# Good news for environmental self-regulation? Finding the right link

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**Abstract**

We investigate financial incentives driving firm disclosure of positive environmental information and the link to environmental outcomes. We classify disclosure by informational content, and find that forward-looking announcements and recognition by a third party bear the largest financial incentives, though only the latter has a strong link to environmental outcomes. Beyond valuing firm financials, the stock market values firm social, environmental, and corporate governance performance as a whole. Our results identify third-party recognition as a channel through which environmental information may induce self-regulation.

**Keywords:** environmental disclosure, environmental responsibility, event study, financial incentives, information as regulation, media release, positive environmental activities, stock returns

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# 1 Introduction

Environmental economists have generated nearly unanimous empirical evidence that public news regarding negative environmental performance of a firm leads to significantly negative financial outcomes for the firm. For example, the initial response of the stock market to mandatory reporting of pollution data to the Toxics Release Inventory was a significantly negative shock to firm returns (Hamilton, 1995), and the stock market loss was larger for more polluting firms relative to firms with better environmental performance (Khanna et al., 1998; Lanoie et al., 1998). Capelle-Blancard and Laguna (2010) find that the stock market reacts significantly to news of chemical disasters, and that the loss in value is related to the seriousness of the disaster; Konar and Cohen (2001) show that poor environmental performance has a significant effect on a firm's intangible asset value, or environmental reputation.

A quite powerful implication of these empirical findings is the opportunity for public information regarding a firm's environmental performance to serve as a lever through which environmental policymakers can augment existing regulations (Konar and Cohen, 1997; Khanna et al., 1998). A firm responds to financial incentives – if environmental liabilities lead to financial liabilities, a firm adjusts its behavior to improve performance. Policymakers can exploit the firm's incentive to reduce pollution (Konar and Cohen, 1997; Khanna et al., 1998) and improve its environmental reputation (Konar and Cohen, 2001; Flammer, 2013). For example, Khanna et al. (1998) show that the release of public information on toxic releases can effectively induce firms to reduce on-site releases and increase off-site transfer of waste.

Our contribution is to assess the extent to which public information regarding *positive* environmental news can also serve as a policy lever to induce firm self-regulation. However, unlike in the case of negative environmental information, the links between positive environmental activities, financial performance, and environmental improvements are not always clear. Negative information (e.g., pollution figures or a chemical disaster) signals responsibility for direct costs of clean up as well as indirect costs of long-term compliance, possible tightening of regulations, and issues related to management inefficiency. Yet, in the case of *positive* environmental information, these links are not well-defined. Should investors view positive environmental activities as long run costs, and respond adversely (Friedman, 1970)? Or, should investors applaud improved production efficiency and/or a strengthened corporate reputation, and look forward to higher profits from increased product differentiation, consumer demand, and loyalty (Ambec and Lanoie, 2008)? Even if we can predict investors' reactions, does the positive environmental activity bear real environmental improvements that policymakers desire? We discuss these issues in detail, and empirically examine the extent to which positive information might induce self-regulation.

Our work is related to recent research that has investigated firm motivation for participating in voluntary environmental abatement programs (Khanna and Damon, 1999; Vidovic and Khanna, 2007) as well as the impact on firm value of environment-related activities (Klassen and McLaughlin, 1996; Khanna and Damon, 1999; Fisher-Vanden and Thorburn, 2011; Lyon and Shimshack, 2012; Oberndorfer et al., 2013). In line with our intuition that the links between environmental information, financial performance, and environmental quality are not always clear, is a lack of consensus as to firm motivation for participating in voluntary environmental abatement programs, the impact of voluntary abatement initiatives on environmental quality, and the impact of these activities on firm financial performance.

Our work builds on previous research in several important ways. Instead of focusing exclusively on environmental activities of a particular type (e.g., Lyon and Shimshack, 2012) or related to participation in a particular program (e.g., Fisher-Vanden and Thorburn, 2011), we focus on a wide array of environmental activities. We use the scope of these activities to explore differences in information contained in different types of events, so that we can better understand the signal that public information regarding different positive environmental activities transmits to investors as well as environmental policymakers. The scope of our analysis allows us to identify factors contributing to the lack of consensus in previous research and reconcile the inconsistent findings.

We apply econometrically robust empirical strategies, many of which have yet to be widely used in the current context. In addition to standard conditional mean regressions and normally distributed test statistics, we use standardized and nonparametric test statistics that are designed to address poor performance issues commonly associated with standard statistical tests (Corrado, 1989; Cowan, 1992; Acharya, 1993; Corrado, 2011). We also use conditional quantile and nonlinear regression models to explore heterogeneity across different firms and environmental activities, and assess the extent to which endogeneity is a driving factor behind empirically observed links between environmental information and financial performance.

The driving focus behind our analysis is a better understanding of the link between positive environmental activities and *actual* environmental performance. Somewhat surprisingly, the literature has not developed these links well; yet, understanding these links is crucial for understanding the potential for positive environmental information to induce firm self-regulation and to augment traditional regulation. We assess the links between positive environmental activities and actual environmental performance in two ways. First, we focus on the nature of the information in different types of events – such as the degree of details, or the timing/stage of the activity being described – to assess which types of events most likely indicate actual environmental change. Second, we incorporate three different firm-level indices that measure firm transparency in environmental activities, firm environmental performance, and overall performance in terms of environ-

mental, social, and corporate governance (Flammer, 2013).[1] This allows us to ascertain whether investors are more likely to respond favorably to news of positive environmental activities for firms that are merely transparent in their environmental activities, or to firms that have established a track record of environmental improvements. From a policy perspective, it is critical that the event describes an activity that likely leads to environmental change, and that the link between positive environmental activities and financial incentives depend significantly on actual environmental performance, and not merely transparency.

We find that there is, in general, a significantly positive stock market reaction to news of positive environmental activities. We also find that self-made announcements of planned future activities bear the largest increase in stock returns among all types of activities in our sample, and recognition of positive environmental performance by a third party bears the second largest financial incentive. The credibility of the latter type via third party recognition also implies a link to real environmental outcomes. We investigate whether firms release positive environmental information strategically, and we find some evidence that some positive environmental news may be released strategically to offset the impact of other news on stock prices. Hence, we cannot rule out the possibility that firms choose the date of certain environmental media releases. We also find that investors benchmark to past corporate social responsibility, but not environmental performance specifically, when receiving new environmental information.

# 2 Theoretical and Empirical Perspectives

## Theoretical Perspectives

The traditional perspective on firm environmental responsibility is that voluntary environmental action comes at a cost to the firm. The firm's objective is to maximize profits, and an executive that directs a firm towards any other goal is not working in the best interest of the firm's shareholders (Friedman, 1970). However, this view has been challenged because firm self-regulation and positive environmental activities may lead to a competitive advantage through benefits such as customer loyalty, and generate revenues that offset the costs of undertaking environmental activities.

The stakeholder theory (Freeman, 1984) states that a firm should consider the interests of all stakeholders, including employees and customers. Different stakeholders have different interests in the firm, and may not be exclusively focused on (short-run) profitability. For instance, long run profitability may be driven by consumer loyalty, which may be a function of voluntary environmental action that may or may not maximize

[1] Environmental disclosure measures only transparency in the environmental activities of the firm, which may be negative, and may not reflect actual environmental performance.

short-run profits. Several theories further suggest specific channels through which firm environmental activities may enhance long-run profitability. The instrumental stakeholder theory (Jones, 1995) states that ethical firm behavior establishes a lasting relationship between the firm and stakeholders by improving firm reputation. The "Porter Hypothesis" aligns a firm's environmental goals with its industrial competitiveness (Porter and Van der Linde, 1995), and the theory of firm resources (Russo and Fouts, 1997) argues that the firm's ability to manage its tangible and intangible resources related to the environment can affect its competitiveness. Environmental responsibility may also be a strategy for product differentiation (McWilliams and Siegel, 2001).

## Empirical Evidence

Empirical findings in terms of the financial impact of positive environmental activities are mixed. Several studies find a negative financial impact of positive environmental activities that imply clear costs to the firm. Gilley et al. (2000) examine product-driven and process-driven corporate environmental actions separately, and find that process-driven activities generate significantly negative abnormal returns.[2] Fisher-Vanden and Thorburn (2011) find shareholder wealth *loss* following news that a firm voluntarily joined the EPA's "Climate Leaders" program, which commits a firm to reducing greenhouse gas emissions. Oberndorfer et al. (2013) find a significantly negative stock market reaction to the inclusion of German firms in the Dow Jones Sustainability World Index, and conclude that the negative reaction indicates financial penalty rather than reward for environmental commitment due to the operating costs. Hassel et al. (2005) find a negative relationship between firm environmental performance and market value of equity, and conclude that investors do not value environmental performance due to associated costs. Others suggest that there may be potential differences in the financial impact of positive environmental activities across industries. Filbeck and Gorman (2004) focus on the relationship between firm financial and environmental performance for public utilities and find the relationship to be negative.

Gilley et al. (2000) do not find a significant stock market reaction to product-driven corporate environmental activities, though a positive financial impact is expected through increased consumer demand and revenue. Fisher-Vanden and Thorburn (2011) also find insignificant stock market reaction following news of firms joining the EPA's "Ceres" program which advocates sustainable business practice. Lioui and Sharma (2012) show that although environmental initiatives are negatively associated with firm financial performance, there is a positive indirect effect of such initiatives through firm research and development which may benefit the firm through increased efficiency. This is consistent

[2]Although some process-driven environmental initiatives aim at reducing costs, the implementation of the initiatives is associated with direct costs, for example, through redesigning the firm's production system.

with the argument by Bushnell et al. (2013) in the context of environmental regulations: investors understand the positive revenue impact of certain environmental regulations, instead of focusing on the compliance cost, and in industries such as electricity, the revenue increase can largely offset the regulatory cost. While improving environmental performance may be costly to the firm, investors see beyond the direct cost and incorporate into their valuation of the firm the impact of superior environmental performance on the firm's ability to generate longer term profit, through channels such as increased revenue and lower risk.

Several studies find a positive stock market reaction to news of an environmental award or recognition of firm environmental performance, in which case explicit costs are not usually mentioned. Klassen and McLaughlin (1996) find that media release of winning an environmental award generates a positive and significant stock market reaction, and Lyon and Shimshack (2012) find that firms ranked in the top 100 (of 500 greenest companies) in Newsweek Magazine's "Greenest Companies ratings" in 2009 have significantly greater abnormal stock returns than the bottom 400. Besides, Albuquerque et al. (2014) find evidence that firms with corporate social responsibility attributes have more loyal demand, which in turn increases firm value. This result is consistent with the theory.

Empirically, there is considerable evidence supporting both a negative effect on firm value and a positive effect on firm value due to environmental activities. In some cases there are clearly different signals of information transmitted to investors, which leads to significantly different stock market reactions. For example, events implying clear costs to the firm tend to lead to a negative financial impact, while environmental recognitions tend to generate a positive effect. In other cases, there is a lack of solid theoretical explanation to support the empirical findings. For example, there is empirical evidence of positive, insignificant, and negative financial impact of environmental activities regarding consumer demand. We add to the literature by investigating financial incentives driving firm disclosure of environmental information by type of information and type of firm.

