2.497)	−0.1438** (−1.990)	−0.1738*** (−3.001)	−0.0760*** (−3.268)	−0.0376* (−1.649)
LOG_TA $(t-1)$	−0.0318*** (−8.238)			−0.0386*** (−29.680)	
LOG_MVE $(t-1)$		−0.0423*** (−10.837)			−0.0461*** (−34.732)
MBR $(t-1)$	0.0061*** (3.400)	0.0108*** (5.958)		0.0003 (0.532)	0.0057*** (9.842)
CAPEXA $(t-1)$	0.9247*** (8.648)	0.9389*** (8.839)	0.5328*** (6.534)	0.3247*** (8.021)	0.3506*** (8.895)
RNDR $(t-1)$	0.0059 (0.361)	0.0196 (1.224)	0.0155 (1.266)	0.0037 (0.693)	0.0205*** (3.987)
ADVR $(t-1)$	−0.3759* (−1.663)	−0.3404 (−1.504)	−0.5602*** (−3.256)	0.1798*** (2.708)	0.2161*** (3.366)
ROA $(t-1)$	−0.6779*** (−12.003)	−0.5777*** (−10.135)	−0.3892*** (−9.264)	−0.4287*** (−21.856)	−0.3250*** (−17.198)
DEBTR $(t-1)$	0.1592*** (4.501)	0.1007*** (2.951)	0.1077*** (4.274)	0.1057*** (8.570)	0.0329*** (2.869)
SALEG $(t-1)$	0.0132 (0.963)	0.0213 (1.564)	0.0015 (0.141)	0.0344*** (7.199)	0.0441*** (9.405)
CHG_ROA $(t-1)$	0.3866*** (6.597)	0.3594*** (6.143)	0.2960*** (5.952)	0.0364* (1.726)	0.0094 (0.457)
GOV $(t-1)$	−0.0053 (−0.839)	−0.0107* (−1.712)	0.0097** (2.011)	−0.0053** (−2.529)	−0.0090*** (−4.345)
MNCS	0.0702*** (3.050)	0.0845*** (3.671)	0.0154 (0.921)	0.0329*** (4.746)	0.0432*** (6.283)
Constant	1.4841*** (47.728)	1.5382*** (49.609)	1.0560*** (65.599)	0.6999*** (66.481)	0.7344*** (69.560)
Year dummy	YES	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES	YES
Observations	22,971	22,971	22,971	22,969	22,969

Table 4 continued

Variables	(1) CAPM_BETA	(2) CAPM_BETA	(3) FF_MKT_BETA	(4) DEVRET	(5) DEVRET
R^2	0.297	0.302	0.136	0.553	0.572
Adj. R^2	0.294	0.299	0.132	0.551	0.570

This table displays the baseline multivariate OLS regressions for the sample over the period of 1991-2012. The main independent variable is the net environmental strength, ENV_NET, in Panel A, and the aggregate environmental index, ENV_IDX, in Panel B. The dependent variable is the CAPM beta in models (1) and (2), Fama–French beta in columns (3) and volatility in columns (4) and (5). The industry dummy is assigned according to the 2 digits of the SIC code. All firm-level variables are winsorized at 1 and 99 %. Robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level. respectively

Table 5 Principal component analysis (PCA)-based CER measure

VARIABLES	(1) CAPM_BETA	(2) CAPM_BETA	(3) FF_MKT_BETA	(4) DEVRET	(5) DEVRET
ENV_PCA ($t-1$)	−0.0098*** (−3.679)	−0.0086*** (−3.267)	−0.0075*** (−3.574)	−0.0032*** (−3.799)	−0.0021** (−2.536)
LOG_TA ($t-1$)	−0.0352*** (−8.943)			−0.0383*** (−28.993)	
LOG_MVE ($t-1$)		−0.0462*** (−11.615)			−0.0457*** (−33.851)
MBR ($t-1$)	0.0057*** (3.121)	0.0109*** (5.842)		0.0004 (0.635)	0.0056*** (9.683)
Other control variables	Same as in the main table (Table 4)				
Constant	1.5142*** (47.707)	1.5714*** (49.620)	1.0627*** (65.290)	0.6939*** (64.749)	0.7285*** (67.727)
Year dummy	YES	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES	YES
Observations	22,303	22,303	22,303	22,301	22,301
R^2	0.307	0.313	0.143	0.551	0.570
Adj. R^2	0.304	0.310	0.139	0.549	0.568

This table includes the multivariate OLS regressions for the sample over the period of 1991−2012. The independent variable is the net first principle component of environmental strength, ENV_PCA. Specifically, ENV_PCA is calculated as the first principle component of environmental strength minus the first principle component of environmental concern. The industry dummy is assigned according to the 2 digits of the SIC code. All firm-level variables are winsorized at 1 and 99 %. Robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level, respectively

with regressors are non-random.[20] The strong negative relation between CER and risk continues to hold. The firm fixed effects results suggest that the inferences from our baseline results (Table 4) are not driven by unobserved time-invariant firm characteristics.

Endogeneity Controls

In this subsection, we conduct tests to address endogeneity concerns due to simultaneity, reverse causality, and omitted variables. We use a two-stage least square method and dynamic system GMM model to alleviate the concern that the negative relation between CER and risk is determined simultaneously by omitted variables.

Two-stage Least Square Regressions

Previous studies on CSR (Jo and Harjoto 2011, 2012; Ioannou and Serafeim 2014) suggest that a firm's CSR engagement is an endogenous variable. We share a similar concern that the decision of a corporation to invest environmentally is endogenous; if so, the CER variable should correlate with the disturbance term, making the OLS estimates biased and inconsistent. To alleviate the endogeneity concerns driven by simultaneity and reverse causality, we use the instrumental variable approach to examine the causal effect of CER on risk. We use a two-stage least

[20] In Table 6, the main independent variable is the net environmental scores, ENV_NET. The results of the aggregate environmental index, ENV_IDX, are consistent and qualitatively similar, and we choose not to report them to save space.

Table 6 Firm fixed effect regressions (within firm)

Variables	(1) CAPM_BETA	(2) CAPM_BETA	(3) FF_MKT_BETA	(4) DEVRET	(5) DEVRET
ENV_NET ($t-1$)	−0.0339*** (−5.181)	−0.0316*** (−4.830)	−0.0094** (−2.060)	−0.0081*** (−4.694)	−0.0075*** (−4.403)
LOG_TA ($t-1$)	−0.0752*** (−4.958)			−0.0363*** (−7.778)	
LOG_MVE ($t-1$)		−0.0616*** (−5.414)			−0.0527*** (−13.893)
MBR ($t-1$)	0.0134*** (7.230)	0.0195*** (9.027)		0.0019*** (3.262)	0.0060*** (9.366)
Other control variables	Same as in the main table (Table 4)				
Constant	1.7549*** (15.116)	1.6199*** (19.464)	1.0204*** (80.659)	0.6653*** (18.437)	0.7627*** (27.166)
Year dummy	YES	YES	YES	YES	YES
Observations	22,971	22,971	22,971	22,969	22,969
Number of firm	3,323	3,323	3,323	3,323	3,323
R^2	0.114	0.114	0.013	0.536	0.548
Adj. R^2	0.112	0.113	0.011	0.535	0.548

This table displays the firm fixed effect regressions for the sample over the period of 1991–2012. The main independent variable is the net environmental strength, ENV_NET. The industry dummy is assigned according to the 2 digits of the SIC code. All firm-level variables are winsorized at 1 and 99 %. Robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level, respectively

square analysis using environmental variable lagged by 2 years as the instrument.[21]

First stage:

$$\begin{aligned} ENV\_NET_{t-1}&(orENV\_IDX_{t-1}) \\ &= \alpha + \beta_1 ENV\_NET_{t-2}(ENV\_IDX_{t-2}) + \beta_2 LOG\_TA_{t-1} \\ &\quad + \beta_3 CAPXA_{t-1} + \beta_4 RNDR_{t-1} + \beta_5 DEBTR_{t-1} \\ &\quad + \beta_6 SALEG_{t-1} + \beta_7 YearDummy \\ &\quad + \beta_8 IndustryDummy + \varepsilon_t. \end{aligned}$$

Second stage:

$$\begin{aligned} Firm\_Risk_t = \alpha &+ \gamma_1 ENV\_NET_{t-1}(orENV\_IDX_{t-1}) \\ &+ \gamma_2 LOG\_TA_{t-1} + \gamma_3 MBR_{t-1} \\ &+ \gamma_4 CAPXA_{t-1} + \gamma_5 RNDR_{t-1} + \gamma_6 ADVR_{t-1} \\ &+ \gamma_7 ROA_{t-1} + \gamma_8 DEBTR_{t-1} + \gamma_9 SALEG_{t-1} \\ &+ \gamma_{10} CHG\_ROA_{t-1} + \gamma_{11} GOV_{t-1} \\ &+ \gamma_{12} MNCs + \gamma_{13} YearDummy \\ &+ \gamma_{14} IndustryDummy + \mu_t. \end{aligned} \quad (4)$$

Ideal instrumental variables should have high correlations with the CER measure and no direct correlation with firm risk. We perform the first-stage F test to validate our choice of instrumental variables. Consistent with our prior knowledge, our first-stage model is highly significant and therefore our choice of instrumental variables satisfies the relevance assumption. We report the results in Table 7, which further confirm the negative association between firm risk and environmental responsibility with a significance level of 99 % for the models.

