Management and Disclosure of Corporate Sustainability Performance

A dissertation presented

by

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in partial fulfillment of the requirements

for the degree of

Doctor of Business Administration

Harvard University

Graduate School of Business Administration

Cambridge, Massachusetts

August 2019

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Abstract

Growing investor interest in sustainability performance and recent regulation have led to increased firm disclosure of environmental (i.e., carbon emissions, water consumption, waste generation, etc.), social (i.e., employee and workplace practices, product safety, etc.), and governance (i.e., political lobbying, anticorruption, etc.) information. This dissertation examines market and non-market forces that shape corporate sustainability disclosure and investment. The first essay studies voluntary sustainability disclosure across financial and sustainability reports and sheds light on investors' interpretation and use of this information. The second essay examines whether mandated disclosure of greenhouse gas emissions leads to emissions reductions among firms already disclosing prior to regulation. The third essay provides the first empirical evidence on investor perceptions of mandated sustainability disclosure.

Acknowledgements

This dissertation was made possible because of my committee members. George Serafeim is a true mentor: he believed in my ideas, encouraged me relentlessly and showed me – by way of example – how persistence and believe in oneself are critical to success. George was a champion of my work, an ongoing advocate for our research and a wise counsel through every stage of my doctoral program. I am deeply thankful to Paul Healy for encouraging me to pursue my passion for sustainability, for reading every word of my papers and for always providing me with constructive and actionable feedback. I am so grateful for the interactions I had with Srikant Datar, which led me to improve my work and reflect on how I could make a difference in the world. I am very thankful to Krishna Palepu for his care and concern over my career, and for being honest and consistent in his advice and feedback. Eddie Riedl is one of the most thoughtful, sincere and intelligent people I have ever met, and I am thankful to have met him, let alone to have had the opportunity to collaborate and publish with him.

I am grateful for the friendships I developed at Harvard, the kindred spirits I met and the unforgettable experiences I shared with my colleagues. My "doc fam" – Hayley Blunden, Hyunjin Kim, David Martin and Lumumba Seegars – were a source of joy and support throughout, but especially in the trying first year and last year of the program. Maryaline Catillon, Carolyn Deller and Bethany Sheridan are like sisters to me. My dear friends Jee Eun Shin, Wei Cai and Alexa Scherf helped me every day with their encouragement, kindness and laughter. I am so grateful I had the opportunity to work with and learn from Clarissa Hauptmann and David Freiberg; there is nothing better than working with your friends. I am thankful to the Doctoral Programs Office, especially Jen Mucciarone, Marais Young, LuAnn Langan and Daria Russell, who truly cared about my success in the program.

Before Harvard there were people who believed in me and supported me, and I know with every fiber of my being that I would not be where I am without them. Cindy Veinot is one of the most exceptional women I've ever known, someone who is equally kind, caring and compassionate as she is accomplished, ambitious and brilliant. Sally Gunz has been my supporter for over a decade and I cannot imagine where I would be without her and her husband John. Sally is someone who uses favors to help others and as a result she has more friends, admirers and people who love her than anyone else I know.

My generous and loving sister – Mandeep Grewal – is forever my role model and hero. My best (and oldest) friends, Dayna Lubelski and Simone Davis, bring me so much joy and perspective. I feel overwhelmed with gratitude to have the constant presence of these three incredible women in my life. My fiancé Aaron Zaretsky is a true partner in every sense of the word. I could have never imagined how empowering it is to have the unconditional love and support of a true partner – it is like having wings. This dissertation is as much mine as it is yours.

Last, but not least, I am most thankful to my two biggest fans who love me more than anyone else in the world: my mother, Ranjana Handa-Grewal and my father, Tejwant Singh Grewal. To my parents, I dedicate this dissertation.

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CHAPTER 1

Introduction

My dissertation examines market and non-market forces that shape corporate sustainability disclosure and investment. I study the capital market effects and real effects (i.e., changes in behavior through investment, use of resources, etc.) of sustainability information disclosed voluntarily and under mandatory reporting regimes. Growing investor interest in sustainability performance and recent regulation have led to increased firm disclosure of environmental (i.e., carbon emissions, water consumption, waste generation, etc.), social (i.e., employee and workplace practices, product safety, etc.), and governance (i.e., political lobbying, anticorruption, etc.) information. Sustainability reporting shares a number of similarities with financial reporting, which is the focus of most disclosure research in accounting, but with a few important differences that I exploit to provide new insights to the disclosure literature through the econometric analysis of archival data.

In my first essay entitled "Disclosure of Emerging Trends: Evidence from Climate Change Business Opportunities", I use climate change as a setting to study firms' voluntary disclosures of emerging trends and their economic consequences. I perform textual analysis of 10-Ks and sustainability reports to identify disclosure of the development and sale of low-carbon products in response to the business opportunities created by climate change ('green opportunities'). I find that firms disclose green opportunities in both their 10-K and in their sustainability report, but on average delay disclosing in their 10-K for 2.5 years after disclosing in their sustainability report. Using data from an index provider, I find that both disclosure channels provide reliable information about future revenues from the sale of low-carbon products. Nevertheless, withholding disclosure of green opportunities from the 10-K has capital market implications. A value-weighted portfolio

of firms disclosing only in the sustainability report earned an annual alpha of 3.09%, while a portfolio of 10-K disclosers does not earn abnormal returns. Firms disclosing only in the sustainability report also exhibit significantly more positive earnings and revenue surprises and earnings announcement returns. This suggests that the stock market does not immediately capitalize on green opportunities disclosed in sustainability reports, which generates superior future accounting performance. I find that the disclosure delay is shorter when the firm has higher shareholder support for climate change-related proposals which is consistent with managerial perceptions of shareholder preferences influencing disclosure decisions.

In my second essay entitled "Real Effects of Disclosure Regulation: Evidence from Mandatory Carbon Reporting", I study whether disclosure regulation generates real effects among firms already disclosing prior to regulation. The majority of extant studies examine real effects among firms *not* disclosing prior to regulation. I exploit the passage of a regulation in the United Kingdom (UK) requiring listed UK-incorporated companies to report greenhouse gas emissions (GHGs) for their entire organization (i.e., Mandatory Carbon Reporting or MCR). A key feature of this setting is that a number of UK firms affected by MCR voluntarily disclosed GHGs prior to MCR. I find that firms voluntarily disclosing GHGs prior to MCR reduce GHGs in the post-MCR period by, on average, 10% relative to matched firms outside of the UK (and private UK firms in a robustness test) that voluntarily disclose GHGs but are unaffected by disclosure regulation. I document a positive association between GHGs reductions and investments in green building retrofits, employee energy-saving efforts, and clean energy purchases. My analysis of survey data suggests that disclosure regulation increases (1) reputational concerns, because regulation provides more decision-useful information about GHGs to investors and other stakeholders, and (2) regulatory concerns, because expectations of 'soft' disclosure regulation foreshadows forthcoming

'hard' regulation (e.g. carbon taxation). Moreover, I find that more senior-level employees have monetary incentives tied to GHGs following MCR, relative to unaffected firms. Prior literature attributes the real effects of mandated reporting to new or improved information; my study provides evidence on additional channels through which disclosure regulation can affect firm behavior, which could apply to other mandatory reporting settings.

My third essay entitled "Market Reaction to Mandatory Nonfinancial Disclosure" provides the first empirical evidence on investor perceptions of mandated nonfinancial disclosure. Co-authored with Professor Edward Riedl (*Boston University*) and Professor George Serafeim (*Harvard Business School*), this paper employs event study methodology to examine the equity market reaction to regulatory events associated with the adoption of a directive in the European Union mandating affected firms to provide disclosures relating to environmental, social and governance (ESG) performance. We document a negative market reaction across the regulatory events of –0.79%, or a loss equivalent to $79M of market capitalization, on average. Cross-sectional analyses reveal a *less negative* market reaction for firms exhibiting stronger pre-directive ESG performance and higher pre-directive ESG disclosure. These results suggest that investors perceive that firms with strong pre-regulation ESG performance will incur a competitive advantage since weak ESG firms will incur higher costs of maintaining weak ESG performance (for example, through penalties) or higher costs to improve ESG performance. Moreover, investors expect costs from increased disclosure to primarily affect low disclosure firms owing to proprietary and political costs of disclosure and, to a lesser extent, direct costs to prepare and disseminate ESG disclosure.

Chapter 2

Disclosure of Emerging Trends: Evidence from Climate Change Business Opportunities

2.1 Introduction

I study the economic consequences of disclosures that firms provide about their plans to address emerging trends. Given changing technological, legal, political, demographic and geographic trends, firms make decisions on how to act on the resulting risks and opportunities. While the Securities and Exchange Commission (SEC) emphasizes investors' need for information about trends and uncertainties, research on disclosure of emerging trends is limited.[1] However, emerging trends may affect product development decisions, resource allocations and ultimately firm profitability; disclosure could therefore be relevant to investors. Moreover, given the broader impacts that trends could have on society and the economy, other stakeholders of the firm (e.g., customers, employees, governments) are likely interested in, and potentially affected by, firm responses. Firms may as a result disclose not only in financial reports but also in channels that are more accessible to non-investors (e.g., corporate websites). Nevertheless, expected costs of disclosing could affect whether and where firms disclose their plans to address emerging trends. In this paper, I provide empirical evidence on such disclosures and their consequences for capital markets.

Firms have incentives to communicate their plans to address emerging trends to investors. Doing so could signal to investors that the firm is responsive to changing market conditions (e.g., Wells 2012). Moreover, disclosing could improve investors' ability to estimate the firm's future

[1] According to the SEC, "Companies should consider including discussion, analysis and plans to address…legislative, regulatory, business and market trends and uncertainties…affecting financing and operating decisions…" (SEC 1989; SEC 2003).

performance (i.e., expected cash flows) and potentially reduce the firm's cost of capital through lower information risk (e.g, Easley and O'Hara 2004). Firms also have incentives to inform non-equity stakeholders (e.g., customers, governments, etc.) of their plans. For example, many of the non-technology companies selected to participate in meetings with White House officials about federal funding, policies and regulation relating to artificial intelligence (AI) were selected on the basis of information they provided on their websites about AI (American Leadership in Emerging Technology, 2017). Relative to investors, non-equity stakeholders are less likely to use financial reporting channels such as SEC filings and conference calls, since disclosures in these channels may be limited in scope or difficult to process. Given incentives to inform both investors and non-equity stakeholders of their responses to emerging trends, companies may disclose in financial channels and newer (i.e., nonfinancial) channels.

However, firms likely expect costs from disclosing their plans. Prior research shows that managers fear the consequences of failing to deliver on stated plans (e.g., Waymire 1985), which may be exacerbated in the high-uncertainty context of emerging trends. In addition, if disclosing invites questions from analysts who seek more information than managers can provide given the uncertainty, firms could lose credibility (Graham et al. 2005). Though firms are liable for information disclosed in all sources, managers may perceive lower accountability for disclosures provided outside of financial channels. As a result, firms will withhold disclosure of emerging trends from financial channels until they have more certainty about their ability to deliver on stated plans, while disclosing *outside* of financial channels where disclosure-related costs are expected to be lower. Alternatively, firms may be deterred from selectively disclosing since regulators and other market participants can identify this behavior, potentially leading to regulatory intervention and loss of reputational capital.

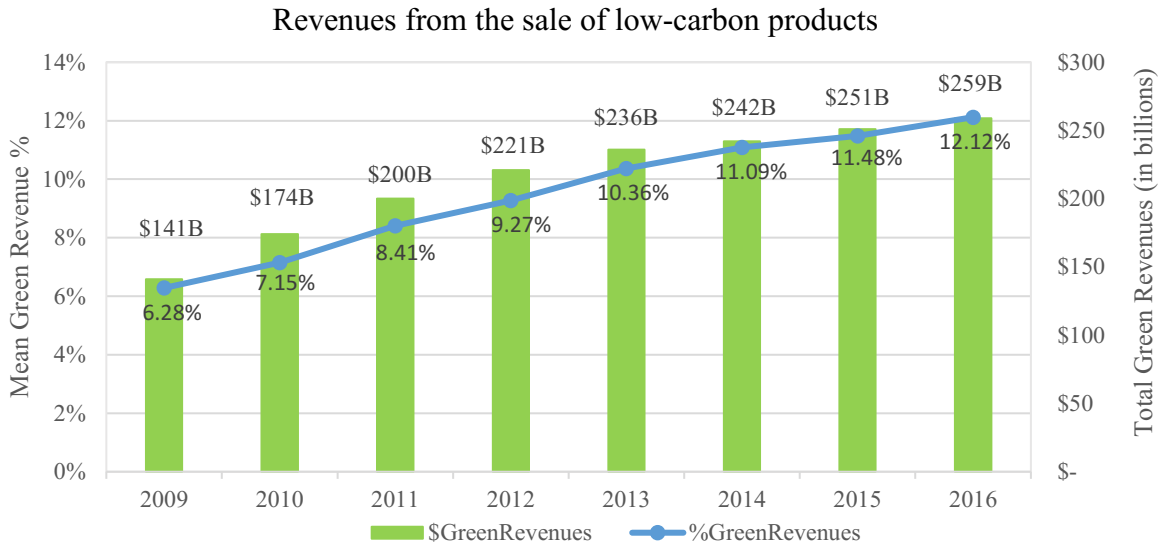
The disclosure channels used to communicate plans to address emerging trends could have consequences for capital markets. For instance, investors and analysts may miss information outside of financial reporting channels owing to frictions (e.g., search costs or limited attention). Another possibility is that capital market participants will rationally decide to ignore information outside of financial channels owing to concerns about its credibility and financial relevance (e.g., Bamber and Cheon 1998).

My setting to study disclosures about emerging trends is climate change. Climate change is a trend that is expected to have significant operating and financial implications for many companies (SEC 2010). I study firm disclosure of plans to capitalize on the business opportunities that arise from climate change ('green opportunities') using forward-looking statements about the sale of low-carbon goods, technologies and services ('green products'). This setting has a number of benefits. First, the financial implications of green opportunities have materialized in recent years with the launch of green products in every sector of the U.S. economy.[2] This allows me to obtain data on the revenues generated from the sale of green products for 747 U.S. firms from 2009 to 2016, and compare green opportunity disclosures with subsequent green product revenues.[3] Second, firms have incentives to disclose green opportunities in financial reports for investors, as well as in sustainability reports for non-equity stakeholders (e.g., environmental non-governmental organizations or NGOs). Sustainability reports are voluntary reports disclosing environmental and social information that can enhance the firm's sustainability reputation (Unerman, 2008). Firms may expect lower disclosure-related costs relative to financial reports since sustainability reports are less regulated and rarely audited (Brown and Zamora 2015). I compare green opportunity

[2] See Table 1.2 Panel B for examples of green products across sectors.
[3] Climate change risks are another candidate for study in this setting. The difficulty in studying climate risk disclosures is that, like other risk-related reporting, there is often no ex-post settling up (Schrand and Elliott 1998).

disclosure decisions within a firm and across its financial and sustainability reports and examine the consequences of these decisions. Third, green opportunities represent an economically significant phenomenon: green revenues in my sample amounted to $259 billion in 2016 and grew by 93% over the years 2009-2016 (see Figure 2.1).

Figure 2.1: Green Revenues



I identify green opportunity disclosures using textual analysis of sustainability reports and MD&A sections of 10-Ks.[4] A green opportunity disclosure is a sentence that contains a forward-looking term such as "company expects" or "management anticipates" (using the approach in Bozanic et al., 2018), and a green product term obtained from proprietary data provided by FTSE Russell. For each firm-year, I determine whether green opportunity disclosure is made in the 10-K and in the sustainability report. Descriptive statistics reveal that, in nearly a quarter of firm-year observations, firms make different green opportunity disclosure decisions across financial and

[4] I combine the text in firms' stand-alone sustainability report with text from firm responses to a climate change survey (provided as part of the stand-alone report or on the firm's website) and refer to this text collectively as firms' sustainability report.

sustainability reports. In virtually all instances, disclosure is initially made *only* in the sustainability report, without an accompanying green opportunity disclosure in the 10-K. However, 95% of firms that disclose green opportunities in the sustainability report subsequently include disclosure in their 10-K. On average, firms start disclosing green opportunities in the 10-K 2.5 years *after* first disclosing in the sustainability report.

I examine whether disclosure channel decisions reflect the reliability of green opportunity disclosures.[5] If managers delay green opportunity disclosure in the 10-K until they can reliably predict future green revenues, or if sustainability disclosures are insincere (i.e., 'greenwashing' as in Ramus and Montiel, 2005), I expect green opportunities disclosed in the 10-K to be more reliable than green opportunities disclosed in the sustainability report. To test this, I examine the association between green opportunities disclosed in sustainability reports only (i.e., not accompanied by green opportunity disclosure in the 10-K) and green opportunities disclosed in both sustainability reports and 10-Ks, and future green revenues. I find that disclosing green opportunities only in the sustainability report (1) increases the likelihood of future green revenues relative to not disclosing, and (2) is positively associated with green revenue growth over multiple years. Supplementing sustainability report green opportunity disclosure with 10-K green opportunity disclosure does not increase the likelihood of future green revenues nor is it associated with higher green revenue growth. I also find that disclosing green opportunities in both the 10-K and in the sustainability report is associated with lower volatility in future green revenues relative to disclosing green opportunities only in the sustainability report. Collectively, this suggests that while disclosure channel decisions reflect management's uncertainty about future green revenues,

[5] Reliability, according to the Financial Accounting Standards Board (FASB), represents the extent to which the information is unbiased, free from error, and representationally faithful (FASB 1980). It is challenging to specify and identify reliability precisely (Maines & Wahlen, 2006). In this paper I adopt the view that green opportunity disclosures are reliable if they relate positively to future green revenues.

both channels convey reliable information about the future occurrence and growth of green revenues.

Next, I study whether analysts incorporate these disclosures in forming earnings and revenue forecasts. My analysis shows that green opportunity disclosures made only in the sustainability report are associated with positive one- and two-year earnings and revenue forecast errors, while green opportunity disclosures made in both the sustainability report and the 10-K are not. My interpretation is that positive earnings and revenue surprises arise in part because analysts do not fully incorporate information from the sustainability report. Analysts' forecasts therefore do not include the 'green' component of earnings and revenues when green opportunities are disclosed only in the sustainability report.

I also examine whether withholding disclosure of green opportunities from the 10-K has aggregate capital market consequences. Frictions (e.g., search costs and investor inattention) could prevent investors from using all information sources (Gow et al. 2018; Dellavigna and Pollet 2009). Alternatively, investors may rationally discount green opportunity disclosures in sustainability reports owing to concerns about the credibility of these reports. I assess the market's incorporation of green opportunity news and the valuation implications (if any) of this news. I find that a portfolio of firms disclosing green opportunities in their 10-K and in their sustainability report does not exhibit significant abnormal returns. Conversely, a portfolio of firms disclosing green opportunities only in their sustainability report earns significantly positive abnormal returns, with alpha estimates suggesting that investors are able to earn as high as 3.09% annual abnormal returns. This implies that investors do not immediately and fully impound green opportunities disclosed in sustainability reports, but do so more efficiently when disclosure is provided in the 10-K. I show that earnings announcement returns account for a meaningful proportion of the

outperformance, suggesting that the price change (alpha) is realized as green opportunities pay off through observable metrics such as higher sales revenues and accounting returns.

Given my findings that withholding green opportunity disclosure from the 10-K, relative to the sustainability report, has implications for price discovery and information intermediation, it is interesting as to why managers delay disclosing these opportunities in the 10-K. I hypothesize that managers perceive net costs (benefits) from disclosing green opportunities in the 10-K (sustainability report) when green revenues are lower and less certain. Over time, as green revenues increase and uncertainty is resolved, the expected costs of disclosing in the 10-K fall and managers opt to disclose green opportunities in the 10-K.

Consistent with this 'costly disclosure' hypothesis, I find that firms with higher green revenues, and firms with lower future green revenue uncertainty, disclose green opportunities more promptly in the 10-K. I find no evidence that 10-K disclosure delays are longer for firms with higher expected proprietary and litigation costs; however, I find that firms receiving greater shareholder support for climate change-related proposals have shorter 10-K delays. A plausible explanation of this result is that the expected costs of disclosing green opportunities in the 10-K are lower when investors pressure firms to improve performance and transparency on climate change impacts. In the absence of this shareholder engagement, firms expect investors to draw adverse inferences from green opportunity news given widespread concerns that sustainability-related efforts are driven by managers' personal and political beliefs rather than by shareholders' interests (e.g., Di Giuli and Kostovetsky 2014).

My paper makes a number of contributions. First, I contribute to the literature on discretionary disclosure by providing evidence in a setting where I can observe disclosure being withheld in one report versus another. Relatively few papers have examined settings where

underlying disclosure choices can be observed. Gow, Wahid and Yu (2018) observe when director biographies withhold information on other directorships using data from Equilar, and Berger and Hann (2007) observe concealed segment profits using the retroactive application of SFAS No. 131. Whereas these papers examine settings where information is withheld altogether, I study firm decisions to withhold disclosure in one report, but provide it in another.

Second, I contribute to the relatively understudied question of which reporting channels managers use (e.g., Bamber and Cheon 1998; Plumlee & Yohn 2010; Elliot et al. 2012; Crowley 2018; Lansford et al. 2018). Firms disclose information in several different venues, such as SEC filings, government filings, conference calls and websites. While prior literature studies disclosure decisions across traditional financial reporting channels (e.g., SEC filings and conference calls), I show that firms also make disclosure choices across traditional and newer reporting channels, such as sustainability reports. My paper is timely in light of the SEC's recent approval of social media networks, such as Twitter and Facebook, as channels for firm disclosure (SEC 2013).

Third, my study is related to literature examining managers' presentation and disclosure choices (e.g., Riedl and Srinivasan 2010; McVay 2006; Merkley 2014) and how information users are affected by these choices (e.g., Schrand & Walther 2000; Bowen et al. 2005; Hirst & Hopkins 1998). This literature mainly studies choices made *within* a given report or SEC filing, whereas I show that investors and analysts are affected by disclosure choices made *across* reports. I also add to the research on limited investor attention (e.g., Hirshleifer and Teoh 2003; Dellavigna and Pollet 2009; Barber and Odean 2008), since inattention is one possible explanation for why investors and analysts do not fully incorporate green opportunity disclosures provided in sustainability reports.

Last, I contribute to research on the capital market implications of voluntary sustainability disclosure (e.g., Dhaliwal et al. 2011 and 2012; Matsumura et al. 2014). Most of this research

focuses on disclosure in sustainability reports or on climate risk reporting in the 10-K (e.g., Matsumura et al. 2017; Berkman et al. 2018), but no study examines disclosure of the same information across financial and sustainability reports. I show that investors and analysts do not fully incorporate green opportunity disclosure in sustainability reports when firms do not also include disclosure in the 10-K, suggesting that frictions or credibility concerns over sustainability reporting may affect price discovery and information intermediation.

2.2 Background and hypothesis development

2.2.1 Background

Virtually no large company is immune to the effects of rapid technological advances, shifts in consumer preferences, changing regulation, or other macroeconomic trends that have the potential to transform industries and the economy (McKinsey 2017). The potential and realized implications of emerging trends have generated considerable practitioner and academic interest in how firms adapt to changing market conditions (e.g., Reeves and Deimler 2011; Wells 2012; Martin 2014). The SEC encourages companies to voluntarily disclose information about trends, plans and uncertainties in the MD&A, but prior research on these disclosures is limited.[6]

Firms also have incentives to share their plans to address emerging trends with non-equity stakeholders (e.g., customers, employees, government officials) who are interested in, or implicated by, the risks and opportunities created by trends. For instance, in response to estimates that thousands of American workers could lose their jobs owing to advancements in artificial intelligence (AI), companies are providing information on their websites about programs to retrain

[6] According to the SEC, "Companies should consider including discussion, analysis and plans to address…legislative, regulatory, business and market trends and uncertainties…affecting financing and operating decisions…" (SEC 1989; SEC 2003).

existing workers (Illanes et al. 2018). This communication could help assuage the concerns of current employees while also helping the firm attract new talent if prospective employees see this as positive signal about how the firm treats its workers. Disclosing responses to emerging trends could also increase the likelihood of influencing federal policy and regulation – which could be strategically beneficial to the firm – since government officials consult with companies at the forefront of emerging trends and use corporate websites to help identify such companies (American Leadership in Emerging Technology, 2017).

My setting to study corporate disclosure of emerging trends is climate change. In particular, I study disclosures that firms provide about their plans to capitalize on the business opportunities that arise from climate change. Relative to other trends, a benefit of this setting is the ability to observe the financial implications of green opportunities given the launch of low-carbon or 'green' products in recent years. I obtain data on the revenues generated from the sale of green products for U.S. firms from a data provider, allowing me to draw more direct inferences relative to settings where the outcomes of emerging trends have not yet materialized or are difficult to observe.

A growing number of companies recognize the current and potential effects on their operations, both positive and negative, associated with climate change.[7] I study climate change opportunity disclosure, rather than climate change risk disclosure, for two reasons. The first is that assessing the financial implications of risk reporting is challenging since costs may be incurred far into the future and are often unobservable (Schrand and Elliott 1998). Data on the revenues generated from the sale of low-carbon products for hundreds of U.S. firms helps overcome this challenge in studying climate change opportunities. The second reason is that climate change risk

[7] Over 3,500 companies globally, of which approximately 800 are U.S. companies, reported climate change information in 2016. See the Carbon Disclosure Project's website for more information: www.cdproject.net.

reporting may be mandatory given the SEC's requirement for firms to disclose material risks in Item 1A of the 10-K. By comparison, firms are not mandated to disclose opportunities. Opportunity disclosures are therefore preferable to study firms' incentives to voluntary disclose information relating to emerging trends (Heiztman, Wasley and Zimmerman 2010).[8]

Like other trends, corporate plans to address the business opportunities that arise from climate change could be of interest to both investors and non-equity stakeholders. Relevant non-equity stakeholders in this setting include environmental non-governmental organizations (NGOs), climate change activists and consumers with environmental preferences. These stakeholders refer to sustainability reports, rather than to financial reports, for information about firms' environmental practices and performance (LeBlanc and DeRose 2013).

Sustainability reports contain environmental (i.e. carbon emissions, water consumption, waste generation, etc.), social (i.e. employee, product, customer related, etc.), and governance (i.e. political lobbying, anticorruption, etc.) information. The number of firms issuing sustainability reports increased from less than 50 in 1995 to over 6,000 in 2015 (Ioannou and Serafeim, 2017).[9] Despite 87% of the S&P 500 Index reporting on sustainability in 2017, the SEC does not mandate sustainability disclosure.[10] Much of this voluntary reporting is driven by demands for transparency from non-equity stakeholders, such as environmental NGOs and human rights advocacy groups.

[8] Heiztman, Wasley and Zimmerman (2010) state that, for mandatory disclosures, firms must disclose information that it deems to be material. Thus, accounting researchers should recognize that disclosure is often provided because of reporting obligations, and is not voluntary. HWZ state that this does not apply to settings where managers have no obligation to disclose, such as disclosures of forward-looking information.

[9] In the past, the terms "sustainability," "environmental, social, and governance" (ESG), and "corporate social responsibility" (CSR) have been used interchangeably. Throughout this paper, I use the word sustainability, given that more firms use this word rather than CSR or ESG to describe voluntary actions to manage the environmental and social impacts of the firms' activities.

[10] Though the SEC mandates governance disclosures such as executive compensation and pay ratios, the governance portion of sustainability disclosures typically does not cover these topics, but rather includes issues such as business ethics and political lobbying.

Some firms issue sustainability reports to market the firm's activities and policies as sustainable when they are not, a practice known as 'greenwashing' (e.g., Ramus and Montiel, 2005; Marquis and Toffel, 2015; Burbano and Delmas, 2015). Increased investor interest in sustainability data is another reason for voluntary sustainability reporting (e.g., Eccles et al. 2011).[11]

2.2.2 Hypothesis development

2.2.2.1 Green opportunity disclosure in financial and sustainability reports

An extensive literature in accounting studies the factors that drive disclosure decisions and the capital market implications of disclosure (Healy and Palepu, 2011). Most prior research focuses on the decision to disclose or not to disclose. By comparison, relatively few studies examine disclosure decisions across reporting channels (Crowley 2018; Elliot et al. 2012; Ma 2012; Plumlee and Yohn 2010; Lansford et al. 2009; Bamber and Cheon 1998).[12]

Firms taking action to capitalize on the business opportunities that arise from climate change have incentives to communicate these plans to investors. This information could improve the prediction of the firm's future performance (i.e., expected cash flows) and reduce the firm's cost of capital through lower information risk (e.g., Easley and O'Hara 2004). Moreover, disclosing green opportunities could signal good news to investors about firm responsiveness to changing market conditions (e.g., Wells 2012). Firms also have incentives to disclose green

[11] For instance, as of 2017 the United Nations Principles for Responsible Investment (UNPRI) had over 1,400 signatories with $60 trillion in assets under management who had committed to incorporate sustainability issues into their investment analysis and ownership policies and practices.

[12] Crowley (2018) develops a model of disclosure incentives across an easy-to-process and a hard-to-process channel in the presence of informed and uninformed investors. Elliot, Hodge and Sedor (2012) examine how subjects perceive earnings restatements made in online videos versus text-based press releases. Ma (2012) examines disclosure of material events in 8-Ks and press releases. Plumlee and Yohn (2010) examine whether restatements are filed in an 8-K report, an amended report or in subsequent regulatory filings. Lansford et al. (2009) examine whether management guidance is issued in conference calls or in press releases. Bamber and Cheon (1998) study the location of earnings forecasts across special press releases and in response to questions from analysts.

opportunities to non-equity stakeholders (e.g., environmental NGOs) interested in identifying companies contributing to the transition to a low-carbon economy. Disclosure could increase the firm's sustainability reputation and help the firm attract talent, reduce the risk of consumer boycotts and smearing campaigns, and form partnerships with key stakeholders (e.g., Cheng et al. 2014; Burbano 2018; Turban and Greening 1997; Henisz et al. 2014). Given these incentives, I expect managers to disclose green opportunities in two reporting channels: a financial reporting channel (e.g., the 10-K) and a nonfinancial reporting channel (e.g., the sustainability report).