# 3 Types of Environmental News and Information

According to the Efficient Market Hypothesis, stock prices incorporate and reflect all relevant information that is available to the market. We therefore expect the stock market reaction to positive environmental news to depend on the extent to which the information conveyed is new – all else equal, news that contains a higher degree of new information is likely to generate a larger stock market response. Furthermore, a rational investor values an event based on the expected net present value of the underlying activity. We expect that in the context of positive environmental news, the manner in which the cost of the activity is described, and the likelihood that (future) costs will be incurred, influence the

expected net present value.

Accordingly, we separate positive environmental news into four categories depending on the newness of information and the level of certainty that the associated cost will be incurred. In doing so, we also consider whether the disclosed activity is likely to lead to actual environmental outcomes, and/or the credibility of the source of the information. The likelihood of the event leading to actual environmental improvements, which is in part a function of the credibility of the event, is of primary interest to policymakers and environmental stakeholders. Discriminating between different types of environmental news allows us to study both the overall financial incentive associated with positive environmental news, the importance of different types of information contained in different types of news, and the implications for environmental outcomes.[3]

We classify news of positive environmental activities into four types:

> **Action** - a current or completed activity that leaves a positive environmental impact or demonstrates firm environmental responsibility;
> **Announcement** - a forthcoming activity initiated by the firm that demonstrates environmental responsibility;
> **Recognition** - recognition of a firm by a third party for its environmental performance;
> **Report** - the release of a firm's environmental report, or a corporate social responsibility report that highlights its environmental activities.

To some extent, all four types of events are likely to generate consumer loyalty and serve as a means of product differentiation. However, different types of events entail significant differences in terms of the newness of information, the economic costs and benefits anticipated by investors, the expected environmental outcome, and how credible the news is, which lead to heterogeneity in the expected financial impact to the firm.

We define action events to be those that are self-reported by the firm, but are ongoing or are at the concluding stages of the environmental activity. While it is possible that the information contained in action events may be completely new to the market, it is likely that news about the environmental activity was made available to the market at an earlier time, for example, at the planning stage. Hence the newness of information for action events lies primarily with an update regarding the stage of the environmental activity. Compared to announcement events, an environmentalist or a policymaker may be more

[3]Very few studies differentiate between types of environmental events (e.g., Gilley et al., 2000). On the contrary, most studies examine stock market reactions to a particular type of positive environmental information (Klassen and McLaughlin, 1996; Fisher-Vanden and Thorburn, 2011; Lyon and Shimshack, 2012). Not only does the variation in event type across studies limit our understanding of the relationship between positive environmental information, financial incentives, and firm environmental performance, this also potentially explains why different studies reach different conclusions.

excited about action events as these events imply current environmental improvements, and with certainty. Yet, action events imply significant costs to the firm that have already materialized. A firm that is reducing its petroleum use according to a multiple-year agreement with the Department of Energy will continue to incur costs until the goal is reached.[4] In addition, the explicit details often included in the news allow readers to assess current and future costs to the firm based on its environmental commitment.[5]

Announcement events are self-reported and forward-looking; for example, a firm plans to launch a new environmental program.[6] The information in announcement events is completely new to the market. Despite being forward-looking, these events communicate environmental stewardship and sustainability of the firm, and likely go a long way in establishing a positive environmental reputation for the firm. At the same time, the cost of the activity will only occur in the future with some probability, which makes it difficult to assess the realized costs to the firm if the activity is undertaken. Therefore, compared to action events, announcement events imply less certain, and in some cases less measurable, future costs as there is no guarantee of fulfillment. This uncertainty also means that these events are less likely to imply actual environmental improvements.

Recognition and report events are both based on the overall environmental performance of the firm over a previous period. Recognition events remind the market of firm past environmental efforts and inform of firm achievements in environmental stewardship. Although recognitions are based on past environmental activities, the newness of this type of event lies in the acknowledgment of the additional achievement, which is not previously known by the market. Since recognition comes from a third party, the associated environmental outcome for this type of information is the most credible among all four types considering the additional verification process, and therefore it is likely of the most interest to policymakers. A recognition event also indicates actual environmental improvements, which are inevitably associated with costs to the firm. The costs are not usually measurable, however, since details of the firm's environmental activities are not included in the media release; instead only general descriptions and accolades of the achievements are provided.

Environment-related reports are typically issued annually. A firm summarizes its efforts and achievements in environmental responsibility over the past year, which directly link to environmental improvements. Plans and outlooks for environmental commitment

[4]In our sample, approximately 90 percent of the action type events are associated with longer term costs that will be carried into the future, while the rest implies one-time costs.

[5]For example, in a news release, the clothing retailer Ann Inc. provided many details of its emissions reduction efforts: in the year 2012 it achieved a 20 percent reduction of emissions over its 2008 baseline, through activities such as installing over 50,000 LED light bulbs in almost 400 stores.

[6]It is also possible for announcement events to be associated with continued costs that are a part of a longer term agenda (for example, a firm renews its commitment to an existing environmental program). The difference between this case and an ongoing action is that the former activity will take place at a future time, and the latter is happening at the time of the news release. In our sample, about 82 percent of the announcement type events imply only future cost.

are provided as well, which comprise the newness of information in this type of event. Hence, the report type is associated with both past and longer term costs and benefits. Compared to the recognition type, these costs and benefits are directly measurable, since a firm provides details of its environmental achievements, the stage it is at towards achieving long-term goals, and specific activities planned for the future.

Table 1 provides an example of each type of media release from our sample. Across all types, the content of the stories indicates substantial commitment by the firm to protect the environment. For the action type, Dean Foods' new refrigerated transportation fleet significantly reduces the firm's carbon footprint. Under the announcement type, Bank of America plans to invest a considerable sum of $20 billion in environmental programs. Computer Science Corporation's press release for its recognition by FTSE4Good Index uses strong words such as "stringent" and "positioned to capitalize", indicating the firm's superior social and environmental performance will considerably benefit the firm. For the report type, Chevron Corporation informed investors of its performance related to environmental issues that are frequently topics of broad public interest: greenhouse gas emissions and disaster recovery.

Since the environmental commitments communicated in these media releases constitute a financial commitment, our *a priori* expectation is that these events generate a statistically significant stock market response. In addition, we expect that investors react differently to different types of events that bear qualitative differences in information. What remains to be seen is whether these financial incentives align with actual improvements in environmental quality, or simply disclosure of activities that are deemed environmentally responsible.

# 4 Data and Methodology

## Media Release

We generate our sample through a keyword search in Factiva and LexisNexis Academic designed to identify all news releases and articles related to the environmental responsibility of public firms listed on the New York Stock Exchange from January 2005 to December 2014. The keywords we use are "environmental responsibility", "environmental stewardship", and "environment AND sustainability". Since firms' environmental responsibility often falls into the broader context of corporate social responsibility, we also use "corporate social responsibility AND environment", focusing on events with an emphasis on environmental issues. We obtain 344 media releases related to positive environmental activities, including 52 actions, 43 announcements, 121 recognitions, and 128 reports.

Figure 1 shows the distribution of the media releases in our sample by type and across

**Table 1:** Examples of positive environmental media release by type

| Type | Event Date | Event Description |
|---|---|---|
| Action | July 9, 2010 | **Dean Foods** unveils a new diesel-free, hybrid electric-powered truck refrigeration system which is cost-efficient and environmentally-sustainable, and significantly reduces emissions. |
| Announcement | March 6, 2007 | **Bank of America** announces its launching of a 20 billion USD Environmental Program on various business activities that include energy efficiency and emissions offsets. |
| Recognition | July 19, 2010 | **Computer Science Corp** is recognized by the FTSE4Good Index Series. Companies in the Series have met stringent social and environmental criteria, and are positioned to capitalize on the benefits of responsible business practice. |
| Report | April 24, 2006 | **Chevron Corporation** issues Corporate Responsibility Report 2005, which provides details on the company's environmental performance, such as natural disaster recovery assistance and greenhouse gas emissions reduction. |

years. Overall there is an increasing trend in the total number of media releases over time, as well as in the number of recognitions and reports, while actions and announcements remain relatively flat. Because of high stock market volatility during the 2008 financial crisis, we focus our analysis on the subsample of events that excludes 19 events for which the estimation period spans the fall of 2008 (Fisher-Vanden and Thorburn, 2011). Our results are similar regardless of whether or not these 19 events are included.

## Stock Returns

For each media release, we obtain the firm's ticker symbol from Bloomberg and the daily stock returns, defined as the holding period return, from the Center for Research in Security Prices (CRSP) for both the estimation window and event window (defined below). We also obtain the benchmark equal-weighted market return from CRSP which is preferred to the value-weighted market return in empirical analyses (Brown and Warner,

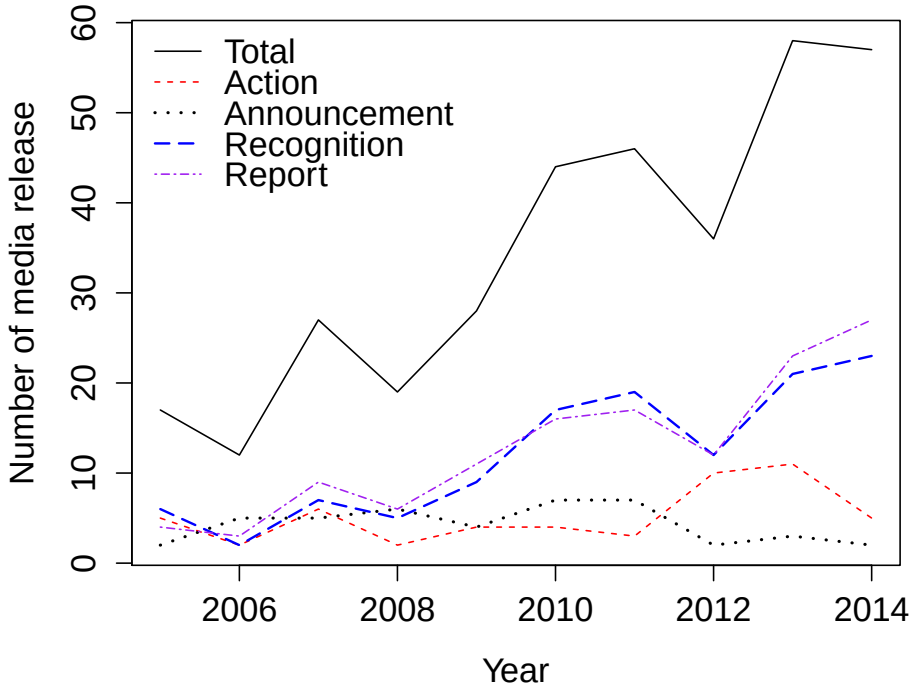


**Figure 1:** Distribution of the media releases in the sample over time and by type

1985; Corrado, 2011). The firms in our sample span all 11 Standard and Poor Economic Sectors, including Consumer Staples (17 percent of our sample), Technology (13 percent), Consumer Cyclicals (12 percent), Utilities (10 percent), Basic Materials (9 percent), Capital Goods (7 percent), Transportation (6 percent), and the rest being Communication Services, Energy, Financials, Healthcare, and Technology.