GMM System Dynamic Model

We use a GMM dynamic panel regression for additional causality checks. The GMM dynamic panel model is often used as a robustness check to address endogeneity concerns due to reverse causality, simultaneity, and omitted variables. We conduct the dynamic panel system GMM model following Blundell and Bond (1998) and Wintoki et al. (2012), which enables us to estimate the CER-risk relation while including both past firm risk levels and fixed effects to account for the dynamic aspects of the CER-risk relation and time-invariant unobservable heterogeneity.

$$\begin{aligned} Firm\_Risk_t = \alpha &+ \beta_1 ENV\_NET_t(orENV\_IDX_t) \\ &+ \beta_2 LOG\_TA_t + \beta_3 MBR_t + \beta_4 CAPXA_t \\ &+ \beta_5 RNDR_t + \beta_6 ADVR_t + \beta_7 ROA_t \\ &+ \beta_8 DEBTR_t + \beta_9 SALEG_t \\ &+ \beta_{10} CHG\_ROA_t + \beta_{11} GOV_t + \beta_{12} MNCs \\ &+ \beta_{13} Firm\_Risk_{t-1} + \beta_{14} Firm\_Risk_{t-2} \\ &+ \beta_{15} YearDummy + \beta_{16} IndustryDummy \\ &+ \mu_t. \end{aligned} \quad (5)$$

[21] Using an environmental variable lagged by two years as the instrument allows us to address the concern of reverse causality. We also use a three-stage least square method with firm risk and CER measures as two dependent variables. In the results (not shown), we obtain a negative and significant association between CER variables and firm risk variables even after controlling for the reverse causality side of CER variables being dependent variables.

Table 7 The two-stage least square (2SLS) regressions

Variables	(1) CAPM_BETA	(2) CAPM_BETA	(3) FF_MKT_BETA	(4) FF_MKT_BETA	(5) DEVRET	(6) DEVRET
ENV_NET ($t-1$)	−0.0125*** (−3.00)		−0.0196*** (−5.33)		−0.0066*** (−4.80)	
ENV_IDX ($t-1$)		−0.1344*** (−2.58)		−0.2369*** (−5.14)		−0.0807*** (−4.72)
LOG_TA ($t-1$)	−0.0343*** (−15.04)	−0.0344*** (−15.10)			−0.0370*** (−45.89)	−0.0370*** (−45.97)
MBR ($t-1$)	0.0042*** (3.50)	0.0042*** (3.48)			−0.0004 (−1.01)	−0.0004 (−1.01)
Other control variables	Same as in the main table (Table 4)					
Constant	1.4947*** (73.29)	1.4957*** (73.37)	1.0616*** (91.25)	1.0617*** (91.26)	0.6822*** (97.08)	0.6825*** (97.17)
Year dummy	YES	YES	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES	YES	YES
First-stage F-stat	0.000	0.000	0.000	0.000	0.000	0.000
Observations	20,091	20,091	20,091	20,091	20,089	20,089
Centered R^2	0.316	0.316	0.148	0.148	0.561	0.561

This table reports the two-stage least square (2SLS) regressions over the sample period of 1991–2012. The dependent variable is the CAPM beta in models (1) and (2), Fama–French beta in models (3) and (4), and volatility in models (5) and (6). The independent variable is either the net environmental strength (ENV_NET) or the aggregate environmental index (ENV_IDX). We use the net environmental strength (ENV_NET) lagged by 2 years or the aggregate environmental index (ENV_IDX) lagged by 2 years as instruments for endogenous variable. Standard errors are robust and robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level, respectively

The results are included in Table 8, which provides negative and significant coefficients on the environment variables (both ENV_IDX and ENV_NET), confirming that risks are on average lower in firms with more CER engagement. Although the statistical significance is a bit lower than that of the OLS and simultaneous regressions, the results still indicate that managers of firms engaging in greater environmental initiatives see reduced firm risk.

We also report the results of two specification tests in Table 8, the AR(2) second-order serial correlation tests and the Hansen J test of over-identification. The AR(2) test yields a p value of 0.228–0.513, suggesting that the null hypothesis of no second-order serial correlation cannot be rejected. The Hansen J-statistic results in a p value of 0.073–0.177, casting only marginal concern that our instruments are not completely valid. In addition, we report the results from a test of the exogeneity of a subset of our instruments. The system GMM estimator makes an additional exogeneity assumption that any correlation between our endogenous variables and the unobserved (fixed) effect is constant over time. This assumption enables us to include the level equations in our GMM estimates and use lagged differences as instruments for these levels. Eichenbaum et al. (1988) and Wintoki et al. (2012) suggest that this assumption can be directly tested based on a difference-in-Hansen test of exogeneity. This test yields a J-statistic that is χ^2 distributed under the null hypothesis that the subsets of instruments in the levels equations are exogenous. The results show a p value of 0.125–0.433 for the J-statistic produced by the difference-in-Hansen test. This result suggests that we cannot reject the null hypothesis that the additional subset of instruments used in the system GMM estimates is exogenous. Overall, our dynamic system GMM results generally support the risk-reduction hypothesis.

Additional Tests

Strength and Concern Components of Environment

Next, we ask whether CER's influence over reducing firm risk is due to the risk-reducing influence of environmental strength or to the negative influence of environmental concern. In other words, does active CER beneficial activity reduce firm risk or does passive avoidance of environmentally harmful activities increase firm risk? To shed light on the relative importance of environmental strength versus environment concern in corporate risk management,

Table 8 Dynamic system generalized method of moment (GMM) regressions

Variables	(1) CAPM_BETA	(2) CAPM_BETA	(3) FF_MKT_BETA	(4) FF_MKT_BETA	(5) DEVRET	(6) DEVRET
ENV_NET	−0.1782*** (−2.845)		−0.0730** (−2.39)		−0.0167** (−2.278)	
ENV_IDX		−0.2029** (−2.526)		−0.8845** (−2.39)		−0.0185** (−2.173)
LOG_TA	−0.1947 (−0.497)	−0.1835 (−0.480)			−0.0762 (−1.480)	−0.0778 (−1.498)
MBR	0.0071 (0.568)	0.0070 (0.503)			−0.0001 (−0.083)	−0.0002 (−0.121)
CAPM_BETA ($t-1$)	0.1864 (1.447)	0.1909 (1.312)				
CAPM_BETA ($t-2$)	0.1761 (0.873)	0.1701 (0.730)				
FF_MKT_BETA ($t-1$)			0.1004 (0.48)	0.0938 (0.45)		
FF_MKT_BETA ($t-2$)			−0.0161 (−0.11)	−0.0431 (−0.28)		
DEVRET ($t-1$)					0.3045*** (5.376)	0.3049*** (5.523)
DEVRET ($t-2$)					−0.0443 (−1.482)	−0.0422 (−1.427)
Other control variables	Same as in the main table (Table 4)					
Constant	1.8922 (0.737)	1.9197 (0.802)	0.9782** (2.46)	1.0169** (2.53)	0.1579 (0.373)	0.1866 (0.445)
Year dummy	YES	YES	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES	YES	YES
Observations	18,979	18,979	18,979	18,979	18,977	18,977
Number of firm	2894	2894	2894	2894	2894	2894
AR(1) test (p value)	0.015	0.030	0.028	0.024	0.000	0.000
AR(2) test (p value)	0.368	0.507	0.862	0.980	0.513	0.486
Hansen test over-identification (p value)	0.115	0.097	0.433	0.413	0.073	0.087
Diff-in-Hansen test of exogeneity (p value)	0.231	0.125	0.631	0.504	0.201	0.237

This table reports the dynamic system generalized method of moment (GMM) regressions over the sample period of 1991–2012. The dependent variable is the CAPM beta in models (1) and (2), Fama–French beta in models (3) and (4), and volatility in models (5) and (6). The variable of interest is either the net environmental strength (ENV_NET) or the aggregate environmental index (ENV_IDX). The AR (1) and AR (2) tests are tests for first-order and second-order serial correlation in the first-differenced residuals, under the null of no serial correlation. The Hansen test of over-identifying restrictions is a test with the joint null hypothesis that instrumental variables are valid, i.e., uncorrelated with error terms. We use lagged three to four periods as instruments for endogenous variables. All the regressors except industry dummies and year dummies are assumed to be endogenous. The difference-in-Hansen test of exogeneity is a test with the null hypothesis that the subsets of instruments that we use in the levels equations are exogenous. Robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level, respectively

we aggregate the strength and concern components separately and test each in the baseline model. The test results are included in Table 9 and provide evidence that both affect future firm risk. More specifically, we find that more environmental strengths and less environmental concerns both help reduce firm risk. As such, our findings indicate that firms' should invest effort in both strengthening environmental protection and avoiding damaging the environment if the management aim is better risk management through environmental efforts. This separate treatment of CER strengths and concerns generally follows Mattingly and Berman (2006), who demonstrate that a firm's social strengths and the track record of its respective social controversies are issues that are both conceptually and empirically distinct, and thus should not be combined for research purposes.