However, firms likely anticipate costs from disclosing green opportunities. Prior research suggests that managers fear the legal sanctions that could result from making misleading statements and the loss to firm credibility and reputation from missed projections (e.g., Waymire 1985; Graham et al. 2005).[13] Nevertheless, these costs might not prevent firms from disclosing green opportunities in sustainability reports. Firms are liable for disclosures made in all mediums (SEC 2013) but firms may perceive lower accountability for disclosures made in sustainability reports. This could arise due to firms' beliefs that frictions (e.g., search costs and inattention) prevent investors from being attentive to disclosures in sustainability reports. Firms might also expect sustainability reports to be disregarded given investor concerns about the reliability of these reports (e.g., Amel-Zadeh and Serafeim 2017). Moreover, CEOs are rarely asked about sustainability matters in quarterly earnings calls and no firm to date has been held liable for claims

[13] Waymire (1985) conjectures that "executives expect legal sanctions, brought by disgruntled shareholders or regulatory agencies like the SEC, to be associated with unattained earnings forecasts." (p. 293). Graham et al. (2005) find that failing to achieve targets (especially those set by management) could cause the firm to lose credibility and raises questions about whether managers have control over the firm. Skinner (1994) also points out that credibility with analysts is an important motivation to avoid negative earnings surprises.

made in sustainability reports (Eccles and Serafeim 2013). Firms may therefore expect lower investor and regulator monitoring of disclosures made in sustainability reports.

This suggests that firms will withhold disclosure of green opportunities from financial reports until they have more certainty about their ability to deliver on stated opportunities, while disclosing *in* sustainability reports where disclosure-related costs are expected to be lower. Assuming that certainty about the ability to deliver on green opportunities increases over time as green product sales increase, this leads to the prediction that firms will disclose green opportunities in the 10-K with a delay relative to the sustainability report.

Alternatively, firms may be deterred from selectively disclosing since regulators and investors could identify and penalize this behavior. This is a relevant concern given that the SEC issued interpretive Guidance on climate change disclosures to remind companies of their obligations to "consider climate change as they prepare disclosure documents" and cautioned that some of the climate change-related information being provided by firms in their sustainability reports may also be required in regulated filings (SEC 2010). Thus, firms may expect regulatory action – in the form of comment letters or forced revisions of previously filed reports – if they do not disclose green opportunities consistently across financial and sustainability reports (e.g., Bozanic et al. 2017).

2.2.2.2 Reliability of green opportunity disclosures

Prior research in accounting examines firms' presentation and disclosure choices, documenting evidence consistent with both informational and opportunistic motivations behind reporting decisions (e.g., Merkley 2014; Riedl and Srinivasan 2010; McVay 2006; Bowen et al. 2005; Schrand and Walther 2000; Hirst and Hopkins 1998). I examine whether firms' disclosure

channel decisions reflect the reliability of green opportunity disclosures. Reliability, according to the Financial Accounting Standards Board (FASB), represents the extent to which information is unbiased, free from error, and representationally faithful (FASB 1980). Though reliability is challenging to identify (Maines & Wahlen, 2006), I adopt the position that green opportunity disclosures are reliable if they relate positively to future green revenues.

Green opportunity disclosures in the sustainability report may be unreliable if firms expect low accountability over disclosures provided in sustainability reports. Few sustainability reports issued by U.S. firms are audited (Brown and Zamora 2015).[14] Thus, firms can more easily disclose green opportunities in sustainability reports without having any current or future intentions to pursue them. Even in the absence of misrepresentations, higher expected litigation and reputation costs associated with claims made in the 10-K could lead firms to wait until they are more certain about future green revenues before disclosing green opportunities in the 10-K than in the sustainability report. As a result, green opportunity disclosures will be a reliable indicator of future green revenues in the former, but not in the latter.

On the other hand, if firms expect sustainability reports to be monitored by investors, analysts and/or non-equity stakeholders, firms will not make misrepresentations and will require reasonable certainty about future green revenues before disclosing green opportunities in sustainability reports. In that case, green opportunity disclosures are expected to be reliable predictors of future green revenues when disclosed in either the 10-K or the sustainability report.

2.2.2.3 Capital market implications of green opportunity disclosures

[14] In my sample of U.S. sustainability reports issued from 2009-2016, 4.2% are externally audited. Wherever possible, I empirically examine whether the results are significantly different for audited versus unaudited sustainability reports; I do not find that this is the case.

It is conceivable that investors will be skeptical of green products and may even require a higher rate of return for firms that disclose green opportunities. Given that venture capital investors lost over $12.5 billion in early-stage clean energy technology investments, investors are apprehensive of new green product developments (Gaddy et al. 2016). Moreover, concerns that sustainability-related efforts are motivated by managers' personal and political beliefs rather than shareholder interests, further cast doubt on the financial returns to green product investments (e.g., Cheng, Hong, and Shue 2014; Benabou and Tirole 2010).

It is also possible that capital market participants are affected by the disclosure channels used by firms to disclose green opportunities. Investors and analysts may dismiss green opportunity disclosures in sustainability reports owing to concerns about the credibility of these reports (e.g., Brown and Zamora 2015). This is consistent with research suggesting that investors are less willing to rely upon forecasts that are viewed as less credible or precise (e.g., Bamber and Cheon, 1998).[15]

There may also be frictions (e.g., search costs or investor inattention) that limit the ability of capital market participants to impound all relevant information, regardless of where it is disclosed. Limited investor attention has been modeled theoretically (e.g., Hirshleifer, Lim and Teoh 2011; Hirshleifer and Teoh 2003; Merton 1987) and shown empirically (e.g., Dellavigna and Pollet 2009; Barber and Odean 2009). Recent research also suggests that search costs may prevent investors from being aware of information in all sources (Gow et al. 2018).

[15] Another possibility is that, if firms do in face wait to disclose green opportunities in the 10-K, the NPV of those projects is larger at that time and warrant a more pronounced response. This could result if the costs to generate early revenues exceeds the costs to generate later revenues.

The above reasons suggest that investors and analysts may not incorporate green opportunity disclosures into valuation and forecast decisions, respectively. If capital market participants do not immediately and fully impound green opportunity news, disclosures may be associated with future stock returns. Returns could be positive, negative, or zero, depending on whether green products increase or decrease shareholder wealth, or are neither value-creating nor value-destroying. It is therefore an empirical question whether markets incorporate green opportunity disclosures and the valuation implications (if any) of green opportunities.

2.3 Data and sample

2.3.1 Green opportunity disclosure

I use textual analysis to identify green opportunity disclosure in financial and nonfinancial reporting channels.[16] My source for the financial reporting channel is the Management Discussion & Analysis (MD&A) section of the 10-K. I use the MD&A because public companies are mandated to file MD&A sections as part of 10-K filings, but the content of the MD&A is largely voluntary (SEC 1980; Beyer et al. 2010). Given my focus on green opportunity disclosure, the MD&A is appropriate because the SEC has guided companies to voluntarily disclose trends, events, commitments, plans, and uncertainties in the MD&A (SEC 1989, 2003). The SEC has also guided companies to voluntarily disclose climate change-related matters in MD&A disclosure (SEC 2010). I restrict my sample to 10-K filings because (1) my review of green opportunity disclosures indicates that those in the 10-K are more comprehensive than those in 10-Q filings and (2) the annual reporting frequency is more appropriate for my empirical analyses since the green

[16] Examples of green opportunity disclosures are provided in Appendix Table III.

revenues data I have are on an annual basis. Therefore, my conclusions about green opportunity disclosures in financial reporting channels relate only to the MD&A disclosures in 10-K filings.[17]

My sources for the nonfinancial reporting channel are (1) sustainability reports and (2) responses to the Carbon Disclosure Project survey questions *"Have you identified any climate-related opportunities with the potential to have a substantive financial or strategic impact on your business?"* and *"Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business."*[18] The Carbon Disclosure Project (CDP) is an investor-led partnership that asks companies to respond to questions about their climate change risk management and performance through an annual online survey. I use the GRI's Sustainability Disclosure Database to identify sustainability reports, which is considered the most comprehensive repository of sustainability reports for North American firms (CSE, 2017). All firms in my sample either issue a sustainability report or respond to the CDP survey – or do both – throughout the sample period.

I develop a Python code that downloads 10-K filings from the SEC EDGAR database and extracts the text from MD&A sections of the 10-K filings. For sustainability reports, which are typically in PDF format, I use the Python package 'pdfMiner' and the programs 'pdf2txt' and 'textract' to convert PDF files into readable text.[19] Since firms generally provide CDP responses as part of their sustainability report, or provide them in the same section of the corporate website where sustainability reports are filed, I combine text from the firm's CDP response and

[17] For completeness, I have also analyzed the text of management forecasts provided in earnings announcements, earnings calls, press releases and 8-K filings. I have noted no instance a firm disclosing green opportunities in these channels *before* the 10-K.

[18] Although the wording of these questions has changed somewhat over the years that the CDP has administered their survey (i.e., since 2004), the questions' objective (i.e., to elicit responses about climate change business opportunities) has remained unchanged. I thank Tim Fryer from the CDP for this insight.

[19] These programs do not have a way to extract tables, images, charts, or other media from PDF documents, but can extract the text and return it as a Python string.

sustainability report and refer to the combined text collectively as sustainability report disclosure. Next, I parse the text from 10-Ks and sustainability reports into sentences. I use sentences as the unit of analysis (rather than words or text lines), consistent with prior research (e.g., Muslu et al. 2015; Bozanic et al. 2018).[20] I classify a sentence as a green opportunity disclosure if the sentence includes (1) a forward-looking term and (2) a green product term. The forward-looking term serves to identify statements that companies make about the future and the green product term serves to identify discussion about low-carbon goods, technologies and services. Together, my measure identifies forward-looking statements about low-carbon products.

I identify forward-looking terms using a library-based approach which relies on lists from prior literature that have been found to be well-specified and powerful in identifying forward-looking information. I use the lists from three studies employing textual analysis for forward-looking information (i.e., Li 2010; Muslu et al. 2015; Bozanic et al. 2018). In these studies, the authors identify words that characterize forward-looking statements and classify any sentence including at least one of those words as a forward-looking sentence. The full list of forward-looking terms that I use is provided in Appendix Table I. To identify green product terms, I use data provided by FTSE Russell (FTSE) based on its review of thousands of public documents (e.g., industry reports, product descriptions, news articles, press releases, regulated filings, websites, market research, etc.). The data I receive consists of descriptions of products, services, goods and technologies that, according to FTSE's research, are contributing to the transition to a low-carbon economy. FTSE collected this data to identify companies that sell green products and to quantify revenue exposure that companies have to green products. The proprietary nature of this data

[20] For example, Muslu et al. (2015) justifies the use of sentences with Ivers (1991), which states that a sentence is the smallest unit of text that communicate an idea, message, notion or thought.

precludes me from sharing the list of green product terms. The green product terms consist of both firm-specific products (e.g., "Ford Focus Electric") and general products (e.g., "electric vehicle"). There are also duplicate terms for the same green product (e.g., "solar panel", "solar powered panel", "photovoltaic panel") to accommodate multiple ways that a green product can be described.[21]

This approach allows me to process 10-Ks and sustainability reports relatively quickly but, as with all library-based approaches used for textual analysis, there are limitations. Since my process for measuring green opportunity statements will likely do so with error, I consider how noise in the measure could affect my inferences. One potential concern is that the disclosure I identify will be too vague or uncertain (1) to warrant an assessment of its reliability, and (2) for investors to price it. Consistent with Hutton et al. (2003) and Bozanic et al. (2018), I do not require green opportunity disclosures to be forecast-like in nature or quantitative.[22] However, I remove the keywords "shall", "should", "can", "could", "may", or "might" from the list of forward-looking terms because prior research has identified these keywords as being associated with uninformative boilerplate disclosures (e.g., legal Safe Harbor language) that do not contain any real forward-looking information (Muslu et al. 2015). Another potential concern is my assumption that forward-looking statements about green products reflect positive (rather than negative) intentions behind the development and sale of green products. To improve my measure's consistency with this interpretation, I remove library terms that include negations (e.g., "does not expect" or "not

[21] I construct the disclosure measure using the full list of green product terms, without discerning which terms relate to a given firm. In untabulated analysis, I use disclosure measure that instead uses a given firm's green product terms; I do not find that my results are qualitatively different.

[22] Hutton et al. (2003) note that statements need not be quantitative to be verifiable, and Bozanic et al. (2018) document that non-quantitative forward-looking information generates significant analyst and investor responses. For example, a statement that the firm expects growth in electric vehicle sales is not quantitative, but can be compared to data on the firm's electric car sales.

intending"), since these forward-looking terms are less likely to be associated with the pursuit of green opportunities. The comprehensiveness of the green product terms from FTSE's data is also a potential concern. If FTSE's process did not identify all green product descriptions that firms use to discuss green opportunities in their sustainability reports or 10-Ks, my green opportunity disclosure indicator variable will be understated. This will most likely introduce noise into the estimates. For instance, in tests that examine disclosure reliability, an understated disclosure variable will bias the association between disclosure and future green revenues towards zero. In tests that examine disclosure and future stock returns, estimates are also likely to be biased towards zero. Moreover, in tests that evaluate the financial implications green opportunity disclosure decisions across 10-Ks and sustainability reports, the estimates should not be systematically biased so long as my measure is equally noisy across both reports.

2.3.2 Green revenues

I obtain data on revenues from the sale of green products from FTSE Russell's Green Revenues data model. The purpose of FTSE's model is to provide investors with data that allows them to monitor the companies and sectors engaged in the transition to a low-carbon economy.[23] FTSE first utilizes data that firms are required to report to the U.S. Environmental Protection Agency (EPA) on the sale of certain low-carbon products. Since the late 1990s, the U.S. EPA requires firms to report sales from products that receive low-carbon certifications from third party organizations, such as electric or hybrid vehicles, renewable energy, machinery and equipment meeting EPA requirements for low emissions, and energy efficient-certified appliances and technologies (Office of the Federal Register, 1997). Since firms are mandated to report this data

[23] See FTSE Russell's description of its Green Revenues model, available at https://www.ftserussell.com/index-series/index-spotlights/green-revenues

and could lose their low-carbon product certifications if they do not comply, this provides increased reliability over the data.[24] For other low-carbon products, FTSE has developed a proprietary taxonomy for green goods, products, technologies, and services. FTSE uses its taxonomy to analyze sub segment revenue data in the audited financial reports of the company and identify what proportion, if any, of the firm's total revenues are generated from green sectors and subsectors. The Green Revenues Factor is calculated for each company between 0 and 100% of revenues and represents green revenues generated by the company in a given year as a fraction of the company's total revenues. FTSE indicates whether the green revenues are calculated using data that firms were required to provide to third-party certifiers, or from firms' sub segment revenue disclosures; for the tests that I perform that utilize this data, I do not find that my inferences are affected by the source of the green revenues data.

2.3.3 Sample

My starting sample consists of FTSE All-World Index constituents, which are large and mid-cap stocks from developed and emerging markets covering 90-95% of the world's investable market capitalization.[25] FTSE provided me with green revenues data for these firms from 2009-2016, inclusive.

Table 2.1 shows how I arrive at my final sample. I start with 3,042 firms and 23,553 firm-year observations. I remove 2,233 non-U.S. firms (17,613 firm-years). I focus on U.S. firms because of the (relative) ease with which financial reports for U.S. firms can be systematically downloaded from the SEC Edgar Database and analyzed, compared to the vast majority of

[24] The EPA also performs periodic audits of the company-reported data.
[25] See FTSE Russell's All-World Index factsheet, available for download from https://www.ftse.com/products/indices/geis-series

financial reports issued by non-U.S. firms for which there is no centralized database. After removing 62 firms (149 firm-years) for which I am unable to obtain data for the control variables required for my analyses, I am left with 747 unique U.S. firms and 5,791 firm-year observations. This sample represents approximately 70% of the market capitalization value of U.S. firms as of 2016.[26]

Table 2.1: Sample Construction

	Firms	**Firm-Years**
FTSE All-World Index	3,042	23,553
Less: Non-US firms	(2,233)	(17,613)
Less: Missing control variables	(62)	(149)
Sample	**747**	**5,791**

Table 2.2 presents the frequency distributions of observations in my sample. In Panel A, I provide an overview of the distribution across years. All years have an approximately equal number of observations. In Panel B, I show the distribution across sectors. My sample is not heavily weighted toward any specific sector, with the most frequently represented sectors being Financials, Consumer Discretionary and Industrials, comprising 16.7%, 15.8% and 14.3% of the sample, respectively. Table 1.2 also reports average green revenues (measured as a percentage of total revenues) across years (Panel A) and sectors (Panel B). Panel A shows a year-over-year increase in green revenues from 2009 to 2016, with mean green revenues doubling from 6% to 12.1% over the 7-year period. Panel B shows variation in green revenues across sectors, with Financials and Telecommunication Services having the lowest green revenues (0.9% and 1.4%,

[26] Inclusion in the FTSE All-World Index depends on firm characteristics such as size, market capitalization and liquidity. Since green revenues are *not* a factor for inclusion, this alleviates the concern that only firms with green revenues survive my sample.

respectively) and Utilities, Industrials and Consumer Staples having the highest proportion (12.4%, 10.5% and 10.1%, respectively).

Table 2.2: Frequencies

Panel A: Frequency by Year

Year	Frequency	Percent	Green Revenue %
2009	691	11.93	6.0%
2010	700	12.09	7.0%
2011	715	12.35	8.1%
2012	723	12.48	9.0%
2013	733	12.66	10.1%
2014	738	12.74	11.0%
2015	744	12.85	11.7%
2016	747	12.90	12.1%
Total	**5,791**	**100**	

Panel B: Frequency by Sector

Sector	Frequency	Percent	Green Revenue %	Green Product Examples
Consumer Discretionary	915	15.80	4.9%	Electric or hybrid vehicles.
Consumer Staples	587	10.14	10.1%	Residential energy efficient heat pumps; LED lighting products.
Energy	267	4.60	7.6%	Solar inversion systems; geothermal power equipment.
Financials	965	16.67	0.9%	Debt and equity financing services to renewable energy projects.
Health Care	367	6.35	4.9%	Microecologics that reduce CO2 emissions in food production; carbon sequestration chemicals.
Industrials	830	14.34	10.5%	Solar photovoltaic modules; energy recovery technology; energy management systems.
Information Technology	373	6.44	8.6%	Products with green saving options; smart grid and metering; low energy IT processes; low consumption data storage solutions.
Materials	678	11.70	9.8%	Thermoplastic composites, which are lighter and make vehicles more fuel-efficient; photovoltaic paste that increases the power output of solar panels.
Real Estate	349	6.03	5.2%	Eco-efficient building design and development.
Telecommunication Services	161	2.78	1.4%	Video conferencing solutions; sale of cables and connection materials for photovoltaic power plants.
Utilities	299	5.16	12.4%	Electricity generated from renewable energy sources (wind, solar, hydro, biofuels).
Total	**5,791**	**100**		

2.4 Research design and empirical tests

2.4.1 Descriptive statistics

I present the frequency of green opportunity disclosures across 10-Ks and sustainability reports in Table 2.3 and Table 2.4. Table 2.3 shows frequencies of green opportunity disclosures where the unit of observation is a firm-year. 42% of firm-years have a green opportunity disclosure in the sustainability report while 20% have a green opportunity disclosure in the 10-K. 19% of firm-years have green opportunity disclosure in both the 10-K and the sustainability report, while 57% have neither. 23% of firm-year observations have a green opportunity disclosure in the sustainability report *only* without an accompanying green opportunity disclosure in the 10-K and 1% of observations have a green opportunity disclosure in the 10-K but not in the sustainability report.[27] The difference between 23% and 1% suggests that firms are more likely to disclose in the sustainability report without also disclosing in the 10-K, rather than disclosing in the 10-K without also disclosing in the sustainability report.

Table 2.4 shows frequencies of green opportunity disclosures using the firm as the unit of observation. Out of 368 firms that ever disclose green opportunities (49% of the full sample of 747 firms), 351 (95%) disclose green opportunities in ***both*** reporting channels at some point in the sample period, while the remaining 17 firms (5%) only disclose in one reporting channel throughout the entire sample period.[28] Of these 17 firms, 15 report in the sustainability report only (without ever disclosing in the 10-K) and 2 report in the 10-K only (without ever disclosing in the sustainability report). All 17 firms start disclosing green opportunities towards the end of the

[27] The null hypothesis of independence between disclosing green opportunities in the 10-K and disclosing green opportunities in the sustainability report is rejected (Chi-square = 6.371; $p < 0.01$).
[28] Data is calculated from Table 2.4 Panel B: 351+ 15+ 2 = 368.

sample period (i.e., in years 2015 or 2016) so it is possible (but not yet observable) that these firms will eventually disclose in the alternate report.

Table 2.3: Frequencies of Green Opportunity Disclosure by Firm-Year

		10-K		
		Disclosure	No Disclosure	
Sustainability Report	Disclosure	1,110 (19%)	1,322 (23%)	2,432 (42%)
	No Disclosure	56 (1%)	3,303 (57%)	3,359 (58%)
		1,166 (20%)	4,625 (80%)	5,791 (100%)

Table 2.4: Frequencies of Green Opportunity Disclosure by Firm

		10-K		
		Disclosure	No Disclosure	
Sustainability Report	Disclosure	351 (47%)	15 (2%)	366 (49%)
	No Disclosure	2 (0.003%)	379 (51%)	381 (51%)
		353 (47%)	394 (53%)	747 (100%)

Table 2.5 Panel A shows summary statistics for variables used in this study. Green revenues as a percentage of total revenues (*GreenRevenues*) has a mean of 9.4% and a standard deviation of 16%. Consistent with Panel A of Table 2.3, the mean of the indicator variable for green opportunity disclosure in the 10-K (*10KGreenOpp)* is 0.20 and the mean of the indicator for green opportunity disclosure in the sustainability report (*SustGreenOpp)* is 0.42. I also tabulate statistics for control variables used in my models. Green opportunity disclosure is likely related to the firm's overall sustainability disclosure strategy and contains forward-looking terms. As a result, I account for potential correlated omitted factors with an array of variables identified in prior literature as being associated with sustainability disclosure and forward-looking disclosure.

I control for firm size, measured as the natural logarithm of total assets (*TotalAssets*), given the positive relation between firm size and sustainability disclosure (e.g., Dhaliwal et al. 2011; Cheng et al. 2014; Grewal et al. 2018) and forward-looking disclosure (e.g., Li 2010; Muslu et al. 2015). Firms with better sustainability performance have higher incentive to disclose (Dye 1985; Dhaliwal et al. 2012), so I control for sustainability performance using the ratings which take into account firms' environmental, social, and governance (ESG) performance, policies, and implementation practices (*ESGPerf*). I also include a control for the quantity of ESG disclosure (*ESGDisc*). I control for financial leverage (*Leverage*) and profitability (*ROA*) because prior research suggests that firms with higher leverage and profitability are more likely to issue sustainability reports (e.g., Dhaliwal et al. 2012).

I include market-to-book ratio (*PTB*) because Li (2010) and Muslu et al. (2015) report that growth firms disclose more forward-looking information. I control for uncertainty (*RetVol*) given that uncertainty could either make firms less likely to issue forward-looking information if they fear the costs of unattained projections (e.g., Bozanic et al. 2017; Waymire 1985), or could induce

managers to disclose more forward-looking information to reduce information asymmetry (e.g., Muslu et al. 2015). I control for whether the MD&A contains forward-looking disclosure (*10KFwdLooking*) given that this could be related to firms' propensity to disclose green opportunities. Since firm characteristics could affect green product revenues, I include the following controls in my regressions: the ratio of research and development expenditures to total revenues (*R&D*), year-over-year sales growth (*Sales1YrGrowth*) and annual returns (*AnnualRet*).

Panel B of Table 2.5 shows the univariate pairwise correlations between these variables. The highest correlation at 0.30 is between *SustGreenOpp* and *GreenRevenues*. *10KGreenOpp* and *GreenRevenues* are also highly correlated at 0.28. As expected, *10KGreenOpp* and *SustGreenOpp* are positively correlated with *ESGDisc, ESGPerf* and *10KFwdLooking*, consistent with green opportunity disclosures being related to ESG disclosure and performance, as well as to forward-looking information. However, the correlations are in the range of 0.19 to 0.24, suggesting my constructs are distinct from these measures. I note that the correlations between the control variables are relatively consistent with prior literature (e.g., Dhaliwal et al. 2012; Matsumara et al. 2014).

Table 2.5: Descriptive Statistics

Panel A: Summary Statistics

Variable	N	Mean	25th Pctile	Median	75th Pctile	Std. Dev.
GreenRevenues (%)	5,791	9.443	0	3.27	14.390	16.068
GRdum	5,791	0.529	0	1	1	1
10KGreenOpp	5,791	0.201	0	0	0	0.448
SustGreenOpp	5,791	0.420	0	0	1	0.636
ESGDisc	5,791	33.019	9.239	30.994	56.033	15.023
ESGPerf	5,791	16.028	8.273	16.503	21.449	2.185
10KFwdLooking	5,791	0.783	1	1	1	0.405
10KDelay	351	2.540	1	3	4	2.981
Leverage	5,791	0.781	0.129	0.480	1.003	1.864
R&D	5,791	0.052	0	0.003	0.038	0.147
PTB	5,791	2.707	1.331	1.974	3.074	3.747
RetVol	5,791	31.760	22.687	29.747	39.248	12.210
ROA	5,791	0.032	0.020	0.049	0.081	0.122
Sales1YrGrowth	5,791	0.053	-0.043	0.045	0.101	0.277
AnnualRet	5,791	0.028	-0.034	0.032	0.044	0.049
TotalAssets	5,791	21.335	19.968	21.427	22.654	1.998
Litigation	5,791	0.173	0	0	1	0.293
ClimChgVoteSupport	5,791	0.138	0.050	0.083	0.212	0.128
StdDev(GreenRevenues)	3,012	3.481	0.928	3.910	5.920	3.201
EPSSurp	5,735	-0.0034	-0.0070	-0.0044	0.0052	0.0093
RevSurp	5,735	-0.0059	-0.0092	-0.0020	0.0030	0.0122

Table 2.5: Descriptive Statistics (Continued)

Panel B: Pearson Correlations

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	GreenRevenues%	1.00													
2	10KGreenOpp	**0.28**	1.00												
3	SustGreenOpp	**0.30**	**0.23**	1.00											
4	ESGDisc	**0.16**	**0.21**	**0.24**	1.00										
5	ESEGPerf	**0.18**	**0.19**	**0.22**	**0.19**	1.00									
6	10KFwdLooking	**0.04**	**0.21**	**0.19**	**0.10**	**0.18**	1.00								
7	10KDelay	0.05	0.11	0.05	-0.04	-0.06	0.06	1.00							
8	Leverage	**0.06**	**0.04**	**0.06**	0.03	-0.02	**-0.13**	0.00	1.00						
9	R&D	**0.18**	0.14	0.03	**0.06**	**0.24**	**-0.16**	**-0.12**	-0.02	1.00					
10	PTB	-0.01	-0.02	0.00	**0.05**	**0.08**	**0.20**	-0.02	**0.07**	**0.19**	1.00				
11	RetVol	**0.08**	-0.05	**-0.07**	**-0.22**	**-0.15**	-0.02	0.00	0.00	0.02	**0.04**	1.00			
12	ROA	**-0.10**	0.00	0.00	**0.05**	**0.09**	**0.07**	**0.08**	**0.05**	**-0.18**	**-0.10**	**0.25**	1.00		
13	Sales1YrGrowth	**0.06**	-0.01	0.03	**-0.04**	0.04	**0.11**	**0.06**	0.04	-0.02	**-0.03**	**0.12**	**0.10**	1.00	
14	AnnualRet	-0.03	-0.03	0.01	**-0.04**	0.00	**0.08**	0.00	0.02	**-0.06**	0.00	**0.22**	**0.12**	**0.19**	1.00
15	TotalAssets	**-0.11**	**0.08**	**0.10**	**0.41**	**0.34**	-0.03	-0.05	**0.04**	**0.27**	-0.02	**-0.05**	-0.30	0.00	**-0.05**

This table presents descriptive statistics. Panel A presents descriptive data. Panel B presents Pearson correlations; boldface numbers represent significance at 5% level or higher. All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix Table II.