## Assessing the Market Reaction

**Standard Method** We perform an event study to estimate the abnormal return, or the extent to which the observed (actual) stock return deviates from the expected rate of return, using the single-factor market model (MacKinlay, 1997).[7] Let the date of the event, i.e., the date of the environmental media release, be day 0. We use an estimation window of 130 trading days prior to a week before the event date, i.e. day -135 to day -6. To estimate the normal stock return, the daily returns of stock $i$ are regressed on the market return over the estimation window:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it},\ t \in [-135, -6],\ i = 1, 2, ..., N, \tag{1}$$

[7]As a robustness check, we also use two alternative models – the single factor CAPM model and the Fama-French three-factor model – to predict the normal returns. The event study results of these models are qualitatively similar to the market model.

where $R_{it}$ is the return of stock $i$ on day $t$, $R_{mt}$ is the equal-weighted market return on day $t$, $\beta_i$ and $\alpha_i$ are parameters to be estimated from the regression, and $\epsilon_{it}$ is the error term such that $E(\epsilon_{it}) = 0$ and $Var(\epsilon_{it}) = \sigma^2_{\epsilon_i}$. The abnormal return ($AR$) for stock $i$ on day $t$ is given by

$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt},\ t \in [\tau_1, \tau_2], \tag{2}$$

where $\tau_1$ and $\tau_2$ denote the beginning and the end of the event window. We consider two event windows spanning the days [-1, 2] and [-1, 3]. To estimate the total impact of the event, the daily abnormal returns are aggregated into the cumulative abnormal return ($CAR$) for stock $i$

$$CAR_i(\tau_1, \tau_2) = \sum_{t=\tau_1}^{\tau_2} AR_{it}. \tag{3}$$

Since there is no overlap in the event windows across securities in our sample, we assume that the abnormal returns are independent across securities, yielding the sample average $CAR$

$$\overline{CAR}(\tau_1, \tau_2) = \frac{1}{N} \sum_{i=1}^{N} CAR_i(\tau_1, \tau_2). \tag{4}$$

Given the standard assumption that $\overline{CAR}(\tau_1, \tau_2) \sim N\left[0, Var(\overline{CAR}(\tau_1, \tau_2))\right]$, the test statistic is

$$\theta = \frac{\overline{CAR}(\tau_1, \tau_2)}{[Var(\overline{CAR}(\tau_1, \tau_2))]^{\frac{1}{2}}} \sim N(0, 1). \tag{5}$$

With the null hypothesis of $\theta = 0$, a significantly positive $\theta$ suggests that positive environmental media releases have a positive and significant effect on a firm's stock value (MacKinlay, 1997).

**Testing Issues and Robustness Checks** The standard event study approach has been criticized because it assumes that stock returns are normally distributed, when often empirical evidence does not support this assumption. One important consequence of violating this assumption is that the standard hypothesis test has low power (Corrado, 1989; Cowan, 1992), which means that when stock returns are not normally distributed, the standard method is not able to reliably detect deviations from the null hypothesis. The standard approach is also likely to falsely reject the null hypothesis when there is event-induced variance, that is, when events have differing effects on firms which increases the cross-sectional dispersion of stock returns (Brown and Warner, 1985; Boehmer et al., 1991). To test our hypothesis in a framework that is robust to these potential issues, we include two alternative tests, the generalized sign test and the standardized cross-sectional test.

The generalized sign test addresses the issue of non-normality in the distribution of

stock returns by comparing the number of the securities with positive cumulative abnormal returns in the event window and the number of expected positive cumulative abnormal returns had the event not occurred. The expected number of positive cumulative abnormal returns is based on the fraction of positive abnormal returns (positive residuals) over the estimation window,

$$\hat{p} = \frac{1}{N}\sum_{i=1}^{N}\frac{1}{130}\sum_{t=-135}^{-6} S_{it}, \tag{6}$$

where $S_{it} = 1$ if $AR_{it} > 0$ and $S_{it} = 0$ otherwise. The test statistic is

$$Z_G = \frac{w - N\hat{p}}{[N\hat{p}(1-\hat{p})]^{1/2}} \sim N(0,1), \tag{7}$$

where $w$ denotes the number of securities with positive cumulative abnormal returns over the event window. Though $Z_G$ has a standard normal distribution, the construction of the test statistic does not depend on normality of stock returns.

We use the standardized cross-sectional test (Boehmer et al., 1991) to correct for the potential cross-sectional increase in the variance of the stock returns on the event date. The test statistic is the ratio of $\overline{SCAR}$, the average standardized $CAR$, to its contemporaneous cross-sectional standard error

$$T_{std-CS} = \overline{SCAR} \Big/ \sqrt{\frac{1}{N(N-1)}\sum_{i=1}^{N}(SCAR_i - \overline{SCAR})^2}, \tag{8}$$

where $SCAR_i = CAR_i \Big/ \hat{s}_i Adj$, $\hat{s}_i$ is the standard deviation of stock $i$'s returns over the estimation window, and $Adj$ is an adjustment term. In order to apply the test to a multiple-day event window, we follow Mikkelson and Partch (1988) and modify the adjustment for forecast error to be

$$Adj = \left(L_2 + \frac{{L_2}^2}{L_1} + \frac{(\sum_{t=\tau_1}^{\tau_2} R_{mt} - L_2\overline{R}_m)^2}{\sum_{t=-135}^{-6}(R_{mt} - \overline{R}_m)^2}\right)^{\frac{1}{2}}, \tag{9}$$

where $L_2 = \tau_2 - \tau_1 + 1$, $L_1 = 130$, and $\overline{R}_m$ is the average market return over the estimation window. The test statistic has a $t$-distribution with 128 degrees of freedom for our sample.

**Table 2:** Average cumulative abnormal return and test statistics

| Event Window | Type | $N$ | $\overline{CAR}$ | $\theta$ | $Z_G$ | $T_{std-CS}$ |
|---|---|---|---|---|---|---|
| **[-1, 2]** | All (incl. 08) | 344 | 0.37 | 2.29** | 4.09*** | 2.17** |
| | All | 325 | 0.40 | 2.58** | 4.28*** | 2.28** |
| | Action | 49 | 0.28 | 0.61 | −0.30 | 0.09 |
| | Announcement | 39 | 1.14 | 2.39** | 2.27** | 2.82*** |
| | Recognition | 116 | 0.39 | 1.52 | 3.59*** | 1.79* |
| | Report | 121 | 0.23 | 0.95 | 2.40** | 0.38 |
| **[-1, 3]** | All (incl. 08) | 344 | 0.47 | 2.61*** | 3.55*** | 2.49** |
| | All | 325 | 0.51 | 2.88*** | 3.72*** | 2.55** |
| | Action | 49 | 0.29 | 0.57 | −0.30 | 0.20 |
| | Announcement | 39 | 1.26 | 2.36** | 1.62 | 2.56** |
| | Recognition | 116 | 0.55 | 1.91* | 3.59*** | 2.12** |
| | Report | 121 | 0.31 | 1.13 | 1.85* | 0.57 |

Columns 4 - 7 report the estimated average cumulative abnormal return (%), and test statistics from the standard z-test ($\theta$), the generalized sign test ($Z_G$), and the standardized cross-sectional test ($T_{std-CS}$). *, **, *** denote statistical significance at the 10%, 5%, and the 1% levels, respectively.

# 5 What Type of Information Does the Market Value?

## Significance of Abnormal Market Returns

Table 2 reports the estimated $\overline{CAR}$ and test statistics from the standard z-test, the generalized sign test, and the generalized standardized cross-sectional test, for all four types of media releases jointly and each type separately, over the event windows [-1, 2] and [-1, 3]. As a robustness check, we also test for significance of the $\overline{CAR}$ for the full sample of securities that includes the 2008 events. The estimated $\overline{CAR}$ ranges from 0.23 percent to 1.26 percent. Compared to other event types, the announcement type has the highest estimated $\overline{CAR}$ of 1.14 percent and 1.26 percent over the two event windows.

The standard test yields a significantly positive market reaction at the 5 percent level when considering all types of media releases jointly, with or without events from the 2008 financial crisis. When separated by event type, announcement is significant at the 5 percent level over both event windows, recognition is significant at the 10 percent level over the event window [-1, 3], and the other types do not show significance.[8]

The generalized sign test shows a significantly positive market reaction at the 1 percent

[8]To assess whether this lack of significance may be a result of low power of the standard test, we calculate the power of the test given the assumed normal distribution and estimated event variance at the significance level of 5 percent. We find the power of the standard test is low; for the types recognition, action and report, the statistical power of the test is below 0.5. This indicates that the standard approach may be subject to misspecification and may not be able to reliably detect deviations from the null hypothesis.

level when events of all types are tested jointly, and for the recognition type over both event windows. Announcement and report are significant at the 5 percent level over the event window [-1, 2], whereas action is not significant in either event window. Results from the standardized cross-sectional test are generally consistent with those from the standard test.

These test results indicate that there is a significantly positive stock market reaction when we consider all four types of media releases jointly, and for the types announcement and recognition individually. There is some evidence to show that a report type event yields a positive stock market reaction, but no evidence for the action type. While both the action events and the announcement events are about a particular activity and likely to build an environmentally friendly firm image, the market reacts more strongly towards announcement events. Similarly, while both recognition and report events are based on firm environmental performance over a past period, the market reacts more strongly towards events recognized by a third party. In all cases, the market reacts less strongly towards events that entail more measurable costs, namely action and report events.

The announcement type has a substantially larger impact on firm stock returns than any other type. This is consistent with the Efficient Market Hypothesis that the stock market incorporates new information into stock prices as soon as it becomes available. Announcement events represent new information as the vast majority of them are initial announcements about planned activities for the future. By contrast, action, recognition, and report events are about activities initiated in the past, so it is possible that information about the events was available to the market prior to the media release. Specifically, it is possible that news about some of these activities was previously released in the form of announcements in the planning stage, and the market reaction to media releases at a later date about the same activities is not as strong.[9] However, firms still release the non-announcement information, which suggests that they expect to benefit from the release; we find that the stock market does react, though at a smaller magnitude.

Our finding that the stock market reacts differently to different types of events bears important implications for environmental self-regulation by firms. On the one hand, with an efficient market, firms are rewarded as soon as they make forward-looking statements disclosing their environmental initiatives. Such statements enhance a firm's pro-environmental image, facilitate product differentiation, and gain consumer loyalty; and the stock market reacts accordingly. However, there is no guarantee that the market follows up on forward-looking announcements, or that a firm is (or should be) punished for not making good on its announcements. Therefore, the stock market incentives are

[9]Of the 286 events in our sample (excluding 2008) that are not announcements, only 15 correspond to announcements in our sample that occurred at a previous point in time. While it is possible that some events correspond to an announcement that predates our sample period, it is clear that at least some non-announcement type events represent new information.

not enough to guarantee announcements lead to actual environmental outcomes.[10]

On the other hand, we also find evidence that the market rewards the types of environmental information that likely translate into environmental outcomes – the recognition type that provides a third party's affirmation of firm efforts and achievements to protect the environment incurs the second largest market reaction among all four types of information. The report type which outlines firm environmental objectives and achievements incurs a significant, albeit smaller, market reaction according to the generalized sign test. The financial incentives significantly associated with these two types of information constitute an incentive for a firm to self-regulate its environmental externalities.

## The Potential for Strategy in Release of Information

Given that news of positive environmental activities generates a significantly positive stock market response, it is possible that a firm uses such news to offset the negative impact of another unrelated event. A firm has flexibility in choosing the date to release news of an action, an announcement, a report, and to some extent a recognition. In our sample the date of a media release regarding an environmental award is in many cases not the same day that the award was granted.