To offer managers more guidance regarding what exactly a firm can do to keep firm risk in control through environmental policy, we test individual environmental strength and concern items in Table 10. Panel A of Table 10 reports the results of the OLS regressions for individual environmental strengths and Panel B reports

Table 9 The relation between strength or concern component of environment and firm risk

Variables	(1) CAPM_BETA	(2) CAPM_BETA	(3) FF_MKT_BETA	(4) DEVRET	(5) DEVRET
Panel A. Strength component of environment					
ENV_STR ($t-1$)	−0.0390*** (−5.210)	−0.0294*** (−3.956)	−0.0071 (−1.412)	−0.0053** (−2.255)	0.0009 (0.378)
LOG_TA ($t-1$)	−0.0251*** (−5.928)			−0.0378*** (−25.372)	
LOG_MVE ($t-1$)		−0.0374*** (−8.719)			−0.0464*** (−30.824)
MBR ($t-1$)	0.0062*** (3.475)	0.0103*** (5.688)		0.0003 (0.499)	0.0057*** (9.840)
Other control variables	Same as in the main table (Table 4)				
Constant	1.4435*** (43.843)	1.5097*** (46.016)	1.0564*** (65.680)	0.6952*** (60.578)	0.7363*** (64.508)
Year dummy	YES	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES	YES
Observations	22,971	22,971	22,971	22,969	22,969
R^2	0.298	0.302	0.135	0.553	0.572
Adj. R^2	0.295	0.299	0.132	0.551	0.570
Panel B. Concern component of environment					
ENV_CON ($t-1$)	−0.0082 (−1.062)	−0.0049 (−0.646)	0.0142** (2.385)	0.0054* (1.921)	0.0056** (2.118)
LOG_TA ($t-1$)	−0.0309*** (−7.477)			−0.0396*** (−27.061)	
LOG_MVE ($t-1$)		−0.0421*** (−10.224)			−0.0470*** (−32.351)
MBR ($t-1$)	0.0059*** (3.318)	0.0107*** (5.871)		0.0003 (0.455)	0.0058*** (9.986)
Other control variables	Same as in the main table (Table 4)				
Constant	1.4797*** (45.980)	1.5380*** (48.352)	1.0559*** (65.553)	0.7058*** (62.703)	0.7396*** (66.692)
Year dummy	YES	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES	YES
Observations	22,971	22,971	22,971	22,969	22,969
R^2	0.297	0.301	0.136	0.553	0.572
Adj. R^2	0.294	0.298	0.132	0.551	0.570

This table is for the multivariate OLS regressions for the sample over the period of 1991–2012. The main independent variable is ENV_STR in Panel A, and ENV_CON in panel B. The industry dummy is assigned according to the 2 digits of the SIC code. All firm-level variables are winsorized at 1 and 99 %. Robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level respectively

those of individual concerns.[22] By testing using individual environmental strengths (concerns), we identify a list of specific environmental strength (concern) dimensions that reduce (increase) firm risk, such as strength in waste management and concern in ozone-depleting chemicals.

In Table 10, there are three dimensions of environmental strength and three dimensions of environmental concern that matter significantly and meaningfully to the level of firm risk. The results reported in Panel A suggest that if firms engage in waste management by recycling or disposal of end-of-life products (ENV_STR_B), policies, programs, and initiatives regarding climate changes (ENV_STR_D), and environment management systems in place (ENV_STR_G), then those efforts are perceived by market participants as risk-reducing activities. If firms are more exposed to regulatory compliance measured by the firm's record of compliance with environmental regulations (ENV_CON_B), manufacturing ozone-depleting chemicals (ENV_CON_C), or being at risk of credit defaults resulting from poor due diligence processes related to environmental concerns, then an increase in firm risk results.

Overall, certain components of environmental strength programs tend to decrease firm risk whereas other components of environmental concern items are likely to increase firm risk. Together, firms with combined CER programs, initiatives, and policies generally do better in risk management.

[22] For space concerns, we use the Fama–French market factor beta as the single risk measure in Table 10. The results using the CAPM beta or volatility are rather consistent; they are available upon request.

Table 10 The relation between individual strength or concern component of environment and firm risk

Variables	(1) FF_MKT_BETA	(2) FF_MKT_BETA	(3) FF_MKT_BETA	(4) FF_MKT_BETA	(5) FF_MKT_BETA	(6) FF_MKT_BETA	(7) FF_MKT_BETA
Panel A. Individual strength component of environment							
ENVIRONMENTAL OPPORTUNITIES ($t-1$)	0.0372* (1.756)						
WASTE MANAGEMENT ($t-1$)		−0.0813*** (−4.109)					
PACKAGING MATERIALS & WASTE ($t-1$)			0.0198 (0.747)				
CLIMATE CHANGE ($t-1$)				−0.0309** (−2.523)			
PROPERTY, PLANT, AND EQUIPMENT ($t-1$)					0.1443 (1.013)		
ENVIRONMENTAL MANAGEMENT SYSTEMS ($t-1$)						−0.0338** (−2.472)	
OTHER STRENGTH ($t-1$)							−0.0068 (−0.499)
Control variables	Same as in the main table (Table 4)						
Constant	1.0688*** (64.227)	1.0686*** (64.225)	1.0690*** (64.176)	1.0692*** (64.201)	1.1019*** (8.889)	1.0349*** (61.849)	1.0689*** (64.130)
Year dummy	YES	YES	YES	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES	YES	YES	YES
Observations	21,422	21,422	21,422	21,422	1,331	12,169	21,422
R^2	0.146	0.146	0.145	0.146	0.313	0.178	0.145
Adj. R^2	0.142	0.143	0.141	0.142	0.277	0.173	0.141

Variables	(1) FF_MKT_BETA	(2) FF_MKT_BETA	(3) FF_MKT_BETA	(4) FF_MKT_BETA	(5) FF_MKT_BETA	(6) FF_MKT_BETA	(7) FF_MKT_BETA	(8) FF_MKT_BETA	(9) FF_MKT_BETA
Panel B. Individual concern component of environment									
HAZARDOUS WASTE ($t-1$)	0.0201 (0.994)								
REGULATORY COMPLIANCE ($t-1$)		0.0250* (1.659)							
OZONE-DEPLETING CHEMICALS ($t-1$)			0.1629*** (4.348)						
TOXIC SPILLS & RELEASES ($t-1$)				0.0217 (1.390)					
CLIMATE CHANGE ($t-1$)					0.0283 (1.640)				
IMPACT OF PRODUCTS & SERVICES ($t-1$)						0.0487 (1.269)			
BIODIVERSITY& LAND USE ($t-1$)							−0.0833** (−1.972)		
OPERATIONAL WASTE ($t-1$)								0.0251 (0.982)	
OTHER CONCERN ($t-1$)									0.0471* (1.686)
Control variables	Same as in the main Table 4								
Constant	1.0737*** (56.910)	1.0685*** (64.132)	1.0738*** (56.966)	1.0689*** (64.129)	1.0632*** (68.075)	1.0402*** (46.157)	1.0405*** (46.247)	1.0395*** (46.121)	1.0693*** (64.190)

Table 10 continued

Variables	(1) FF_MKT_BETA	(2) FF_MKT_BETA	(3) FF_MKT_BETA	(4) FF_MKT_BETA	(5) FF_MKT_BETA	(6) FF_MKT_BETA	(7) FF_MKT_BETA	(8) FF_MKT_BETA	(9) FF_MKT_BETA
Year dummy	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	17,206	21,422	17,206	21,422	19,185	4,216	4,216	4,216	21,422
R^2	0.139	0.146	0.139	0.145	0.139	0.270	0.270	0.270	0.146
Adj. R^2	0.134	0.142	0.135	0.142	0.135	0.256	0.257	0.256	0.142

Notes This table is for the multivariate OLS regressions for the sample over the period of 1991-2012. . The dependent variable is the Fama French beta, while the main independent variable is each individual strength component in Panel A and each individual concern component in Panel B. The industry dummy is assigned according to the 2 digits of the SIC code. All firm level variables are winsorized at 1% and 99%. Robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level respectively

Environmental Responsibility and Downside Risk

The total risk metric that we use, the standard deviation of daily stock returns, captures volatility on both the upside and the downside. Shareholders, however, may only consider the downside volatility to be a risk and favor the upside swing. Thus, we double check our results using downside risk metrics as dependent variables in the baseline model. In addition, some literature suggests that the traditional CAPM beta is a biased estimate (Price et al. 1982). Accordingly, it is possible that our estimated CAPM beta is a biased estimate. Price et al. (1982) infer that the regular beta underestimates the risk for low-beta stocks and overestimates the risk for high-beta stocks. In particular, the downside risk strongly outperforms the traditional CAPM in terms of its ability to explain the cross section of U.S. stock returns, as suggested by Post and Van Vliet (2004). To mitigate such potential problems, we use two downside risk measures, the downside beta (E_Beta) of Estrada (2002), and the second-order lower partial moment (SLPM) of Price et al. (1982) (see the definitions of E_Beta and SLPM in Table 1). The results are included in Table 11.[23] The consistency and significance of Table 11, which shows the negative association between the downside risk measures and CER, lends additional support to our findings, adding more rigor to our inferences and making the previous results more robust.