2.4.2 Timing of green opportunity disclosures

I first examine whether there is a timing difference between when firms disclose green opportunities in the 10-K and the sustainability report. For the 351 firms from Table 2.4 that disclose green opportunities in both reports, I subtract the year of the first sustainability report green opportunity disclosure from the year of the first 10-K green opportunity disclosure:

$$\textit{10-K Delay} =$$

$$\textit{Year of First } 10K \textit{ Green Opp Disc}_i - \textit{Year of First Sust. Report Green Opp Disc}_i \quad (1)$$

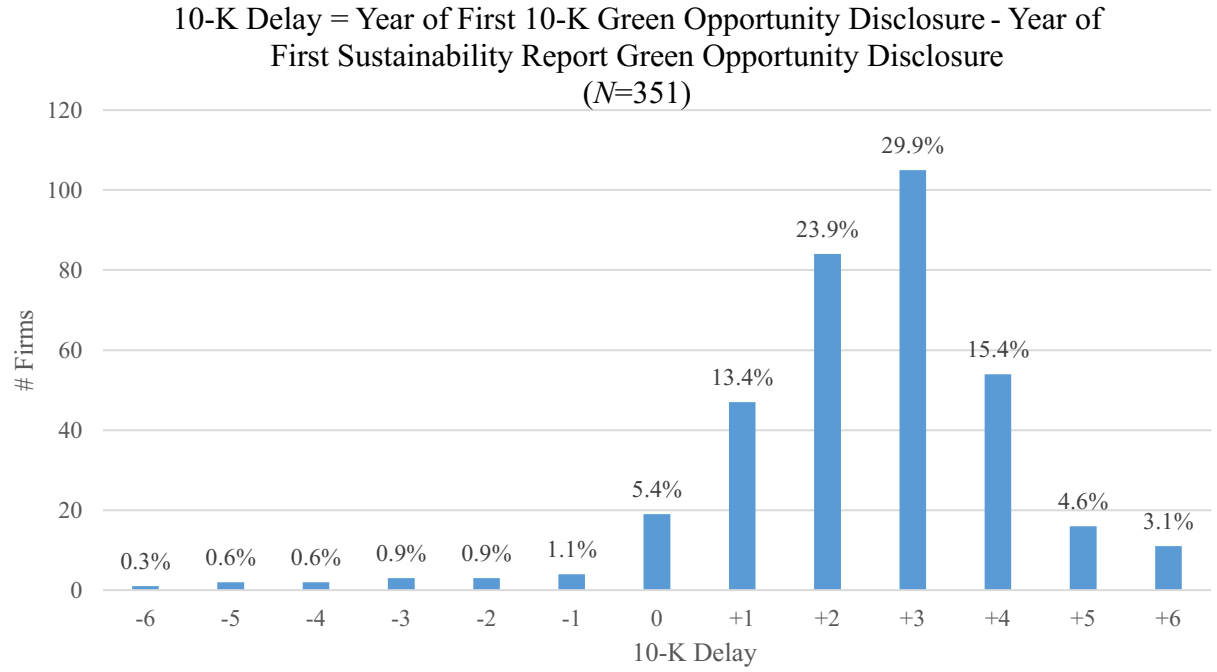
I focus on the first disclosure year because I observe that the decision to start disclosing green opportunities (in either report) is 'sticky', consistent with voluntary disclosure representing a disclosure commitment (Graham et al. 2005).[29] Figure 2.2 plots the distribution of the timing difference (in years) between when firms first report in the sustainability report versus the 10-K. I name this timing difference *10-K Delay* because the frequencies of this variable suggest that firms typically start to disclose green opportunities in the 10-K *after* disclosing green opportunities in the sustainability report.[30] In particular, fewer than 5% of the firms disclose green opportunities in the 10-K before disclosing in the sustainability report and 5.4% start disclosing in both reports in the same year. The remaining approximately 90% start disclosing in the 10-K after having already begun to disclose in the sustainability report. The average (median) *10-K Delay* is 2.5 (3) years,

[29] There are a small number of exceptions. Three firms stop disclosing (one in the sustainability report and two in the 10-K) and four firms go back and forth between disclosing and not disclosing throughout the sample period. I use the first disclosure year in both reports for these firms, but the results are virtually unchanged if I omit these nine firms from the analysis.

[30] I note that 97% of the firm-years that have a green opportunity disclosure in both the 10-K and in the sustainability report refer to the same green product term(s). My inferences are not affected by omitting the observations that do not include the same green product terms.

suggesting that firms wait on average 2.5 years after first disclosing green opportunities in the sustainability report to start disclosing green opportunities in the 10-K.[31]

Figure 2.2: Frequency of the 10-K Delay



2.4.3 Reliability of green opportunity disclosures

Given this descriptive finding of a disclosure delay between the 10-K and the sustainability report, it is plausible that managers make disclosure channel decisions based on the reliability of green opportunity disclosures. According to the Financial Accounting Standards Board (FASB), reliability is the extent to which information is unbiased, free from error, and representationally faithful (FASB 1980). Maines and Wahlen (2006) assert that it is difficult for researchers,

[31] It is possible that, for the 59 firms with green opportunity disclosures in the first year of the sample period (i.e., 2009), disclosure began in an earlier year. For these firms, I verify the sustainability reports issued prior to 2009, and MD&A disclosures in 10-Ks for fiscal years dating back to 2005. I note seven instances where these firms disclosed prior to 2009; removing these observations from the analyses does not alter my inferences.

practitioners and standard-setters to examine and identify reliability precisely. In this study, I adopt the view that green opportunity disclosures are reliable if they relate positively to future green revenues. My reasoning is that a positive association between green opportunity disclosure and future green revenues suggests that disclosure reliably predicts future green revenues.

If managers delay disclosure of green opportunities in the 10-K until they can reliably predict future green revenues or use sustainability reports to misrepresent their efforts, green opportunity disclosures in the 10-K will be a reliable indicator of future green revenues, while green opportunity disclosures in the sustainability report only will *not* be a reliable indicator of future green revenues. However, if managers use sustainability reports alone to reliably and truthfully predict green revenues in earlier years, reliability will not influence the reporting channel used to report green opportunities. To test this, I estimate the following logistic regression model:

$$\begin{aligned}\text{Logit}[\Pr(GreenRevenues_{i,t+n} | X_1 \dots X_t = 1)] \\ = \alpha_0 + \beta_1 SustOnly_{i,t} + \beta_2 Sust\&10K_{i,t} + \beta_3\, ESGDisc_{i,t} + \beta_4\, ESGPerf_{i,t} \\ + \beta_5\, 10KFwdLooking_{i,t} + \beta_6\, Leverage_{i,t} + \beta_7\, R\&D_{i,t} + \beta_8 PTB_{i,t} \\ + \beta_9 RetVol_{i,t} + \beta_{10} ROA_{i,t} + \beta_{11} Sales1YrGrowth_{i,t} + \beta_{12} AnnualRet_{i,t} \\ + \beta_{13} TotalAssets_{i,t} + \alpha_i + \delta_t \\ + \varepsilon_{i,t} \qquad (2)\end{aligned}$$

where n=1, 2, 3 or 4, α_i represents firm fixed effects that absorb all observed and unobserved time-invariant firm characteristics and δ_t represents year fixed effects that control for common macroeconomic shocks that affect all firms.[32] There are two main variables of interest. The first,

[32] I do not include contemporaneous green revenues in this model given the inclusion of firm fixed effects. As shown in Arellano and Bond (1991), including a lagged dependent variable as a regressor in a static panel date model violates strict exogeneity because the lagged dependent variable is correlated with the idiosyncratic error.

SustOnly, is an indicator equal to one in firm-years when a green opportunity disclosure is made in the sustainability report only (i.e., not accompanied by a green opportunity disclosure in the 10-K). The second variable, *Sust&10K*, is an indicator equal to one in firm-years when a green opportunity disclosure is made in both the 10-K and in the sustainability report. Given the few firm-years when green opportunities are disclosed only in the 10-K (56 observations, per Table 2.3), I remove these observations.

The results are presented in Table 2.6. Panel A of Table 2.6 uses, as dependent variables, indicators equal to 1 if the firm has non-zero green revenues in years *t+1* to *t+4* and 0 otherwise. Across all specifications, the odds ratios for *SustOnly* indicate that disclosing green opportunities only in the sustainability report increases the likelihood of future green revenues. In specification (1), the odds ratio of 2.13 (*z*-stat=3.04) suggests that disclosing green opportunities in the sustainability report alone in year *t* increases the likelihood of green revenues in year *t+1* by 2.13 times, relative to when the firm does not disclose green opportunities. The odds ratios for *Sust&10K* are also indicative of an increased likelihood of future green revenues in years *t+1* to *t+4* (i.e., the odds ratios exceed 1), but the estimates for *SustOnly* and *Sust&10K* are statistically indistinguishable. This indicates that disclosing green opportunities in the 10-K does not, on average, make future green revenues more likely relative to disclosing green opportunities only in the sustainability report.

Table 2.6 Panel B uses year-over-year changes in the green revenues percentage as the dependent variable. I use this dependent variable to assess whether green opportunity disclosures are associated with green revenue changes over multiple years and whether the magnitude of these changes depends on the disclosure channel. The coefficient on *SustOnly* is positive and significant except for the specification in Column 4 which uses the change in green revenues from *t+3 to t+4*

as the dependent variable. The estimates suggest that disclosing green opportunities in the sustainability report alone is associated with positive future changes in green revenue (i.e., growth) ranging from 2.5 to 3.0 percentage points on a year-over-year basis. Once again, the coefficients on *Sust&10K* are positive and significant but statistically equivalent to that of the coefficients on *SustOnly*; this indicates that green opportunity disclosures in the 10-K are not predictive of higher green revenue growth relative to green opportunity disclosures provided only in the sustainability report.

While these results suggest that green opportunity disclosures in both channels are reliable indicators of the future occurrence and growth of green revenues, disclosure channel decisions may reflect managers' uncertainty about the amount and timing of future green revenues. This uncertainty could lead firms to withhold green opportunity disclosures from the 10-K, but may not prevent disclosure in sustainability reports which face lower scrutiny and attention from analysts and investors. This leads to the prediction that green opportunities disclosed in the sustainability report alone are associated with more uncertain future green revenues relative to green opportunities disclosed in both the 10-K and sustainability report. To measure uncertainty, I use the standard deviation of green revenues in the years subsequent to disclosure (requiring at least two years of post-disclosure data). The uncertainty measure, *StdDev(GreenRevenues)*, captures the variability of future green revenues. Focusing only on the subset of firms that ever disclose green opportunities in the sample period, I regress *StdDev(GreenRevenues)* on the independent variables in equation (2). Panel C of Table 2.6 tabulates the results. The coefficient on *SustOnly* is negative and significant (coef. = -0.714, *t*-stat = -2.39) and the coefficient on *Sust&10K* is negative and significant (coef. = -1.369, *t*-stat = -2.56); the estimates on *Sust&10K* and *SustOnly* are statistically different. These estimates suggest that disclosing green opportunities in the sustainability report

alone, and in the 10-K and sustainability report together, are associated with *lower* variability of future green revenues relative to not disclosing green opportunities (the coefficient estimates represent approximately 22-42% of the standard deviation of *StdDev(GreenRevenues)*). Moreover, disclosing green opportunities in the 10-K is associated with lower volatility of future green revenues, or lower uncertainty about future green revenues, relative to disclosing green opportunities in the sustainability report alone. This finding is consistent with managers making disclosure channel decisions based on the uncertainty surrounding future green revenues.

Table 2.6: Relationship between green opportunity disclosure and future green revenues

Panel A: Green revenues as an indicator variable				
Logistic regressions	(1)	(2)	(3)	(4)
Dependent variable	$Pr(GRdum_{t+1}=1)$	$Pr(GRdum_{t+2}=1)$	$Pr(GRdum_{t+3}=1)$	$Pr(GRdum_{t+4}=1)$
	Odds Ratio (z-stat)	Odds Ratio (z-stat)	Odds Ratio (z-stat)	Odds Ratio (z-stat)
SustOnly	2.131*** (3.04)	1.893** (2.34)	1.952** (2.52)	1.882** (2.31)
Sust&10K	2.039*** (3.10)	1.991** (2.41)	1.823** (2.36)	1.739** (2.29)
ESGDisc	1.101** (2.13)	1.203** (2.31)	1.198* (1.84)	1.421** (2.19)
ESGPerf	1.220* (1.82)	1.121 (1.12)	1.301* (1.78)	1.209* (1.83)
10KFwdLookingDisc	0.447 (0.93)	0.212 (0.25)	0.682 (0.71)	0.554 (0.51)
Leverage	0.312 (0.82)	0.456 (0.93)	0.582* (1.94)	0.433* (1.81)
R&D	1.021 (1.24)	0.921 (1.02)	1.201* (1.83)	1.440 (1.42)
PTB	1.502** (2.11)	1.302 (1.53)	1.421** (2.30)	1.502* (1.83)
RetVol	0.458 (0.39)	0.319 (0.31)	0.723 (0.20)	0.649 (0.56)
ROA	1.346* (1.85)	1.233* (1.92)	1.693** (2.28)	1.577** (2.41)
Sales1YrGrowth	1.172 (1.45)	0.921 (1.23)	0.559 (0.64)	0.293 (0.14)
AnnualRet	0.592* (1.93)	0.698* (1.82)	0.909* (1.90)	0.821 (1.52)
TotalAssets	1.102 (1.23)	1.450** (2.02)	1.193 (1.38)	1.651** (2.34)
N	5030	4286	3548	2815
Pseudo R2	41.5%	42.6%	43.1%	42.7%
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Comparison of coef. on *SustOnly* and *Sust&10K*. Test for $\beta_1<\beta_2$ Null: $\beta_1=\beta_2$	p-value=0.280	p-value=0.326	p-value=0.210	p-value=0.342

Table 2.6: Relationship between green opportunity disclosure and future green revenues (Continued)

Panel B: Green revenues in year-over-year changes

OLS models	(1)	(2)	(3)	(4)
Dependent variable	ΔGreenRevenues t to t+1	ΔGreenRevenues t+1 to t+2	ΔGreenRevenues t+2 to t+3	ΔGreenRevenues t+3 to t+4
SustOnly	2.532***	3.051**	2.648**	1.154
	(2.64)	(2.42)	(2.37)	(1.46)
Sust&10K	2.711***	3.248**	2.493**	0.894
	(2.71)	(2.22)	(2.18)	(1.29)
ΔESGDisc	0.023*	0.019*	0.020*	0.017
	(1.83)	(1.82)	(1.74)	(1.19)
ΔESGPerf	0.019	0.013	0.026*	0.022*
	(1.42)	(1.14)	(1.92)	(1.78)
Δ10KFwdLookingDisc	0.002	0.001	0.002	0.003
	(0.22)	(0.64)	(0.71)	(0.20)
ΔLeverage	0.000	0.000	0.000	0.000
	(0.51)	(0.27)	(0.28)	(0.22)
ΔR&D	0.000	-0.001	-0.001	-0.001
	(-1.01)	(-0.97)	(-1.32)	(-1.25)
ΔPTB	0.000	0.000	0.000	-0.001
	(-0.45)	(-0.10)	(-0.58)	(-0.63)
ΔRetVol	0.000	0.000	0.000	0.000
	(0.56)	(0.89)	(0.71)	(0.84)
ΔROA	0.000	0.000	0.000	-0.001
	(-1.40)	(-1.89)	(-1.32)	(-1.21)
ΔSalesExclGreen	0.002**	0.003**	0.003**	0.005**
	(1.99)	(2.21)	(2.05)	(2.31)
ΔAnnualRet	0.000	0.000	0.000	0.000
	(-0.57)	(-0.03)	(0.05)	(0.31)
ΔTotalAssets	-0.002***	-0.003***	-0.004	-0.005***
	(-3.37)	(-3.12)	(-3.05)***	(-3.28)
Constant	-0.04	-0.019	0.035	0.141
	(-0.60)	(-0.19)	(0.28)	(1.42)
N	5030	4286	3548	2815
Adj R2	54.6%	52.4%	51.3%	50.2%
Year fixed effects	Yes	Yes	Yes	Yes
Comparison of coef. on *SustOnly* and *Sust&10K*. Test for $\beta_1<\beta_2$ Null: $\beta_1=\beta_2$	p-value=0.151	p-value=0.122	p-value=0.182	p-value=0.143

Table 2.6: Relationship between green opportunity disclosure and future green revenues (Continued)

Panel C: Standard Deviation of Green revenues	
OLS models	
Dependent variable	StdDev(Green Revenues)
SustOnly	-0.714**
	(-2.39)
Sust&10K	-1.369***
	(-2.56)
ESGDisc	0.259
	(0.77)
ESGPerf	0.921
	(1.24)
10KFwdLookingDisc	1.302
	(1.49)
Leverage	0.569*
	(1.89)
R&D	0.482
	(0.82)
PTB	0.301
	(1.15)
RetVol	0.314**
	(2.16)
ROA	-0.953**
	(-2.23)
Sales1YrGrowth	0.095
	(0.80)
AnnualRet	-1.823
	(-1.41)
TotalAssets	-1.019**
	(-2.17)
constant	-0.827
	(-0.83)
N	3012
Adj R2	49.3%
Year fixed effects	Yes
Firm fixed effects	Yes
Comparison of coef. on *SustOnly* and *Sust&10K*. Test for $\beta_1>\beta_2$ Null: $\beta_1=\beta_2$	p-value=0.018

This table presents results of multivariate analyses of green revenues regressed on an indicator equal to 1 for firm-year observations where green opportunities are disclosed in the sustainability report only at time t (SustOnly), and an indicator equal to 1 for firm-year observations where green opportunities are disclosed in the sustainability report and in the 10-K at t (Sust&10K), and other control variables. Panel A regresses disclosure variables on an indicator equal to 1 if the firm generates green revenues. Panel B regresses disclosure variables on changes in green revenues. Panel C regresses disclosure variables on the standard deviation of green revenues subsequent to disclosure. All controls are winsorized at the 1- and 99- percent levels and are defined in Appendix Table II. t-statistics (z-statistics in Panel A) appear in parentheses and are based on standard errors clustered by firm. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively.

2.4.4 Capital market effects of green opportunity disclosures

2.4.4.1 Earnings announcements

Next, I examine whether analysts use these disclosures in forming forecasts of revenues and earnings. There is substantial evidence that analysts respond to information that managers provide about future earnings (e.g., Waymire 1986; Jennings 1987; Cotter et al., 2006). However, analysts may be less willing to rely on information that they view as being as less credible (e.g., Bamber and Cheon 1998). Analysts may also be unaware of forward-looking information in sustainability reports. If, on average, analysts do not incorporate green opportunity disclosures, forecasts will not include the 'green' component of revenues and earnings.

I study whether green opportunity disclosures are associated with earnings and revenue surprises by regressing the one- or two-year earnings and revenue surprise on *SustOnly* and *Sust&10K*, and controls including firm and year fixed effects. The one-year earnings (revenues) surprise is the actual earnings (revenues) per share minus the median Institutional Brokers Estimate System (I/B/E/S) analyst forecast, deflated by the stock price at fiscal year-end. I/B/E/S consensus forecast is taken eight months prior to the end of the forecast period, i.e., four months after the previous fiscal year-end. Since most annual reports are filed within three months of the fiscal year-end, this helps to ensure that analysts have prior earnings and revenue information when forming forecasts. The two-year earnings and revenues surprises are calculated similarly, with the consensus forecast taken 20 months prior to year-end. Consistent with model (2), I remove the 56 observations where green opportunity disclosure is made in the 10-K but not in the sustainability report.

The results are shown in Table 2.7, Panel A. The coefficient estimates on *SustOnly* are positive and significant across all specifications at the 5% level or better, while the coefficients on

Sust&10K are insignificant. This suggests that green opportunities disclosed in the sustainability report only are associated with significantly more positive 1- and 2-year earnings and revenue surprises relative to when no green opportunity disclosure is made. Moreover, disclosing green opportunities in both the 10-K and the sustainability report is not associated with earnings and revenue surprises relative to when no green opportunity disclosure is made.[33] A plausible explanation for these results is that the larger positive EPS and revenue surprises arise in part because analysts miss information in the sustainability report. As a result, analysts' forecasts do not include the 'green' component of revenues and earnings when green opportunity disclosure is made only in the sustainability report.

I examine stock price consequences of such surprises by calculating the abnormal returns to earnings announcements. I obtain the earnings announcement dates for my sample firms from I/B/E/S and calculate three-day (-1, +1) returns in excess of a market model that is estimated using up to 255 trading days and ending 46 days before the event date. Panel B of Table 2.7 presents the results of univariate comparisons which show that firms exhibit abnormal announcement returns of 0.62% following disclosure of green opportunities in the sustainability report alone, significantly different from the 0.30% exhibited when disclosure is provided in both the 10-K and the sustainability report. As will be explained in Section 2.4.4.2.2., these announcement responses explain a meaningful proportion of the abnormal returns earned by a portfolio of firms disclosing green opportunities in the sustainability report alone.

[33] The null hypothesis that the coefficients are equivalent is rejected across all specifications.

Table 2.7: Earnings announcements

Panel A: Earnings and revenues surprises

OLS Models	(1)	(2)	(3)	(4)
Dependent variable	1-year earnings surprise	2-year earnings surprise	1-year revenue surprise	2-year revenue surprise
SustOnly	0.0051***	0.0064***	0.0039***	0.0042**
	(4.94)	(3.25)	(4.54)	(2.33)
Sust&10K	0.0019	0.0017	0.0009	0.0007
	(1.26)	(1.02)	(0.98)	(0.25)
GreenRevenues	0.0281	0.0321	0.0127	-0.0312
	(1.27)	(1.38)	(1.24)	(-0.33)
ESGDisc	0.0012	0.0025	0.0037	0.0037
	(1.03)	(1.52)	(1.22)	(1.00)
ESGPerf	0.0013	0.0025	0.0045	0.0023
	(1.43)	(1.16)	(1.52)	(1.03)
10KFwdLookingDisc	0.0005	0.0003	0.0003	0.0004
	(0.42)	(0.27)	(0.72)	(0.38)
Leverage	0.0003	0.0007	0.0006	-0.0004
	(0.67)	(0.42)	(0.59)	(-1.03)
R&D	-0.0012	-0.0000	0.0004	0.0010
	(-1.52)	(-0.32)	(1.02)	(1.32)
PTB	0.0020**	0.0052***	0.0038**	0.0017**
	(2.03)	(3.56)	(2.44)	(2.12)
RetVol	-0.0035	0.0010	-0.0049	-0.0008
	(-1.04)	(1.21)	(-1.22)	(0.95)
ROA	0.0009	-0.0009	0.0008	0.0006
	(0.31)	(-0.47)	(0.92)	(0.59)
Sales1YrGrowth	0.0006	0.0003	-0.0006	0.0005
	(1.08)	(0.78)	(-0.64)	(1.02)
AnnualRet	0.0002	-0.0002	-0.0002	-0.0002
	(1.36)	(-1.51)	(-1.42)	(-1.28)
TotalAssets	0.0045***	0.0034***	0.0027***	0.0023***
	(28.94)	(31.24)	(12.12)	(11.67)
constant	-0.0429	-0.0277***	-0.0136***	-0.0513***
	(-34.53)	(-18.23)	(-10.01)	(11.94)
N	5735	4991	5735	4991
Adj R2	21.20%	20.30%	16.20%	16.70%
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Comparison of coef. on *SustOnly* and *Sust&10K*. Test for $\beta_1>\beta_2$ Null: $\beta_1=\beta_2$	p-value=0.009	p-value=0.007	p-value=0.011	p-value=0.010

Table 2.7: Earnings announcements (Continued)

Panel B: Earnings announcement returns

	SustOnly	Sust&10K
CAR	0.62	0.30
N	5,050	4,042
t-stat (difference from 0)	(32.11)***	(4.47)***
t-stat (difference in means)	(2.22)**	

Panel A of this table presents results from estimating the association between earnings and revenue surprises on an indicator variable for whether a firm disclosed green opportunities in the most recent sustainability report only (*SustOnly*), and an indicator variable for whether a firm disclosed in both the most recent 10-K and sustainability report (*Sust&10K*). The 1- (2-) year earnings or revenue surprise is the actual earnings-per-share or revenue-per-share minus the I/B/E/S median analyst forecast 8 (20) months prior to the end of the forecast period, deflated by the stock price 20 days before the earnings announcement. Controls are calculated at the previous year-end, are winsorized at the 1- and 99- percent levels and are defined in Appendix Table II. *t*-statistics appear in parentheses and are based on standard errors clustered by firm. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. Panel B of this table reports (-1, +1) abnormal returns to quarterly earnings announcements. Abnormal returns are calculated above a market model where coefficients are estimated over a 255-day period ending 46 days before the earnings announcement. Average announcement returns to firms disclosing green opportunities only in the sustainability report (*SustOnly*) are compared to firms that disclose in both the 10-K and in the sustainability report (*Sust&10K)*.

2.4.4.2 Calendar-Time Portfolio Returns

I examine whether withholding disclosure of green opportunities from the 10-K has aggregate capital market consequences. Frictions (e.g., search costs and investor inattention) could prevent investors from using all information sources (Gow et al. 2018; Dellavigna and Pollet 2009). For instance, investors may face search costs associated with identifying value-relevant information in sustainability reports. Prior research suggests that sustainability reports contain both financially-material and immaterial disclosures and investors have the burden of distinguishing between the two (Khan et al. 2016). Alternatively, absent any frictions, investors may rationally disregard green opportunity disclosures in sustainability reports owing to concerns about the credibility of these reports where firms have incentives to greenwash.

Any of these explanations could result in green opportunity disclosures in sustainability reports being associated with future stock returns. Returns could be positive, negative, or zero; though my findings suggest that green opportunity disclosures are associated with average future green revenues and green revenue growth, the expenses and foregone opportunities are unobservable. Investing in green opportunities could therefore increase shareholder value, decrease shareholder value, or be neither value-creating nor value-destroying.

To test the market's incorporation of green opportunity disclosures and the future performance implications (if any) of green opportunities, I form value-weighted and equal-weighted portfolios of firms that disclose green opportunities and estimate abnormal stock return performance of the portfolios (i.e., alpha) from Fama and French (1993) monthly calendar-time regressions that include the market, size and book-to-market factors. Since annual reports are available for almost all firms by the end of March, I construct portfolios at the end of March and use the most recent sustainability report information available at that time to allow an implementable trading strategy. Portfolios are held from the beginning of April until the end of March of the following year. Portfolios are rebalanced at the end of March each year by removing firms that reach the end of their holding period and adding firms that have made a green opportunity disclosure.

Results are reported in Table 2.8. Panel A reports results for the value-weighted portfolios and Panel B reports results for the equal-weighted portfolios. Column 1 reports results for Portfolio A, the portfolio composed of all green opportunity disclosers in the sample regardless of where green opportunity disclosure is made. The results suggest that this portfolio does not earn abnormal returns. The intercept (alpha) estimate from the value-weighted portfolio is 0.03% (*t*-stat=0.78) or

0.33% annualized, and is not significantly different from zero. The alpha estimate from the equal-weighted portfolio is 0.04% (*t*-stat=0.54) or 0.44% annualized, and is not significant.

I divide disclosers into two subgroups according to the disclosure channel used to report green opportunities and form the portfolios separately for these groups. Column 2 reports results for Portfolio B, the portfolio composed of firms that disclose green opportunities in the sustainability report only. Column 3 reports results for Portfolio C, the portfolio composed of firms that disclose green opportunities in the 10-K and in the sustainability report.

The alpha estimates for Portfolio B in Column 2 suggest that value- and equal-weighted portfolios of firms disclosing green opportunities only in sustainability reports earns significantly positive abnormal returns. The alpha estimate from the value-weighted portfolio is 0.26% (*t*-stat=2.84) or 3.09% annualized, and is significant at the 1% level. The estimate from the equal-weighted portfolio is 0.25% (*t*-stat=2.77) or 2.99% on an annual basis, and is also significant at the 1% level. By comparison, the alpha estimates for Portfolio C in Column 3 do not suggest outperformance of the value-weighted or the equally-weighted portfolios of firms that disclose green opportunities in both the 10-K and sustainability report.[34] This suggests that investors can earn as high as 3.09% annual abnormal returns on a value-weighted portfolio of firms disclosing green opportunities only in their sustainability reports.

2.4.4.2.1 Robustness

I present a series of robustness tests below the annualized alphas from the Fama and French (1993) three-factor model. First, I assess robustness of the results to different factor models. I estimate alphas using a four-factor model that includes the Carhart (1997) momentum factor, a five-factor model that includes the investment and profitability factors from Fama and French

[34] The alphas are statistically different between Portfolio B and Portfolios A and C, respectively.

(2015), and a five-factor model that includes momentum and liquidity factors (Pastor and Stambaugh 2003). The inferences are unaffected by these alternative factor models. I find a 3.02%, 2.85% and 3.41% outperformance (significant at the 5% level or better) of the sustainability report-only value-weighted portfolio on a four-factor model, a Fama and French (2015) five-factor model, and a five-factor model that includes momentum and liquidity, respectively (2.79%, 3.04% and 2.63% using equal-weighted portfolios). The estimates from these alternative factor models continue to show that the portfolio of firms disclosing in any report (Portfolio A in Column 1) and in both the 10-K and sustainability report (Portfolio C in Column 3) does not exhibit significant abnormal returns.

The second robustness test in Table 2.8 analyzes different time periods. I split the analysis period to before and after 2011 (the midpoint of my full period of examination). I analyze performance over different time periods to assess whether investors impound information more efficiently after learning about the financial implications or credibility of green opportunity disclosures in the sustainability report. For instance, if investors are initially skeptical of green opportunity disclosures but learn over time that disclosures provide reliable information about future green revenues, disclosures may be associated with stock returns in the earlier period (i.e., before 2011) but not in the later period (i.e., after 2011). My results for all green opportunity disclosers (Portfolio A in Column 1) and green opportunity disclosers in the 10-K (Portfolio C in Column 3) suggest that there is no outperformance in any of the sub-periods. In contrast, the alpha estimates for Portfolio B in Column 2 suggest that the portfolio of firms disclosing only in sustainability reports earns significantly positive abnormal returns in both time periods analyzed. Thus, learning does not appear to help investors impound green opportunity disclosures in sustainability reports more efficiently into stock price over time.