For each of the 325 events in our sample, we search within the window of [-7, 7] days relative to the event date for potentially confounding events. In particular, we look for news of earnings announcements, dividend issuance, analysts' rating change, and mergers and acquisitions. We find that 128 events in our sample have other events within the [-7, 7] window that may affect the firm's stock price. Yet, there is no obvious pattern in the distribution of the potentially confounding events among types of environmental media releases (18 actions, 14 announcements, 39 recognitions, and 57 reports), or in terms of the kinds of information contained. We only identify 16 potentially confounding media releases that contain obviously negative news; these include announcements of earnings and dividends that fall below expectation, downgrading, and violations of environmental regulations. For these negative news events, we find that the positive environmental media release in our sample usually follows or immediately precedes the negative confounding event (13 out of 16 cases), with the majority being recognitions or reports (13 out of 16 cases). It is also possible that some of the other confounding events are interpreted as negative by investors or analysts, though not explicitly indicated in the media release. For example, for the many cases of dividend issuance and earnings announcements, it is possible that the reported dividends or earnings fall below investors' expectation, leading to a negative reaction. Therefore, we cannot rule out the possibility that firms use positive environmental information to offset a negative stock market effect of other events.

Table 3 shows the results of our event study tests for the subsample of 197 firms after

[10]We remain agnostic to why forward-looking statements may go unfulfilled. It may be an issue of green-washing; it also may be that unanticipated factors force the firm to deviate from its expected path.

**Table 3:** Average cumulative abnormal return and test statistics – unconfounded

| **Event Window** | **Type** | $N$ | $\overline{CAR}$ | $\theta$ | $Z_G$ | $T_{std-CS}$ |
|---|---|---|---|---|---|---|
| **[-1, 2]** | All | 197 | 0.53 | 2.51** | 4.16*** | 3.09*** |
| | Action | 30 | 0.48 | 0.76 | −0.53 | 0.34 |
| | Announcement | 26 | 1.33 | 2.23** | 3.17*** | 2.92*** |
| | Recognition | 77 | 0.34 | 1.04 | 3.14*** | 2.19** |
| | Report | 64 | 0.46 | 1.33 | 2.19** | 1.06 |
| **[-1, 3]** | All | 197 | 0.64 | 2.71*** | 3.02*** | 3.07*** |
| | Action | 30 | 0.27 | 0.38 | −0.90 | −0.17 |
| | Announcement | 26 | 1.57 | 2.35** | 1.60 | 2.77** |
| | Recognition | 77 | 0.58 | 1.56 | 2.68*** | 2.59*** |
| | Report | 64 | 0.51 | 1.33 | 1.94∗ | 1.07 |

Columns 4 - 7 report the estimated average cumulative abnormal return (%), and test statistics from the standard z-test ($\theta$), the generalized sign test ($Z_G$), and the standardized cross-sectional test ($T_{std-CS}$). *, **, *** denote statistical significance at the 10%, 5%, and the 1% levels, respectively.

excluding confounding events. There does not appear to be any substantial qualitative change in the results compared to the results reported in Table 2. According to the standard test, the $\overline{CAR}$ is significantly positive at the 5 percent level or lower for all types of media releases jointly, and for the type announcement, over both event windows. The generalized sign test and the standardized cross-sectional test show very similar levels of statistical significance across all event types compared to the full sample. One interesting finding is that the magnitude of the abnormal return for announcement events is substantially larger for this subsample that excludes potentially confounded events.

By contrast, when we examine the subsample of media releases with confounding events in Table 4, the significance almost all disappears, except for results of the generalized sign test on all types jointly and recognition. Using a two-sample $t$-test we find that the $\overline{CAR}$ of the potentially confounded subsample is significantly lower than that for the subsample that excludes potentially confounding events for all types jointly, announcement, and report at the 1 percent level over both event windows. Meanwhile, the $\overline{CAR}$ for recognition events is higher for the potentially confounded subsample than the subsample that excludes confounding events over the event window [-1, 2]. These results suggest that when multiple public announcements of a firm occur over a short period of time, the positive environmental information from a third party provides the strongest financial incentive that is able to offset the (potentially negative) effect of the confounding information.

**Table 4:** Average cumulative abnormal return and test statistics – confounded

| Event Window | Type | $N$ | $\overline{CAR}$ | $\theta$ | $Z_G$ | $T_{std-CS}$ |
|---|---|---|---|---|---|---|
| **[-1, 2]** | All | 128 | 0.21 | 0.91 | 1.66* | 0.05 |
| | Action | 18 | 0.003 | −0.01 | 0.42 | −0.15 |
| | Announcement | 14 | 0.63 | 0.85 | −0.79 | 0.73 |
| | Recognition | 39 | 0.54 | 1.32 | 2.11** | 0.49 |
| | Report | 57 | −0.05 | −0.15 | 0.90 | −0.71 |
| **[-1, 3]** | All | 128 | 0.30 | 1.17 | 2.19** | 0.42 |
| | Action | 18 | 0.43 | 0.65 | 0.90 | 0.66 |
| | Announcement | 14 | 0.46 | 0.55 | 0.28 | 0.52 |
| | Recognition | 39 | 0.58 | 1.27 | 2.75*** | 0.58 |
| | Report | 57 | 0.03 | 0.08 | 0.37 | −0.61 |

Columns 4 - 7 report the estimated average cumulative abnormal return (%), and test statistics from the standard z-test ($\theta$), the generalized sign test ($Z_G$), and the standardized cross-sectional test ($T_{std-CS}$). *, **, *** denote statistical significance at the 10%, 5%, and the 1% levels, respectively.

# 6 What Drives the Market Reaction?

## Potential Drivers

We next explore the determinants of the magnitude of the $CAR$s upon release of positive environmental information. We obtain data on firm financial characteristics from Compustat, using quarterly data for the most recent quarter prior to the event. These characteristics include firm size, profitability, market-to-book ratio, leverage ratio, and market capitalization of equity. Detailed definitions of these variables as well as Compustat codes are available in Table A1 of Appendix A.

A larger firm is more likely to draw greater investor attention and lead to a greater market reaction. A more profitable firm may have access to greater resources to cover the costs of environmental activities, and therefore elicit a more favorable investor reaction. Conversely, we expect that investors may perceive firms with more debt (a higher leverage ratio) to be more costly or risky – for these firms, news of engagement in environmental activities may lead to a less favorable investor reaction. Information regarding firms with greater market capitalization is easier to obtain (Gebhardt et al., 2001), and thus we expect that the stock market reaction to environmental news of these firms is less strong, since the news brings relatively less new information to the market. Finally, investors may perceive engagement in positive environmental activities for a firm with more growth opportunities (a higher market-to-book ratio) to be more costly due to the opportunity cost of not engaging in other investment opportunities.

In addition to these financial characteristics, we include an index measuring the degree

of environmental disclosure by each firm, an index of environmental performance, and an equal-weighted rating of the firm's environmental, social, and corporate governance (ESG) performance. The firm environmental performance score and equal-weighted ESG rating are obtained from Datastream's ASSET4 ESG database. The environmental performance score is based on firm performance in three categories – emissions reduction, resource reduction, and product innovation – and covers 46 sub-categories. The score ranges from 0 to 100 with 100 indicating best performance. The equal-weighted ESG rating ranges from 0 to 100, and measures a firm's overall performance in environmental, social, and corporate governance. The environmental disclosure score measures the transparency of, or the extent to which a firm discloses environmental activities, and is obtained from Bloomberg's ESG database. The score ranges from 0.1 to 100, with a full score indicating complete disclosure regarding every data point collected by Bloomberg.[11] It is important to emphasize that a higher disclosure score does not imply superior environmental performance; the correlation between the environmental disclosure score and environmental performance score for our sample is only 0.38.

These variables are important in our analysis for two reasons. First, we expect that investors use a firm's existing environmental transparency or performance as a benchmark when receiving news of positive environmental activities. Since firm ESG performance is often considered in the same context – for instance, the screening criteria of socially responsible investment funds usually cover all of the three ESG aspects – investors may also benchmark the firm's overall ESG performance. Second, these variables shed light on the link between the financial incentives identified via our tests of significance of the abnormal stock returns and measured environmental performance. A significantly positive relationship between the performance measures and the magnitude of the abnormal stock return indicates that the financial incentives align with actual environmental improvements; in such a case, positive environmental information can serve to encourage firm self-regulation. If, however, environmental performance is not significantly related to the magnitude of the abnormal returns, but environmental disclosure is significantly related, the story is that financial incentives are aligned with environmental transparency only, and not necessarily with actual environmental improvements.

It is also possible that investors evaluate environmental responsibility differently for firms from different industries, which implies that the impact of stock market reaction on firm self-regulation may differ across industries. Therefore, we include industry effects in the regressions. Specifically, we use the Standard & Poor economic sectors to categorize different industries; the omitted category is Communication Services. Finally, to examine whether there is a different market reaction to different types of media release, we include indicators for the four different types of media release (action is the omitted category).

[11] Bloomberg collects data on fields such as greenhouse gas emissions, water use, and oil spills based on firms publicly available environmental information.

Descriptive statistics for the continuous variables are shown in Table A2 of Appendix A.

## Conditional Mean Regressions

To evaluate the potential drivers, we estimate conditional mean regressions using the model

$$CAR_i = X_i'\gamma + u_i, \quad u_i \sim N(0, \sigma^2), \quad i = 1, 2, ..., N, \tag{10}$$

where $X_i$ is a vector of potential drivers of the market reaction, $\gamma$ is a vector of parameters, and $u_i$ is the error term. We regress the $CAR$s over both event windows on three sets of regressors. The first set includes only firm financial characteristics and environmental characteristics; for the second, we add the indicators for event type; and for the third set we add the industry indicators. Table 5 shows the results from the six regression models. Firm size (measured by total assets) is significantly positive in all models, indicating that larger firms are able to catch more investor attention via media releases. The market also reacts more favorably to positive environmental information of more profitable firms. Because profitability reflects a firm's efficiency in managing its resources, this result indicates that environmental activities are considered more affordable to more profitable firms. Market capitalization of equity is negative and significant in all models, suggesting that for firms with more information available to the stock market, new positive environmental information is rewarded less by the market.

The equal-weighted ESG rating is positive and significant in all models, while the environmental performance score is not significantly different from zero in any of the models. This indicates that while the market favors positive environmental information for a firm with better past ESG performance, it does not separately value environmental performance. Since the coefficient of correlation between the environmental performance score and the ESG performance score is relatively high (0.77), we also examine two sets of models that each have one of the two scores taken out. Regression results show that the environmental performance score is never significant when the ESG performance score is excluded, while the ESG performance score is significant in all models with the $CAR$s over the event window [-1, 3]. This provides further evidence that the market evaluates overall ESG performance instead of environmental performance alone when valuing positive environmental information. The environmental disclosure score is negative and significant in the three models with the event window [-1, 3] at a 10 percent significance level or lower, and at a 15 percent level in Models (1) and (3) with the event window [-1, 2]. *Ceteris paribus*, the magnitude of the market reaction towards environmental information is smaller for a firm that has greater environmental transparency. The disclosure of environmental information helps to reduce uncertainty of future firm environmental performance and potential liabilities, and thus holding past ESG and environmental performance constant, the market reacts with a smaller magnitude towards new information

when there is greater transparency. These results indicate that there is a link between financial outcomes and firm environmental transparency, as well as environmental performance. For the latter, however, the financial incentives align with good ESG performance as a whole, rather than solely with good environmental performance.