Cross-Industry Analysis of the CER-Risk Association

Thus far, we have found that environmentally responsible firms have lower risk. However, it is very unlikely that environmental indicators have the same relevance in every single sector. For example, for controversial businesses such as tobacco companies, positive environmental behavior helps make up for their products killing their users and thus may reduce the risk of the business. In service-oriented industries, which are not sensitive to the environment, corporate investment in this dimension may not be valued by the financial markets and may backfire and increase firm risk.

In this subsection, we test the CER-risk relationship in the manufacturing sector versus that in the service sector. In particular, we divide the cross section of firms into different sectors and industries according to their SIC codes and rerun the test for the manufacturing (service) sector and for each industry within the sector. The SIC classifications are obtained from the U.S. Department of Labor. The details are included in Appendix 4. We run one baseline model (OLS with control variables) and one model with endogeneity

[23] In Table 11, the main independent variable is the net environmental score, ENV_NET. The results of the aggregate environmental index, ENV_IDX, are consistent and qualitatively similar, thus we choose not to report them to save space.

Table 11 The relation between CER and downside risk (E_BETA and SLPM) with control variables

Variables	(1) E_BETA	(2) E_BETA	(3) SLPM	(4) SLPM
ENV_NET ($t-1$)	−0.0170*** (−3.237)	−0.0143*** (−2.774)	−0.0039*** (−3.576)	−0.0022** (−2.075)
LOG_TA ($t-1$)	−0.0188*** (−5.417)		−0.0213*** (−28.322)	
LOG_MVE ($t-1$)		−0.0303*** (−8.746)		−0.0250*** (−33.065)
Other control variables	Same as in the main table (Table 4)			
Constant	1.2391*** (44.636)	1.3026*** (47.517)	0.3988*** (65.587)	0.4155*** (68.863)
Year dummy	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES
Observations	22,971	22,971	22,969	22,969
R^2	0.275	0.279	0.522	0.537
Adj. R^2	0.272	0.276	0.520	0.535

This table displays the multivariate OLS regressions for the sample over the period of 1991–2012. The main dependent variable is Down sidebeta (E_beta) in columns (1) and (2), second-order lower partial moment (SLPM) in columns (3) and (4). The main independent variable is the net environmental score, ENV_NET. The industry dummy is assigned according to the 2 digits of the SIC code. All firm-level variables are winsorized at 1 and 99 %. Robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level, respectively

control of the relationship between firm risk and CER. The test results are reported in Table 12.

To conserve space, in Table 12 we only report the coefficient of the environmental variable. Panel A reports our test results for the manufacturing sector, the service sector, and others. In the SIC classifications of Appendix 4, there are 10 sectors (or divisions), A to J. Division D is the manufacturing sector, Division I is the service sector, and the other eight divisions are included in "others." Panel A agrees with our cross-industry variation hypothesis, which predicts a negative coefficient for manufacturing and a positive coefficient for service. Panel B includes the test results for each individual industry in manufacturing, service, and others. Consistent with Panel A, the risk-reduction effect of CER, e.g., a negative coefficient, is largely retained in the manufacturing sector, especially in Food and Kindred Products (SIC 20, $n = 565$), Chemical and Allied Products (SIC 28, $n = 2038$), and Industrial Machinery and Equipment (SIC 35, $n = 1395$), in which the size of the cross-sectional sample is relatively large, supporting hypothesis 3(a).[24] For the 17 other manufacturing industries, the CER-firm risk associations are largely insignificant. This is at least partially explained by the small sample size.[25] For firms in the service sector, commitment to the environment is considered costly and inefficient, and thus tends to increase firm risk. The evidence is most prominent in the business services industry (SIC 73, $n = 2034$), the largest industry in the service sector, supporting hypothesis 3(b). For the remaining eight service industries, the CER-firm risk associations are mostly insignificant.

In the 33 other industries categorized as belonging to neither the manufacturing nor the service sectors, firm risks are irresponsive to the corporate performance on the environment, in line with hypothesis 3(c), with the exception of Metal and Mining (SIC 10, $n = 93$), which shows a positive CER-risk association. Another two notable exceptions are Oil and Gas Extractions (SIC 13, $n = 810$) and Automotive Dealers and Service Stations (SIC 55, $n = 194$), which suggest an occasional, but significant inverse association between CER and firm risk. Presumably, because both Oil and Gas Extractions and Automotive Service Stations provide lots of environment-damaging oils and materials, their CER initiatives and programs help reduce their firm risk.

Combined, our main inverse CER-firm risk associations seem to come mostly from three large manufacturing industries: Food and Kindred Products (SIC 20, $n = 565$), Chemical and Allied Products (SIC 28, $n = 2038$), and Industrial Machinery and Equipment (SIC 35, $n = 1,395$), and possibly also from Oil and Gas Extractions (SIC 13, $n = 810$). Thus, we conclude that our cross-industry

[24] Recently, Albuquerque et al. (2013) find that CSR decreases systematic risk and that a negative CSR-risk association is more pronounced in differentiated product industries, including furniture and fixtures, printing and publishing, rubber and plastic products, stone, glass, and clay products, fabricated metal products, machinery, electrical equipment, transportation equipment, instruments, and miscellaneous products (Giannetti et al. 2011). Albuquerque et al. (2013) claim that profit maximization (and therefore, possible risk reduction) may come from product differentiation strategies. Their main focus is on CSR, not on CER, and our results shed some light on whether differentiated goods industries demonstrate stronger CER-risk associations. Panel B of Table 12 indicates that only Industrial Machinery and Equipment (SIC 35) decreases firm risk, but not the other differentiated product industries.

[25] The nature of statistical testing is to uncover the characteristics of population using samples. A larger sample more reliably reflects the population and thus offers more reliable statistical inference. When sample size is small relative to the population, the potential bias is large.

Table 12 Cross-industry relation between CER and firm risk with control variables

Industry(sic 2digits)	CAPM_BETA				FF_MKT_BETA				DEVRET				
	OLS		2SLS		OLS		2SLS		OLS		2SLS		
	Coeff	T_value	Coeff	T_value	Coefft	T_value	Coeff	T_value	Coeff	T_value	Coeff	T_value	*N*
Panel A. Manufacturing sector, service sector, and others													
Manufaturing	−0.0202**	(−2.229)	−0.0237***	(−4.27)	−0.0262***	(−3.462)	−0.0341***	(−7.05)	−0.0017***	(−3.048)	−0.0023***	(−5.79)	10,125
Services	0.0540***	(2.838)	0.0855***	(4.42)	0.0422***	(2.977)	0.0294**	(2.01)	0.0039***	(2.837)	0.0050***	(3.61)	3205
Others	0.0139	(1.140)	0.0283***	(3.67)	0.0048	(0.525)	0.0078	(1.24)	0.0005	(0.591)	0.0014**	(2.44)	9532
Panel B. Individual industries in manufacturing, services, and others													
Manufacturing													
20 Food & kindred products	−0.0496***	(−2.958)	−0.0387**	(−2.28)	−0.0136	(−1.087)	−0.0072	(−0.47)	−0.0163**	(−2.299)	−0.0038***	(−2.80)	565
21 Tobacco products	−0.0490	(−0.421)	−0.1755***	(−5.26)	0.1178**	(3.773)	0.2646***	(3.57)	0.0009	(0.011)	0.0108**	(2.24)	36
22 Textile mill products	−0.0838	(−0.549)	−0.8425	(−0.67)	0.1556	(1.062)	0.0931	(1.17)	0.0453	(0.453)	0.0391	(0.77)	40
23 Apparel & other textile products	0.0833	(0.627)	0.1709	(1.24)	0.0834	(1.203)	0.0963	(0.82)	0.0487	(1.230)	0.0279**	(2.38)	218
24 Lumber & wood products	0.0098	(0.356)	0.0571	(0.92)	−0.0212	(−0.639)	−0.0137	(−0.33)	0.0130	(1.179)	0.0054	(1.21)	121
25 Furniture & fixtures	0.0210	(0.653)	0.0240	(0.66)	0.0067	(0.342)	−0.0053	(−0.17)	0.0030	(0.352)	−0.0001	(−0.04)	194
26 Paper & allied products	−0.0045	(−0.154)	0.0246	(0.88)	−0.0056	(−0.236)	0.0075	(0.27)	−0.0098	(−1.154)	−0.0011	(−0.47)	293
27 Printing & publishing	−0.0143	(−0.298)	−0.2757**	(−2.21)	−0.0222	(−0.386)	−0.0890	(−1.10)	0.0034	(0.181)	−0.0149	(−1.33)	263
28 Chemical & allied products	−0.0405**	(−2.500)	−0.0636***	(−6.08)	−0.0353**	(−2.287)	−0.0513***	(−5.37)	−0.0195***	(−3.904)	−0.0058***	(−6.86)	2038
29 Petroleum & coal products	0.0365	(1.130)	0.0284	(0.55)	0.0149	(0.498)	0.0278	(0.91)	0.0113	(0.929)	−0.0020	(−0.41)	136
30 Rubber & miscellaneous plastics products	0.0281	(0.412)	0.0730*	(1.80)	−0.0079	(−0.212)	0.0186	(0.46)	0.0076	(0.263)	0.0019	(0.52)	228
31 Leather & leather products	−0.1677*	(−1.817)	0.0023	(0.02)	−0.1039	(−1.132)	0.0499	(0.35)	−0.0385	(−1.129)	−0.0035	(−0.39)	107
32 Stone, clay, & glass products	0.0444	(0.719)	0.0851	(1.38)	−0.0017	(−0.024)	0.0407	(0.67)	0.0263	(1.186)	0.0090**	(2.13)	105
33 Primary metal industries	0.0099	(0.259)	0.0293	(0.88)	−0.0007	(−0.028)	0.0144	(0.54)	−0.0074	(−0.732)	−0.0026	(−1.10)	321
34 Fabricated metal products	−0.0139	(−0.300)	0.0022	(0.05)	−0.0008	(−0.024)	0.0063	(0.18)	0.0155	(1.003)	0.0057*	(1.81)	323
35 Industrial machinery & equipment	−0.1015***	(−4.544)	−0.1128***	(−6.28)	−0.0503***	(−3.553)	−0.0669***	(−4.67)	−0.0195***	(−3.067)	−0.0050***	(−3.97)	1395
36 Electronic & other electric equipment	−0.0298	(−1.017)	−0.0076	(−0.33)	−0.0063	(−0.431)	−0.0104	(−0.60)	0.0056	(0.701)	0.0023	(1.37)	1720
37 Transportation equipment	−0.0140	(−0.590)	−0.0170	(−0.81)	−0.0124	(−0.588)	−0.0118	(−0.60)	−0.0054	(−0.943)	−0.0023	(−1.56)	571
38 Instruments & related products	0.0017	(0.047)	0.0108	(0.50)	0.0048	(0.193)	0.0124	(0.68)	0.0012	(0.169)	0.0008	(0.55)	1264
39 Miscellaneous manufacturing industries	−0.2094**	(−2.303)	−0.1648	(−1.56)	−0.0855	(−1.346)	0.0066	(0.07)	−0.0841**	(−2.784)	−0.0089	(−1.08)	187
Services													
70 Hotels & other lodging places	0.2320	(0.615)	0.2620***	(3.78)	0.3964**	(4.413)	1.4998	(1.26)	−0.1330	(−0.508)	−0.0101	(−0.58)	33
72 Personal services	0.1037	(0.424)	0.8969	(0.53)	−0.1341	(−0.438)	0.0364	(0.07)	0.1262	(0.589)	0.0570	(0.46)	56
73 Business services	0.0588**	(2.562)	0.0924***	(3.51)	0.0239*	(1.700)	0.0183	(0.87)	0.0209***	(3.201)	0.0047**	(2.50)	2034
75 Auto repair, services, & parking	0.0373	(0.511)	−0.2245	(−1.26)	0.3220	(0.967)	0.2978	(1.49)	−0.0992*	(−2.216)	−0.0442**	(−2.54)	58
78 Motion pictures	−0.3358	(−0.407)	0.4203	(0.69)	0.1443	(0.474)	0.4893	(0.96)	−0.1936**	(−2.613)	−0.0769*	(−1.88)	67
79 Amusement & recreation services	0.0764*	(1.809)	0.0836	(1.09)	0.1049***	(3.675)	0.1068	(1.59)	−0.0202	(−1.513)	−0.0069	(−1.16)	174
80 Health services	−0.0154	(−0.189)	−0.0641	(−0.57)	0.0116	(0.135)	−0.0534	(−0.50)	−0.0307	(−0.999)	−0.0058	(−0.53)	315