The third robustness test in Table 2.8 uses a subset of green opportunity disclosers that have above sample-median green revenues at the time of disclosure. A possible explanation for the outperformance of firms disclosing only in the sustainability report is that investors delay incorporating green opportunity news into stock price until green revenues are financially material. Thus, it is not inattention to, or disbelief of, the sustainability report but rather materiality of green revenues that affects whether investors impound green opportunities into valuation decisions. If this is the case, firms that disclose green opportunities in the sustainability report when green revenues are higher – which I define as being above the median of green revenues of the sample – should not earn significant abnormal returns. However, I continue to find outperformance of a portfolio of firms disclosing green opportunities only in the sustainability report and having above-median green revenues. The annualized alpha is 3.72% for the value-weighted portfolio and 3.41% for the equal-weighted portfolio; both estimates are significant at the 1% level.

Table 2.8: Calendar-time portfolio analysis of abnormal stock returns

Panel A: Value-weighted portfolios

	(1) Portfolio A: All green opportunity disclosers	(2) Portfolio B: Firms disclosing green opportunities only in sustainability reports	(3) Portfolio C: Firms disclosing in 10-Ks & sustainability reports	**t-stat (difference in Alphas)** Portfolio B vs. Portfolio A	Portfolio B vs. Portfolio C
Market	0.9759***	1.0324***	0.9831***		
	(18.16)	(17.33)	(16.15)		
SMB	-0.1078**	-0.0812*	-0.1284**		
	(-2.35)	(-1.67)	(-2.35)		
HML	0.0812*	0.1024**	0.1522**		
	(1.99)	(2.05)	(2.41)		
Intercept	0.0003	0.0026***	0.0004		
	(0.78)	(2.84)	(0.54)		
Annualized Alpha from Fama and French (1993) 3-factor model	0.33% not sig	**3.09% sig at 1%**	0.42% not sig	(2.34)**	(2.21)**
Annualized Alpha from 3-factor model + momentum (Carhart 1997)	0.41% not sig	**3.02% sig at 1%**	0.21% not sig	(2.31)**	(3.02)***
Annualized Alpha from 5-factor model (Fama and French 2015)	0.10% not sig	**2.85% sig at 5%**	0.28% not sig	(2.26)**	(2.19)**
Annualized Alpha from 3-factor + momentum and liquidity (Pastor and Stambaugh 2003)	0.30% not sig	**3.41% sig at 1%**	0.46% not sig	(2.94)***	(2.55)**
Subperiods					
Analysis Period: 2005-2010	0.37% not sig	**3.02% sig at 1%**	0.25% not sig	(2.30)**	(2.39)**
Analysis Period: 2011-2016	0.25% not sig	**2.89% sig at 5%**	0.35% not sig	(2.22)**	(1.87)*
Subset of Firms					
High (above median) Green Revenues	1.04% not sig	**3.72% sig at 1%**	0.84% not sig	(2.57)**	(2.98)***

Table 2.8: Calendar-time portfolio analysis of abnormal stock returns (Continued)

Panel B: Equal-weighted portfolios

	(1) Portfolio A: All green opportunity disclosers	(2) Portfolio B: Firms disclosing green opportunities only in sustainability reports	(3) Portfolio C: Firms disclosing in 10-Ks & sustainability reports	t-stat (difference in Alphas) Portfolio B vs. Portfolio A	t-stat (difference in Alphas) Portfolio B vs. Portfolio C
Market	0.9602***	1.0102***	0.9405***		
	(16.21)	(15.42)	(14.76)		
SMB	0.1012**	0.0692*	0.294**		
	(2.24)	(1.74)	(2.15)		
HML	0.0847***	0.0748**	0.1551**		
	(2.81)	(2.25)	(2.21)		
Intercept	0.0004	0.0025***	0.0004		
	(0.54)	(2.77)	(0.32)		
Annualized Alpha from Fama and French (1993) 3-factor model	0.44% not sig	**2.99% sig at 1%**	0.43% not sig	(2.21)**	(2.31)**
Annualized Alpha from 3-factor model + momentum (Carhart 1997)	0.32% not sig	**2.79% sig at 5%**	0.25% not sig	(2.16)**	(2.65)**
Annualized Alpha from 5-factor model (Fama and French 2015)	0.27% not sig	**3.04% sig at 1%**	0.33% not sig	(2.34)**	(2.32)**
Annualized Alpha from 3-factor + momentum and liquidity (Pastor and Stambaugh 2003)	0.28% not sig	**2.63% sig at 5%**	0.42% not sig	(1.87)*	(1.86)*
Subperiods					
Analysis Period: 2005-2010	0.19% not sig	**2.84% sig at 5%**	0.26% not sig	(2.15)**	(2.22)**
Analysis Period: 2011-2016	0.23% not sig	**3.11% sig at 1%**	0.34% not sig	(2.76)***	(2.75)***
Subset of Firms					
High (above median) Green Revenues	1.12% not sig	**3.41% sig at 1%**	0.51% not sig	(2.31)**	(2.55)**

This table reports alphas and factor loadings from monthly calendar-time Fama-French (1993) regressions for value-weighted (Panel A) and equal-weighted (Panel B) portfolios of firms that disclose green opportunities. The first column reports the results for the portfolio composed of all green opportunity disclosers in the sample, regardless of where the disclosure is made; the second column report the results for the portfolio composed of firms that only disclose green opportunities in the sustainability report; and the third column reports the results for the portfolio composed of firms that disclose green opportunities in the 10-K and in the sustainability report. Portfolio abnormal performance is estimated as the intercept of the Fama-French (1993) time series regressions. SMB and HML are the Fama and French (1993) size and book-to-market factors, respectively. *t*-statistics appear in parentheses and recalculated using Newey and West (1987) which allows for the error terms to be heteroskedastic and serially correlated. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. Below these results, I report alphas using different factor models and subsets of the original sample.

Next, I investigate whether attributes of green opportunity disclosures explain the outperformance. If firms provide lower quality disclosure in the sustainability report, analysts and investors will be less capable of incorporating green opportunity news provided in the sustainability report. This would suggest that the content of the disclosures, rather than the reporting channel used, explains the excess returns of firms that disclose only in the sustainability report. To assess this possibility, I compare across 10-Ks and sustainability reports: (1) the quantitative intensity of green opportunity disclosures (i.e., the percentage of green opportunity disclosures that contain quantitative information), (2) the quantity of green opportunity disclosures (i.e., the percentage of total sentences that are green opportunity sentences), and (3) the readability of green opportunity disclosures (i.e., the *ReadIndex* from Guay, Samuels and Taylor (2018)).

Results are presented in Table 2.9. Panel A shows univariate comparisons of the three disclosure attributes examined. Column 1 presents averages of the disclosure attributes in the sustainability report, Column 2 presents averages in the 10-K, and Column 3 presents the differences. On average, 33% of green opportunity disclosures in the sustainability report are quantitative, compared to 36% in the 10-K; the difference is insignificant (*t*-stat=0.82). Of the reports that disclose green opportunities, 6% of the sustainability-report sentences include green opportunity disclosures, whereas 1% of MD&A sentences include green opportunity disclosures. This difference is statistically different at the 1% level (diff=5.02; *t*-stat=3.84). The slightly higher *ReadIndex* for green opportunity disclosures in the 10-K suggests that green opportunity disclosures in the 10-K are slightly *less* readable than green opportunity disclosures in the sustainability report (diff= -0.19, *t*-stat=1.73). These univariate results suggest that on average, firms devote a greater fraction of the sustainability report to green opportunities than they do in the MD&A. Moreover, green opportunity disclosures in the sustainability report are on average

slightly less complex and more readable than those in the 10-K. Overall, these findings suggest that it is unlikely that lower quality disclosure explains outperformance of the firms that only disclose green opportunities in the sustainability report.

Another possibility is that, after starting to disclose green opportunities in the 10-K, firms improve green opportunity disclosures in the sustainability report. If firms provide higher quality disclosure in the 10-K, reporting practices may improve in the sustainability report to match practices in the 10-K. Outperformance of the sustainability report-only portfolio could reflect disclosures being less usable until disclosure begins in the 10-K, and be unrelated to the reporting channel where disclosure is provided. I assess this by comparing attributes of green opportunity disclosures in the sustainability report in the year *before* the firm starts disclosing green opportunities in the 10-K, to attributes of green opportunity disclosures in the sustainability report in the year *after* the firm starts disclosing in the 10-K. Results are shown in Panel B of Table 1.9. I do not find that any of the three disclosure attributes (i.e., quantity, quantitative intensity and readability) change significantly from before to after the firm starts disclosing in the 10-K, suggesting that this is not a likely explanation for the outperformance.

Table 2.9: Univariate comparisons of sustainability report and 10-K green opportunity disclosure attributes

Panel A: Comparing disclosure attributes across reports

Attribute	Definition	*SustGreenOppDisc* (***N***=2,432) (1)	*10KGreenOppDisc* (***N***=1,166) (2)	Difference (1)-(2)
% Quantitative	Number of green opportunity disclosures that contain quantitative information, as a percentage of all green opportunity disclosures. I follow Huang et al. (2014) and classify a green opportunity disclosure as quantitative if it: (1) includes words such as "dollars", "thoughts", or "millions", or numbers followed by scaled abbreviations (e.g., $10M or $5B) (2) includes numbers (3) includes any references to U.S. currency (i.e., "$"), or (4) includes percentages (the word "percent" or the symbol "%").	0.331	0.361	-0.03 (0.82)
%GreenIntensity	Number of green opportunity sentences as a percentage of the total sustainability report or MD&A sentences.	6.12	1.10	5.02 (3.54 ***)
ReadIndex	Readability of green opportunity disclosures using the approach in Guay, Samuels and Taylor (2018) which combines several established measures of readability. *ReadIndex* is the first principal component of the Flesch-Kincaid readability, LIX readability, RIX readability, Gunning Fog readability, ARI readability, and SMOG readability. Each of these measures is effectively a function of word complexity and sentence length, and higher values correspond to less readable text.	-0.081	-0.062	-0.019 (-1.73*)

Table 2.9: Univariate comparisons of sustainability report and 10-K green opportunity disclosure attributes (Continued)

Panel B: Univariate comparisons of green opportunity disclosure attributes in the sustainability report, before and after the firm starts disclosing green opportunities in the 10-K

Attribute	*SustGreenOppDisc* in year **before** first 10K GreenOppDisc for firm *i* (***N***=351) (1)	*SustGreenOppDisc* in year **after** first 10K GreenOppDisc for firm *i* (***N***=351) (2)	Difference (1)-(2)
% Quantitative	0.312	0.319	-0.007
			(0.72)
%GreenIntensity	6.38	6.36	0.02
			(0.43)
ReadIndex	-0.092	-0.093	0.001
			(0.29)

This table presents univariate comparisons. Panel A presents means of the green opportunity disclosure attributes (defined in the table) in the sustainability report (Column 1) and in the 10-K (Column 2). Column 3 presents the differences. Panel B presents means of the disclosure attributes in the sustainability report in the year before the firm starts disclosing green opportunities in the 10-K (Column 1) and in the year after (Column 2). Column 3 presents the differences. ***,**,* represent significance for two-tailed tests of differences and *t*-statistics are shown in parentheses.

2.4.4.2.2 Synthesis of the capital market effects of green opportunity disclosures

My findings suggest that green opportunities disclosed in sustainability reports were not immediately capitalized by investors. Note that market inefficiencies or frictions (e.g., investor inattention, search costs, etc.) are not the only explanation for these results. In the past, returns from early-stage clean energy investments were poor (Gaddy et al. 2016; Golden, 2018). As a result, it may be rational for investors to discount green opportunity news in the sustainability report until disclosure is provided in a credible reporting channel such as the 10-K, where managers are more likely to disclose new product investments that will be beneficial to shareholders.

Since profits are persistent and affect stock returns only to the extent that they are unexpected, the forecast and earnings announcement surprises shown in Table 2.7 suggest that green opportunities disclosed in sustainability reports were not fully and immediately impounded, but generated superior future accounting performance. With four quarterly announcements per year, the average quarterly surprise of 0.42% for firms disclosing only in the sustainability report (shown in Panel B of Table 2.7) implies that earnings surprises account for over 1.68% of the firms' outperformance. This is a meaningful portion of the 3.09% value-weighted alpha (2.99% equal-weighted alpha) shown in Table 2.8. Given post-earnings announcement drift (e.g., Bernard and Thomas, 1989), earnings surprises may account for an even greater proportion of the total excess returns. This short event-study window suggests that the calculation of abnormal returns is less sensitive to the asset pricing model used and addresses the concern that the abnormal returns stem from a yet-to-be-discovered risk factor. These results are consistent with prior studies (e.g., La Porta, Lakonishok, Shleifer, and Vishny 1997; Edmans 2011) which document that positive earnings surprises account for a meaning proportion of the outperformance results in their settings.

2.4.5 Why do firms delay disclosure of green opportunities in the 10-K? Exploratory analysis

My results suggest that withholding disclosure from the 10-K, relative to the sustainability report, affects price discovery and information intermediation. Although there are a number of possible reasons for managers to delay 10-K disclosure, I test one hypothesis and leave further investigation of how firms choose among various reporting channels to future research.

I hypothesize that different disclosure-related costs and benefits across 10-Ks and sustainability reports affect when firms disclose green opportunities in these reports. I predict that in earlier years when green revenues are lower and less certain, managers perceive net costs (benefits) from disclosing green opportunities in the 10-K (sustainability report). Over time, as green revenues increase and uncertainty is resolved, the expected costs of disclosing in the 10-K fall and managers supplement disclosure in the sustainability report with disclosure in the 10-K.

A number of costs could underlie this behavior. First, higher green revenues allow managers to assure investors that green products are financially viable, helping to mitigate investor concerns about the pursuit of green opportunities. Widespread beliefs that sustainability efforts are driven by managers' private rent extraction (e.g., Benabou and Tirole 2010) and the significant losses borne by investors from clean energy technology start-ups (Gaddy et al. 2016; Golden 2018), could lead managers to expect adverse consequences if they disclose green opportunities in the 10-K.[35] Adverse consequences could include (1) a decrease in firm value if investors discount the firm owing to governance concerns, and (2) forced turnover if managers are perceived as making investments that are harmful to shareholder interests. These concerns are unlikely to transfer to sustainability reports because investors often ignore or dismiss these reports. Second, firms face potential legal sanctions from making misleading statements in financial reports (e.g.,

[35] Prior research suggests that managers may pursue sustainability for private benefits (Brammer and Millington 2008; Cheng, Hong, and Shue 2014), or because doing so is consistent with their personal and political beliefs (Di Giuli and Kostovetsky 2014).

Francis, Philbrick, and Schipper 1994; Waymire 1985), whereas claims made in sustainability reports are rarely scrutinized (e.g., Eccles and Serafeim 2013). Higher green revenues therefore increase managers' confidence in their ability to deliver on stated green opportunities, which could lower the expected litigation and reputational costs from disclosing in the 10-K. Third, as firms become more established in the green products market and generate higher green revenues, managers will be less concerned about the proprietary costs associated with sharing information about green opportunities with competitors who may pay more attention to 10-Ks than to sustainability reports.

To test this 'costly disclosure' hypothesis, I regress the timing difference between when firms start disclosing green opportunities in the 10-K and sustainability report (i.e., *10-K Delay*) on measures for litigation risk, proprietary costs, shareholder preferences for climate change investments, the financial materiality of green revenues and future green revenue uncertainty. Litigation risk and proprietary costs are predicted to be positively associated with *10-K Delay* and shareholder support for climate change investments is expected to have a negative relation with *10-K Delay*. I predict that green revenue materiality will shorten the delay, while greater uncertainty about future green revenues will increase the delay.

Litigation risk is measured with an indicator variable equal to 1 for firms with membership in highly litigious industries (*Litigious*), following the approach in Francis, Philbrick and Schipper (1994a, 1994b). The proprietary cost variable is calculated as research and development expenditures scaled by total revenues in the year immediately prior to the firm's first green opportunity disclosure (*R&D*). I assume that it is more costly for firms with greater investment in research and development, which compete more on the basis of innovation, to reveal competitive information via disclosure of green opportunities in the 10-K. Shareholder support for climate

change investments is measured using the mean vote-for-percentage for climate change shareholder proposals at the focal firm across all years (with available data) before the first green opportunity disclosure (*ClimChgVoteSupport*).[36] Future green revenue uncertainty is measured as the standard deviation of green revenues in the years subsequent to the first green opportunity disclosure (*StdDev(GreenRevenues)*). The materiality of green revenues is measured as the firm's green revenues in the first green opportunity disclosure year (*GreenRevenues*).

The dependent variable, *10-K Delay*, is regressed on the measures of litigation risk, proprietary costs, shareholder support for climate change efforts, green revenues materiality and future green revenue uncertainty. Panel A of Table 2.5 reports descriptive statistics for these variables. *10-K Delay* is measured at the firm level and *Litigation* is measured at the industry-level, therefore my regression includes sector fixed effects to control for unobserved reporting practices at the sector level. I include the full set of control variables that could affect firms' green opportunity disclosures, as described in section 2.4.1. Table 2.10 presents the results. As predicted, the coefficient on *GreenRevenues* is negative and significant (coef. = -0.032, *t*-stat = -2.51) and the coefficient on *StdDev(GreenRevenues)* is positive and significant (coef. = 0.183, *t*-stat = 2.27). In terms of economic significance, a one-standard deviation increase in *Green Revenues* (*StdDev(GreenRevenues)*) is associated with a 6-month (7-month) shorter (longer) 10-K delay, on average. The coefficients on *Litigious* and *R&D* are positive but insignificant. However, the coefficient on *ClimChgVoteSupport* is negative and significant (coef. = -2.593, *t*-stat = -2.30),

[36] I identify climate change shareholder proposals following the approach in Grewal et al. (2016). I download shareholder proposals from 1997 to 2016 from ISS and remove non-socially responsible investment proposals using the "Resolution Type" field. I use the one-line description of the proposal to identify climate change proposals. A proposal is classified as climate change-related if it describes: climate change risks, renewable energy alternatives, energy efficiency, greenhouse gas emissions, carbon principles, or energy efficiency plans. I note from my review that the majority of climate change shareholder proposals engage companies to report on, or improve, the firms' climate change impacts.

suggesting that higher (lower) investor support for climate change-related investments reduces (increases) the 10-K delay. A one-standard deviation increase in shareholder voting support for climate change-related proposals is associated with a 4-month shorter delay, on average, between when firms start disclosing green opportunities in the 10-K versus the sustainability report.

These results suggest that the materiality of green revenues and climate change-related shareholder pressure lowers the expected costs of disclosing green opportunities in the 10-K, while future green revenue uncertainty increases the expected costs of disclosing in the 10-K, consistent with the costly disclosure hypothesis. For the shareholder pressure result, one plausible explanation is that, in the absence of this active engagement, managers expect investors to draw adverse inferences from green opportunity news. This is because, in the past, returns from early-stage climate change investments were poor (Gaddy et al. 2016; Golden, 2018) and there are widespread concerns that sustainability-related efforts are driven by managers' private rent extraction and personal and political beliefs, rather than by shareholders' preferences (e.g., Brammer and Millington 2008; Cheng, Hong, and Shue 2014; Di Giuli and Kostovetsky 2014). Active pressure and engagement by shareholders mitigates managers' concerns that investors, upon learning about firms' pursuit of green opportunities, will discount the firm owing to governance concerns.

Table 2.10: Factors associated with the delay between disclosing green opportunities in the 10-K and the sustainability report

OLS	Dependent variable: 10-K Delay
Litigious	0.491
	(1.22)
R&D	0.042
	(0.31)
ClimChgVoteSupport	-2.593**
	(-2.30)
StdDev(GreenRevenues)	0.183**
	(-2.27)
GreenRevenues	-0.032**
	(-2.51)
ESGDisc	0.042
	(1.32)
ESGPerf	0.021
	(1.11)
10KFwdLookingDisc	0.059
	(0.91)
Leverage	0.837***
	(3.71)
PTB	-1.129***
	(3.71)
RetVol	0.039
	(1.56)
ROA	0.985
	(2.23)**
Sales1YrGrowth	-0.016
	(-1.11)
AnnualRet	0.009
	(0.53)
TotalAssets	0.651**
	(1.99)
Constant	0.217*
	(1.69)
N	351
Adj R2	61.3%
Sector fixed effects	Yes

This table estimates factors associated with the length of time between the first 10-K green opportunity disclosure and the first sustainability report green opportunity disclosure. 10-K Delay is the difference between the year of the first 10-K green opportunity disclosure and the year of the first sustainability report green opportunity disclosure for a given firm. *Litigious* is a dummy=1 for membership in highly litigious industries, defined in Francis, Philbrick and Schipper (1994a, 1994b). *R&D* is total research and development expenditures scaled by total revenues, a proxy for

proprietary cost concerns. *ClimChgVoteSupport* is the mean vote-for-percentage for all climate change-related shareholder proposals that went to vote for the firm in the years leading up to the first green opportunity disclosure. Control variables are defined in Appendix Table II. *t*-statistics appear in parentheses and are based on standard errors clustered by industry. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively.

2.5 Conclusion

I use disclosure that firms provide about business opportunities that arise from climate change as the setting to study disclosure strategies of emerging trends and their consequences. Consistent with green opportunities being of interest to both equity and non-equity stakeholders of the firm, I find that firms disclose green opportunities in their 10-K and in their sustainability report. However, firms delay disclosing green opportunities in their 10-K relative to their sustainability report for, on average, 2.5 years.

Despite both disclosure channels providing reliable information about future revenues from the sale of low-carbon products, withholding disclosure of green opportunities from the 10-K appears to have real economic consequences. Stock prices respond promptly to green opportunity disclosures provided in the 10-K, but respond more slowly to disclosures provided only in the sustainability report, which generates positive subsequent returns. Green opportunity disclosures made only in the sustainability report also exhibit significantly more positive earnings and revenue forecast errors and earnings announcement returns. This suggests that the stock market does not fully value green opportunities disclosed in sustainability reports.

I perform exploratory analyses into the factors associated with delayed disclosure of green opportunities in the 10-K. I find that firms with higher green revenues have shorter 10-K delays, consistent with firms requiring green revenues to be financially material before disclosing green opportunities in financial reports. Moreover, firms with higher future variability in green revenues

take longer to disclose green opportunities in the 10-K, consistent with uncertainty playing a role in firms' disclosure channel decisions. I also document that firms receiving greater shareholder support for climate change-related shareholder proposals (e.g., proposals for firms to reduce greenhouse gas emissions or increase transparency on climate change impacts) disclose green opportunities more promptly in the 10-K. A plausible explanation is that shareholder pressure and engagement mitigates managers' concerns that investors, upon learning about firms' pursuit of green opportunities, will draw adverse inferences owing to beliefs that sustainability efforts represent an agency problem.

It is important to note the limitations of my results. Notably, since I do not have a natural experiment with random assignment of the variable of interest to firms, the data admit non-causal explanations. For instance, green opportunities may proxy for other variables that are positively related to stock returns and also misvalued by the market. However, the outperformance that I document is concentrated in firms that disclose green opportunities only in the sustainability report; later, when these same firms disclose green opportunities in the 10-K, outperformance disappears. This helps to alleviate concerns that time-invariant unobservables (such as good management) account for the majority of the results. However, I cannot rule-out time-varying unobservables (such as increases management quality subsequent to disclosure in the sustainability report, but not subsequent to disclosure in the 10-K).

I contribute to several strands of literature that examine disclosure and its consequences. I also innovate beyond prior disclosure research by studying a setting in which I can directly observe the withholding of disclosure in the 10-K relative to another reporting channel. My findings should be useful to academics, regulators, and practitioners who wish to better understand the use of newer and less-traditional reporting channels by firms and their possible capital market consequences. A

promising area for future research is how firms choose among various reporting channels, including newer mediums such as social media. My study is also timely given recent calls for the SEC to mandate environmental, social and governance reporting for U.S. companies. Regulation of sustainability disclosures could potentially improve their credibility and alleviate search costs or inattention to sustainability reports suggested by my findings.

Chapter 3

Real Effects of Disclosure Regulation: Evidence from Mandatory Carbon Reporting

3.1 Introduction

In this paper I examine whether disclosure regulation affects the real outcomes of firms already disclosing prior to regulation. Disclosure regulation has been shown to generate real effects or "changes in behavior in the real economy (e.g., investment, use of resources, consumption)" (Leuz and Wysocki 2017 p.545). Extant literature documents that mandated disclosure improves investment efficiency and financial stability, reduces tax avoidance and improves corporate accountability.[1] At the same time, reporting requirements often carry unintended consequences. Gao, Wu and Zimmerman (2009) documents avoidance strategies for SOX Section 404 compliance and Gipper (2016) shows increases in management compensation following mandated compensation disclosure. Regardless of the consequences documented, prior literature attributes real effects of mandated reporting to new or improved information, which contracting stakeholders use to influence the reporting firm's behavior. Whether mandated reporting generates behavioral changes for firms that are *already* being transparent is less understood. Whereas prior research has focused on firms that *do not* disclose prior to regulation or firms that *improve* transparency after regulation, I study whether disclosure regulation generates real effects among firms that *already* disclose in the manner required by new reporting requirements.

The answer to this question is unclear. Theory predicts that when firms increase disclosure, information asymmetries are lowered and monitoring is improved, which can help reduce inefficiencies in managerial decisions (Kanodia and Sapra 2016). New or more disseminated

[1] See Cho (2015), Dyreng, Hoopes and Wilde (2016), Christensen, Floyd, Liu and Maffett (2017), Granja (2018) and Rauter (2017).

information about the reporting firm also allows activist NGOs and consumers to shame and pressure the firm to change its behavior (e.g., Christensen et al. 2017; Dyreng et al. 2016; Rauter 2017). This suggests that regulation should not generate real effects among firms that disclose *prior* to regulation and that do not improve transparency *after* regulation.

On the other hand, there are other theories linking disclosure regulation to the behavior of already-disclosing firms. One possibility is that regulation produces widespread reporting by a large number of firms since the previously non-disclosing firms, as well as the already-disclosers, must disclose. This increased availability of information may reduce information processing costs and enhance the decision-usefulness of the disclosed information. Regulation could therefore increase the use of disclosures by market participants and heighten attention to the disclosed information, resulting in more pressure on already-disclosing firms to change behaviors after regulation. Another possibility is that disclosure regulation leads managers and investors to revise their expectations regarding the likelihood of future, potentially more costly regulation.

To examine this question, I exploit the passage of a regulation in the United Kingdom (UK) requiring listed UK-incorporated companies to report greenhouse gas emissions (GHG) for their entire organization in annual financial reports (hereafter mandatory carbon reporting, or MCR). A key feature of this setting is that a number of the affected firms voluntarily disclose GHG prior to MCR in a manner consistent with the requirements of MCR. I study whether MCR affects the GHG of these already-disclosing firms (see Figure 3.1). As a benchmark, I use matched firms outside the UK (and private UK firms unaffected by MCR as a robustness test) that voluntarily disclose GHG and are unaffected by GHG disclosure regulation.

Figure 3.1: Treatment and Control Samples

Voluntary Discloser	Mandatory Discloser	**Treatment Sample ('already-disclosers')**
Pre	Post	
Voluntary Discloser	Voluntary Discloser	**Control Sample**
Pre	Post	
Non-Discloser	Mandatory Discloser	**Focus of prior literature - not the focus of this study**
Pre	Post	

My analysis offers two key findings. First, I document that mandated reporting generates incremental real effects among firms that are already being transparent. Specifically, I find that firms voluntarily disclosing GHG prior to MCR reduce GHG in the post-MCR period, relative to firms that also voluntarily disclose GHG but are unaffected by disclosure regulation. As support for this result, I document a positive relation between GHG reductions and investments in green building retrofits, employee energy-saving efforts, and clean energy purchases. Second, I document that mandated reporting (1) increases reputational concerns, consistent with regulation providing more decision-useful information to investors and other stakeholders, and (2) increases regulatory concerns, consistent with 'soft' disclosure regulation foreshadowing future 'hard' regulation (e.g. carbon tax). Consistent with disclosure regulation elevating the importance of GHG within the firm, I show that higher-ranking employees have incentives tied to GHG following MCR, relative to unaffected firms.

Using firm-level GHG data, I compare changes in GHG following the effective date of the mandate for affected 'treated' firms (i.e., listed, UK-incorporated firms that voluntarily disclose GHG prior to MCR) to that of matched unaffected 'control' firms (i.e., non-UK firms that voluntarily disclose GHG and are not affected by GHG disclosure regulation). I ensure the reporting boundary as well as the methodology used to measure GHG are the same before and

after the mandate, to help mitigate concerns that these changes are confounding my results.[2] Control firms are matched to treated firms along dimensions of pre-mandate GHG levels, industry, size, profitability, capital intensity, and growth. I control for flexible time and static firm-level differences through the inclusion of year and firm fixed effects, and time-varying controls. I validate that pre-period trends in GHG are similar between treated and control firms, but events coinciding with MCR that differentially affect UK firms and non-UK firms could still confound my inferences. I conduct a search and exclude from the analyses firms with confounding events and regulations. I also assess the robustness of the results to using private companies in the UK that are unaffected by MCR as control firms; inferences are unchanged.

My first set of results suggest that disclosure regulation generates incremental real effects among already-disclosers. There is a statistically significant average decrease in GHG of 10% in the years after MCR for UK firms that voluntarily disclose prior to MCR, relative to matched control firms that voluntarily disclose throughout the sample period and are unaffected by mandated disclosure. I do not find that a decrease in operating activities, understated GHG or a shift of GHG information into financial reports (e.g., Christensen et al. 2017) are likely reasons behind the observed GHG reductions. Alternatively, I find evidence consistent with already-disclosers employing behavioral changes (e.g. heat and light switch-off campaigns; video-conferencing in lieu of travel), new energy investments (e.g. renewable energy installations; green power purchases), and green building investments (e.g. retrofits, LEED certification) to achieve GHG reductions.