When media release type effects are added, announcement is significantly positive in Model (2) and Model (3), indicating that investors react more favorably towards announcements which contain new information about future firm environmental activities as opposed to activities that are completed (i.e. actions) and about which the market may already have some information. Since an $F$-test on the coefficients of all the industry indicators shows that these variables are jointly insignificant, in the following analyses we exclude industry effects.

We also consider differential impacts of these firm characteristics on the two subsamples of $CAR$s that include and exclude the potentially confounded media release events. When events are potentially confounded, only firm size out of all financial characteristics remains as a significant driver of the magnitude of the $CAR$ (Table 6). We continue to find that ESG performance and environmental disclosure are significantly positive and negative, respectively. Table 7 shows our results from the unconfounded sample. With this sample, firm size, profitability, and market value of equity are statistically significant with signs consistent with those for the full sample, while the environmental characteristics variables are insignificant.

These results suggest that when positive environmental information is the only information released to the market, the magnitude of the market reaction is primarily driven by firm financial characteristics – all else equal, the market rewards larger and more profitable firms, and those with less information available to the market. However, when there are potentially confounding events near the event date, environmental characteristics are the main drivers of the market reaction. Yet, recall that with confounding information, the market reaction captured in the event study may not be solely towards the environmental information, hence the result is not sufficient to establish a link between firm environmental characteristics and the stock price impact of positive environmental information. Therefore, while we find evidence for a link between the stock market reaction to positive environmental information and firm financial characteristics as well as firm environmental characteristics based on our full sample, Tables 6 and 7 suggest that financial characteristics are the main drivers of the magnitude of the significant market reaction to positive environmental information.

**Table 5:** Results from conditional mean regressions – full sample

| | Event Window [-1, 2] | | | Event Window [-1, 3] | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Size | 0.008*** | 0.008*** | 0.010** | 0.011*** | 0.011*** | 0.013*** |
| | (0.003) | (0.003) | (0.004) | (0.003) | (0.003) | (0.004) |
| Profit | 0.183* | 0.224** | 0.238** | 0.211* | 0.264** | 0.279** |
| | (0.109) | (0.111) | (0.113) | (0.116) | (0.118) | (0.120) |
| Market to Book | 0.0003 | 0.0002 | 0.0003 | 0.001 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Leverage | −0.013 | −0.013 | −0.024 | −0.021 | −0.021 | −0.039** |
| | (0.015) | (0.015) | (0.018) | (0.016) | (0.016) | (0.019) |
| Market Cap | −0.010*** | −0.010*** | −0.012*** | −0.014*** | −0.014*** | −0.016*** |
| | (0.003) | (0.003) | (0.004) | (0.003) | (0.003) | (0.004) |
| Disclosure | −0.0002 | −0.0001 | −0.0002 | −0.0002* | −0.0003** | −0.0003** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Env. Performance | −0.0002 | −0.0002 | −0.0002 | −0.0002 | −0.0002 | −0.0002 |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| ESG Performance | 0.0004* | 0.0004* | 0.0004* | 0.0004** | 0.0004** | 0.0004** |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Announcement | | 0.011* | 0.013* | | 0.007 | 0.008 |
| | | (0.007) | (0.007) | | (0.007) | (0.007) |
| Recognition | | 0.002 | 0.003 | | 0.005 | 0.007 |
| | | (0.005) | (0.005) | | (0.005) | (0.006) |
| Report | | −0.003 | −0.002 | | −0.004 | −0.002 |
| | | (0.005) | (0.005) | | (0.005) | (0.006) |
| Basic Materials | | | −0.011 | | | −0.022 |
| | | | (0.014) | | | (0.015) |
| Capital Goods | | | −0.021 | | | −0.027* |
| | | | (0.015) | | | (0.015) |
| Energy | | | −0.022 | | | −0.030* |
| | | | (0.015) | | | (0.016) |
| Consumer Cyclicals | | | −0.013 | | | −0.022 |
| | | | (0.014) | | | (0.015) |
| Consumer Staples | | | −0.009 | | | −0.015 |
| | | | (0.014) | | | (0.015) |
| Financials | | | −0.016 | | | −0.026 |
| | | | (0.016) | | | (0.017) |
| Health Care | | | −0.022 | | | −0.033** |
| | | | (0.015) | | | (0.015) |
| Technology | | | −0.014 | | | −0.026* |
| | | | (0.014) | | | (0.015) |
| Transportation | | | −0.002 | | | −0.009 |
| | | | (0.014) | | | (0.015) |
| Utilities | | | −0.013 | | | −0.020 |
| | | | (0.014) | | | (0.015) |
| Observations | 232 | 232 | 232 | 232 | 232 | 232 |
| $R^2$ | 0.069 | 0.095 | 0.141 | 0.097 | 0.120 | 0.171 |
| Adjusted $R^2$ | 0.035 | 0.050 | 0.050 | 0.064 | 0.076 | 0.084 |
| F Statistic | 2.062** | 2.094** | 1.556* | 2.981*** | 2.715*** | 1.957*** |

Columns 2-7 report coefficient estimates and standard errors (in parentheses) from regressions of $CAR$s on firm characteristics. *, **, *** denote statistical significance at the 10%, 5%, and the 1% levels, respectively. All models include a constant. The number of observations is reduced from 325 (Table 2) to 232 due to the limitations in the financial and environmental characteristics data. Event study results in Table 2 do not change if restricted to this reduced sample of observations.

**Table 6:** Results from conditional mean regressions – confounded sample

| | Event Window [-1, 2] | | Event Window [-1, 3] | |
|---|---|---|---|---|
| **Variable** | (1) | (2) | (3) | (4) |
| Size | 0.012* | 0.013* | 0.013* | 0.015* |
| | (0.007) | (0.007) | (0.008) | (0.007) |
| Profit | −0.303 | −0.213 | 0.090 | 0.198 |
| | (0.511) | (0.515) | (0.545) | (0.537) |
| Market to Book | 0.002 | 0.001 | 0.001 | 0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Leverage | −0.008 | −0.015 | −0.011 | −0.021 |
| | (0.029) | (0.029) | (0.031) | (0.030) |
| Market Cap | −0.008 | −0.009 | −0.011 | −0.012 |
| | (0.008) | (0.008) | (0.009) | (0.008) |
| Disclosure | −0.0005** | −0.001*** | −0.0005** | −0.001*** |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Env. Performance | −0.0002 | −0.0002 | −0.0001 | −0.0001 |
| | (0.0003) | (0.0003) | (0.0003) | (0.0003) |
| ESG Performance | 0.001** | 0.001** | 0.001* | 0.001** |
| | (0.0004) | (0.0004) | (0.0004) | (0.0004) |
| Announcement | | −0.0005 | | −0.002 |
| | | (0.012) | | (0.012) |
| Recognition | | 0.008 | | 0.012 |
| | | (0.009) | | (0.010) |
| Report | | −0.007 | | −0.009 |
| | | (0.008) | | (0.009) |
| Observations | 83 | 83 | 83 | 83 |
| $R^2$ | 0.169 | 0.223 | 0.123 | 0.213 |
| Adjusted $R^2$ | 0.079 | 0.102 | 0.028 | 0.091 |
| F Statistic | 1.878* | 1.848* | 1.293 | 1.748* |

Columns 2-5 report coefficient estimates and standard errors (in parentheses) from regressions of $CAR$s on firm characteristics. *, **, *** denote statistical significance at the 10%, 5%, and the 1% levels, respectively. All models include a constant.

## Conditional Quantile Regressions

Figure 2 shows the densities of $CAR$s over both event windows. The two density plots display very similar distributions of the $CAR$s.[12] Further, the results from the conditional mean regressions are similar when we regress $CAR$s over the two event windows on the same set of regressors.[13] For these reasons, we focus our subsequent analyses on the event window [-1,3].

Figure 2 also shows the $CAR$s take both negative and positive values. This means that while *on average* the market responds positively to news of positive environmental

[12]A two-sample Kolmogorov-Smirnov test fails to reject the null hypothesis that the two distributions of $CAR$s are equivalent with a $p$-value of 0.64.

[13]In addition, the two sets of $CAR$s have similar ranges (the interquartile ranges for the $CAR$s over the event windows [-1, 2] and [-1, 3] are [-0.009, 0.019] and [ -0.010, 0.020] respectively), and the $\overline{CAR}$ over the event window [-1, 3] (0.51 percent) is slightly higher than that of the event window [-1, 2] (0.40 percent), indicating that on average, the effect of the event carries through the longer window.

**Table 7:** Results from conditional mean regressions – unconfounded sample

| | Event Window [-1, 2] | | Event Window [-1, 3] | |
|---|---|---|---|---|
| **Variable** | (1) | (2) | (3) | (4) |
| Size | 0.007** | 0.007** | 0.010*** | 0.011*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Profit | 0.201* | 0.211* | 0.212* | 0.229* |
| | (0.109) | (0.112) | (0.118) | (0.122) |
| Market to Book | 0.0003 | 0.0002 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Leverage | −0.015 | −0.012 | −0.026 | −0.023 |
| | (0.018) | (0.018) | (0.019) | (0.019) |
| Market Cap | −0.010*** | −0.010*** | −0.015*** | −0.016*** |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| Disclosure | −0.0001 | −0.00003 | −0.0001 | −0.0001 |
| | (0.0001) | (0.0001) | (0.0002) | (0.0002) |
| Env. Performance | −0.0003 | −0.0003 | −0.0003 | −0.0003 |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| ESG Performance | 0.0003 | 0.0003 | 0.0004 | 0.0004 |
| | (0.0002) | (0.0002) | (0.0003) | (0.0003) |
| Announcement | | 0.013 | | 0.009 |
| | | (0.008) | | (0.009) |
| Recognition | | 0.0001 | | 0.003 |
| | | (0.006) | | (0.007) |
| Report | | 0.001 | | 0.001 |
| | | (0.006) | | (0.007) |
| Observations | 149 | 149 | 149 | 149 |
| $R^2$ | 0.088 | 0.111 | 0.133 | 0.140 |
| Adjusted $R^2$ | 0.036 | 0.040 | 0.083 | 0.071 |
| F Statistic | 1.683 | 1.556 | 2.684*** | 2.035** |

Columns 2-5 report coefficient estimates and standard errors (in parentheses) from regressions of $CAR$s on firm characteristics. *, **, *** denote statistical significance at the 10%, 5%, and the 1% levels, respectively. All models include a constant.

activities, for some firms/events the response is negative. We plot the densities of $CAR$s for each type of media release over the event window [-1, 3] in Figure 3. Figure 3 shows the differences among the distributions of $CAR$s across the four types of events. The action type has a smaller mean than the other three types, and the announcement type has a heavier right tail.