Table 12 continued

Industry(sic 2digits)	CAPM_BETA				FF_MKT_BETA				DEVRET				
	OLS		2SLS		OLS		2SLS		OLS		2SLS		
	Coeff	T_value	Coeff	T_value	Coefft	T_value	Coeff	T_value	Coeff	T_value	Coeff	T_value	*N*
82 Educational services	−0.0310	(−0.489)	−0.1209	(−0.75)	0.0767	(1.242)	0.0538	(0.41)	−0.0464	(−1.602)	−0.0121	(−0.93)	117
87 Engineering & management services	0.1088*	(1.855)	0.1278*	(1.73)	0.0936*	(1.817)	0.0397	(0.59)	0.0109	(0.579)	0.0083	(1.30)	351
Others													
01 Agricultural production—crops	−0.0121	(−0.152)	0.2433**	(2.05)	−0.0376	(−0.385)	0.2860**	(1.99)	0.0018	(0.068)	0.0017	(0.25)	44
10 Metal, mining	0.1237***	(3.748)	0.1453***	(4.73)	0.0962***	(5.091)	0.0958***	(3.96)	0.0232**	(2.945)	0.0051***	(3.11)	93
12 Coal mining	−0.0180	(−0.379)	−0.0191	(−0.36)	−0.0408	(−0.974)	−0.0204	(−0.54)	−0.0058	(−0.377)	0.0001	(0.02)	68
13 Oil & gas extraction	−0.0327***	(−3.259)	−0.0274**	(−2.10)	−0.0062	(−0.612)	0.0043	(0.38)	−0.0098*	(−1.735)	−0.0011	(−1.00)	810
14 Nonmetallic minerals, except fuels	−0.0843	(−1.430)	−0.3210**	(−2.00)	−0.0439	(−0.455)	−0.1026	(−0.58)	−0.0364*	(−2.049)	−0.0119**	(−2.16)	44
15 General building contractors	0.0190	(0.299)	0.0564	(0.68)	0.0170	(0.459)	0.0055	(0.09)	0.0380	(1.544)	0.0062	(0.90)	132
16 Heavy construction, except building	0.0258	(0.238)	−0.0109	(−0.08)	−0.0059	(−0.076)	−0.0449	(−0.42)	0.0316	(0.956)	0.0138	(1.26)	83
17 Special trade contractors	0.5001*	(1.967)	0.5692	(0.76)	0.1748	(0.859)	−0.3349	(−0.64)	0.0939	(0.731)	−0.0732	(−1.03)	48
40 Railroad transportation	0.0238	(0.699)	0.0459	(1.13)	0.0678	(1.222)	0.0988***	(3.11)	0.0110	(1.160)	0.0057**	(2.51)	93
42 Trucking & warehousing	−0.0380	(−0.402)	−0.0380	(−0.43)	−0.0458	(−0.645)	−0.0391	(−0.58)	−0.0014	(−0.092)	−0.0018	(−0.30)	156
44 Water transportation	0.3405	(1.085)	0.7603**	(2.52)	0.4162*	(2.231)	0.7236***	(2.86)	0.0326	(0.471)	0.0130	(0.57)	52
45 Transportation by air	0.0371	(0.529)	0.0911	(1.49)	0.0885	(1.405)	0.1159*	(1.95)	−0.0039	(−0.189)	−0.0028	(−0.50)	185
47 Transportation services	0.0969	(0.937)	0.4026*	(1.86)	−0.0330	(−0.422)	0.1540	(0.92)	0.0884	(1.312)	0.0302	(1.44)	99
48 Communications	0.0086	(0.266)	0.0078	(0.17)	0.0056	(0.270)	0.0105	(0.25)	−0.0012	(−0.141)	0.0008	(0.22)	613
49 Electric, gas, & sanitary services	−0.0093	(−0.846)	−0.0087	(−0.99)	0.0007	(0.069)	−0.0022	(−0.31)	−0.0073*	(−1.827)	−0.0018**	(−2.46)	1192
50 Wholesale trade—durable goods	−0.1278*	(−1.742)	−0.1743**	(−2.33)	−0.0607	(−0.940)	−0.1332**	(−2.15)	−0.0180	(−0.819)	−0.0043	(−0.79)	431
51 Wholesale trade—nondurable goods	0.0162	(0.234)	0.0313	(0.52)	−0.0014	(−0.029)	0.0005	(0.01)	−0.0114	(−0.486)	−0.0046	(−0.93)	216
52 Building materials & gardening supplies	−0.0701	(−2.001)	−0.1703	(−1.44)	−0.1464**	(−3.375)	−0.3638***	(−3.29)	−0.0251***	(−6.102)	−0.0112**	(−2.38)	76
53 General merchandise stores	0.0321	(0.779)	0.0371	(0.68)	−0.0307	(−1.042)	−0.0410	(−0.85)	0.0065	(0.367)	−0.0002	(−0.05)	206
54 Food stores	0.0231	(0.879)	0.0296	(0.79)	−0.0220	(−0.412)	−0.0052	(−0.12)	0.0467**	(2.792)	0.0116***	(3.20)	114
55 Automative dealers & service stations	−0.1384*	(−1.969)	−0.1915***	(−2.93)	−0.0728	(−1.175)	−0.0722	(−1.37)	−0.0760***	(−4.106)	−0.0198***	(−3.64)	194
56 Apparel & accessory stores	−0.0519	(−1.141)	−0.0361	(−0.34)	−0.0267	(−0.724)	0.0373	(0.37)	−0.0023	(−0.120)	0.0040	(0.50)	351
57 Furniture & homefurnishings stores	−0.0772	(−0.733)	−0.1619	(−0.72)	−0.1282	(−1.740)	−0.3315**	(−2.11)	0.0707*	(1.831)	0.0314*	(1.86)	104
58 Eating & drinking places	0.0574	(1.134)	0.0676	(1.27)	−0.0316	(−0.597)	−0.0521	(−1.35)	0.0141	(0.681)	0.0036	(0.73)	326
59 Miscellaneous retail	0.0933	(0.923)	0.0864	(1.34)	0.0908	(1.436)	0.0538	(0.92)	0.0173	(0.601)	−0.0016	(−0.31)	389
60 Depository institutions	0.0391	(1.110)	0.0600	(1.29)	0.1083***	(4.844)	0.0935***	(2.63)	0.0037	(0.355)	0.0001	(0.02)	1640
61 Nondepository institutions	0.0042	(0.066)	0.0345	(0.40)	0.0079	(0.135)	−0.0350	(−0.51)	0.0091	(0.328)	0.0055	(0.75)	185
62 Security & commodity brokers	0.0597	(1.194)	0.0564	(0.74)	0.0900*	(1.923)	0.0818	(1.28)	0.0217	(1.591)	0.0036	(0.63)	422
63 Insurance Carriers	0.0013	(0.030)	−0.0030	(−0.04)	0.0562	(1.465)	0.0389	(0.71)	−0.0056	(−0.401)	−0.0003	(−0.06)	840
64 Insurance agents, brokers, & service	0.0551	(0.937)	0.1779	(1.33)	−0.0061	(−0.179)	0.0499	(0.51)	0.0196	(0.607)	0.0123	(0.98)	94
65 Real estate	0.0668	(0.782)	0.3313	(1.53)	0.1310	(1.632)	0.3214*	(1.92)	−0.0062	(−0.280)	0.0122	(0.79)	83