[2] This contrasts settings in which the information provided in the pre-regulation period is difficult to aggregate or understand, compared to the information provided in the post-regulation period (e.g., Delmas et al. 2010; Rauter 2017; Downar et al. 2019).

My second set of analyses investigates why disclosure regulation generates real effects among already-disclosers. MCR requires all listed, UK-incorporated firms to report GHG data in CEO/CFO-certified annual reports; requires GHG to be reported for the same organizational boundary used for financial reporting; and specifies which methodologies should be used to measure and report GHG. I hypothesize that mandating disclosure by all listed U.K.-incorporated firms and regulating the reporting choices available to managers improves the availability and comparability of GHG disclosures which reduces information processing costs and allows investors and other stakeholders to integrate GHG into decision-making (Healy and Palepu 2001; Maines and McDaniel 2000). I also hypothesize that disclosure regulation signals that the government is willing to impose future, potentially more costly, regulations on firms' GHG, given that mandated disclosure of GHG was a precursor to GHG taxation in other countries. Using survey data, I find empirical evidence in support of my hypotheses. Specifically, I show that already-disclosers perceive greater reputational and regulatory risks to their business from climate change following MCR, relative to matched firms.

My results suggest that MCR revised the expected costs and benefits of GHG and increased the importance of GHG within the firm. Prior research suggests that a shift in organizational priorities can lead firms to modify managerial control systems (e.g. Van der Stede, Chow and Lin, 2006; Campbell, Datar, Kulp and Narayanan 2002; Simons 1987). Consistent with this, I find that already-disclosing firms provide monetary incentives to more senior-level employees to reduce GHG following MCR.

Prior research has primarily focused on firms forced to disclose as a result of mandated reporting, showing that new disclosure facilitates monitoring and feeds-back to the real actions of the firm (Kanodia and Sapra, 2016). My paper documents that mandated reporting also produces

real effects among firms voluntarily disclosing prior to the regulation, due to reputational and regulatory concerns, which elevate the importance of the issue within the firm. Reputational concerns arise because regulation increases the decision-usefulness of disclosure relative to voluntary reporting, thereby increasing investor and stakeholder attention to, and use of, the disclosed information. Regulatory concerns arise because 'soft' reporting regulation increases expectations of future 'hard' regulation to impose explicit costs on firm outputs and behaviors.

Although my focus on GHG and MCR regulation could limit the generalizability of my results, my study nonetheless provides direct evidence on previously undocumented mechanisms through which disclosure regulation affects firm behavior, which likely apply to other mandatory reporting settings. For example, extensive pension disclosure requirements mandated by FAS No. 36 increased transparency of the assumptions used to calculate pension liabilities, allowing investors to identify companies using overly generous interest rates, something that was infeasible when unstandardized disclosure practices could mask these assumptions (Churyk, Reinstein and Thomas, 2013). Moreover, new disclosure requirements for state-regulated banks may have led state banks to take action to reduce their failure rates to pre-empt the costly regulation faced by national banks (Granja 2018), and mandated disclosure of subsidiary locations may have led firms to reduce their use of subsidiaries in tax haven countries to prevent government action such as increased cash repatriation tax rates (Dyreng et al. 2015).

My findings also have implications for regulations mandating corporate disclosure of environmental and social responsibility data, given the recent trend towards employing such policies (Leuz and Wysocki, 2017).[3] Though over 7,000 of companies around the world

[3] The SEC has adopted rules relating to regulating disclosures of conflict minerals, health and safety violations at mine sites, and payments to foreign governments for the extraction of natural resources. U.S. policymakers are also

voluntarily disclose environmental and social data,[4] my findings provide insights into why regulation can be an effective policy tool to affect firm behavior, even among voluntary disclosers.

3.2 Prior literature, research question and background on Mandatory Carbon Reporting

3.2.1 Prior literature and research question

Prior literature documents that real effects accrue to firms that do not disclose prior to disclosure regulation, or to firms that improve disclosure significantly. This literature suggests that disclosure regulation generates real effects because improved transparency – which arises from new, more detailed or more disseminated information – facilitates monitoring of the reporting firm's behavior (Kanodia and Sapra 2016). For example, Cheng, Dhaliwal and Zhang (2013) show that firms mandated to report internal control weaknesses for the first time under the Sarbanes-Oxley Act improved investment efficiency, Cho (2015) finds that improvements in mandated segment reporting following SFAS 131 increased investment efficiency, and Rauter (2017) documents that more detailed disclosures about extraction payments to foreign host governments reduced illicit payment practices. Chen, Hung and Wang (2018) find that firms in China experience a decrease in profitability subsequent to mandatory corporate social responsibility (CSR) reporting, and the cities most impacted by the mandate experience a decrease in their industrial wastewater and sulfur dioxide emissions. Christensen et al. (2017) examines the real effects of including mine-safety information in financial reports as part of the Dodd-Frank Act and finds that

considering mandatory reporting requirements for climate change risks and political contributions. The European Commission recently mandated new nonfinancial disclosures related to firms' ESG performance.

[4] See "ESG Metrics: Reshaping Capitalism?" *Harvard Business School Publishing* (Technical Note 116-037), March 2016.

shifting information into a highly-disseminated disclosure channel decreased mine-site injuries relative to when the required information was disclosed elsewhere.[5]

Though past studies have focused on firms that improve disclosure or disclosure dissemination following regulation, there is often variation in the pre-regulation disclosure practices of affected firms. For instance, firms affected by new reporting rules may already be in compliance with the rules. My review of the literature suggests that prior studies have largely ignored this heterogeneity. For instance, Chen et al. (2018) excludes firms that voluntarily released disclosure before mandated reporting; their figures suggest that voluntary disclosers comprise 35%-50% of the affected firms. Granja's (2018) sample includes state banks that voluntarily provided financial reports prior to the adoption of reporting requirements (i.e., around 35% of the affected firms) but the empirical analysis does not distinguish between already-disclosing firms and non-disclosing firms. Gipper (2016) describes how firms provide varying levels of pay disclosure prior to CD&A disclosure requirements, but does not exploit this heterogeneity. One exception is Daske, Hail, Leuz and Verdo (2008), which examines capital-market effects around the introduction of mandatory IFRS reporting among firms that voluntary switched to IFRS prior to the mandate. Daske et al. (2008) document liquidity and valuation benefits for voluntary adopters in the year of the switch to IFRS, which they propose could reflect comparability benefits that accrue to the voluntary adopters when other firms in the country adopt IFRS.

[5] A literature outside of accounting shows how disclosure mandates are used in lieu of regulation that requires or prohibits certain behaviors. This research has also focused on settings where the information being mandated is not already being voluntarily disclosed, and finds that consumer pressure arising from increased transparency yields outcomes consistent with regulators' intentions. For example, when Los-Angeles based restaurants were required to display health inspection scores in their windows, researchers found evidence consistent with rapid increases in these inspection scores as well as lower hospitalization rates for food-related illnesses (Jin et al. 2003). Similar evidence has been found in the context of mandating disclosure of patient health outcomes (Dranove et al. 2003, Kolstad 2013), toxic pollutants (Konar et al. 1997) and drinking water quality (Bennear et al. 2008).

I study whether disclosure regulation generates real effects among firms that are already voluntarily disclosing in the manner required by the regulation. I verify that GHG data provided prior to MCR is comparable to after MCR comes into effect, in order to isolate the effect of disclosure regulation rather than confounding it with other changes affecting the location, understandability and dissemination of GHG disclosure.[6] Thus, the channels documented in prior literature of new, improved or more accessible information increasing investor and stakeholder monitoring (e.g. Cho 2015), consumer boycotts and activist shaming (e.g. Rauter 2017) and investor awareness (Christensen et al. 2017), are unlikely to be driving mechanisms in my setting.

There are, however, other theories linking disclosure regulation to real effects among already-disclosers. For one, disclosure regulation could increase the usefulness of GHG information to investors. Prior research suggests that investors integrate GHG information into stock valuation, but the lack of comparable information is an impediment to the use of this data (Amel-Zadeh & Serafeim 2017).[7] MCR requires all listed, UK-incorporated firms to report GHG data in CEO/CFO-certified annual reports; requires GHG to be reported for the same organizational boundary used for financial reporting; and specifies which methodologies should be used to measure and report GHG. MCR should therefore produce widespread, comparable reporting across a large number of firms, which would presumably make it less costly for outsiders to process GHG information relative to when GHG are disclosed voluntarily (Maines and

[6] I verify that the reporting boundary and the methodology used to measure GHG are the same before and after the mandate and remove firms where this is not the case. This contrasts settings in which the information provided in the pre-regulation period is difficult to aggregate or understand, compared to the information provided in the post-regulation period (e.g., Delmas et al. 2010; Rauter 2017). I also perform analyses on firms that disclose GHG in financial reports *prior* to regulation, to rule-out increased dissemination or other 'disclosure-channel' effects (e.g., Christensen et al. 2017).

[7] Prior studies document that investors price firms' GHG. See, for example: Amel-Zadeh & Serafeim (2017); Griffin, Lont & Sun (2017); Matsumara, Prakash and Vera-Munoz (2014) & Eccles, Serafeim and Krzus (2011). In addition, Kruger (2016) studies the effect of MCR on firm value, and documents that affected firms experience positive valuation effects.

McDaniel 2000; Healy and Palepu 2001; Leuz and Wysocki 2016).[8] If disclosure regulation produces more decision-useful information relative to voluntary reporting, there could be heightened investor and stakeholder attention to the information, greater integration of the information into decision-making by investors, and more pressure on firms to change behaviors. This suggests that already-disclosing firms will face increased reputational concerns regarding GHG following mandated reporting, resulting in efforts to reduce GHG.

A second theory involves the perceived threat of future regulation. MCR may signal the UK's willingness to impose future regulations on firm GHG. This would not be an unreasonable presumption since Australia, Japan, Sweden and the state of California all mandated disclosure prior to passing regulation to tax emissions.[9] Managers may perceive that MCR is a signal that future regulation to impose explicit costs on GHG – such as carbon taxation – is forthcoming unless they self-regulate, leading firms to reduce GHG either to pre-empt future regulation, or to be prepared should it happen.[10] Moreover, if MCR causes investors to reassess the likelihood of future government regulation and the resulting compliance, litigation and/or remediation costs, the mandate could affect security prices through a numerator effect (i.e., cash flows), and, if investors require higher returns for financing the operations of firms that are more likely to be affected by future regulation, the mandate could affect security prices through a denominator effect (i.e., cost

[8] Past studies show that financial statement comparability increases analyst forecast accuracy and reduces dispersion (e.g. Bradshaw, Miller and Serafeim 2009; De Franco, Kothari and Verdi 2011).

[9] The escalation of transparency regulation to more explicit regulation that imposes costs on firm outputs or behaviors has occurred in a number of contexts. For instance, requiring large U.S. companies in the 1970s to disclose payments made to foreign government official shed light on the extent of unlawful payment practices and provided impetus for the Foreign Corruption Practices Act, which brought criminal penalties for violations. See http://moritzlaw.osu.edu/students/groups/oslj/files/2013/02/73.5.Koehler.pdf. Another example is mandated disclosure of mining accidents from mine operators to the Mine Safety and Health Administration in 1977, which was followed by requirements for regular mine inspections and penalties for safety violations.

[10] Maxwell, Lyon and Hackett (2002) explore firms' incentives to preempt future regulation. Their model implies that increased threat of government regulation induces firms to reduce pollution emissions.

of equity). Both will give managers an incentive to undertake real actions to reduce GHG, so long as managers' utility functions incorporate the value of the firm.

Overall, it is an empirical question whether MCR will affect GHG for voluntarily disclosing firms. My goal is to assess the existence and size of any such effects.

3.2.2 Background on Mandatory Carbon Reporting

Mandatory Carbon Reporting (MCR) was first proposed as a possibility in 2008, when the UK Climate Change Act (the Act) was passed. Section 85 of the Act required the UK Government to either mandate disclosure of GHG in the annual reports of UK companies by April 2012, or explain to Parliament why no such regulations had been made (DEFRA, 2012). According to a research report, the requirements under Section 85 received no specific mention in any of the press releases or news articles surrounding the passage of the Act, and considerable uncertainty existed as to whether regulators would impose the disclosure burden on firms.[11]

Research findings from a report commissioned by the UK Government were released on November 30, 2010. The main finding was that British companies reporting their GHG voluntarily experience benefits such as cost savings and improved relations with investors and customers.[12] On May 11, 2011 the UK Government published a consultation report setting out four options to achieve more widespread and consistent GHG reporting. Only one option proposed enhanced voluntary reporting, while the other three options related to mandatory reporting (either for all quoted companies; all large companies; or all companies whose energy consumption exceeds a

[11] See http://www.sustainalytics.com/voluntary-mandatory-reporting-evolution-ghg-disclosure#_edn8
[12] See https://www.gov.uk/government/news/new-research-shows-reporting-greenhouse-gas-emissions-benefits-business

threshold).[13] On March 17, 2012 the UK Government released a report outlining why no regulations had yet been introduced on company reporting of GHG, essentially meeting the April 6, 2012 deadline imposed by Section 85 of the Act. The main reason cited was that the requirements to report might represent an unnecessary regulatory burden.[14] Finally, on June 20, 2012, the Deputy Prime Minister announced that all listed UK companies would have to report GHG from the start of the next financial year, on an annual basis, in the Directors' Report (the UK equivalent of SEC Form 10-K in the United States).[15]

The benefit of this setting for my research question is that the stated objective of MCR is to achieve corporate GHG reductions, despite many UK firms already being transparent. Regulators and high-ranking government officials expect that MCR will help the UK achieve its carbon reduction goals. Deputy Prime Minister Nick Clegg stated that "…this law will play a critical role in helping the UK meet its goals to cut [carbon dioxide] emissions by four million tons by 2021" and Secretary of State for the Environment Caroline Spencer believes that "[mandatory carbon reporting] will make firms accountable for their carbon footprint" (DEFRA, 2012). Since nearly half of the affected firms already voluntarily disclosed their GHG prior to MCR, the effect of MCR on GHG for these firms is difficult to predict ex-ante. [16]

3.3 Research design

The objective of this study is to measure the causal effect of MCR on GHG levels, where the unit of analysis is a firm.

[13] See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82356/110511-ghg-emissions-condoc1.pdf
[14] See https://www.gov.uk/government/publications/company-reporting-of-greenhouse-gas-emissions
[15] See https://www.gov.uk/government/news/leading-businesses-to-disclose-greenhouse-gas-emissions
[16] See http://www.sustainalytics.com/voluntary-mandatory-reporting-evolution-ghg-disclosure#_edn8

The legislation requires listed UK-incorporated firms to disclose the annual quantity of Scope 1 and Scope 2 GHG in metrics tons of carbon dioxide equivalent (CO2e).[17] My empirical strategy relies on the institutional fact that only UK-incorporated publicly-listed firms (on the Main Market of the LSE, NYSE or NASDAQ) are subject to the mandate, and hence only these "treated" firms are required to disclose their GHG in annual reports for years ended on or after September 30, 2013. After removing non-UK firms with confounds (see section 3.3.1 for details) I construct a matched sample of "control" firms unaffected by the mandate using single nearest-neighbor propensity score matching without replacement within a specified caliper width.[18] I employ a difference-in-differences approach to compare GHG in treated and control firms before and after the passage of the transparency regulation. Specifically, I estimate a two-way fixed-effects model over the years 2006-2015:

$$Y_{it} = \alpha_i + \lambda_t + \beta_1 \, Treat_i \, x \, Post_t + \sum \beta_{it} \, \text{controls} + \varepsilon_{it} \qquad (1)$$

where Y_{it} is the natural logarithm of GHG in metric tons of carbon dioxide equivalent or emissions productivity, as defined in Appendix Table IV. I obtain emissions data from several sources including the Carbon Disclosure Project, Bloomberg ESG and hand-collected data from CSR reports and corporate websites. α_i refer to firm fixed effects that absorb all observed and unobserved time-invariant firm characteristics and λ_t refer to year fixed effects that control for common macroeconomic shocks that affect all firms. I run alternate specifications including time-varying firm controls (size, profitability, price-to-book ratio, leverage, capital intensity and sales growth) and time-varying country controls (the carbon intensity of the electrical grid and gross

[17] According to the GHG Protocol, Scope 1 emissions are direct emissions from sources that are owned or controlled by the reporting entity, while Scope 2 emissions are indirect emissions from purchased electricity, heat or steam that are a result of the reporting entity's activities but originate from sources owned or controlled by another entity. See http://www.ghgprotocol.org/calculationg-tools-faq.

[18] I conduct a number of robustness checks which are described in section 3.3.

domestic product, which help account for country-specific shocks to carbon intensity and demand, respectively) defined in Appendix Table IV.[19] The average treatment effect is the estimated β_1 coefficient on the interaction $Treat_i \, x \, Post_t$ which captures the change in emissions for treated firms after the regulation relative to the change for matched control firms. $Post_t$ is an indicator equal to one in years 2013, 2014, and 2015 and $Treat_i$ is an indicator coded as one if the firm is covered by the regulation and does not have any confounds. I use two-way clustering of the error terms at the level of the firm and year to account for autocorrelation in the data within a firm across years, and across firms within a year (see Bertrand et al. 2004). I estimate OLS models.

The assumption of this model is that $Treat_i$ is uncorrelated with all unobservables (i.e., the error term, ε_{it}). However, if treatment and control firms are inappropriately matched, there could be differences between these two groups that bias the estimate of β_1. Further, since no law passes in a vacuum, it is possible that regulators passed the law knowing that UK firms would reduce emissions in the post-period regardless of the mandate, which could bias β_1 downwards. In the following sections, I describe the assumptions of the matching and difference-in-differences approaches and explain how I address these concerns.

3.3.1 Confounding events

My analysis involves matching UK to non-UK firms. Consequently, I must account for regulations and events that could confound my inferences, both within and outside of the UK. Appendix Table V presents a summary of emissions regulations (e.g., carbon taxation, cap-and-

[19] In order to report the GHG associated with a firm's activities, the Greenhouse Gas Protocol and other international GHG reporting standards require firms to convert activity data such as distance travelled, liters of fuel consumed and electricity used into carbon emissions using country-specific conversion factors. These rates differ between countries and over time due to carbon intensity of the energy grid (e.g. electricity generation by coal is more carbon intensive than that generated by natural gas, so the emissions factors reflect this). I include a control for the average carbon intensity of the electrical grid across all regions in a given country for which data is available.

trade schemes and emissions disclosure mandates) and nonfinancial disclosure regulations (e.g. sustainability disclosure mandates) that passed or came into effect during this period, as well as my approach to remove these confounds.

First, I identify factors that could affect the emissions levels of firms in other countries. I remove firms from these countries from the pool of possible control firms to mitigate the concern that firms from these countries do not serve as appropriate counterfactuals for UK firms. Appendix Table VI contains a comprehensive description of these regulations. To account for possible confounds, I remove firms from countries where emissions regulations passed during the sample period (i.e., 2006-2015) since these regulations are likely to differentially affect the emissions levels of these non-UK firms relative to UK firms. This leads me to exclude firms from Australia, Ireland, Japan, New Zealand, South Korea, Switzerland and the United States. I also remove firms from countries where broad nonfinancial disclosure regulations passed during the "confound period" – which I define as 2011-2015 – since the mandated disclosure of broad ESG information prior to this period is unlikely to materially affect the emissions levels of these non-UK firms relative to UK firms. This leads me to exclude firms from Brazil, France, India, Norway and Taiwan.

Second, I account for UK carbon-reduction regulations, cap-and-trade schemes, taxation or incentive programs occurring concurrently with MCR, which could confound my results. I search the UK Government Department for Environment, Food and Rural Affairs (DEFRA) website for all policies, publications, consultations and announcements relating to GHG. I summarize the identified confounds, as well as my approach to address them, in Appendix Table V.

3.3.2 Data and sample

My starting sample consists of all 2,530 securities listed on the London Stock Exchange as of June 30, 2012. See Table 3.1 for the sample construction. I remove Alternative Market Shares not subject to the regulation (1,171 securities), depository receipts, fixed interest securities and warrants (339 securities), firms not incorporated in the UK (153 securities) and equity investment instruments, REITS, holding companies and trusts (349 securities). This leaves 518 UK-incorporated companies that are covered by the regulation. After removing UK securities with confounds (54 securities) and firms missing GHG prior to MCR (221 firms), I am left with 243 UK firms voluntarily disclosing GHG prior to the regulation. My primary source for Scope 1 and Scope 2 GHG data is the Carbon Disclosure Project (CDP) database. Established in 2003, the CDP is an investor-led partnership that asks companies annually to submit information voluntarily on their climate change risk management and performance through an online response system, known as the CDP Information Request. Firms can choose to respond to the CDP Information Request, which has over 200 questions, some of which relate to GHG. I supplement these data with emissions data from Bloomberg ESG where responses were not submitted to the CDP but emissions were disclosed elsewhere. I further supplement the data with hand-collected emissions information from corporate CSR reports and websites. To ensure that my results are not confounded by changes in scope, reporting boundary and/or methodology for measuring GHG, I remove 50 firms that switched any of these attributes from the pre- to post-period (i.e., pre-2013 and post-2013) or for which I cannot determine this information. This leaves me with 193 UK firms. There are 845 non-UK firms that are eligible for matching due to GHG data availability, removing confounds and removing firms that change reporting methodologies/scope. This leaves 1,038 firms and 6,237 firm-years.

Table 3.1: Sample Construction

Firms listed on the London Stock Exchange as of June 30, 2012	2,530
Remove: Alternative Market Shares not subject to MCR	(1,171)
Remove: depository receipts, fixed interest securities, warrants	(339)
Remove: firms not incorporated in UK	(153)
Remove: equity investment instruments, REITs, holding companies, trusts	(349)
UK firms covered by MCR	**518**
Remove: firms with confounding carbon regulations (i.e. energy power producers, EU ETS firms)	(54)
Remaining UK firms covered by MCR	**464**
Less: missing GHG prior to MCR	(221)
UK firms voluntarily disclosing GHG prior to MCR	**243**
Less: changed reporting scope/methodology	-50
UK sample	**193**
Add: Non-UK firms eligible for matching (no confounds)	845
Total # of UK and non-UK firms	**1,038**
Firm-years	**6,237**

Table 3.2 presents summary statistics for the sample prior to matching and Table 3.3 presents the correlation matrix, with all variables defined in Appendix Table IV. As expected, the natural logarithm of greenhouse gas emissions (*TotalGHG*) is strongly positively related to proxies for size (*MarketCap, Assets*), which is consistent with prior literature documenting that carbon emissions are proportional to firm size (e.g., Ioannou, Li and Serafeim 2015). *TotalGHG* is also positively correlated with leverage (*Leverage*), capital expenditures as a percentage of sales (*Capex*), sales growth (*SalesGrowth*) and grid carbon intensity (*GridCarbonIntensity*). *EmissionsProductivity*, defined as the ratio of sales revenue generated per metric ton of carbon dioxide equivalent emitted, is negatively related to *TotalGHG*, *ROA, PTB, Leverage* and *GridCarbonIntensity* and is positively related to *MarketCap* and *Assets*. The correlations between the financial control variables are in line with expectations.

Table 3.2: Summary Statistics

Variable name	# Firms	Firm-years	Mean	Median	SD
TotalGHG	1,038	6,237	14.07	14.58	13.39
EmissionsProductivity	1,038	6,237	368,051	23,950	1,207,818
MarketCap	1,038	6,237	22.48	22.51	22.02
Assets	1,038	6,237	23.34	22.92	17.77
ROA	1,038	6,237	5.63	4.90	7.22
PTB	1,038	6,237	2.77	1.67	7.53
Leverage	1,038	6,237	23.94	21.45	17.36
Capex	1,038	6,237	12.10	3.34	11.05
SalesGrowth	1,038	6,237	6.63	4.27	17.79
GridCarbonIntensity	1,038	6,237	551.32	312.67	254.86
GDP	1,038	6,237	2.29	0.055	8.52

Table 3.3: Pearson Correlations

	TotalGHG	Emissions Productivity	MarketCap	Assets	ROA	PTB	Leverage	Capex	SalesGrowth	GridCarbon Intensity
TotalGHG	1									
EmissionsProductivity	-0.158***	1								
MarketCap	0.429***	-0.011	1							
Assets	0.361***	0.012	0.794***	1						
ROA	-0.036***	-0.013	0.191***	-0.169***	1					
PTB	-0.005	-0.003	0.043***	-0.018*	0.080***	1				
Leverage	0.037***	-0.008	-0.057***	-0.004	-0.042***	-0.011	1			
Capex	-0.025**	0.003	-0.043***	-0.048	-0.053***	-0.001	-0.007	1		
SalesGrowth	-0.030**	0.010	-0.011	-0.076***	0.141***	0.011	0.022**	0.001	1	
GridCarbonIntensity	0.059**	-0.118**	0.192**	-0.029	-0.055*	0.029	-0.004	0.009	0.038	1
GDP	0.021	0.029	0.331***	0.042	0.101**	0.127**	-0.021	0.103*	0.104*	0.052*

*** p<0.01, ** p<0.05, * p<0.10. All variables are winsorized at the 1- and 99- percent levels, and defined in Appendix A.

3.3.3 Matching

Having formed my sample, I use propensity score matching to construct a matched sample of firms that achieve balance – statistically indistinguishable distributions between the treated and controls – across a set of exogenous covariates in the pre-mandate period (i.e., 2006-2012). Given the strong correlations between *MarketCap* and *Assets*, I match only on *MarketCap*; I also match on return on assets ratio (*ROA)*, price-to-book ratio (*PTB*), *TotalGHG*, *GridCarbonIntensity* and *GDP* in the pre-period. I also include the six digit Global Industry Classification System (GICS) digit in the matching algorithm, due to toxic emissions being, in part, a function of industry activities (Doshi et al. 2013). Table 3.4 shows the matched sample attained by employing single nearest-neighbor propensity score matching without replacement within a specified caliper width.[20] This algorithm yields 171 matched firm-pairs.[21]

Table 3.4: Matched Sample: U.K. Treatment firms and Non-U.K. Control firms

	Treatment	**Control**	**Total**
Available firms	193	845	1038
Less: unmatched from propensity score matching	22	674	696
Matched sample	**171**	**171**	**342**

Table 3.5 illustrates how matching improves the balance in the means of the exogenous covariates across the treatment and control samples. Each row in the table reports the means for the treatment and control firms and a t-statistic from regressing each covariate on the treatment dummy ($Treated_i$). Panel A of Table 3.5 compares the sample of UK firms affected by the regulation to the sample of non-UK firms prior to matching, while Panel B compares the means

[20] A caliper width of 0.1 times the pooled standard deviation of the logit of the propensity score was used (Rosenbaum and Rubin, 1985)

[21] I verify the robustness of my inferences to using alternative matching approaches; see section 4.2 Robustness.

for the matched samples. Note that matching produces balance for all measures along means, apart from *Assets* which remains statistically significantly different at the 10% level. I include time-varying firm controls – including *Assets* – in the regressions, to account for any remaining differences.

Table 3.5: Covariate Balance in Full and Matches Samples

Sample	Panel A			Panel B		
	Full Sample Before Matching			Sample After Matching		
	Treatment	Control	t-stat	Treatment	Control	t-stat
TotalGHG (from 2006-2012)	14.11	14.02	**2.32**	14.07	14.05	1.03
MarketCap	22.14	22.98	**2.41**	22.18	22.24	1.40
Assets	23.61	24.03	**3.89**	23.34	23.44	**1.85**
ROA	6.94	7.04	**1.80**	6.58	6.52	1.35
PTB	2.05	1.77	1.03	1.95	1.90	1.37
Leverage	43.42	22.31	**1.72**	31.64	27.82	0.71
Capex	13.93	11.53	**2.10**	12.62	11.46	1.37
SalesGrowth	6.23	5.12	0.92	5.87	5.14	0.92
GridCarbonIntensity	411.51	572.31	**3.12**	411.51	401.45	1.44
GDP	2.68	2.37	**2.76**	2.68	2.62	1.28
# of firms	193	845		171	171	

Notes: Unit of analysis is a firm. T-statistics corresponding to p<10% are represented in boldface. Note that matching is done in 2012 for financial variables, the year before the regulation came into effect, and in 2006-2012 for GHG emissions.

I test the assumption that the covariates between the matched treated and control groups are statistically indistinguishable across all sample moments (i.e., the overlap assumption). Appendix Figure A plots the kernel density of the eight matching covariates; in all cases, the estimated densities of the treated and control groups have most of their respective masses in regions in which they overlap each other. Therefore, I fail to find evidence that the overlap assumption is violated.

Table 3.6 shows sector representation across matched samples. The distribution across sectors is very similar between treated and control firms, which is a function of having matched

on industry in the propensity score algorithm. Table 3.7 shows country representation across the matched samples. Control firms are well distributed, with no more than 11% of the sample coming from any given country.