Figures 2 and 3 echo our previous discussion about the importance of differentiating between event types. First, they provide clues for the mixed findings from existing empirical studies that each examine a particular type of environmental activity. Since the $CAR$s of positive environmental information are distributed across negative and positive values, and differently across event types, it is possible that each of the studies focuses on a particular portion of the distribution. Second, from a policy perspective, it is important to encourage environmental information with links to both financial outcomes and environmental outcomes. The mass of $CAR$ for the announcement and recognition

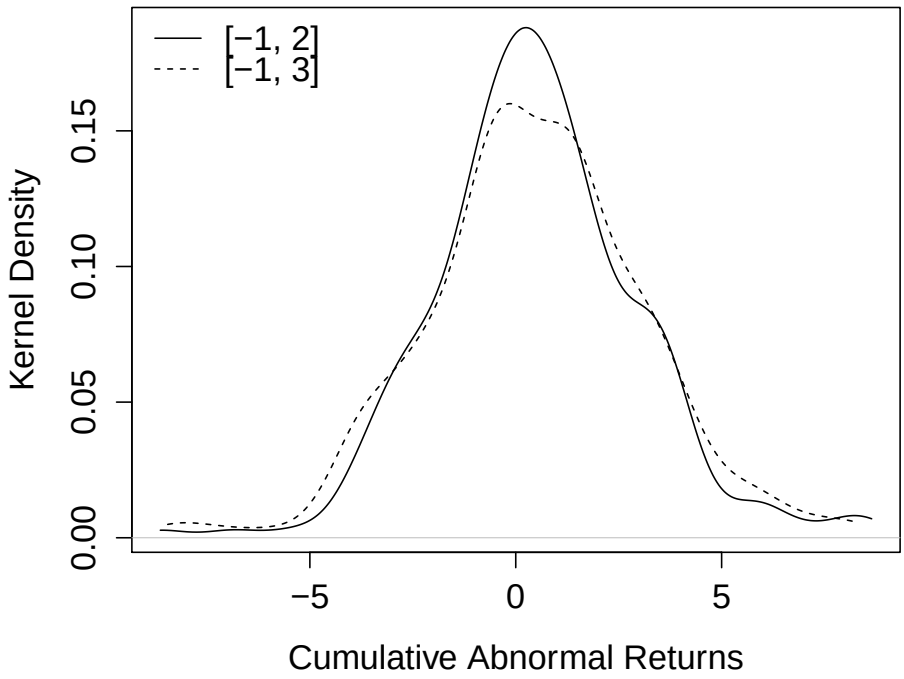


**Figure 2:** Density plots of cumulative abnormal returns

types are concentrated in the first quadrant of Figure 3, which indicates stronger financial incentives for these types of information. Yet, recognition has a stronger link to actual environmental performance, and thus encouraging this type of information is more likely to lead to actual environmental improvement.

To assess the extent to which the relationship between firm financial and environmental characteristics and $CAR$s varies with heterogeneity in the $CAR$s, we use a conditional quantile regression to estimate the effect of the regressors on the $CAR$s at different points of the distribution. Results are reported in Table 8. The signs and statistical significance of the coefficients are largely consistent with the results from Model (5) of the conditional mean regressions. Firm size is significantly positive across all five quantiles, and the effect of firm size seems to be homogeneous in magnitude, given the standard error confidence bound. Profitability is significantly positive only at the 0.10 and 0.25 percentiles, with the marginal effect decreasing with the percentiles. This suggests that when the market reacts unfavorably towards positive environmental information, holding all other factors constant, more profitable firms are penalized less; but when the market reacts favorably, firms with greater profitability are not rewarded differently from firms with lower profitability. This supports our earlier discussion that the market evaluates the costs associated with environmental activities. When the market reacts unfavorably towards positive environmental information, higher profitability to an extent shields a

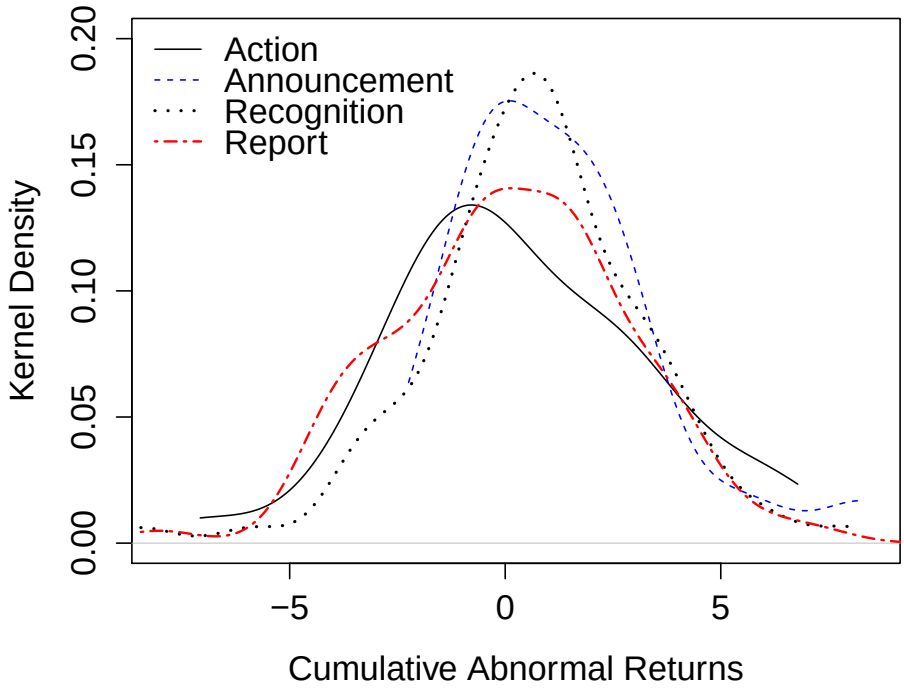


**Figure 3:** Density plots of cumulative abnormal returns by type, [-1,3]

firm from unfavorable market reactions, possibly because environmental activities are considered more affordable to more profitable firms even though overall the market attaches negative value to the events. Market capitalization is significantly negative at the 0.50, 0.75, and 0.90 quantiles, with the marginal effect increasing (in absolute value) with the percentiles, and insignificant at the other quantiles. When the market reacts favorably towards positive environmental information, holding all other factors constant, firms with more information available to the market are rewarded less by the market, while the market is indifferent about market capitalization when reacting unfavorably towards positive environmental information.

The environmental disclosure score is significantly negative at the 0.50 and 0.75 quantiles, and insignificant at the other quantiles. That is, when the market reacts favorably towards positive environmental information, firms with higher past environmental transparency tend to be rewarded less, while the level of transparency is not an important factor when the market reacts unfavorably towards positive environmental information. The environmental performance score, while insignificant in terms of the mean effect, is significantly negative at the 0.10 quantile. When the stock market penalizes positive environmental information, all else equal, firms with better past environmental performance are penalized even more, possibly because the costs associated with good environmental performance aggravate the unfavorable stock market reaction. The indicator for the an-

**Table 8:** Results from conditional quantile regressions – full sample

| | Percentiles of Distribution | | | | |
|---|---|---|---|---|---|
| | 0.10 | 0.25 | 0.50 | 0.75 | 0.90 |
| Size | 0.012** | 0.008** | 0.007** | 0.009** | 0.011** |
| | (0.005) | (0.003) | (0.003) | (0.004) | (0.006) |
| Profit | 0.395* | 0.265* | 0.171 | 0.047 | 0.018 |
| | (0.213) | (0.154) | (0.181) | (0.234) | (0.266) |
| Market to Book | 0.0003 | 0.0004 | 0.001 | 0.001 | 0.002* |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Leverage | 0.008 | −0.0003 | −0.018 | −0.027 | −0.029 |
| | (0.03) | (0.028) | (0.026) | (0.022) | (0.027) |
| Market Cap | −0.011 | −0.007 | −0.009* | −0.013** | −0.018*** |
| | (0.007) | (0.005) | (0.005) | (0.005) | (0.005) |
| ESG Performance | 0.001 | 0.0003 | 0.0003 | 0.0001 | −0.0001 |
| | (0.001) | (0.0004) | (0.0002) | (0.0003) | (0.0003) |
| Disclosure | 0.0002 | −0.0002 | −0.0003* | −0.0005** | −0.0001 |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Env. Performance | −0.001* | −0.0002 | −0.000005 | 0.0002 | 0.0003 |
| | (0.0003) | (0.0002) | (0.0002) | (0.0002) | (0.0003) |
| Announcement | 0.018* | 0.009 | 0.013 | 0.0004 | −0.001 |
| | (0.010) | (0.009) | (0.009) | (0.012) | (0.012) |
| Recognition | 0.007 | 0.010 | 0.011 | 0.008 | −0.012 |
| | (0.011) | (0.008) | (0.007) | (0.012) | (0.010) |
| Report | −0.007 | −0.002 | 0.003 | 0.001 | −0.007 |
| | (0.009) | (0.008) | (0.008) | (0.012) | (0.010) |

Columns 2-6 report coefficient estimates and standard errors (in parentheses) from quantile regressions of $CAR$s on firm characteristics. *, **, *** denote statistical significance at the 10%, 5%, and the 1% levels, respectively. All models include a constant. The number of observations is 232.

nouncement type is positive and significant at the 0.10 quantile, suggesting that when the market reacts unfavorably towards positive environmental information, forward-looking announcements associated with less substantial costs are penalized less. This echos our earlier discussion about how investor perception about environmental activities may vary with the underlying costs.

We also explore differences in the conditional distribution of $CAR$ across the subsets of events that are potentially confounded or unconfounded. The interquartile ranges for the two samples are [-0.010, 0.017] (confounded sample) and [-0.010, 0.020] (unconfounded sample) over the event window [-1, 3]. Though the two-sample Kolmogorov-Smirnov test does not indicate a significant difference between the two distributions, it is possible that the regressors have heterogeneous effects on the two samples. We show the results in Appendix B as they are largely consistent with those from the conditional mean regressions for the two samples.

## Addressing Concerns of Endogeneity

It is possible that firms make a strategic decision when releasing positive environmental information via the media based on private information. For example, a firm is more likely to make its environmental activities public if it expects a net benefit from the media release. A firm that undertakes a positive environmental activity, but does not expect a significant and positive stock market reaction, may not make the news public. Therefore, the events we observe are sampled from a non-random subset of the population – the firms that choose not to make the environmental activities public are unobserved. This leads to a sample selection problem, in which a firm forms its decision to disclose its environmentally responsible activity based on some selection variables that are correlated with the expected outcome of the media release. Econometrically, our regression model becomes one of incidental truncation (Greene, 2005).

Specifically, Equation (10) is augmented in the following way. If a firm decides whether to publicly disclose its environmentally responsible activity based on private information, under the assumption of normally distributed errors, the model in Equation (10) becomes the sample selection model:

$$\begin{aligned} d_i^* &= Z_i'\eta + v_i, \\ d_i &= 1 \text{ if } d_i^* > 0 \end{aligned} \tag{11}$$

in which $d_i^*$ is a latent variable that represents the firm's decision to release news of positive environmental activities, $d_i$ is an indicator that equals to 1 if the firm chooses to release, $Z_i$ is a matrix of selection variables, $\eta$ is a vector of parameters, and

$$CAR_i = \begin{cases} CAR_i \text{ if } d_i^* > 0 \\ \text{is unobserved otherwise.} \end{cases} \tag{12}$$

If $u_i$ in Equation (10) and $v_i$ in Equation (11) are correlated, the events we observe are sampled from an incidentally truncated distribution, and the ordinary least squares estimator of $\gamma$ is inconsistent (Greene, 2005). The situation is further complicated by the fact that we do not observe firms that undertake positive environmental activities but choose not to release the information via the media. This precludes us from deploying the other two methods commonly used to estimate the conditional model, namely the two-step least squares method of Heckman (1979) and full information maximum likelihood (Prabhala, 1997). We therefore use a nonlinear least squares model (see Greene (2005) for a discussion). The details of the methodology and the results are described in Appendix B.