Table 12 continued

Industry(sic 2digits)	CAPM_BETA				FF_MKT_BETA				DEVRET				N
	OLS		2SLS		OLS		2SLS		OLS		2SLS		
	Coeff	T_value	Coeff	T_value	Coeff	T_value	Coeff	T_value	Coeff	T_value	Coeff	T_value	
67 Holding & other investment offices	−0.0356	(−0.319)	1.0896	(0.07)	0.0547	(0.456)	4.2084	(0.29)	0.0250	(1.085)	0.0281	(0.02)	153
99 Non−classifiable establishments	−0.2471**	(−5.577)	0.0564	(0.42)	−0.0008	(−0.034)	−0.0189	(−0.25)	−0.1139*	(−2.558)	−0.0149**	(−2.08)	40

This table displays the multivariate OLS and Two-stage Least Square (2SLS) regressions across the two-digit industries for the sample over the period of 1991–2012. The independent variable is the net environmental strength (ENV_NET). We include all control variables same as in the Table 4, but not report in here. We use the net environmental strength (ENV_NET) lagged by two years as instruments for endogenous variable in the 2SLS model. Coeff. is the coefficient on ENV_NET in our two models. All firm level variables are winsorized at 1 and 99 %. Robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level respectively

variation hypothesis 3 is supported for large industries, but not for other small individual industries.

CER-Risk Association Based on MSCI IVA Database

Although the KLD database used is one of the most comprehensive and most respected CSR ratings databases in the world and has been used in hundreds of studies, it does not indicate how it calculates each screening category to determine a company's overall environmental rating. The KLD only provides the assignment of a binary (0 and 1) code to each strength and concern in each of its CSR categories. Moreover, in some cases, the KLD database is incomplete, particularly with respect to those companies that have operations outside the U.S. Finally, the KLD database has an unbalanced panel structure, which raises certain construct validity issues (Chatterji et al. 2009). Nevertheless, Sharfman (1996) and others argue that researchers should feel confident when using the KLD measures to study CSR, particularly because the database taps into the core of CSR.

As of 2015, however, KLD data is really very simplistic in nature, and therefore, MSCI recommends academics to use the MSCI Environmental, Social, and Governance (ESG) Intangible Value Assessment (IVA) Database. For additional robustness check, we use the dataset assembled from MSCI ESG IVA Database. The IVA universe coverage currently comprises the following: Top 1,500 companies of the MSCI World Index; Top 25 companies of the MSCI Emerging Markets Index; Top 275 companies by market cap of the FTSE 100 and the FTSE 250 excluding investment trusts; and ASX 200 across 36 countries or districts. And they provide ratings of 1859 companies in their active universe and archived ratings for an additional 658 previously rated companies.

We use the environmental factors from MSCI ESG IVA database during the period of 2007–2011. From ESG IVA database, we estimate CER measure of environmental index (IVA_ENV) as the arithmetic average of 15 main Intangible Value Assessment (IVA) environmental factors (see the details of IVA_ENV composition in Appendix 5). Table 13 presents the regression results showing that while the number of sample observations is relatively small in U.S. during the 2007– 2011 periods, IVA environmental measure of IVA_ENV is inversely associated with firm risk measures. The coefficients on IVA_ENV remain negative and significant in the presence of all of the control variables in all specifications. As a result, we maintain that the results obtained from MSCI ESG IVA are consistent with our main findings that the firm-level environmental friendly practices contribute to the risk reduction of a company's stock. Thus, this evidence adds to the validity of our empirical results.

Table 13 CER-risk association based on MSCI ESG IVA database

Variables	(1) CAPM_BETA	(2) FF_MKT_BETA	(3) DEVRET	(4) CAPM_BETA	(5) FF_MKT_BETA	(6) DEVRET	(7) CAPM_BETA	(8) DEVRET
IVA_ENV ($t-1$)	−0.0195*** (−3.674)	−0.0088** (−1.970)	−0.0097*** (−3.969)	−0.0196*** (−3.309)	−0.0100** (−2.078)	−0.0087*** (−3.166)	−0.0099* (−1.723)	−0.0043* (−1.652)
LOG_TA ($t-1$)				−0.0164* (−1.827)		−0.0128*** (−2.899)		
LOG_MVE ($t-1$)							−0.0640*** (−7.077)	−0.0349*** (−8.351)
MBR ($t-1$)				0.0009 (0.481)		0.0003 (0.398)	0.0023 (1.192)	0.0011 (1.418)
CAPEXA ($t-1$)				0.7619*** (3.348)	0.4339** (2.188)	0.3214*** (2.754)	0.6737*** (3.040)	0.2866** (2.559)
RNDR ($t-1$)				0.0854 (0.554)	0.1965 (1.507)	0.2690*** (4.262)	0.0798 (0.535)	0.2821*** (4.658)
ADVR ($t-1$)				−0.5645* (−1.734)	−0.1836 (−0.713)	−0.0183 (−0.135)	−0.4695 (−1.519)	0.0343 (0.272)
ROA ($t-1$)				−0.9489*** (−8.025)	−0.3344*** (−3.692)	−0.4655*** (−8.745)	−0.7849*** (−7.126)	−0.3607*** (−7.591)
DEBTR ($t-1$)				0.0149 (0.231)	−0.0576 (−0.998)	0.0732** (2.261)	−0.0504 (−0.801)	0.0381 (1.224)
SALEG ($t-1$)				0.0263 (0.555)	0.1590*** (3.722)	0.0349 (1.489)	0.0532 (1.159)	0.0487** (2.148)
CHG_ROA ($t-1$)				−0.0997 (−0.516)	−0.1431 (−0.900)	−0.1940** (−2.187)	−0.1720 (−0.903)	−0.2369*** (−2.717)
GOV ($t-1$)				0.0027 (0.612)	0.0014 (0.387)	0.0003 (0.156)	0.0022 (0.496)	0.0000 (0.021)
MNCS				0.0738*** (3.224)	0.0203 (1.082)	0.0268** (2.478)	0.1060*** (4.757)	0.0414*** (3.978)
Constant	1.7437*** (33.067)	1.2276*** (26.563)	0.7271*** (26.072)	1.9421*** (17.330)	1.2370*** (25.824)	0.8659*** (16.171)	2.3199*** (23.656)	1.0295*** (21.844)
Year dummy	YES	YES	YES	YES	YES	YES	YES	YES
Industry dummy	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1,634	1,634	1,633	1,610	1,615	1,609	1,610	1,609
R^2	0.460	0.303	0.560	0.493	0.326	0.598	0.509	0.616
Adj. R^2	0.442	0.281	0.546	0.472	0.300	0.582	0.489	0.601

This table displays the baseline multivariate OLS regressions using the data from MSCI ESG IVA database for the sample over the period of 2007–2011. The main independent variable is the environmental index obtained from MSCI ESG IVA database (IVA_ENV). From ESG IVA database, we estimate IVA_ENV as the arithmetic average of 15 main Intangible Value Assessment (IVA) environmental factors (see the details of IVA_ENV composition in Appendix 5). The dependent variable is the CAPM beta in models (1), (4), and (7), Fama–French beta in columns (2) and (5), and stock return volatility in columns (3), (6), and (8). The industry dummy is assigned according to the 2 digits of the SIC code. All firm-level variables are winsorized at 1 and 99 %. Robust t-statistics are presented in parentheses. The definitions of variables are provided in Table 1. ***, **, and * indicate statistical significance at the 1, 5, and 10 %, level respectively

Discussion

Our study makes several important contributions. First, and most obvious, is its contribution to the finance and managerial literature. Our study shows that the choices firms' managers make with respect to environmental issues influence firm risk. Specifically, at least one of the factors underlying managerial decisions related to the environment is their risk management consideration, a factor that has been examined infrequently in the literature on management.