Table 3.6: Sector Representation After Matching

	Treat		Control	
	#	%	#	%
Consumer Discretionary	17	10%	18	11%
Consumer Staples	15	9%	17	10%
Energy	34	20%	34	20%
Financials	10	6%	9	5%
Health Care	5	3%	4	2%
Industrials	39	23%	37	22%
Information Technology	8	5%	6	4%
Materials	35	20%	37	22%
Real Estate	8	5%	9	5%
	171	100%	171	100%

Table 3.7: Country Representation After Matching

	Treat		Control	
	#	%	#	%
United Kingdom	171	100%	0	0%
Canada			10	6%
Denmark			21	12%
Finland			16	9%
Germany			25	15%
Greece			3	2%
Hong Kong			6	4%
Italy			17	10%
Netherlands			25	15%
South Africa			9	5%
Spain			16	9%
Sweden			19	11%
Turkey			4	2%
	171	100%	171	100%

3.4 Baseline results

3.4.1 Effect of MCR on GHG

Table 3.8 presents estimates of regression model (1) for GHG. The dependent variable, *TotalGHG*, is the natural logarithm of total greenhouse gas emissions in metric tons of carbon dioxide equivalent for firm *i* in year *t.* Columns 1-4 present OLS regression coefficients from equation (1). The coefficients on $Treated_i \, x \, Post_t$ is of interest. Across all specifications – which differ depending on the inclusion of firm fixed effects, year fixed effects and time-varying firm controls – the coefficient estimate on $Treated_i \, x \, Post_t$ is negative and statistically significant at the 5% and 1% significance levels. The estimates suggest that treated firms reduced emissions on average by 9.5% to 15.4% in response to MCR. In the specification which includes firm- and year-fixed effects and time-varying controls (i.e., Column 4), the estimated average treatment effect is a reduction in GHG of 9.5%, significant at the 5% level.

A first order concern is that firms affected by MCR adopt costly processes and technologies, which adversely impact operating activities and result in the observed lower GHG. In this case, one would expect emissions productivity – defined as sales revenue divided by GHG – to decline relative to control firms in the post-MCR period. To test for this possibility, I estimate model (1) with Emissions Productivity as the dependent variable in Table 2.9. The coefficient estimate on $Treated_i \, x \, Post_t$ is positive across all specifications and the coefficient estimate is statistically significant at the 10% level or lower.[22]

[22] Firms can reduce emissions by scaling back on operations (e.g. producing less goods) or by making operational, technological or behavioral changes (e.g. using more efficient fuel combustion technology). Sales revenue is a commonly-used measure of firm-level activity. Though the relationship between emissions and operating activities could be non-linear, prior research suggests that, in general, there is a positive linear association between operating activities and GHG (e.g. Ioannou et al. 2015).

Table 3.8: Estimates of the Effect of Mandatory Carbon Reporting on Greenhouse Gas Emissions

Sample: UK firms and matched non-UK firms Dependent Variable: *TotalGHG* Post=2013, 2014, 2015	(1)	(2)	(3)	(4)
Treat x Post	-0.1543 [0.0556]***	-0.1493 [0.0596]***	-0.1121 [0.0472]***	-0.0958 [0.0402]**
Post	0.1194 [0.0791]	0.0928 [0.0512]*		
Treat	-0.0174 [0.0601]	-0.0207 [0.0468]		
Assets		0.9629 [0.0515]***		0.4625 [0.0322]***
ROA		-0.0100 [0.0081]		-0.0011 [0.0013]
PTB		-0.0362 [0.0225]		-0.0079 [0.0036]**
Leverage		0.1414 [0.4179]		0.1922 [0.1106]*
Capex		0.0067 [0.0042]		-0.0017 [0.0007]**
SalesGrowth		0.0414 [0.0258]		0.0444 [0.0315]
GDP		0.0045 [0.0025]*		0.0032 [0.0018]*
GridCarbonIntensity		0.00016 [0.0000]**		0.00027 [0.00013]**
constant	-9.103 [-1.2679]***	-9.021 [1.1392]***	-4.341 [1.0231]***	-2.504 [0.7279]***
Firm fixed effects	No	No	Yes	Yes
Year fixed effects	No	No	Yes	Yes
Observations (firm-years)	2401	2401	2401	2401
Adj Adj R-squared	0.3271	0.3834	0.62341	0.6615

Notes: Robust standard errors clustered by firm and year in brackets; *** p<0.01, ** p<0.05, * p<0.10. Unit of analysis is a firm. All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix A. Post is a dummy variable equal to 1 in the period that the mandate is in effect (i.e. years 2013, 2014, 2015)

Table 3.9: Estimates of the Effect of Mandatory Carbon Reporting on Emissions Productivity

Sample: UK firms and matched non-UK firms

Dependent Variable: *EmissionsProductivity*

Post=2013, 2014, 2015	(1)	(2)	(3)	(4)
Treat x Post	15,670	12,431	11,834	12,754
	[7,342]**	[6,982]*	[4,273]**	[6,364]**
Post	1,829	5,928		
	[2,955]	[3,251]*		
Treat	1,002	2,280		
	[1,039]	[2,168]		
Assets		-4,259		13,915
		[2,048]**		[15,354]
ROA		475		-182
		[468]		[222]
PTB		3,385		162
		[3,882]		[521]
Leverage		-41,548		-71,974
		[31,619]		[46,232]
Capex		-783		-152
		[149]***		[268]
SalesGrowth		4,600		3,823
		[3274]		[2,374]
GDP		460		312
		[244]*		[253]
GridCarbonIntensity		18.92		15.94
		[9.182]**		[7.179]**
constant	-83,403	-154,264	-282,697	-248,021
	[1,312]***	[48,228]***	[322,629]	[359,271]
Firm fixed effects	No	No	Yes	Yes
Year fixed effects	No	No	Yes	Yes
Observations (firm-years)	2401	2401	2401	2401
# firms	342	342	342	342
Adj R-squared	0.25823	0.3022	0.6289	0.6384

Notes: Robust standard errors clustered by firm and year in brackets; *** p<0.01, ** p<0.05, * p<0.10. Unit of analysis is a firm. All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix A. Post is a dummy variable equal to 1 in the period that the mandate is in effect (i.e. years 2013, 2014, 2015).

Another concern is that firms are misrepresenting their emissions performance, resulting in the observed emissions reductions. Voluntary GHG disclosures need not be verified by a third-party auditor, and even under MCR, there is no requirement for emissions data to be externally verified. I separate the sample of voluntary disclosers into firms that receive assurance over GHG from at least 2011 onwards, and those that do not. There are 47 UK firms and 125 non-UK firms in my starting sample that receive assurance over GHG.[23] I employ the same matching algorithm previously described, which yields 32 matched-pairs of treated and control firms that receive assurance over GHG, and 40 matched-pairs of treated and control firms that do not receive assurance over GHG. I estimate equation (1) using OLS and report the results in Table 3.10. Column 1 estimates the coefficient on $Treated_i \times Post_t$ for the matched sample of treated and control assurance firms, while Column 2 estimates the coefficient for the matched sample of treated and control non-assurance firms. The coefficients across both samples are statistically indistinguishable; the estimates suggest that MCR led assurance and non-assurance firms to reduce emissions by on average 11% and 10%, respectively. As such, the effect of MCR on emissions does not appear to be due to misrepresentation. Collectively, the results in Tables 2.8-2.10 present evidence consistent with firms responding to MCR through emissions reductions, rather than through scaled-back operations or misrepresentation.

[23] I obtain information pertaining to GHG verification from CDP responses and from environmental disclosures made in CSR reports and corporate websites. If I cannot find this information, I assume that the firm does not receive assurance over GHG.

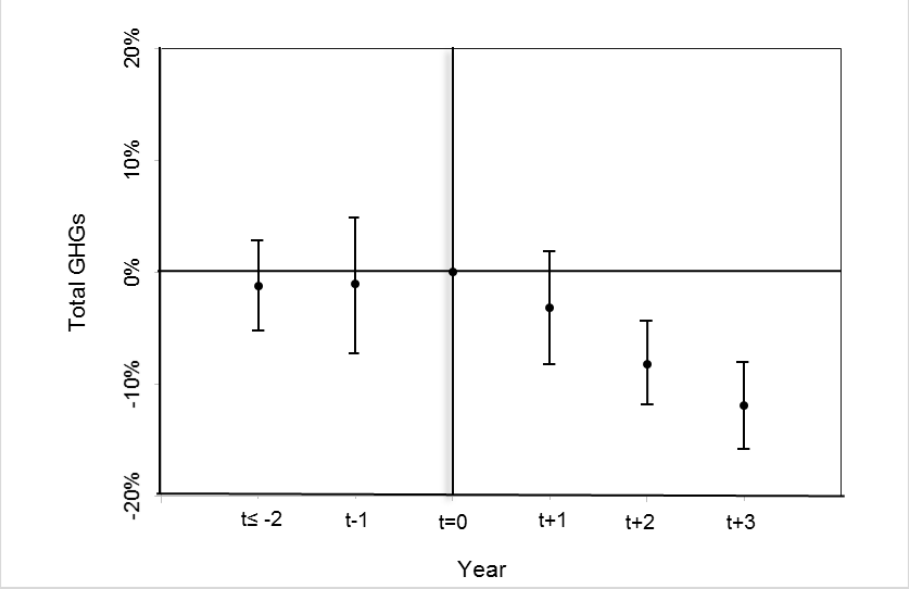
Table 3.10: Estimates of the Effect of Mandatory Carbon Reporting on Emissions for Assurance & Non-Assurance Firms

Post=2013, 2014, 2015	Sample: Assurance UK firms and matched controls (1)	Sample: Non-assurance UK firms and matched controls (2)
Treat x Post	-0.1109	-0.1044
	[0.0513]**	[0.0456]**
Assets	0.4476	0.6208
	[0.1328]***	[0.2266]***
ROA	-0.0012	-0.0023
	[0.0021]	[0.0036]
PTB	-0.0087	-0.0030
	[0.0059]	[0.0070]
Leverage	0.1993	0.2453
	[0.2627]	[0.3697]
Capex	-0.0021	-0.0025
	[0.0018]	[0.0048]
SalesGrowth	0.0583	0.0442
	[0.0293]**	[0.0236]*
GDP	0.0033	0.0042
	[0.0028]	[0.0019]**
GridCarbonIntensity	0.0002	0.0003
	[0.0001]**	[0.0001]**
constant	-2.525	-2.492
	[0.9581]***	[0.7302]***
Comparison of coefficients Treat x Post: Test for (1) > (2) Null hypothesis (1) = (2) P-value 0.582		
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Time-varying firm controls	Yes	Yes
Observations (firm-years)	434	527
# firms	64	80
Adj R-squared	0.6935	0.7174

Notes: Robust standard errors clustered by firm and year in brackets; *** p<0.01, ** p<0.05, * p<0.10. Unit of analysis is a firm. All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix A. Post is a dummy variable equal to 1 in the period that the mandate is in effect (i.e. years 2013, 2014, 2015)

Equation (1) uses a standard difference-in-differences framework where the treated firms are matched to firms unaffected by the mandate using propensity scores, described in the previous section. The key assumption of this model is that the mean outcome changes in the control group are a valid estimate of the counterfactual mean outcome changes in the treatment group, if the regulation had not occurred. This assumption is impossible to test directly, which is a limitation of all studies using this type of design (Imbens and Wooldrige 2009). However, in Figure 3.2, I plot the treatment effects in event time to test if pre-period trends in the outcome variables are similar between treat and control firms. I find that the coefficients of *Treat x Post* are close to zero and statistically insignificant in the time periods leading up to mandatory carbon disclosure, suggesting that the parallel trends assumption is satisfied. Moreover, GHG decrease sharply after mandatory carbon reporting regulation is in effect. Figure 3.3 (Figure 3.4) provides graphical evidence that the trends in GHG (emissions productivity) in the pre-MCR period are parallel for the two groups, suggesting that the groups should follow the same paths over time in the absence of the regulation.

Figure 3.2: Greenhouse Gas Emissions in Event Time



This figure reports the coefficients of OLS regressions estimating the effect of mandatory carbon reporting on greenhouse gas emissions in event time. I estimate model (1) but replace the *Treat x Post*

variable with 6 separate dummy variables, each marking one time period relative to the year the mandate comes into effect (t=0). I omit the indicator for year t=0 which serves as the benchmark period with an OLS coefficient and standard error of zero. Vertical lines represent 95% confidence intervals for the point estimates in each time period.

Figure 3.3: Difference in means of GHG emissions levels

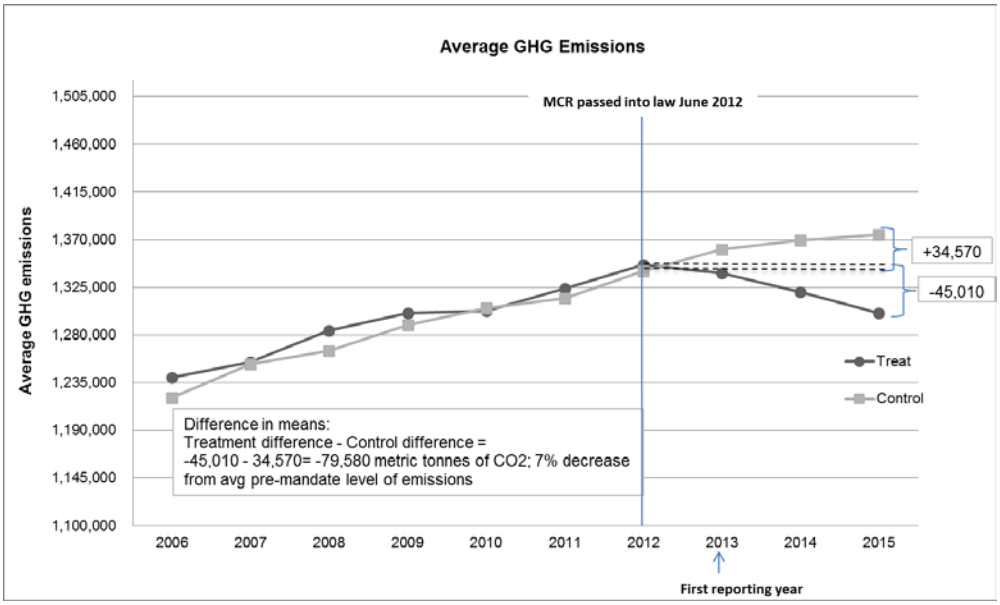
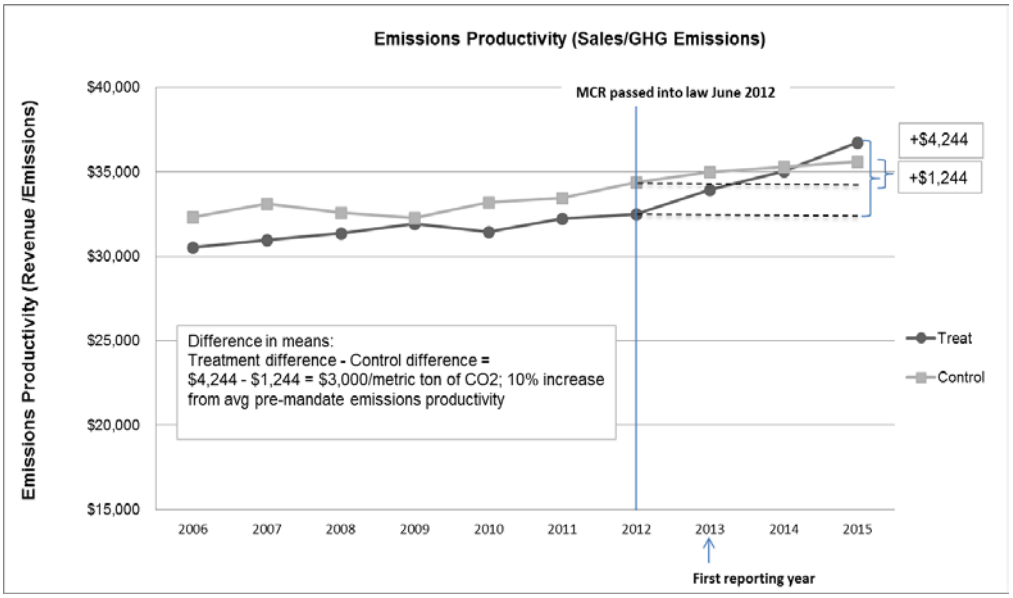


Figure 3.4: Difference in means of GHG emissions productivity



3.4.2 Robustness

I perform several robustness tests for the main results reported in Table 3.8. First, to determine whether my results are sensitive to the matching approach employed, I perform a number of alternative matches under the first heading of Appendix Table VII. I use the full unmatched sample and find that my results are robust (coef= -0.0921, t-stat=3.12). I match UK firms to German firms only (coef= -0.1144, t-stat=2.15) and to Dutch firms only (coef= -0.0883, t-stat=1.74) to address concerns that non-EU firms are driving the results, and find that my results hold. I also use coarsened exact matching (Iacus, King and Porro 2011) and estimate a CEM-weighted OLS regression, finding similar results (coef= -0.1002, t-stat=2.30). I also verify the robustness of the results to three alternative matching approaches (untabulated): (i) one-to-many matching with weighted OLS; (2) reshuffling the observations prior to matching to ensure the matching without replacement approach is not sensitive to the order of observations; (3) matching with replacement. Inferences are unchanged.

Under the second heading of Appendix Table VII, I use an alternative definition for my dependent variable. The log-linear model of the amount of GHG could overstate the treatment effect because the log specification captures the skewed distribution of GHG. Thus, I use untransformed GHG as the dependent variable and continue to find results similar to that of the main analysis.

A remaining threat to identification is that omitted UK-specific factors are driving the changes in GHG, because matching is done between UK and non-UK firms. To address this concern, I obtain emissions data from 2011-2015 for all of the private and public UK companies that are covered by the Carbon Reduction Commitment Energy Efficient Scheme (CRC), which is a mandatory scheme designed to improve energy use among large organizations that are not part of the EU ETS. Covered organizations must monitor and report their emissions and buy allowances

for emitted carbon. Given that MCR only affects listed UK firms, this data allows me to test whether, relative to non-listed (i.e. private) UK firms unaffected by MCR, listed UK firms changed GHG in response to MCR. However, there are limitations to this test. MCR requires disclosure of both Scope 1 and 2 emissions, whereas CRC emissions do not cover all Scope 1 emissions. Thus, changes to CRC emissions may not be representative of a firm's total Scope 1 and 2 GHG changes. Another limitation is that private and public companies often face different incentives relating to emissions, which may result in other factors driving treatment effects (Tomar, 2016). In addition, if there are spillover-effects and private firms expect mandatory carbon reporting to affect them at some later point, they may react, resulting in a violation of the Stable Unit Treatment Value Assumption (SUTVA), which assumes that a firm's outcomes are unaffected by another firm's treatment assignment. In spite of these limitations, the advantage of a within-UK test is that UK firms under the CRC are not covered by any other emissions or efficiency incentives, and all UK CRC firms – regardless of listing status – are treated similarly under the CRC. The data I have provides unique firm identifiers and classifies firms by listing status, but is anonymized; thus, I match public UK firms to private UK firms on pre-period CRC emissions (i.e. emissions in years 2011) using propensity scores. This process yields 197 matched firm-pairs. Appendix Table VIII presents OLS coefficient estimates of model (1), where I alter the use of lagged dependent variables (in columns 1 and 3), and firm fixed effects (in column 4), as suggested by Angrist and Pischke (2009). The results suggest that the 'upper-bound' estimate on *Treat x Post* is -0.17 (significant at the 1% level) and the 'lower-bound' is -0.12 (significant at the 5% level), which are in-line with the baseline estimates in Table 3.8.

3.5 Channels

3.5.1 Channels from prior literature

My first set of results suggest that real effects are larger when disclosures relating to real outcomes are mandated, relative to when disclosures are made voluntarily. In this section, I examine why firms have incentives to change behavior under mandatory reporting.

Prior literature documents three channels through which disclosures affect real outcomes: increased monitoring (Cho 2015; Granja 2018), shaming (Rauter 2017) and information dissemination (Christensen, Floyd, Liu and Maffett 2017). These papers show that, armed with disclosures that are new, more granular or more readily available, contracting stakeholders can discipline the reporting firm. The commonality across these prior studies is that, following mandated reporting, disclosure provided by the reporting firm improves or is more accessible.

My setting allows me to test among these alternative mechanisms. To reiterate, in contrast to prior studies, I ensure that GHG disclosure provided voluntarily by UK firms prior to mandatory carbon reporting is identical to GHG disclosure provided after the regulation comes into effect, to ensure that any documented real effects do not reflect changes to the presentation and understandability of GHG data.[24] My approach in testing among alternative mechanisms is to identify instances where the mechanisms from prior literature *already* existed when disclosures were made voluntarily, and test whether real effects are present after disclosures are mandated. If so, this suggests the likely presence of another mechanism.

First, I identify a subset of firms that already face high levels of monitoring over GHG before mandatory carbon reporting. Since increased monitoring of GHG in the post-regulation period could result in greater efforts by firms to improve emissions performance, I classify firms

[24] This contrasts settings in which the information provided in the pre-regulation period is difficult to aggregate or understand, compared to the information provided in the post-regulation period (e.g., Christensen et al. 2017; Delmas et al. 2010, Rauter 2017).

that are covered by the European Union Emissions Trading Scheme (EU ETS) before and after MCR as *Monitored*.[25] EU ETS firms are the highest emitters in the EU and, relative to non-EU ETS firms, face considerable scrutiny and monitoring over their emissions by regulators, public interest groups and NGOs (Ellerman & Joskow, 2008). As such, one would not expect to observe significant performance improvements among EU ETS firms in response to MCR if increased monitoring over GHG is the primary mechanism.

Second, I identify a subsample of firms that are likely to be the target of environmental NGO campaigns, even prior to MCR (Rauter 2017). Consistent with Rauter (2017)'s findings that NGO campaigns commonly focus on large and well-known companies, I classify *Large* firms as those with above-median market capitalization in 2012 (one year prior to MCR).

Third, MCR requires GHG data to be reported within annual financial reports, whereas the disclosures were often provided outside of financial reports prior to MCR (such as in standalone CSR reports or on portions of corporate websites dedicated to environmental information). Financial reports are widely disseminated, suggesting that investors, financial analysts and the news media that follow UK filings are more likely to become aware of GHG after MCR, even if they are not explicitly looking for them.[26] My results could therefore be driven by increased dissemination of GHG data, consistent with the finding in Christensen et al. (2017). If this is the case, I would not expect the difference-in-differences estimator to be significant for the subset of

[25] I identify EU ETS firms by using the fields in the CDP and Bloomberg that identify firms that are covered by the EU ETS. I further confirm whether the firm is part of the EU ETS by searching for the firm in the EU ETS registry accessible through the EU ETS website: https://ec.europa.eu/clima/policies/ets/registry_en#tab-0-1

[26] See also Delmas et al. (2010) which finds a change in the fuel mix percentages of a large electric utility firm in the U.S. following a mandatory disclosure program, and suggests that consumers increase demand for fuels perceived as environmentally favorable and decrease demand for fuels perceived as environmentally unfavorable when they are given simple, easily interpretable and directly provided information. Also, Bae, Wilcoxen and Popp (2010) document that the Toxics Release Inventory program in the United States was only effective at reducing health risks when information was communicated more effectively to the public, suggesting that the manner in which information is communicated to those who can pressure firms is important for improving behavior.

firms disclosing GHG within financial reports *prior* to MCR. I classify firms that disclose GHG within financial reports (including annual reports and other regulatory filings) prior to MCR as the *Disclose in Financial Reports* subsample.[27] I also identify an intersecting subset of firms that are *Monitored*, *Large* and *Disclose in Financial Reports.*

Table 3.11 presents the coefficients of OLS regressions estimating model (1) using the various subsamples. Across all subsamples, the coefficient on *Treat x Post* is negative and statistically significant, and the economic magnitudes are similar to those of the baseline results in Table 2.8. These results show that firms already facing high monitoring, NGO attention and GHG data dissemination prior to disclosure regulation change behavior in response to MCR. This suggests the possible existence of an alternative mechanism.

[27] I use responses to the CDP survey question "Have you published information about your company's GHG performance for this reporting year in places other than in your CDP response?" to identify firms that report emissions in financial reports.

Table 3.11: Tests of Mechanisms

Sample: UK firms and matched non-UK firms	Highly Monitored Firms	Large Firms	Disclose in Financial Reports	Overlap of all 3
Post=2013, 2014, 2015	(1)	(2)	(3)	(4)
Treat x Post	-0.0732	-0.1290	-0.0870	-0.0845
	[0.0432]*	[0.0549]**	[0.0393]**	[0.0326]**
Assets	0.4470	0.4165	0.4476	0.4141
	[0.1405]***	[0.1172]***	[0.1328]***	[0.1239]***
ROA	-0.0012	-0.0015	-0.0012	-0.0016
	[0.0021]	[0.0021]	[0.0021]	[0.0022]
PTB	-0.0090	-0.0088	-0.0087	-0.0088
	[0.0061]	[0.0057]	[0.0059]	[0.0060]
Leverage	0.2712	0.2427	0.1993	0.3155
	[0.2759]	[0.2624]	[0.2627]	[0.2767]
Capex	-0.0019	-0.0020	-0.0021	-0.0018
	[0.0018]	[0.0018]	[0.0018]	[0.0018]
SalesGrowth	0.0636	0.0311	0.0383	0.0274
	[0.0588]	[0.0285]	[0.0329]	[0.0191]
constant	-2.364	-3.162	-2.525	-3.045
	[3.157]	[2.673]	[3.001]	[2.808]
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Time-varying firm controls	Yes	Yes	Yes	Yes
Observations (firm-years)	1045	1134	1085	976
# firms	140	170	144	116
# Treat	70	85	72	58
# Controls	70	85	72	58
Adj R-squared	0.6005	0.6664	0.6743	0.6597

Notes: Robust standard errors clustered by firm and year in brackets; *** p<0.01, ** p<0.05, * p<0.10. Unit of analysis is a firm. All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix A.Post is a dummy variable equal to 1 in the period that the mandate is in effect (i.e. years 2013, 2014, 2015). *Highly Monitored Firms* consists of firms regulated by the European Union Emissions Trading Scheme (EU ETS). *Large Firms* are firms with above-median Total Assets in year t (i.e. 2012). *Disclose in Financial Report* firms are firms that voluntarily report GHG prior the MCR. Column (4) reports coefficient estimates for the intersection of the subsamples in Columns (1)-(3).

3.5.2 Reputational and regulatory concerns

Having established the possible existence of an alternative mechanism, I use field data to uncover the specific channel. I conduct loosely-structured interviews with 17 managers from UK firms in my sample who have knowledge of, or responsibility for, GHG in their organizations. I learn from these interviews that mandatory carbon reporting (1) increases the decision-usefulness of GHG information and heightens the attention paid to GHG by investors and other stakeholders, and (2) signals more likely future government action over GHG to impose direct costs or penalties on GHG (e,g., taxation, fines, penalties). Though no such regulations have passed since MCR, one interviewee said: "Taxation will happen …a few years of consistent reporting is needed before [the government] can do this, and the EU ETS is not working. That's no secret." Others expressed similar sentiments.

I test whether these perceptions are representative of the broader set of firms affected by MCR. The CDP asks survey respondents (since 2011) to list and assess the risks to their business that are driven by climate change. I examine whether firms affected by MCR perceive: (1) a greater number of regulatory and reputational climate change risks to their business, (2) a larger magnitude of impact from regulatory and reputational climate change risks to their business, (3) a shorter timeframe that regulatory and reputational climate change risks would materialize, and (4) a higher likelihood that regulatory and reputational climate change risks would occur, in response to MCR, relative to unaffected firms. The CDP annual questionnaire has over 200 questions and it is rare for firms to respond to all questions in each year; rather than use a difference-in-differences design, I perform a changes analysis which is described below.

In the first test, I examine whether treatment firms list a higher number of regulation-related and reputation-related climate change risks to their business in the post-period relative to the pre-

period and relative to control firms. I compute the number of (regulatory) [reputational] climate change risks listed by each firm in my sample in a given year, and then average this over the pre-period (survey responses submitted from 2011 until June 2012) and the post-period (survey responses submitted after June 2012 until 2014).[28] I name this variable *NumberRisks* (mean= 3.46, sd= 3.19) [mean=1.45, sd=2.21]. I compute the difference between *NumberRisks* from the post-period to the pre-period for each firm, to obtain the dependent variable *ΔNumberRisks*.

In the second test, I examine whether treatment firms perceive a greater magnitude of impact from (regulatory) [reputational] climate change risks in response to MCR. I convert the responses for "Magnitude of Impact" for each regulation risk into numerical form (i.e., Unknown=0, Low=1, Low-Med=2, Med=3, Med-High=4, High=5) and I average this for each firm-year, and then average this over the pre- and post- periods. I name this variable *MagnitudeImpact* (mean=2.50, sd= 1.46) [mean=3.34, sd=2.13]. I compute the difference between *MagnitudeImpact* from the post-period to the pre-period for each firm, to obtain the dependent variable *ΔMagnitudeImpact*.

In the third test, I examine whether treatment firms perceive a shorter timeframe for when (regulation) [reputation]-related risks driven by climate change will materialize, in response to MCR. I convert the responses for "Timeframe" for each regulation risk into numerical form (i.e., "Unknown"=0, "Current"=1, "Up to 1 year"=2, "1-3 years"=3, "1-5 years"=4, "3-6 years"=5, "6-10 years"=6, ">6 years"=7 and ">10 years"=8) and I average this for each firm-year, and then average this over the pre- and post- periods. I name this variable *Timeframe* (mean= 3.56, sd=

[28] I am grateful to the CDP for providing me with the "Submitted Date" for the surveys in years 2011 and 2012 (a field which became available as part of the dataset in 2013).

1.82) [mean=3.41, sd=2.56]. I compute the difference between *Timeframe* from the post-period to the pre-period for each firm, to obtain the dependent variable *ΔTimeframe*.