We do not find strong evidence to indicate a sample selection problem. Results from the nonlinear least squares regressions are similar to those from the conditional mean regressions, and the parameter that captures the sample-selection correction term is not significant.

# 7 Policy Implications

The effectiveness of positive environmental information in augmenting traditional environmental regulation relies on a continuous link from information disclosure to financial outcomes to environmental outcomes. If the financial incentives associated with positive environmental information motivate firms to self-regulate their environmental impacts and lead to improved environmental quality, then positive environmental information may be an effective policy tool. Based on our findings, we draw two policy implications.

*First*, while there is a link between positive environmental information and financial outcomes, particularly for the announcement and recognition types of information, the link to environmental outcomes is not always apparent. While it provides larger financial incentives, the announcement type is forward-looking with a relatively weak link to actual environmental improvement. From an environmental policy perspective, in order for this type of environmental information to elicit environmental improvements, there needs to be a mechanism that strengthens the link to environmental outcomes (i.e. one that ensures that firms will adhere to their stated goals). Yet, such a mechanism does not naturally exist in the market. Among all types of positive environmental information we consider, the strongest candidate for stimulating self-regulation that leads to real environmental improvement is the recognition type, because on the one hand, recognition is the only type of information that the market reacts positively to, with or without confounding information, and on the other hand, it provides independent affirmation of a firm's environmental performance, which warrants credibility compared to other self-proclaimed activities.

*Second*, environmental policymakers can only rely on positive environmental information to buttress existing regulations if the financial market incentives to engage in positive environmental activities are closely aligned with environmental outcomes. While we find that firm environmental performance (in part) drives the stock market reaction to positive environmental information, it is within the context of the whole package of environmental, social, and corporate governance performance, and the market does not reward environmental performance alone. This finding weakens the link between environmental performance and stock market incentives for self-regulation, and implies that this link is stronger only when environmental, social, and corporate governance performance as a whole improves. From a policy-making perspective, to further strengthen the link between firm positive environmental information and financial outcomes, promoting firm adoption of standards in all three aspects of environmental, social, and corporate governance performance may be more effective than in a single aspect.

# 8 Conclusions

We investigate the extent to which positive environmental information may stimulate firm self-regulation of environmental outcomes by assessing the financial incentives underlying the release of positive environmental information and the link to environmental outcomes. Based on theoretical arguments that establish links between firm environmental performance, financial outcomes, and the publicity of firm environmental responsibility, our empirical analyses are composed of two parts. First, we examine the stock market reaction towards media releases of firm environmentally responsible activities, paying particular attention to the differential financial outcomes of different signals, represented by four types of environmental news. Then, we examine the drivers of the market reaction, including firm financial characteristics, firm environmental characteristics, and event type effects. We examine the mean effects and heterogeneous distributional effects of the potential drivers, and address the issue of firm decision to publicly disclose environmental activities. In both parts of the empirical analyses, we explore the possibility that environmental news is released strategically.

Our event study results show that overall there is a significantly positive stock market reaction towards positive environmental information. The separate event studies by the types of events show evidence of a positive market reaction towards forward-looking statements representing new information about a planned environmental activity (the announcement type), and recognition of environmental responsibility by a third party (the recognition type). There is only weak indication of a positive market reaction to the release of environmental reports, and no evidence of stock market reaction towards the action type. We conclude that forward-looking statements that represent new information of future activities and third-party environmental recognitions to the firm tend to generate positive financial outcomes.

Our conditional mean regressions show that *ceteris paribus*, larger and more profitable firms (with less information available to the stock market), and firms with lower past environmental transparency and better ESG performance are likely to receive a more favorable stock market reaction in the form of higher $CAR$s. Our conditional quantile regressions further reveal the heterogeneous distributional effects of profitability, market capitalization of equity, environmental disclosure, environmental performance, and the event type announcement. Furthermore, we find that when there is no confounding information, firm financial characteristics are the main drivers of market reaction, while when there is confounding information near the event date, environmental characteristics are the main drivers of market reaction, though the $\overline{CAR}$s from the event studies for this subsample are mostly insignificant. We conclude that there is evidence that the primary determinants of the stock market reaction towards positive environmental information concern a firm's financial performance, while the effect of its environmental characteristics

may only be secondary.

Our findings show that in the context of the different events we consider, third-party recognition is the only type for which the financial incentives provided by positive environmental information align with environmental improvements, and that the link between the financial incentives and firm environmental performance lies in the overall performance in environmental, social, and corporate governance issues. From a policy perspective, we conclude that the existing links between financial incentives and environmental outcomes make third-party recognition a strong candidate for being a policy tool that stimulates firm environmental self-regulation. Further, promoting firm environmental, social, and corporate governance performance strengthens the link between firm positive environmental activities and financial incentives.

# Appendix A

**Table A1:** Variables and definitions for the cross-sectional analyses

| Variable | Description | Definition | Data Source |
|---|---|---|---|
| Size | Log of total assets | Log of total assets (AT) | Compustat |
| Profit | Return on assets | Net income (NI)/Total assets (AT) | Compustat |
| Market to Book | Market value of equity to book value of equity | Market value of equity (Fiscal year-end price (PRCC_F) times number of shares outstanding (CSHO)) over book value of equity (Stockholder's equity (SEQ) plus balance sheet deferred tax and investment tax credit (TXDITC) less book value of preferred stock (PSTKRV)) | Compustat |
| Leverage | Leverage ratio | Long-term debt (DLTT) over total assets (AT) | Compustat |
| Market Cap | Market capitalization of equity | Fiscal year-end price (PRCC_F) times number of shares outstanding (CSHO)) | Compustat |
| Disclosure | Firm environmental disclosure score | Measures the extent to which a firm discloses its environmental activities. Data points collected by Bloomberg are weighted in terms of importance, scores range from 0.1 for firms of minimal disclosure to 100 for firms that disclose every data point | Bloomberg |
| Env. Performance | Firm environmental performance score | Measures environmental performance in three categories: emissions reduction, resource reduction, and product innovation, covering 46 sub-categories. Scores range from 0 to 100 | Datastream |
| ESG Performance | Equal-weighted ESG rating | Equally weighted among the three ESG aspects, environmental, social, and corporate governance, to measure a firm's overall performance | Datastream |

**Table A2:** Descriptive statistics of continuous variables

| Variables | Mean | Std. Dev. | Minimum | Maximum | Median |
|---|---|---|---|---|---|
| Size | 10.025 | 1.368 | 7.927 | 14.581 | 9.890 |
| Profit | 0.016 | 0.017 | −0.125 | 0.126 | 0.015 |
| Market to Book | 3.337 | 3.462 | 0.639 | 17.816 | 2.032 |
| Leverage | 0.238 | 0.128 | 0.000 | 0.638 | 0.228 |
| Market Cap | 9.767 | 1.182 | 6.786 | 12.476 | 9.676 |
| Disclosure | 34.355 | 15.362 | 2.326 | 76.033 | 34.496 |
| Env. Performance | 81.208 | 17.299 | 8.910 | 97.080 | 87.855 |
| ESG Performance | 87.219 | 13.214 | 23.960 | 98.210 | 93.190 |

Number of observations: 232.

# Appendix B

## Additional Results from Conditional Quantile Regressions

Table B1 shows results of the conditional quantile regressions for the potentially confounded sample whereas Table B2 shows results of the conditional quantile regressions for the unconfounded sample.

**Table B1:** Results from conditional quantile regressions – confounded sample

| | Percentiles of Distribution | | | | |
|---|---|---|---|---|---|
| | 0.10 | 0.25 | 0.50 | 0.75 | 0.90 |
| Size | 0.030* | 0.024* | 0.016 | 0.005 | 0.016 |
| | (0.017) | (0.012) | (0.010) | (0.010) | (0.016) |
| Profit | 1.337 | 0.770 | 0.272 | −0.644 | 0.180 |
| | (1.124) | (0.831) | (0.705) | (0.780) | (1.401) |
| Market to Book | 0.0005 | −0.0003 | 0.001 | 0.001 | −0.0001 |
| | (0.003) | (0.003) | (0.002) | (0.002) | (0.004) |
| Leverage | −0.056 | −0.050 | −0.030 | −0.014 | −0.034 |
| | (0.067) | (0.054) | (0.038) | (0.038) | (0.051) |
| Market Cap | −0.029 | −0.024 | −0.017 | −0.006 | −0.014 |
| | (0.021) | (0.014) | (0.011) | (0.011) | (0.017) |
| ESG Performance | 0.001 | 0.002* | 0.0007 | 0.0008 | 0.0004 |
| | (0.001) | (0.0009) | (0.0007) | (0.0007) | (0.0007) |
| Disclosure | −0.0008* | −0.0007** | −0.0006** | −0.0008** | −0.0002 |
| | (0.0004) | (0.0003) | (0.0003) | (0.0003) | (0.0004) |
| Env. Performance | −0.0004 | −0.0004 | 0.00003 | 0.0002 | 0.0001 |
| | (0.0006) | (0.0005) | (0.0003) | (0.0005) | (0.0006) |
| Announcement | 0.022 | −0.003 | −0.004 | −0.007 | −0.008 |
| | (0.024) | (0.021) | (0.019) | (0.016) | (0.019) |
| Recognition | 0.047** | 0.023 | −0.002 | −0.0006 | 0.009 |
| | (0.020) | (0.018) | (0.017) | (0.014) | (0.015) |
| Report | 0.006 | −0.002 | −0.021 | −0.017 | −0.007 |
| | (0.020) | (0.019) | (0.017) | (0.013) | (0.013) |

Columns 2-6 report coefficient estimates and standard errors (in parentheses) from quantile regressions of $CAR$s on firm characteristics. *, **, *** denote statistical significance at the 10%, 5%, and the 1% levels, respectively. All models include a constant. The number of observations is 83.