A second important contribution our study makes is related to CSR. A company's environmental policies are generally seen in the literature as part of the company's CSR (Mitchell et al. 1997; Gibson 2000; Kaler 2002; Crane and Matten 2004). Our study shows, therefore, that risk consideration is influenced by a firm's CSR stance, at least to the extent that risk is one of the factors that appears to play a role in managerial decisions to invest in environmental initiatives and activities. Third, we find that the negative CER-firm risk association mainly comes from a few large manufacturing industries. This finding may suggest that the previous findings of an inverse association between CSR and firm risk may also come from a few certain industries that should be investigated.

Our study has a few limitations. First, our study only considers the influence of CER engagement on risk management decisions. There are clearly other factors influencing these decisions, such as economic considerations including the availability of capital to fund CER initiatives, social and political factors, and legal considerations. All of these factors undoubtedly exert some degree of influence on risk management decisions and some may even exert greater influence than CER. Our study is therefore confined to a limited portion of the wide range of factors that influence and motivate a firm's risk management decisions.

Second, our study only looks at firms headquartered in the U.S. There are reasons to think that, without further study, our results should be limited to the U.S. and should not be extrapolated to other nations. The U.S. culture in general differs from the cultures of other nations. The U.S. population tends to be culturally homogeneous, which is not true for the populations of all countries. For this reason, we can neither claim that our conclusions apply to the firms of other nations, nor to companies headquartered in other nations. It would be fruitful, we believe, for future studies to examine whether firm risk in other nations is also affected by CER activities.

Overall, despite these limitations, we consider our main empirical findings of a negative association between firm risk and firm environmental initiatives and the mixed cross-industry evidence of CER-risk association to be an important step in understanding how the CER-risk nexus affects businesses. Nevertheless, both environmental concerns and firm risk are very much moving targets. It would be interesting to see whether future studies find evidence that the relationship between firm risk and a firm's environmental initiatives is subject to change over time.

Conclusion

Over the past decade, CER has drawn considerable interest from regulators, academics, and practitioners as more managers incorporate CER activities into their business operations. Although the demand for environment protection continues to grow all over the world, there has been a dearth of research into measurable economic consequences in risk dimensions with respect to corporate environmental strength.

In this article, we examine the empirical influence of CER involvement on firm risk for a comprehensive sample of U.S. firms from 1991 to 2012. We find that CER engagement is negatively associated with firm risk after controlling for various firm characteristics. This negative association between CER and risk remains intact when we use firm fixed effects, apply alternative CER measures, or mitigate potential endogeneity. This negative relation is possibly from insurance-like protection, improving risk management, providing market appeal to customers, improving information transparency, or simplifying access to financial markets, and is consistent with the risk-reduction hypothesis. Our cross-industry investigation further reveals that the risk reduction mainly comes from certain industries such as Food and Kindred Products, Chemical and Allied Products, and Industrial Machinery and Equipment.

Our study demonstrates that environmental initiatives are generally associated with lower levels of firm risk for a company, a stance that the scholars of finance, management, and environmental studies would see as a positive influence. This risk-reducing effect of CER provides some alternative evidence to the tenacious premise of what we may call the "shareholder wealth maximization" view. Because CER initiatives typically require initial investments that do not have a short-term pay-off and are likely to have no positive pay-off even in the long run, managers do not invest in CER initiatives unless legally required to do so. Externalities considerations, therefore, play no role in the managers' environmental decisions, which are instead governed by considerations related to shareholder value maximization or compliance with environmental laws. Contrary to the profit motive-based intuition, our results suggest that investors, financial managers, and other stakeholders, including policy makers dealing with CER initiatives, should continue to pursue environment-oriented initiatives, given that firms with higher CER initiatives show reduced firm risk.

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Appendix

Appendix 1

See Fig. 1.

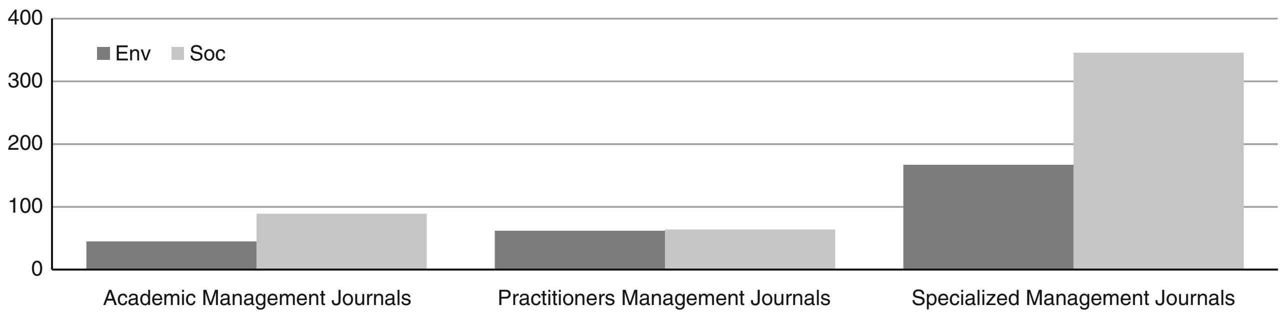

Fig. 1 Number of Articles Published in CER and CSR (1995-2013). This appendix is a reproduction of Fig. 2 in Montiel and Delgado-Ceballos (2014). It counts the number of articles published in Academic Management Journals, Practitioners Management Journals, and Specialized Management Journals in two subject areas, environmental management, and corporate social responsibility (1995–2013)

Appendix 2

See Table 14.

Table 14 Measurements of CSR and CER

	Dow Jones Sustainability Index	Global Reporting Initiative	Bansal (2005)	Kolk et al. (2010)
Social	1. Human capital development 2. Talent attraction and retention 3. Occupational health and safety 4. Stakeholder engagement 5. Social reporting	1. Labor practices and decent work 2. Human rights 3. Society 4. Product responsibility	1. Considered stakeholder interests 2. Communicated environmental risk 3. Improved health and safety issues 4. Protected local communities' rights 5. Improved facility's visual aspect 6. Funded local community projects	1. Labor/management relations 2. Occupational health and safety 3. Training 4. Equal opportunity 5. Child labor/force labor 6. Community, volunteer program 7. Corruption, equality, and mutual benefit 8. Consumer health and safety, labeling, marketing communities
Environmental	1. Environmental mgmt system 2. Environmental performance 3. Climate strategy 4. Product stewardship 5. Biodiversity	1. Materials 2. Energy 3. Water 4. Biodiversity 5. Emissions, effluents, and waste 6. Products and services 7. Compliance 8. Transport 9. Overall	1. Products' harmful environmental impacts 2. Environmentally damaging inputs 3. Inputs from renewable sources 4. Environmental impacts of processes 5. Operations in environmentally sensitive locations 6. Likelihood of environmental accidents 7. Reduced waste 8. Re-used waste 9. Disposed waste responsibly 10. Handled toxic waste responsibly	1. Recyclable materials 2. Energy conservation 3. Emissions and waste

This appendix originates from Table 4 in Montiel and Delgado-Ceballos (2014). It lists the items used for measuring the social dimension and the environmental dimension of corporate sustainability (CS) in various studies and secondary sources

Appendix 3

See Table 15.

Table 15 List of environmental strength and environmental concern dimensions in KLD

ENVIRONMENT STRENGTHS (ENV_STR_)
ENV_STR_A (environmental opportunities): This indicator evaluates how companies are taking advantages of opportunities in the market for environmental technologies, and/or to develop or refurbish buildings with green building characteristics including lower embodied energy, recycled materials, lower energy and water use, waste reduction, and healthier and more productive working environments. (from 1991)
ENV_STR_B (waste management): This indicator evaluates companies that are at risk of incurring liabilities associated with pollution, contamination, and the emission of toxic and carcinogenic substances, and/or companies that produce or sell electronic products face risks associated with recycling and/or disposal of end-of-life electronic products. (from 1991)
ENV_STR_C (packaging materials & waste): This indicator evaluates companies are that at risk of losing access to markets or at risk of facing added costs to come into compliance with new regulations related to product packaging content and end-of-life recycling or disposal of packaging materials. (from 1991)
ENV_STR_D (climate change): This indicator measures a firm's policies, programs, and initiatives regarding climate change. (from 1991)
ENV_STR_F (property, plant, and equipment): The company maintains its property, plant, and equipment with above average environmental performance for its industry. (from 1991 to 1995)
ENV_CON_G (environmental management systems): This indicator measures whether a firm has an environmental management system (EMS) in place, and whether it is certified to a third party standard, such as ISO 14001. (from 2006)
ENV_STR_H (water stress): This indicator evaluates how well companies manage the risk of water shortages impacting their ability to operate, losing access to markets due to stakeholder opposition over water use, or being subject to higher water costs. (from 2012)
ENV_STR_I (biodiversity & land use): This indicator evaluates how companies manage the risk of losing access to markets, and incurring litigation, liability, or reclamation costs due to operations that damage fragile ecosystems. (from 2012)
ENV_STR_J (raw material sourcing): This indicator evaluates how companies manage the risks of damaging their brand value by sourcing or utilizing raw materials with high environmental impact. (from 2012)
ENV_STR_X (other strength): This indicator measures a firm's environmental management policies, programs and initiatives that are not covered by any other MSCI ESG Research environmental ratings metrics. Factors affecting this evaluation include, but are not limited to, companies are at risk of credit defaults resulting from poor due diligence processes related to environmental concerns. (from 1991)
ENVIRONMENT CONCERN (ENV_CON_)
ENV_CON_A (hazardous waste): 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. (from 1991 to 2009)
ENV_CON_B (regulatory compliance): This indicator measures a firm's record of compliance with environmental regulations. Factors affecting this evaluation include, but are not limited to, fines/sanctions for causing environmental damage, and/or violations of operating permits. (from 1991)
ENV_CON_C (ozone-depleting chemicals): The company is among the top manufacturers of ozone-depleting chemicals such as HCFCs, methyl chloroform, methylene chloride, or bromines. (from 1991 to 2009)
ENV_CON_D (toxic spills & releases): This indicator measures the severity of controversies related to a firm's hazardous waste spills and releases. (from 1991)
ENV_CON_F (climate change): This indicator measures the severity of controversies related to a firm's climate change and energy-related policies and initiatives. (from 1999)
ENV_CON_G (impact of products & services): This indicator measures the severity of controversies related to the environmental impact of a firm's products and services. (from 2010)
ENV_CON_H (biodiversity & land use): This indicator measures the severity of controversies related to a firm's use or management of natural resources. (from 2010)
ENV_CON_I (operational waste): This indicator measures the severity of controversies related to the impact of a firm's non-hazardous operational waste. (from 2010)
ENV_CON_J (supply chain management): This indicator measures the severity of controversies related to the environmental impact of a company's supply chain and the sourcing of natural resources (from 2012)
ENV_CON_K (water management): This indicator measures the severity of controversies related to a firm's water management practices. (from 2012)
ENV_CON_X (other concern): This indicator measures the severity of controversies related to a firm's environmental impact. (from 1991)