In the fourth test, I examine whether treatment firms perceive a greater likelihood of realizing (regulation) [reputation]-related climate change risks, in response to MCR. I convert the responses for "Likelihood" for each risk into numerical form (i.e., "Unknown"=0, "Exceptionally unlikely"=1, "Very Unlikely"=2, "Unlikely"=3, "About as likely as not"=4, "More likely than not"=5, "Likely"=6, "Very Likely"=7, "Virtually certain"=8) and I average this for each firm-year, and then average this over the pre- and post- periods. I name this variable *Likelihood* (mean= 4.87, sd= 1.34) [mean=4.99, sd=2.11]. I compute the difference between *Likelihood* from the post-period to the pre-period for each firm, to obtain the dependent variable *ΔLikelihood*.

Appendix Figures B1 and B2 plot the mean risk perceptions for matched treated and control firms in event time. The pre-period trends (and levels) are very similar. Moreover, the graphical representations demonstrate sharp changes in treatment firms' perceptions once MCR comes into effect.

Table 3.12 Panel A presents the results from regressing an indicator for *Treated* on the measures for perceptions of climate change regulatory risks. In Column (1), the number of regulation-related climate change risks to their business perceived by managers increased for treatment firms relative to control firms from the pre- to the post- period (coefficient on *Treated*= 0.54, significant at the 5% level) but this result is no longer significant in Column (2) after controlling for changes in financial variables over the same period (i.e., change in total assets, profitability, price-to-book ratio, leverage, capital intensity and sales growth). Columns (3) and (4) do not provide evidence consistent with managers assessing a greater magnitude of impact to their business from regulation-related climate change risks in response to MCR. However, Columns (5)

and (6) present strong evidence of managers assessing a shorter timeframe, or more imminent realizations of risks relating to climate change regulation, in response to MCR. The coefficients of -0.49 and -0.53 (significant at the 1% level) on *Treated* represent around 26-29% of the standard deviation of *Timeframe*. Columns (7) and (8) present evidence consistent with managers assessing a greater likelihood of facing regulation-related climate change risks to their business in response to MCR, and the coefficients of 0.23 and 0.24 (significant at the 5% level) represent approximately 17-18% of the standard deviation of *Likelihood*.

Panel B of Table 3.12 presents results for the effect of MCR on managerial perceptions of reputational risks posed by climate change to their business. I do not find that managers perceive a greater number of reputational risks as a result of mandated carbon reporting. However, I find evidence consistent with managers perceiving a greater impact from reputational risks, a shorter timeframe that reputational risks will materialize, and a greater likelihood that reputational risks will materialize, in the years following MCR and relative to matched control firms. The coefficient estimates in the specifications that include control variables suggest that the increase in risk perceptions represent 28-41% of the standard deviation of the dependent variables.

These results provide evidence consistent with managers perceiving regulation and reputation risks relating to climate change as being more imminent and more likely to impact their business, because of mandated GHG reporting. Managers also perceive greater impact to their business of reputational risks driven by climate change owing to disclosure regulation.

Table 3.12: Estimates of the Effect of Mandatory Carbon Reporting on Perceptions of Climate Change Business Risks

Panel A: Regulatory Risks

Sample: UK firms and matched non-UK firms

	Δ Number Risks (1)	Δ Number Risks (2)	Δ Magnitude Impact (3)	Δ Magnitude Impact (4)	Δ Timeframe (5)	Δ Timeframe (6)	Δ Likelihood (7)	Δ Likelihood (8)
Treat	0.5440	0.2387	0.0667	0.0289	-0.4928	-0.5300	0.2344	0.2408
	[0.2572]**	[0.4922]	[0.0768]	[0.0918]	[0.1226]***	[0.1501]***	[0.1010]**	[0.1190]**
Δ Assets		-0.3935		0.0389		-0.0792		-0.0223
		[0.1973]**		[0.0370]		[0.0592]		[0.0420]
Δ ROA		0.0246		0.0025		-0.0177		0.0117
		[0.0205]		[0.0075]		[0.0114]		[0.0102]
Δ PTB		0.0649		-0.0191		0.0541		-0.0169
		[0.0820]		[0.0202]		[0.0286]*		[0.0275]
Δ Leverage		-0.6828		-0.0789		-0.8652		0.0556
		[0.8652]		[0.2918]		[0.3708]**		[0.4523]
Δ Capex		0.0034		0.0008		0.0014		0.0012
		[0.0077]		[0.0024]		[0.0027]		[0.0038]
Δ SalesGrowth		-0.0007		0.0041		0.0072		0.0099
		[0.0134]		[0.0052]		[0.0066]		[0.0057]*
Δ GDP		0.0081		0.0050		0.0052		0.0043
		[0.0042]*		[0.0049]		[0.0025]**		[0.0046]
Δ GridCarbonIntensity		0.0002		0.0001		0.0003		0.0003
		[0.0000]**		[0.0000]**		[0.0001]**		[0.0001]**
constant	-0.4357	8.0630	-0.0845	-0.8818	-0.1148	1.8573	-0.2440	0.1757
	[0.1525]***	[4.1364]*	[0.0513]	[0.7722]	[0.0766]	[1.2292]	[0.0799]***	[0.8882]
Observations	342	342	342	342	342	342	342	342
Adj R-squared	0.0346	0.0611	0.0281	0.0283	0.0451	0.0674	0.0388	0.0402

Table 3.12: Estimates of the Effect of Mandatory Carbon Reporting on Perceptions of Climate Change Business Risks (Continued)

Panel B: Reputation Risks

Sample: UK firms and matched non-UK firms

Dependent Variable:	Δ Number Risks	Δ Number Risks	Δ Magnitude Impact	Δ Magnitude Impact	Δ Timeframe	Δ Timeframe	Δ Likelihood	Δ Likelihood
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treat	0.1930	0.1648	0.6683	0.5902	-0.8053	-0.7701	0.9034	0.8651
	[0.3722]	[0.2201]	[0.260]***	[0.2626]**	[0.4140]*	[0.3599]**	[0.4875]*	[0.4451]*
Δ Assets		-0.2292		0.0103		-0.1382		-0.0492
		[0.2638]		[0.0661]		[0.0482]***		[0.0264]*
Δ ROA		0.0108		0.0078		-0.0103		-0.0019
		[0.0338]		[0.0081]		[0.0155]		[0.0279]
Δ PTB		0.0293		0.0732		0.0692		-0.0123
		[0.0109]***		[0.0645]		[0.0534]*		[0.0120]
Δ Leverage		-0.3742		0.0823		-0.0842		0.0289
		[0.2531]		[0.0641]		[0.0762]		[0.0123]**
Δ Capex		-0.0060		0.0042		0.0049		0.0292
		[0.0111]		[0.0080]		[0.0044]		[0.0164]*
Δ SalesGrowth		0.0027		-0.0074		0.0043		0.0147
		[0.0369]		[0.0082]		[0.0051]		[0.0087]*
Δ GDP		0.0041		0.0073		0.0052		0.0033
		[0.0022]*		[0.0036]**		[0.0030]*		[0.0019]*
Δ GridCarbonIntensity		0.0004		0.0002		0.0001		0.0003
		[0.0002]**		[0.0000]**		[0.0000]**		[0.0001]**

Table 3.12: Estimates of the Effect of Mandatory Carbon Reporting on Perceptions of Climate Change Business Risks (Continued)

constant	-1.4732	2.4753	-0.1949	-0.2649	0.1883	0.5923	0.6271	-0.9342
	[1.4568]	[2.2851]	[0.0882]**	[0.1374]*	[0.1203]	[0.6192]	[0.7812]	[0.5050]*
Observations	342	342	342	342	342	342	342	342
Adj R-squared	0.0313	0.0586	0.0592	0.0721	0.0364	0.0782	0.0388	0.0507

Notes: Robust standard errors clustered by firm in brackets; *** p<0.01, ** p<0.05, * p<0.10. Unit of analysis is a firm. All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix A. The control variables are measured as the change from the pre- and post- periods. ΔNumber Risks, ΔMagnitudeImpact, ΔTimeframe and ΔLikelihood are firm-specific measures of the change in the responses that managers provide to CDP survey questions regarding how risks relating to climate change regulation will affect their business (Panel A), and how climate-related developments will impact their reputation (Panel B) from the post-period (survey responses submitted from July 2012 until Dec 2014) relative to the pre-period (survey responses submitted from 2011 to June 2012).

3.5.2.1 Robustness

The result that firms affected by MCR perceive greater regulatory and reputational risks to their business may be due to a general increase in climate change risk perceptions that is unrelated to disclosure regulation. To address this concern, I use responses to questions about physical risks of climate change as a pseudo-test, because disclosure regulation should not affect managers' expectations about the physical risks of climate change and how such risks will affect their business. Under the third heading in Appendix VII, I do not find evidence consistent with MCR affecting managers' perceptions of physical climate change risks.

3.6 Effects of MCR on incentives and investment

My analysis so far suggests that disclosure regulation results in GHG reductions among firms that were already voluntarily disclosing. However, *how* real outcomes are achieved is unanswered. In this section, I provide insights into the internal organizational changes that led to GHG reductions.

3.6.1 Incentives

Prior literature finds that performance measures should be linked to the organization's strategy, in order to generate the desired outcomes and behaviors (e.g. Van der Stede, Chow and Lin, 2006; Campbell, Datar, Kulp and Narayanan 2002; Kaplan and Norton 2001; Simons 1987). I test whether, in response to MCR, firms change incentive systems in order to incentivize behaviors that reduce GHG. To examine this, I use answers to the CDP survey question "Who is entitled to receive incentives relating to the management of climate change issues?" for the treat and control firms in my sample. This question has been asked since 2011 and I follow an approach that is similar to Ioannou, Li & Serafeim (2015) in coding the responses as follows: 0="None" or

"N/A"; 1="All employees"; 2="Environmental Positions"; 3="Managers"; 4="C-suite"; 5="Board". Since firms provide multiple responses in a year if there are multiple organizational levels that receive incentives, I create a measure equal to the most senior employee level that receives incentives to manage climate change issues, for each firm-year. I then take the mean of this measure for the pre-period (years 2011 and 2012) and the post-period (years 2013 and 2014), and name this variable *HighestEmplIncentive* (mean= 2.37, sd=0.74). The change in *HighestEmplIncentive* from the pre- to post- period for each firm is my dependent variable, *ΔHighestEmplIncentive*.

Table 3.13 report OLS coefficients from regressing an indicator for *Treated* on Δ*HighestEmplIncentive*. Columns (1) and (2) report evidence consistent with affected firms providing incentives to higher-ranking employees for the management of climate change issues, in response to MCR. The estimates on *Treated* of 0.19 and 0.21 (significant at the 1% and 5% levels, respectively) represent approximately 26-28% of the standard deviation in *HighestEmplIncentive*. The result imply that disclosure regulation elevates the importance of the issue of climate change within the firm, leading to changes in control systems that incentivize GHG reductions and assign accountability over GHG to more senior-level employees.

Table 3.13: Estimates of the Effect of Mandatory Carbon Reporting on Incentives to Manage Climate Change Issues

Sample: UK firms and matched non-UK firms Dependent Variable: Δ Employee Level Incentives	(1)	(2)
Treat	0.1925 [.0637]***	0.2088 [.0936]**
Δ Assets		0.0316 [0.0268]
Δ ROA		-0.0059 [0.0117]
Δ PTB		0.0085 [0.0293]
Δ Leverage		-0.0811 [0.2456]
Δ Capex		0.0024 [0.0024]
Δ SalesGrowth		-0.0092 [0.0047]*
Δ GDP		0.0038 [0.0029]
Δ GridCarbonIntensity		0.0003 [0.0000]***
constant	-0.0517 [0.0465]	-0.6972 [0.5850]
Observations	218	218
# Treat	109	109
# Controls	109	109
Adj R-squared	0.0623	0.0792

Notes: Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.10. Unit of analysis is a firm. All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix A. The control variables are measued as the change from the pre- and post- periods. *Δ Employee Level Incentives* is a firm-specific measure of the change in the average employee level that receives incentives to manage climate change issues, from the post-period (survey responses submitted from July 2012 to Dec 2014) relative to the pre-period (survey responses submitted from 2011 until June 2012).

3.6.2 Investment

My final analysis seeks to understand whether firms made specific investments to achieve emissions reductions. Addressing this question allows me to more clearly ascertain whether affected firms took action to reduce GHG, rather than a spurious or correlated omitted variable

driving the results. Further, this analysis provides, to my knowledge, the first empirical evidence on what organizational actions, efforts, programs and investments yield emissions reductions.

To address this question, I search for narrative environmental disclosures in the annual reports of the 171 firms in my treatment sample for fiscal year 2013, the first year that MCR is in effect. I perform a keyword search for "emissions", "carbon" and "greenhouse" to locate these disclosures and then create indicator variables to categorize the emissions-reduction efforts described by the firms in their narratives disclosures. The emissions-reduction efforts described fall broadly into six categories: *EnergyEfficiencyInvestment* (mean=0.39, sd=0.49), which includes purchasing energy efficiency technology and upgrading to more efficient machinery and equipment; *EmployeeBehaviorChange* (mean=0.34, sd=0.47) which includes heating and lighting switch-off campaigns and encouraging employees to reduce travel and use video-conferencing; *GreenEnergy* (mean=0.27, sd=0.49) which includes renewable energy installations and green power purchases; *GreenBuilding* (mean=0.25, sd=0.45) which constitutes building retrofits and designs to reduce energy consumption; *CarbonTracking* (mean=0.33, sd=0.60) which involves making investments to monitor and report on emissions levels and performance; and *Disposals* (mean=0.05, sd=0.20) which involves disposing, selling or otherwise divesting from business segments, divisions or subsidiaries. I also create a variable called *NoDisclosure* (mean=0.12, sd=0.42) for the firms for which I could not find a description of the actions or efforts to reduce emissions.

Table 3.14 tabulates coefficient estimates from regressing each of the aforementioned indicators on the percentage change in *TotalGHG* and *EmissionsProductivity*, controlling for financial variables and sector fixed effects. The dependent variables *%ΔTotalGHG* and *%ΔEmissionsProductivity* are firm-specific measures of the percentage change in *Total GHG* and

Emissions Productivity, respectively, from 2012 to 2015. Column (1) of Table 2.14 shows a negative and statistically significant relationship between *%ΔTotalGHG* and *GreenBldg, GreenEnergy* and *BehaviorChangeEmployees*, with the coefficient estimates suggesting that, all else equal, disclosing emissions-reducing actions relating to green building investments, green energy procurement and behavioral changes among employees, is associated with emissions reductions of 16%, 16% and 10% on average, respectively, in the years following MCR, representing approximately 20-31% of the standard deviation of *%ΔTotalGHG*. The estimates in Column (2) suggest that disclosing energy efficiency investments (*EnergyEfficiencyInvestment),* green building investments, green energy procurement and behavioral changes, is associated with emissions productivity improvements of 24%, 18%, 14% and 15% on average, respectively, in the years following MCR, representing approximately 21-33% of the standard deviation of *%ΔEmissionsProductivity.* In contrast, I do not find that disclosures relating to *CarbonTracking* or *Disposals* are associated with subsequent emissions reductions or emissions productivity improvements. The insignificant coefficient on *NoDisclosure* suggests that firms that do not disclose their efforts or actions to reduce emissions, do not subsequently decrease emissions and do not increase emissions productivity.

A caveat to this analysis is that I am using management disclosures to proxy for real actions. While it is possible that managers withhold disclosure of their actions, efforts or investments relating to emissions reductions, doing so would bias against detecting a relation between my measures and subsequent emissions reductions. If such disclosures consist of cheap-talk, there would also be low ability to detect a relation between disclosed actions and subsequent emissions reductions. However, since the narrative disclosures are unaudited, I cannot know for certain whether the disclosures are truthful. Firms could misrepresent their efforts; for example,

stating they are procuring green energy when they are in fact making green building retrofits, although I do not have an *ex-ante* prediction as to why this would be. Annual reports in the UK are certified by the Chief Executive Officer and the Chief Financial Officer, providing at least some comfort around the credibility of the narrative disclosures used to construct my proxies for emissions-reducing efforts. Nevertheless, these caveats should be taken into account when interpreting the results in this section.

Table 3.14: How firms reduce emissions levels and improve emissions productivity

Dependent Variable:	%Δ TotalGHG	%Δ EmissionsProductivity
	(1)	(2)
NoDisclosure	-1.20	4.02
	[13.04]	[12.27]
EnergyEfficiencyInvestment	-8.95	33.63
	[7.72]	[11.89]***
BehaviorChangeEmployees	-10.21	15.21
	[4.11]**	[5.84]**
GreenEnergy	-16.14	17.85
	[5.72]***	[6.01]***
GreenBuilding	-16.16	24.92
	[7.56]**	[9.50]**
CarbonTracking	10.04	5.19
	[6.32]	[4.93]
Disposals	-8.97	6.07
	[9.67]	[6.22]
Δ Assets	0.05	0.04
	[0.07]	[0.06]
Δ ROA	-0.50	0.99
	[0.38]	[0.37]**
Δ PTB	0.05	-0.13
	[0.03]*	[0.03]***
Δ Leverage	18.88	30.09
	[34.49]	[39.51]
Δ Capex	0.26	0.23
	[0.25]	[0.21]
Δ SalesGrowth	0.41	1.19
	[0.38]	[0.48]**
Δ GDP	0.24	0.14
	[0.20]	[0.21]
Δ GridCarbonIntensity	0.04	0.03
	[0.01]**	[0.02]*
constant	16.75	29.90
	[9.28]*	[26.89]
Sector Fixed Effects	YES	YES
Observations	171	171
# firms	171	171
Adj R-squared	0.22	0.27

Notes: Robust standard errors clustered by sector in brackets; *** p<0.01, ** p<0.05, * p<0.10. Unit of analysis is a firm. All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix A. The control variables are measured as the change from 2012 to 2015. *%Δ TotalGHG* and *%ΔEmissionsProductivity* are firm-specific measures of the percentage change in greenhouse gas emissions levels and intensity, respectively, from 2012 to 2015.

3.7 Conclusion

I study whether real effects are larger after disclosure is mandated, among firms voluntarily disclosing prior to the regulation. Prior literature documents that when regulation requires firms to provide new information, higher quality information, or more accessible information, stakeholder pressure arising from increased awareness results in behavioral changes (e.g. Cho 2015; Christensen et al. 2017). Whether disclosure regulation yields behavioral changes when firms are already being transparent, however, is less understood.

My setting to examine this question is the United Kingdom, which passed a law requiring all UK-incorporated publicly traded companies to report GHG for their entire organization in their annual reports starting in 2013 (Mandatory Carbon Reporting, or MCR). A key feature of this setting is that a number of firms affected by MCR voluntarily report GHG prior to the regulation in the same way required by the regulation. This allows me to isolate and estimate the magnitude of the incremental real effects among already-disclosing firms.

My analysis offers two key findings. First, I document that mandated reporting generates incremental real effects among firms that are already being transparent ('already-disclosers'). Specifically, I find that firms voluntarily disclosing GHG prior to MCR reduce GHG in the post-MCR period, relative to firms that also voluntarily disclose GHG but are unaffected by disclosure regulation. As support for this result, I document a positive relation between GHG reductions and investments in green building retrofits, employee energy-saving efforts, and clean energy purchases. My second key finding is that disclosure regulation increases the importance of the issue that the regulation relates to. Reducing GHG becomes a more important issue owing to (1) reputational concerns, consistent with regulation providing more decision-useful information to investors and other stakeholders, and (2) regulatory concerns, consistent with 'soft' disclosure

regulation foreshadowing future 'hard' regulation (e.g. carbon tax). Consistent with MCR elevating the importance of GHG, I show that higher-ranking employees in already-disclosing firms have monetary incentives tied to GHG following MCR relative to unaffected firms.

Overall, my findings suggest that GHG become a more important issue within the firm when GHG disclosure is mandated, owing to increased expected reputational and regulatory costs associated with GHG. This in turn affects the control systems and organizational processes relating to GHG and results in behavioral changes that are stronger than those produced under voluntary reporting.

My findings suggest that disclosure regulation can have behavioral implications that do not exist when disclosure is provided voluntarily, a finding that should be relevant to a number of mandatory reporting settings. For example, the introduction of disclosed internal control weaknesses after the Sarbanes-Oxley Act may have heightened attention to reporting quality and increased the risk of further related regulation, incentivizing firms to improve internal controls. New disclosure requirements for state-regulated banks (Granja 2018) may have led state banks to take action to reduce their failure rates to pre-empt the costly regulation faced by national banks, and mandated disclosure of subsidiary locations (Dyreng et al. 2015) may have led firms to reduce their use of subsidiaries in tax haven countries to prevent further government action such as increased cash repatriation tax rates.

Prior literature in accounting examines the economic consequences of disclosure regulation, documenting benefits as well as costs and unintended consequences (see Leuz and Wysocki 2017 for a review). My paper contributes to this literature by presenting a previously undocumented consequence: disclosure regulation increases the expected reputational costs associated with the mandated information and signals future (potentially more costly) regulatory

actions.[29] I contribute to the real effects literature by documenting that disclosure regulation can produce real effects among already-disclosing firms that do not change their transparency.

My findings have implications for regulations mandating corporate disclosure of environmental and social responsibility data, given the recent trend towards employing such policies (Leuz and Wysocki, 2017). Though thousands of companies around the world voluntarily disclose environmental and social data, my findings suggest that mandated reporting can be an effective tool to change firm behavior, even among voluntary disclosers.[30] My findings should also be informative in the current context of US securities law, where the SEC's Investor Advisory Committee has recently proposed mandatory disclosure of environmental and social responsibility data as part of the SEC's revision of Regulation S-K, despite 81% of firms on the S&P 500 Index reporting this information voluntarily.[31]

It is important to note the limitations of my results. First, the main threat to identification is a violation of the parallel-trends assumption. Although I find evidence consistent with the validity of the assumption, and I control for concurrent changes that I think are likely to affect my analyses (e.g., excluding firms affected by concurrent regulatory initiatives), it is possible that there are other changes that I have not identified. If such changes differentially affect the emissions of UK and non-UK firms, they could confound my inferences. Second, my focus on this regulatory

[29] This latter result supports Maxwell, Lyon and Hackett (2002) whose model implies that the increased threat of government regulation induces firms to reduce pollution emissions, and is also consistent with Tietenberg (1998) who asserts that regulated reporting likely precedes other pollution control policy steps.

[30] U.S. policymakers are considering implementing mandatory reporting requirements for climate change risks and political contributions, and the SEC has already adopted rules relating to regulating disclosures of conflict minerals, health and safety violations at mine sites, and payments to foreign governments for the extraction of natural resources. The European Commission recently mandated new nonfinancial disclosures related to firms' ESG performance in the European Union.

[31] Letter from SEC Investor Advisory Committee to SEC Division of Corporation Finance (June 15, 2016). Accessed from: https://www.sec.gov/spotlight/investor-advisory-committee-2012/iac-approved-letter-reg-sk-comment-letter-062016.pdf

setting in the UK could limit the generalizability of my findings. Third, although a reduction in GHG likely has benefits, I am unable to speak to all of the potential costs and benefits of this regulation, and thus cannot conclude about the overall welfare effects. Further, my results speak only to the incremental effects of mandated reporting over voluntary reporting, and I cannot compare the effects of more stringent forms of regulation – such as imposing explicit costs on GHG – or the effects other regulatory mechanisms and tools on GHG. A comparison of the effectiveness of various regulatory approaches is undoubtedly an interesting topic for future research.

Chapter 4

Market Reaction to Mandatory Nonfinancial Disclosure

4.1 Introduction

This study investigates the equity market reaction to events associated with the adoption of mandatory nonfinancial disclosure: specifically, passage of European Union (EU) Directive 2014/95 on disclosure of nonfinancial information. This directive requires affected companies to disclose in their annual management report information on policies, risks, and outcomes regarding environmental matters, social and employee aspects, respect for human rights, anticorruption issues, and diversity in their board of directors. It applies to firms (i) listed on EU exchanges or with significant operations in the EU, (ii) defined as "large" (i.e., with 500 or more employees), or (iii) designated as public-interest entities by EU Member States due to their activities, size, or number of employees. The directive is intended to provide investors and other stakeholders with a more comprehensive picture of firm performance.

We assess the equity market's perception of the anticipated cross-sectional effects associated with this directive by investigating the market reaction to three key events affecting its adoption. We focus on equity holder reactions to this disclosure regulation for several reasons. First, regulators identify equity investors as key constituents in the formulation of the regulation.[1] Second, the investment community is a major source of demand for more nonfinancial firm disclosures (Eccles, et al. 2011; Cheng et al. 2014). For example, investors of some $60 trillion have committed to integrate nonfinancial data into their investment decisions, and assess

[1] For example: "investors' access to nonfinancial information is a step towards reaching the milestone of having in place by 2020 market and policy incentives rewarding business investments in efficiency under the roadmap to a resource-efficient Europe." See European Commission: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0095

companies' nonfinancial performance when voting in annual general meetings. Third, new corporate reporting practices, such as integrated reporting practiced by an increasing number of firms around the world, have defined the primary audience of this information to be investors (Serafeim 2015). Finally, as the regulation has not yet been enforced, we are unable to study how consumers and other stakeholders respond to the directive. In contrast, studying equity market reactions to key regulatory events allows us to infer equity holder expectations about the future costs and benefits associated with these disclosures. An inherent caveat is that we are unable to measure the potential social welfare of this regulation (which may or may not be reflected in stock returns), which may be justified from the social planner's perspective.

Following prior research employing event study methodology to market-wide regulation (e.g., Zhang 2007; Armstrong et al. 2010), our dependent variable is the firm's cumulative five-day abnormal stock return, centered on the event dates, and aggregated across the three sample events. To isolate market effects attributable to the directive, we adjust our treatment firms' stock return with a comparable return for control firms, identified via a matching algorithm using the same country and sector, and having the nearest congruence in size and price-to-book ratio. Thus, we measure abnormal returns as the difference between the stock return for the treatment firm and that for the matched control firm. Our final sample includes a cross-section of firms from around the world that are covered by the directive. Our study focuses on three events, all of which are assessed as *ex ante* increasing the likelihood that this regulation mandating increased non-financial disclosures will be adopted.

We make three key predictions. First, we predict an on average negative market reaction to the sample events, as we assume that prior to the mandate investors expect firms are making optimal disclosure decisions, such that equilibrium conditions generate the expectation of costs

exceeding benefits for firms affected by the disclosure regulation. There is tension in this expectation: if investors perceive firms as making suboptimal decisions due to agency conflicts or other off-equilibrium behavior, this suggests an overall positive stock price reaction. Second, we derive a cross-sectional prediction that the market reaction to these events is less negative for firms having stronger pre-directive non-financial performance. The three non-financial pillars considered in our analysis correspond to those promulgated under the proposed regulation: environmental, social, and governance (collectively referred to as ESG). We predict that the passage of the regulation will lead investors to place higher weight on ESG information in decision-making, due to expectations of: increased enforcement of existing environmental and social regulations; increased future regulations; and/or product and labor market participants being more likely to make decisions based on corporate ESG performance. Specifically, we predict that investors will perceive that firms with strong pre-regulation ESG performance will incur a competitive advantage since weak ESG firms will either incur higher costs of maintaining weak ESG performance (for example, through penalties) or higher costs to improve ESG performance. Third, we derive a second cross-sectional prediction that stock price reactions will be less negative for firms with stronger pre-directive non-financial disclosure. This prediction derives from expected costs from increased disclosure that are likely to affect low disclosure firms; these include proprietary and political costs of disclosure, and, to a lesser extent, direct costs to prepare and disseminate the disclosure.

Empirical results support each prediction. First, we document an average negative market reaction across the three sample events of –0.79%, or a loss equivalent to $79M of market capitalization, on average. However, this effect masks cross-sectional variation as the negative returns are concentrated in firms with weak ESG performance and disclosure: those with above-

median ESG performance and disclosure exhibit a positive abnormal return of 0.52%. This latter result is consistent with equity investors perceiving the expected costs associated with the directive to (on average) exceed the expected benefits, but also with the costs being concentrated in those firms with weaker pre-directive ESG performance and disclosure. Second, using regressions that include industry and country fixed effects, we document a less negative market reaction for firms exhibiting stronger pre-directive ESG performance (particularly in the areas of governance and environmental). Further analyses reveal this relation is accentuated for those firms having the most material ESG-related items: those with above-average risk exposure to ESG issues relative to other firms in their industries. Finally, we document less negative stock price reactions for firms exhibiting higher pre-directive ESG disclosure, suggesting that investors anticipate costs to exceed benefits for low disclosure firms. Further analyses reveal this relation is moderated by: (i) high R&D expenditures (proxying for expected proprietary costs), consistent with investor expectations of the mandate being more pronounced for low disclosure firms in constraining them to reveal information that will harm their competitiveness; and (ii) high industry-adjusted profitability (proxying for expected political costs), consistent with investor expectations of such firms being more likely targets for political action. We note the cross-sectional results are robust to: alternative benchmarking to define the dependent variable of abnormal returns; alternative samples, such as including only EU-domiciled firms; inclusion of various firm-control variables; and a placebo test confirming that observed differences in market returns do not occur on non-event dates.

Finally, we note that an alternative explanation for the on average negative market returns is that the directive itself does not impose significant costs, but serves as signal of stringent future regulations (and thus generates a negative market reaction). We argue that this appears unlikely as a full explanation for the observed negative market reaction, due to our findings that the positive

association between pre-mandate ESG disclosure and stock returns is moderated by proxies for proprietary costs and political costs of disclosure. These latter results are consistent with investors anticipating direct costs (in the form of proprietary and political costs) of this disclosure directive.