The differences between these two tables echo the differences highlighted between these samples by the conditional mean regressions. With confounding events, the environmental characteristics variables tend to have greater effects on the $CAR$, with the environmental disclosure score significantly negative at all but the 0.90 percentile, and the ESG performance score significantly positive at the 0.25 percentile. The only significant financial characteristics variable is firm size, which is positive at the 0.10 and 0.25 percentiles. With no confounding events, the firm financial characteristics variables have a greater effect on the $CAR$s. Firm size is significantly positive at all but the 0.90 percentile, profitability is significantly positive at the 0.10 percentile, market-to-book ratio is significantly positive at the 0.10 and 0.90 percentiles, and market value of equity is

**Table B2:** Results from conditional quantile regressions – unconfounded sample

| | Percentiles of Distribution | | | | |
|---|---|---|---|---|---|
| | 0.10 | 0.25 | 0.50 | 0.75 | 0.90 |
| Size | 0.013*** | 0.011*** | 0.008* | 0.013** | 0.008 |
| | (0.005) | (0.004) | (0.004) | (0.006) | (0.007) |
| Profit | 0.322* | 0.291 | 0.102 | 0.190 | −0.115 |
| | (0.179) | (0.180) | (0.220) | (0.257) | (0.294) |
| Market to Book | 0.002* | 0.001 | 0.001 | 0.001 | 0.002* |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Leverage | −0.023 | −0.034 | −0.031 | −0.025 | −0.043 |
| | (0.033) | (0.038) | (0.035) | (0.035) | (0.041) |
| Market Cap | −0.014* | −0.014** | −0.012* | −0.018** | −0.019** |
| | (0.007) | (0.006) | (0.006) | (0.008) | (0.008) |
| ESG Performance | 0.0005 | 0.0005 | 0.0004 | 0.0003 | 0.0001 |
| | (0.0005) | (0.0005) | (0.0004) | (0.0005) | (0.0005) |
| Disclosure | 0.0003 | 0.000005 | −0.0001 | −0.0001 | −0.0002 |
| | (0.0003) | (0.0002) | (0.0002) | (0.0003) | (0.0002) |
| Env. Performance | −0.0006* | −0.0005 | −0.0002 | 0.00004 | 0.0002 |
| | (0.0003) | (0.0003) | (0.0003) | (0.0003) | (0.0003) |
| Announcement | 0.013 | 0.008 | 0.015 | 0.010 | 0.003 |
| | (0.011) | (0.009) | (0.011) | (0.019) | (0.022) |
| Recognition | 0.003 | 0.007 | 0.015 | 0.017 | −0.014 |
| | (0.010) | (0.009) | (0.010) | (0.017) | (0.002) |
| Report | −0.009 | 0.003 | 0.009 | 0.021 | −0.007 |
| | (0.009) | (0.009) | (0.010) | (0.018) | (0.019) |

Columns 2-6 report coefficient estimates and standard errors (in parentheses) from quantile regressions of $CAR$s on firm characteristics. *, **, *** denote statistical significance at the 10%, 5%, and the 1% levels, respectively. All models include a constant. The number of observations is 149.

significantly negative across all percentiles. The only significant environmental characteristics variable is the environmental performance score, which is negative at the 0.10 percentile.

**Table B3:** Nonlinear least squares regression estimates

| | Model (1) | | Model (2) | |
|---|---|---|---|---|
| Variables | Coef. | St. Err. | Coef. | St. Err |
| Size | 0.009*** | (0.002) | 0.008*** | (0.002) |
| Profit | 0.001 | (0.005) | 0.002 | (0.003) |
| Market to Book | 0.001 | (0.001) | 0.001 | (0.001) |
| Leverage | −0.012 | (0.012) | −0.008 | (0.009) |
| Market Cap | −0.011*** | (0.003) | −0.010*** | (0.003) |
| ESG Performance | 0.0005* | (0.0002) | 0.0005** | (0.0002) |
| Disclosure | 0.0003 | (0.0002) | −0.0003* | (0.0002) |
| Env. Performance | 0.0002 | (0.0002) | −0.0002 | (0.0002) |
| Announcement | | | 0.006 | (0.006) |
| Recognition | | | 0.004 | (0.005) |
| Report | | | −0.003 | (0.005) |

Columns 2-5 report coefficient estimates and standard errors (in parentheses) from nonlinear least squares regressions of $CAR$s over the event window [-1, 3] on firm characteristics, and event types. *, **, *** denote statistical significance at the 10%, 5%, and the 1% levels, respectively. All models include a constant.

## Results from the Nonlinear Least Squares Regressions

Assuming that $u_i$ in Equation (10) and $v_i$ in Equation (11) are bivariate normally distributed with correlation parameter $\rho$, we can derive the conditional mean of the truncated sample and use nonlinear least squares to consistently estimate the parameters. Specifically, the conditional mean is

$$\begin{aligned} E[CAR_i|X_i, CAR_i \text{ is observed }] &= X_i'\gamma + \rho\sigma\phi(-Z_i'\eta)/[1-\Phi(-Z_i'\eta)] \\ &= X_i'\gamma + \kappa\lambda_i, \end{aligned} \tag{13}$$

where $\kappa = \rho\sigma$, $\phi(\cdot)$ and $\Phi(\cdot)$ are the probability density function and cumulative distribution function of the normal distribution, and $\lambda_i = \phi(-Z_i'\eta)/[1-\Phi(-Z_i'\eta)]$ is the inverse Mills ratio. The presence of $\lambda$ accounts for the selection problem and allows us to obtain consistent estimates of $\gamma$.

Results from the nonlinear least squares regressions show that $\kappa$ (unreported), the coefficient that measures the degree of sample-selection, is not significantly different from 0. Therefore, the primary results are not driven by endogeneity. Table B3 shows the coefficient estimates from the nonlinear least squares regressions are similar to those reported in Table 5. In both models in Table B3, firm size is significantly positive, and market capitalization is significantly negative. The ESG performance score is significantly positive for both models, and the environmental disclosure score is significantly negative for Model (2). Profitability, while significantly positive in both the conditional mean and conditional quantile regressions, is not significant in either of the nonlinear least squares models, indicating that it may be related to firms' decisions of making public their environmental activities.

# References


Acharya, S. (1993). The value of latent information: alternative event study methods. *Journal of Finance 48*, 363–385.

Albuquerque, R. A., A. Durnev, and Y. Koskinen (2014). Corporate social responsibility and firm risk: theory and empirical evidence. *Available at SSRN 1961971*.

Ambec, S. and P. Lanoie (2008). Does it pay to be green? A systematic overview. *Academy of Management Perspectives 22*(4), 45–62.

Boehmer, E., J. Masumeci, and A. B. Poulsen (1991). Event-study methodology under conditions of event-induced variance. *Journal of Financial Economics 30*(2), 253–272.

Brown, S. J. and J. B. Warner (1985). Using daily stock returns: the case of event studies. *Journal of Financial Economics 14*(1), 3–31.

Bushnell, J. B., H. Chong, and E. T. Mansur (2013). Profiting from regulation: evidence from the European carbon market. *American Economic Journal: Economic Policy 5*(4), 78–106.

Capelle-Blancard, G. and M.-A. Laguna (2010). How does the stock market respond to chemical disasters? *Journal of Environmental Economics and Management 59*(2), 192–205.

Corrado, C. J. (1989). A nonparametric test for abnormal security-price performance in event studies. *Journal of Financial Economics 23*(2), 385–395.

Corrado, C. J. (2011). Event studies: a methodology review. *Accounting & Finance 51*(1), 207–234.

Cowan, A. R. (1992). Nonparametric event study tests. *Review of Quantitative Finance and Accounting 2*(4), 343–358.

Filbeck, G. and R. F. Gorman (2004). The relationship between the environmental and financial performance of public utilities. *Environmental and Resource Economics 29*(2), 137–157.

Fisher-Vanden, K. and K. S. Thorburn (2011). Voluntary corporate environmental initiatives and shareholder wealth. *Journal of Environmental Economics and Management 62*(3), 430–445.

Flammer, C. (2013). Corporate social responsibility and shareholder reaction: the environmental awareness of investors. *Academy of Management Journal 56*(3), 758–781.

Freeman, R. E. (1984). *Strategic Management: A Stakeholder Approach.* Boston: Pitman.

Friedman, M. (1970). The social responsibility of business is to increase its profits. *The New York Times Magazine September 13*.

Gebhardt, W. R., C. Lee, and B. Swaminathan (2001). Toward an implied cost of capital. *Journal of Accounting Research 39*(1), 135 –176.

Gilley, K. M., D. L. Worrell, W. N. Davidson, and A. El-Jelly (2000). Corporate environmental initiatives and anticipated firm performance: the differential effects of process-driven versus product-driven greening initiatives. *Journal of Management 26*(6), 1199–1216.

Greene, W. H. (2005). Censored data and truncated distributions. *Available at SSRN 825845*.

Hamilton, J. T. (1995). Pollution as news: media and stock market reactions to the toxics release inventory data. *Journal of Environmental Economics and Management 28*(1), 98–113.

Hassel, L., H. Nilsson, and S. Nyquist (2005). The value relevance of environmental performance. *European Accounting Review 14*(1), 41–61.

Heckman, J. J. (1979). Sample selection bias as a specification error. *Econometrica 47*(1), 153–161.

Jones, T. M. (1995). Instrumental stakeholder theory: a synthesis of ethics and economics. *Academy of Management Review 20*(2), 404–437.

Khanna, M. and L. A. Damon (1999). EPA's voluntary 33/50 program: impact on toxic releases and economic performance of firms. *Journal of Environmental Economics and Management 37*(1), 1–25.

Khanna, M., W. R. H. Quimio, and D. Bojilova (1998). Toxics release information: a policy tool for environmental protection. *Journal of Environmental Economics and Management 36*(3), 243–266.

Klassen, R. D. and C. P. McLaughlin (1996). The impact of environmental management on firm performance. *Management Science 42*(8), 1199–1214.

Konar, S. and M. A. Cohen (1997). Information as regulation: the effect of community right to know laws on toxic emissions. *Journal of Environmental Economics and Management 32*(1), 109–124.

Konar, S. and M. A. Cohen (2001). Does the market value environmental performance? *Review of Economics and Statistics 83*(2), 281–289.

Lanoie, P., B. Laplante, and M. Roy (1998). Can capital markets create incentives for pollution control? *Ecological Economics 26*(1), 31–41.

Li, H., N. Khanna, and M. Vidovic (2015). Third party certification and self-regulation: evidence from Responsible Care and accidents in the US chemical industry. *working paper*.

Lioui, A. and Z. Sharma (2012). Environmental corporate social responsibility and financial performance: disentangling direct and indirect effects. *Ecological Economics 78*, 100–111.

Lyon, T. P. and J. P. Shimshack (2012). Environmental disclosure: evidence from Newsweek's green companies rankings. *Business & Society XX(X)*, 1–44.

MacKinlay, A. C. (1997). Event studies in economics and finance. *Journal of Economic Literature XXXV*, 13–39.

McWilliams, A. and D. Siegel (2001). Corporate social responsibility: a theory of the firm perspective. *Academy of Management Review 26*(1), 117–127.

Mikkelson, W. H. and M. M. Partch (1988). Withdrawn security offerings. *Journal of Financial and Quantitative Analysis 23*(02), 119–133.

Oberndorfer, U., P. Schmidt, M. Wagner, and A. Ziegler (2013). Does the stock market value the inclusion in a sustainability stock index? An event study analysis for German firms. *Journal of Environmental Economics and Management 66*(3), 497–509.

Porter, M. E. and C. Van der Linde (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives 9*(4), 97–118.

Prabhala, N. R. (1997). Conditional methods in event studies and an equilibrium justification for standard event-study procedures. *Review of Financial Studies 10*(1), 1–38.

Russo, M. V. and P. A. Fouts (1997). A resource-based perspective on corporate environmental performance and profitability. *Academy of Management Journal 40*(3), 534–559.

Vidovic, M., M. S. Delgado, and N. Khanna (2015). Third party certification and the effectiveness of voluntary pollution abatement programs: evidence from Responsible Care. *working paper*.

Vidovic, M. and N. Khanna (2007). Can voluntary pollution prevention programs fulfill their promises? Further evidence from the EPA's 33/50 program. *Journal of Environmental Economics and Management 53*, 180–195.