This appendix lists the 10 strength and 11 concern dimensions in the KLD environment category based on KLD'S Ratings Definitions, User Guide & ESG Ratings Definition 2011, 2012, and 2013. For each strength or concern, a company is given a rating indicator of 0 or 1. KLD uses dummy values to identify a company's environmental status. A rating of 1 implies a company's significant involvement in that specific environmental issue and 0 indicates no such involvement

Appendix 4

See Table 16.

Table 16 2-Digit SIC (standard industrial classification) codes

A.	Division A	Agriculture, Forestry, and Fishing
		Major Group 01: Agricultural Production Crops
		Major Group 02: Agriculture Production Livestock and Animal Specialties
		Major Group 07: Agricultural Services
		Major Group 08: Forestry
		Major Group 09: Fishing, Hunting, and Trapping
B.	Division B	Mining
		Major Group 10: Metal Mining
		Major Group 12: Coal Mining
		Major Group 13: Oil and Gas Extraction
		Major Group 14: Mining and Quarrying of Nonmetallic Minerals, Except Fuels
C.	Division C	Construction
		Major Group 15: Building Construction General Contractors and Operative Builders
		Major Group 16: Heavy Construction other than Building Construction Contractors
		Major Group 17: Construction Special Trade Contractors
D.	Division D	Manufacturing
		Major Group 20: Food And Kindred Products
		Major Group 21: Tobacco Products
		Major Group 22: Textile Mill Products
		Major Group 23: Apparel and Other Finished Products Made From Fabrics and Similar Materials
		Major Group 24: Lumber and Wood Products, Except Furniture
		Major Group 25: Furniture and Fixtures
		Major Group 26: Paper and Allied Products
		Major Group 27: Printing, Publishing, and Allied Industries
		Major Group 28: Chemicals and Allied Products
		Major Group 29: Petroleum Refining and Related Industries
		Major Group 30: Rubber and Miscellaneous Plastics Products
		Major Group 31: Leather And Leather Products
		Major Group 32: Stone, Clay, Glass, and Concrete Products
		Major Group 33: Primary Metal Industries
		Major Group 34: Fabricated Metal Products, Except Machinery and Transportation Equipment
		Major Group 35: Industrial and Commercial Machinery and Computer Equipment
		Major Group 36: Electronic and Other Electrical Equipment and Components, Except Computer Equipment
		Major Group 37: Transportation Equipment
		Major Group 38: Measuring, Analyzing, and Controlling Instruments; Photographic, Medical And Optical Goods; Watches and Clocks
		Major Group 39: Miscellaneous Manufacturing Industries
E.	Division E	Transportation, Communications, Electric, Gas, and Sanitary Services
		Major Group 40: Railroad Transportation
		Major Group 41: Local and Suburban Transit And Interurban Highway Passenger Transportation
		Major Group 42: Motor Freight Transportation and Warehousing
		Major Group 43: United States Postal Service
		Major Group 44: Water Transportation
		Major Group 45: Transportation by Air
		Major Group 46: Pipelines, Except Natural Gas
		Major Group 47: Transportation Services

Table 16 continued

		Major Group 48: Communications
		Major Group 49: Electric, Gas, and Sanitary Services
F.	Division F	Wholesale Trade
		Major Group 50: Wholesale Trade-durable Goods
		Major Group 51: Wholesale Trade-non-durable Goods
G.	Division G	Retail Trade
		Major Group 52: Building Materials, Hardware, Garden Supply, and Mobile Home Dealers
		Major Group 53: General Merchandise Stores
		Major Group 54: Food Stores
		Major Group 55: Automotive Dealers and Gasoline Service Stations
		Major Group 56: Apparel and Accessory Stores
		Major Group 57: Home Furniture, Furnishings, and Equipment Stores
		Major Group 58: Eating and Drinking Places
		Major Group 59: Miscellaneous Retail
H.	Division H	Finance, Insurance, and Real Estate
		Major Group 60: Depository Institutions
		Major Group 61: Non-depository Credit Institutions
		Major Group 62: Security and Commodity Brokers, Dealers, Exchanges, and Services
		Major Group 63: Insurance Carriers
		Major Group 64: Insurance Agents, Brokers, and Service
		Major Group 65: Real Estate
		Major Group 67: Holding and Other Investment Offices
I.	Division I	Services
		Major Group 70: Hotels, Rooming Houses, Camps, and Other Lodging Places
		Major Group 72: Personal Services
		Major Group 73: Business Services
		Major Group 75: Automotive Repair, Services, and Parking
		Major Group 76: Miscellaneous Repair Services
		Major Group 78: Motion Pictures
		Major Group 79: Amusement and Recreation Services
		Major Group 80: Health Services
		Major Group 81: Legal Services
		Major Group 82: Educational Services
		Major Group 83: Social Services
		Major Group 84: Museums, Art Galleries, and Botanical and Zoological Gardens
		Major Group 86: Membership Organizations
		Major Group 87: Engineering, Accounting, Research, Management, and Related Services
		Major Group 88: Private Households
		Major Group 89: Miscellaneous Services
J.	Division J	Public administration
		Major Group 91: Executive, Legislative, and General Government, Except Finance
		Major Group 92: Justice, Public Order, and Safety
		Major Group 93: Public Finance, Taxation, and Monetary Policy
		Major Group 94: Administration Of Human Resource Programs
		Major Group 95: Administration of Environmental Quality And Housing Programs
		Major Group 96: Administration of Economic Programs
		Major Group 97: National Security and International Affairs
		Major Group 99: Nonclassifiable Establishments

The details on information of sic classification are available from United States department of labor at https://www.osha.gov/pls/imis/sic_manual.html

Appendix 5

See Table 17.

Table 17 MSCI IVA scores

IVA factor	IVA sub-score			Key metrics
Environmental risk factors (*ESG_ERF*)	*ER1*	1	Historic liabilities	Controversies including natural resource-related cases, widespread or egregious environmental impacts
	ER2	2	Operating risk	Emissions to air, discharges to water, emission of toxic chemicals, nuclear energy, controversies involving non-GHG emissions
	ER3	3	Leading/sustainability risk indicators	Water management and use, use of recycled materials, sourcing, sustainable resource management, climate change policy and transparency, climate change initiatives, absolute and normalized emissions output, controversies
	ER4	4	Industry-specific risk	Default = 5, if no significant industry-specific risk identified
Environmental management capacity (*ESG_EMC*)	*EMC1*	5	Environmental strategy	Policies to integrate environmental considerations into all operations, environmental management systems, regulatory compliance, controversies
	EMC2	6	Corporate governance	Board independence, management of CSR issues, board diversity, compensation practices, controversies involving executive compensation and governance
	EMC3	7	Environmental management systems	Establishment and monitoring of environmental performance targets, presence of environmental training, stakeholder engagement
	EMC4	8	Audit	External independent audits of environmental performance
	EMC5	9	Environmental accounting/reporting	Reporting frequency, reporting quality
	EMC6	10	Environmental training & development	Presence of environmental training and communications programs for employees
	EMC7	11	Certification	Certifications by ISO or other industry- and country-specific third party auditors
	EMC8	12	Products/materials	Positive and negative impact of products & services, end-of-life product management, controversies related to environmental impact of P&S
Environmental opportunity factors (*ESG_EOF*)	*EO1*	13	Strategic competence	Policies to integrate environmental considerations into all operations and reduce environmental impact of operations, products & services, environmental management systems, regulatory compliance
	EO2	14	Environmental opportunity	Beneficial products and services that reduce others' consumption of energy, production of hazardous chemicals, and overall resource consumption
	EO3	15	Performance	Percent of revenue represented by identified beneficial products & services

Source MSCI Environmental, Social, and Governance (ESG) Intangible Value Assessment (IVA) Database

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