This study makes three contributions. First, prior research provides evidence that *voluntary* nonfinancial disclosure has economic effects (Dhaliwal et al. 2011; Cheng et al. 2014) and that investors seek nonfinancial data (Eccles et al. 2011). Other research finds that regulations in particular countries, which mandated the disclosure of nonfinancial information, led to increases in the quantity and quality of nonfinancial information (Ioannou and Serafeim 2015).[2] Related, recent research documents a negative stock price reaction around the passage of regulation mandating firms to make expenditures on social responsibility activities (Manchiraju and Rajgopal 2016). We build on these papers by documenting equity market perceptions that mandating the provision of nonfinancial information leads to net benefits (costs) for firms that have made investments to improve (that have weak) ESG-related performance and disclosures. Second, our study provides evidence that price reactions to proposed nonfinancial regulation depend on the anticipated wealth transfers across firms or across stakeholders. Prior research documents negative stock price reactions among firms more likely to transfer wealth from shareholders to bondholders (e.g., Cornett et al. 1996). We document more negative stock price reactions among firms with poor nonfinancial performance, consistent with the enhanced visibility of this latter performance leading equity holders of these firms to anticipate future wealth transfers to other firms with stronger ESG performance and/or other stakeholders (e.g., labor, governments and regulators). Finally, the differential contribution of the firm's ESG performance and ESG disclosure to the

[2] We also build on papers examining how nonfinancial measures and performance relate to other aspects of the firm's information environment (e.g., earnings quality in Kim et al. 2012) or operating decisions (e.g., corporate tax avoidance in Hoi et al. 2013).

observed market reaction in our study provides first evidence (to our knowledge) of the distinctness of these constructs, which is important for future research in this area.

Section 2 provides the background and hypothesis development. Section 3 presents our research design. Section 4 describes our sample selection and descriptive statistics. Section 5 presents our primary results. Section 6 concludes.

4.2 Background and hypothesis development

4.2.1 Background

In recent decades, the number of firms disclosing nonfinancial information has grown significantly. For example, companies issuing sustainability or CSR reports has increased from less than 50 in 1995 to more than 6,000 in 2015 (Ioannou and Serafeim 2015). Contributing factors include pressure from stakeholder groups on companies to disclose information on the environmental and social impact of their operations, as well as the related governance procedures (Delmas and Toffel 2008; Reid and Toffel 2009).

In addition, there has been increased investor interest in nonfinancial data (Eccles et al. 2011). For example, heightened government regulation around environmental issues has been shown to contribute significantly to increased non-regulated disclosure of environmental liabilities (Barth, McNichols, and Wilson 1997). Similarly, investor and regulatory concerns around environmental issues are associated with increased narratives for environmental disclosures (Neu, Warsame, and Pedwell 1998). Prior research also documents a positive relation between environmental performance and environmental disclosure consistent with broader predictions of voluntary disclosure theory; it further finds that firms with unfavorable prior year media coverage are more likely to make soft claims of environmental commitments, which are not readily verifiable, consistent with socio-political theories that stress the importance of organizational

legitimacy (Clarkson et al. 2008). Finally, prior literature also documents that firms with superior ESG performance have better access to finance (Cheng et al. 2014), and firms issuing sustainability reports a lower cost of capital (Dhaliwal et al. 2011; El Ghoul et al. 2011).

Most of the preceding research is built on firms' voluntary disclosure practices; in contrast, more recently several mandatory nonfinancial disclosure regulations have emerged. Ioannou and Serafeim (2015) finds that firms in four countries (China, Denmark, Malaysia, and South Africa) not only increase disclosure, but also seek assurance of those disclosures and adopt reporting guidelines that increase comparability of disclosed information. Other research reveals that mandatory disclosure programs have forced companies to improve their operating performance relating to the environment (Delmas, Montes-Sancho, and Shimshack 2010), food and water safety (Bennear and Olmstead 2008; Jin and Leslie 2003), surgical outcomes (Kolstad 2013) and patient health outcomes (Dranove et al. 2003).

While these latter studies focus on the real effects of nonfinancial disclosure regulation, our study examines investor perceptions of the expected costs and benefits of regulations mandating such nonfinancial disclosures. In addition, the regulation we study requires broad nonfinancial disclosures versus the more targeted (and typically industry-specific) disclosures that are the focus of prior literature. Thus, the broader application of our studied regulation increases the generalizability of our findings.

4.2.2 Hypothesis development

The mandated disclosure of nonfinancial information can have a number of effects on the equity prices of affected firms. We first discuss the expected "on average" effect: that is, the absolute effect of the regulation on the population of affected firms. We then discuss the cross-

sectional effect, conditional on key firm characteristics we predict will lead to observable variation in the market reaction.

Regarding the on average effect, the mandated disclosure can lead to both costs and benefits from an equity investor standpoint. Broadly, investors may expect three major types of benefits. First, the mandated disclosures can increase information relevant for valuation purposes (i.e., informational benefits); this can improve the prediction of firms' future performance (i.e., expected cash flows) and/or clearer expectations of firms' inherent risks, and thus reduce firms' cost of capital through lower information risk (Easley and O'Hara 2004). Second, the mandated disclosures can increase the effectiveness of monitoring, such as the assessment of environmental performance. Third, these mandatory disclosures could lead firms to improve their operational efficiency, such as through reduced energy consumption, improved product quality, or better employee recruitment. In contrast, investors may expect major sources of costs. The first includes direct costs of preparing, disseminating, and assuring the new information; however, such costs have been argued to be fairly minimal to most firms.[3] Thus, we view two other costs as more central: proprietary costs (whether the regulation mandates disclosure of information expected to be harmful to a firm's competitiveness); and political costs (whether the mandated disclosures allow governments, regulators, and non-governmental interest groups to pressure firms to invest in projects perceived as negative net present values to shareholders) (Jensen and Meckling 1978; Watts and Zimmermann 1978; Healy and Palepu, 2001). This latter includes both potential increased enforcement of existing regulation, as well as potential additional future regulation.

[3] An EU impact assessment study indicates that "the cost of a full mandatory reporting obligation could therefore be roughly estimated in a range varying between €33,000 and €604,000 per year per company," with the actual number being a function of the company's size. The seemingly limited materiality of these costs, relative to the scale of the affected firms, suggests they are unlikely a primary driver of observed negative market reaction to this regulation. See http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52013SC0127.

If investors expect firms are making optimal ESG disclosure and performance choices prior to the mandate, equilibrium conditions would generate the prediction that the costs of the disclosure mandate will outweigh the benefits. Consistent with this perspective, we make the following hypothesis:

H_1: There is a negative stock price reaction to events increasing the likelihood of mandated nonfinancial disclosure.

However, investors may perceive that firms are making suboptimal decisions due to agency conflicts or other off-equilibrium behavior; such conditions would lead to an overall positive stock price reaction.

We next turn to our two cross-sectional predictions; both build on the assumption that the above expected benefits and costs can vary based on firms' current ESG performance and disclosure. The first prediction suggests that observed market reactions will vary by firms that have shown themselves to be stronger versus weaker in terms of *ESG performance*.[4] The mandatory disclosure regulation has been characterized both as a failure and an historic milestone in moving the business sector to improve its ESG performance. The regulation requires companies to broadly "disclose in their management report relevant and useful information on their policies, main risks, and outcomes relating to at least environmental matters, social and employee aspects, respect for human rights, anticorruption and bribery issues, and diversity in their board of directors" (see Appendix IX for details). However, critics note that the regulation does not require *specific* reporting guidelines, suggesting significant flexibility in what companies will be required to report in terms of both Key Performance Indicators and narrative information; nor does it require the assurance of the reported information, raising concerns about the information's reliability.

[4] We thank several political figures and institutional investors for useful discussion relating to parts of this section.

At the same time, proponents consider the regulation to be an historic success by providing a clear signal that European governments will reward (disadvantage) companies with good (bad) ESG performance. As Richard Howitt, MEP European Parliament Rapporteur on Corporate Social Responsibility puts it: "At one level, today's vote is a pathetic rubber-stamping of a deal already done. At another it is a landmark decision in the quest for corporate accountability over many decades." The opposition by a segment of the business community suggests that the passage of this regulation is an important event for business. For example, in 2011 a letter rejecting the disclosure regulation proposal was written by the German government—copy and pasted word-for-word from a letter written by the German Business Association fewer than 24 hours before.[5] In addition, interference by UK Prime Minister David Cameron limited the regulation, reducing its scope from 18,000 to 6,000 European firms. Finally, opposition was raised by EUROCHAMBRES (the Association of European Chambers of Commerce and Industry, which represents a European network of 2,000 regional and local Chambers): their letter requesting comments indicated their opposition to the new rule, and alternatively lobbied to continue a voluntary disclosure regime. These examples highlight the considerable interest in this regulation, and strongly suggest its expected material effects on business.

Governments can affect competitive dynamics related to ESG issues both directly using non-market mechanisms, and indirectly using market mechanisms. First, they can enact regulations that increase taxes on polluting activities (such as the emission of greenhouse gases), fines on violations of employee and product safety procedures, prosecutions for human rights violations, and stricter enforcement of anti-bribery laws. Second, they can gradually force (more) companies to disclose (more) information to allow market participants to make different decisions.

[5] See https://www.theguardian.com/sustainable-business/eu-non-financial-reporting-how-richard-howitt

Thus, this regulation will force non-disclosing firms to disclose information for the first time, and likely push those firms already voluntarily-disclosing to provide additional information (Ioannou and Serafeim, 2015). If such disclosures raise awareness about a firm's ESG performance, this could affect consumers (e.g., to buy products from firms with good ESG performance), employees (e.g., to seek employment at firms with good ESG performance), and investors (e.g., to allocate capital to firms with good ESG performance). Even among firms already disclosing ESG information, governments can enhance the salience and perceived importance of ESG information through mandatory reporting, making it more likely to be used in decision-making. Governments can also signal—through disclosure regulation—increased likelihood of future ESG regulations that are more substantive and extensive (e.g., pollution taxes).[6] Anticipating that both market and non-market mechanisms will affect a company's ability to compete in labor, product and capital markets investors will likely penalize firms with poor ESG performance.

Studies provide evidence that (some) market participants make decisions as a function of firms' ESG performance. In a product market setting, Hainmueller and Hiscox (2012a) conducts a field experiment with Gap Inc.; the paper finds that denim jean labels with information about a program to reduce water pollution in manufacturing increased sales by 8% for female shoppers, but had no discernable impact on sales for men or outlet shoppers. A second field experiment in 111 Banana Republic outlet stores finds that labels with fair labor standards lead to higher sales of more expensive women's clothing, but has no impact on sales of lower-priced items (Hainmueller and Hiscox, 2012b). In a labor market setting, Turban and Greening (1997) finds a positive

[6] For example, Australia, Sweden and California all mandated disclosure of greenhouse gas emissions prior to enacting regulation to tax these emissions. Australia mandated greenhouse gas emissions reporting in 2008 for large corporations, followed by a carbon tax in 2012; Japan mandated emissions reporting in 2006 and launched a cap-and-trade scheme in 2010; and the state of California mandated emissions reporting for large emitters in 2009, and a cap-and-trade scheme ensued in 2013.

association between the firms' ESG measures and the participant-given scores of attractiveness as an employer, suggesting firms with more positive ratings may have competitive advantages over firms with lower ratings, because they attract more applicants. Further, a recent study used a startup firm to randomly assign social responsibility treatments to nearly 600 recruits in two online labor marketplaces (Burbano 2016), documenting that receiving information about a company's social responsibility led to reduced salary requirements for a job, and also increased workers motivation. In a capital market setting, Cheng, Ioannou and Serafeim (2014) examines how ESG performance can reduce firms' capital constraints. Using a sample of over 750 firms over 2000–2009, the paper finds that firms with better ESG performance face lower capital constraints. Dhaliwal et al. (2011) finds that firms initiating ESG reporting experienced a decrease in their cost of equity capital, if they had strong ESG performance. Collectively, these studies provide evidence consistent with an increasing number of stakeholders making decisions based on ESG data.

In summary, the passage of the regulation could lead investors to increase the weight on ESG information, due to expectations of: increased enforcement of existing ESG-related regulations; increased future regulations; or product and labor market participants being more likely to make decisions based on corporate ESG performance. Under these conditions, firms with strong ESG performance will incur a competitive advantage because peers with weak ESG performance will either have a higher cost of maintaining weak ESG performance (e.g., from penalties), or incur costs to shift from weak to strong ESG performance. Thus, investors will price these anticipated competitive effects, generating a positive (negative) stock price reaction for those with strong (weak) ESG performance. Accordingly, we predict a positive association between

stock returns around announcements related to the regulation and investors' assessments of firms' existing ESG performance.[7]

H_{2a}: Stock price reactions to events increasing the likelihood of mandated nonfinancial disclosure are positively associated with ESG performance ratings.

Our second cross-sectional prediction is that investors will react to the announcement of the regulation as a function of firms' pre-regulation *ESG disclosures*. As discussed above, investors may expect three major types of benefits associated with the mandated disclosures: (i) mandated disclosures increasing information relevant for valuation purposes; (ii) increased effectiveness of monitoring, such as the assessment of environmental performance; and (iii) improved operational efficiency (such as through reduced energy consumption). Collectively, these expected benefits lead to a prediction of a negative relation between observed stock price reactions and ESG disclosure, as the expected benefits will be higher for firms with low ESG disclosure levels prior to the regulation.

In contrast, investors may expect three sources of costs. As previously discussed, the first includes direct costs of preparing and disseminating the new information; since these costs are expected to be minimal, however, we concentrate on the two other expected costs.[8] The first is proprietary costs: that is, the regulation can mandate disclosure of information that investors expect will be harmful to the firm's competitiveness. The second is political costs: that is, the mandated disclosures can allow governments, regulators, and non-governmental interest groups to pressure firms to invest in projects perceived as negative net present values to shareholders (e.g., Jensen

[7] As discussed later in our research design, we proxy for a firm's ESG performance using the ratings of a firm's ESG performance, which take into account their ESG strategies, policies, and implementation practices. Investors increasingly use such ratings to make investment decisions, evidenced by the growth of MSCI ESG research, the largest provider of ESG data, which includes 47 of the largest 50 asset managers as clients: https://www.msci.com/documents/10199/b3d456db-353a-4eea-8f08-c12447427940.

[8] See http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52013SC0127.

and Meckling 1978; Watts and Zimmermann 1978; Healy and Palepu, 2001). If equity investors anticipate that firms with low pre-directive ESG disclosure levels will incur higher proprietary costs and/or political costs as they disclose more information in response to the mandate, relative to their high disclosure peers, this leads to a prediction of a positive relation between stock price reactions and ESG disclosure.

Accordingly, we predict the relation between ESG disclosure and investor response to this mandated regulation will reflect equity investor perceptions of the netting of the above benefits and costs. As with H_1, under the assumption that firms are making optimal ESG disclosure and performance choices prior to the mandate, equilibrium conditions would generate the prediction that the costs of the disclosure mandate will outweigh the benefits. Since both costs and benefits are predicted to be negatively correlated with ESG pre-directive disclosure levels, we expect a positive association between disclosure levels and market reaction.

H_{2b}: Stock price reactions to events increasing the likelihood of mandated nonfinancial disclosure are positively associated with ESG disclosure scores.

4.3 Research design

4.3.1 Dependent variable

Our dependent variable is CAR_i, the cumulative abnormal return for firm i to events identified as affecting the likelihood of passage for the directive mandating increased nonfinancial disclosures in the EU. Several research design choices warrant discussion. First, consistent with prior research, we accumulate the return measure over days (–2, +2), where day 0 is the event date to capture any leakage prior to the events, and allow the equity markets to impound the anticipated effects into firms' stock prices. As our sample spans different equity markets, this also mitigates

differences in overall levels of market efficiency. Untabulated results are robust to alternatively using a 3-day (–1, +1) return.

Second, following prior research (e.g., Armstrong et al. 2010), our analyses focus on the *aggregation* of market reactions across the identified events. That is, we draw our inferences from assessment of the market reactions to all events aggregated, versus assessing each event individually, as the directive's passage resulted from a several year process. Thus, the equity market's reaction to any particular event and its effect on passage of the directive is conditional on the collective responses from previous events. In addition, aggregation reduces noise in any particular event (e.g., due to the release of other non-regulation information not fully removed from the observed market return). We further note that inclusion of irrelevant (exclusion of relevant) events from our sample increases noise (reduces power); both should bias against finding results consistent with our expectations.

Third, a critical design choice in event studies examining regulatory events affecting a large population of firms is the identification of an appropriate benchmark return to remove any non-regulatory news coinciding on the examined event dates, and thus derive a well-measured "abnormal" stock return. We assign each treatment firm to a corresponding control firm, matched on country, sector, market capitalization, and price-to-book ratio. Matching on country of domicile (sector) eliminates any market reaction that is attributable to country-specific (sector-specific) news coinciding but unrelated to our examined event dates. Matching on market capitalization and price-to-book controls for general effects attributable to similar firms' information environment, risk, or growth. Thus, for each event, we calculate the difference between the observed 5-day stock return for treatment firm *i* and that for the control firm *j*. For each firm *i*, *CAR* is the aggregation of these differences across the three identified sample events.

4.3.2 Cross-sectional analyses

We assess cross-sectional variation in the market response to the sample events using:

$$CAR_i = \alpha_1 + \beta_1 EnvScore_i + \beta_2 SocScore_i + \beta_3 GovScore_i + \beta_4 ESG\_Discl_i + \beta_5 Asset\_Mgr_i + \beta_6 Asset\_Owner_i + \beta_7 MTB\_Top_i + \beta_8 MCAP\_BotQ_i + \beta_9 Loss_i + \beta_{10} ADR_i + \beta_{11} EPS\_Volat_i + \beta_{12} Accruals_i + \text{Country Fixed Effects} + \text{Industry Fixed Effects} + \varepsilon_i \quad (1)$$

The dependent variable is CAR_i, the cumulative abnormal return for firm *i* aggregated across the three identified events affecting passage of the directive, as defined above.

We include the following four experimental variables (see Appendix X):

$EnvScore_i$ a MSCI variable that scores from 0–10 and measures the performance of firm *i* in relation to energy and climate change, natural resource consumption and waste management issues in 2013;

$SocScore_i$ a MSCI variable that scores from 0–10 and measures the performance of firm *i* in relation to human capital, health and safety, products and services, and supply chain issues in 2013;

$GovScore_i$ a MSCI variable that scores from 0–10 and measures the quality of firm *i*'s governance processes and structure in 2013;[9] and

[9] MSCI (Morgan Stanley Capital International) ESG Research provides environmental, social and governance ratings, screening and compliance tools to investors wanting to integrate nonfinancial factors into their investment processes. Analysts first determine the key nonfinancial issues affecting each industry that have the highest potential material impact on a company's financial performance, and then assign a weight. Using both company-disclosed and third-party sources, analysts score each key issue on a scale from 0 (worst) to 10 (best), evaluating the companies' relative risk exposure and performance to industry best practice. The weighted average of the key issue scores are aggregated to provide each company with an overall ESG performance score, as well as three disaggregated performance scores (one each for environmental, social, and governance).

ESG_Discl$_i$ a Bloomberg variable that scores from 0–100 and measures the quantity of ESG disclosures made by firm *i* in 2013.[10]

The regressions also include a number of firm-level control variables: *Asset_Mgr*; *Asset_Owner*; *MTB_TopQ*; *MCAP_BotQ*; *Loss*; *ADR*; *EPS_Volat*; and *Accruals* (all defined in Appendix X).[11] These variables control for firm characteristics, which could lead to variation in observed market reactions (including several identified to affect other outcome variables; e.g., Dhaliwal et al. 2011). Finally, the regressions include fixed effects for both country and industry to control for average differences in abnormal returns that may vary by either factor, with standard errors clustered by country.[12]

If investors expect higher net benefits for firms with higher levels of pre-directive ESG performance, then we predict positive coefficients on *EnvScore*, *SocScore*, and *GovScore*; this is

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Company ratings are updated on an annual cycle, with occasional individual ratings changes occurring when a company is involved in an extraordinary "ESG Event" with substantial negative social or environmental impact. MSCI ESG coverage has increased from 250 firms in 1999 to over 6,000 firms in 2014.

[10] Bloomberg calculates an ESG (environmental, social, and governance) Disclosure score to quantify a company's transparency in reporting ESG information. *Environmental* data relate to emissions, water, waste, energy and operational policies around environmental impact. Examples include the level of carbon emissions, the amount of waste discarded, and the amount of electricity used. *Social* data relate primarily to employees, products and impact on communities. Examples include employee turnover, percentage of women in workforce, and the number of suppliers audited based on social criteria. *Governance* data relate to board structure and function, firm's political involvement, and executive compensation, as collected from available corporate disclosures. The ESG score is based on 100 out of 219 raw data points that Bloomberg collects, and is weighted to emphasize the most commonly disclosed data fields; it is normalized to range from zero (for companies not disclosing any ESG data) to 100 (for those disclosing every data point collected). Bloomberg accounts for industry-specific disclosures by normalizing the final score based only on a selected set of fields applicable to the industry type. For example, "Total Power Generated" is counted into the disclosure score of utility companies only. Past research shows that these disclosure scores attract the most attention by investors (Eccles et al. 2011).

[11] We conduct two additional analyses. First, we directly control for the distance on employees, total assets and revenues between treatment and control firms in our cross-sectional models. Specifically, we assign each firm to a decile based on the distance between the employees of a treatment firm and its control (or total assets or revenues). Then we include three additional variables as controls in our models that represent the decile each firm falls into. Second, we include as an additional control variable the relative size of a firm's sales that are in the EU. For both analyses, results are unchanged to our primary specifications.

[12] All analyses are robust to double-clustering standard errors at the country and industry level (untabulated), with significance levels that are typically stronger than those tabulated.

our test of H_{2a}. If investors expect greater net benefits for firms with higher pre-directive ESG disclosure, we predict a positive coefficient on *ESG_Discl*; this is our test of H_{2b}.[13]

4.4 Events and sample selection

We assess three events during 2011–2014 as having a major effect on the likelihood of mandated nonfinancial reporting in the EU. We identify potential events by examining (i) press releases by the European Parliament (EP), European Commission (EC), and European Financial Reporting Advisory Group; and (ii) *Dow Jones News Retrieval* using "nonfinancial reporting", "social and environmental information", "EU nonfinancial legislation," and "EU mandatory nonfinancial disclosure." This yields 21 potential events (Appendix XI). We verify each event's timing, content, and directional effect on the likelihood of this mandated nonfinancial disclosure. We eliminate those confirming earlier events, and relating to broader ESG issues or voluntary nonfinancial disclosure, obtaining three sample events.[14]

The first event is April 16, 2013: the EC presented the Proposal for the Directive to amend existing accounting legislature with the intent of improving the disclosure of ESG matters by certain companies. Large companies (defined as 500+ employees, and either total assets of €20

[13] We note that our predictions relate to the *absolute* level of a firm's performance or disclosure, not its level relative to its industry. We follow this process, because industry benchmarking could add measurement error in our estimates as it would not be consistent with investor expectations. Consider the following example: a carbon tax regulation would affect a coal company with the best environmental performance (firm A) more than it would affect a technology firm with the worst environmental performance (firm B), since even the most environmentally-conscious coal company has higher carbon emissions than the least-environmentally conscious technology firm. However, industry-adjusting environmental performance would likely create the (incorrect) impression that firm A is less affected by the regulation than firm B.

[14] To confirm the robustness of our event selection, we conduct untabulated analyses replicating our primary cross-sectional tests using the 18 potential events (that is, the 21 potential events, less the three chosen for our sample). As expected, we fail to find significant market reactions using those 18 excluded events. We also examine the 18 excluded events individually; we find that only one exhibits any significant market reactions. This excluded event is February 17, 2014, and relates to a news release of how negotiations between the EU parliament and the Council may lead to a deal in the coming days on this directive. The event that we include among the three sample events (i.e., February 26, 2014) is when the deal actually occurs. The on average market reaction to this omitted event is negative, as expected given the other results in the paper (–0.0025, *t*-statistic = 2.57). All results are robust to including this event.

million+ or revenue of €40 million+) would be required to disclose relevant material ESG information in their annual reports. While this topic previously had been under discussion in the EU, this date marks the first clear commitment to require companies to disclose this information.[15] While this event focuses on the presentation (versus passage) of the Proposal, it occurs after considerable efforts to understand the need for the legislation, including stakeholder feedback and outlining the legislation's framework. Further, the EC rarely presents a Proposal without clear support for its adoption. The second event is February 26, 2014, when the European Council reached an agreement on the Proposal. The third event is April 15, 2014, when the EC adopted the Proposal.[16] Both latter events relate to the Proposal's adoption. We view all three events as increasing the likelihood of mandatory nonfinancial reporting adoption in the EU.[17]

Common to event studies, we examine whether particular non-directive related news is issued systematically across our three identified events, to mitigate concerns of confounds regarding observed market reactions. We search the US and European editions of the *Wall Street Journal*, as well as the US and European editions of Reuters, Bloomberg and the European edition of the *Financial Times*, for news unrelated to mandatory EU nonfinancial reporting during our event windows. We filter our search to include only headline listings, headline-only content and page-one stories. For our first event (April 16, 2013), the terrorist attacks at the Boston Marathon

[15] As stated in the Proposal for the Directive, it reflects the findings of two years' worth of consultations, dialogues and impact assessments that the Commission maintained with interested parties (e.g., preparers, users). Dialogues leading to this proposal include: (1) in 2011 and 2012, two public consultations on the disclosure of non-financial information by EU companies, with a majority of stakeholders supporting the need to improve the current legislative framework; (2) in 2011 and 2012, five Expert Group meetings with stakeholders and Member States' representatives to discuss details of the legislative proposal; and (3) in 2010 and 2011, two impact assessments by the Commission to identify areas of inadequate transparency of nonfinancial information.

[16] We note that the Proposal was officially passed into law on September 29, 2014, when it was adopted by the EU Member States in the European Council. We exclude this event, as it is a formality confirming the adoption vote on April 15, 2014, as reflected in the latter day's press release: "Following today's adoption by the European Parliament, the Council is expected to formally adopt the proposal in the coming weeks."

[17] We searched for, but failed to identify, events expected to decrease the likelihood of EU adoption of this regulation to allow investigation using events with opposite stock price reactions.

on April 15, 2013 likely negatively affected the returns of US firms. Further, on April 15, 2013 gold prices fell by 9% to a two-year low, which would negatively impact the returns of mining firms. For our third event (April 16, 2014), banks in the EU are likely negatively affected by the adoption of several banking reforms on April 16, 2014.[18]

For these global news events, we pay particular attention to the abnormal event returns and the appropriateness of the matched control firms. For the first event date with potentially confounding news of the Boston Marathon bombing, the average abnormal return (i.e., after matching) for the 605 US treatment firms is 0.31%. Similarly, the average abnormal return for European banks on the third event date with confounding news of the EU bank reform is –0.14%. Thus, the matching appears to mitigate any extreme non-regulatory market effects attributable to either the bombing or the banking reform.

Table 4.1 presents the sample selection. We begin with Bloomberg's 2014 population of 15,133 firms with ESG coverage, which provides the widest ESG disclosure coverage (Ioannou and Serafeim 2015). We exclude firms missing any event returns, and those domiciled in South Africa, yielding a sample of 12,162 available firms.[19] We separate this latter group into firms affected versus unaffected by the directive. Firms affected by the directive are identified using the Proposal for the Directive (Directive) on non-financial reporting, obtained from the EUR-Lex database. The Directive specifies that the new rules apply only to companies (both listed as well as other public-interest entities, such as banks and insurance companies) having over 500

[18] In addition, a bias could arise if (i) around the events firms release their earnings numbers and (ii) earnings surprises are systematically higher or lower for treatment firms compared to control firms. Accordingly, in untabulated results we include earnings surprise (*E_SURP*) for each firm, measured as the difference between the actual and last consensus forecast divided by absolute actual earnings in 2013 and 2014, and averaged across the two years. The coefficient on *E_SURP* is insignificant; further, all other results are unchanged.

[19] The publicly-traded South African firms focus on natural resource extraction, particularly gold. As previously discussed, gold prices and firm returns have high volatility on our events (e.g., average stock returns of –15%), suggesting likely confounds. For this reason, and due to a lack of viable within-country control firm matches, we exclude South African firms.

employees, operating in any of the 28 EU member countries via geographic segment data, and having either a balance sheet total of €20 million or revenues of €40 million. Using Worldscope data (supplemented with hand-collected data on employee count), we identify 2,417 firms falling under the scope of the Directive; this constitutes our treatment sample.[20]

The remaining 9,745 firms are the potential control firms. Treatment firms are matched to control firms by country (using headquarters) and Global Industry Classification Standard (GICS) sector, and then the closest match for total market capitalization and price-to-book ratio. We delete 364 treatment firms due to inability to obtain a matched control firm in the same country-sector pair; this leads to 2,053 firm-pairs for our univariate analyses. Additional data requirements lead to 1,249 firm pairs for the cross-sectional tests; missing ESG performance data is the primary cause for the reduced sample.

[20] We also estimate a regression discontinuity around the 500 employee threshold. However, most firms within the +/– 100 employee range around the 500 employee threshold are small, and thus are missing data on nonfinancial disclosure and nonfinancial performance levels. Thus, the sample is small for this analysis; and we fail to find results using this sample.

Table 4.1: Sample selection

Panel A. Identification of Available Firms

	# of firms
Bloomberg population (for 2014)	15,133
Less: South African firms	260
Less: missing required information for matching	2,711
Available firms	12,162

Panel B. Matching of Treatment and Control Firms

	Treatment	Control	Total
Available firms	2,417	9,745	12,162
Less: unmatched from propensity score matching	364	7,692	8,056
Matched Sample: Univariate Analysis	**2,053**	**2,053**	**4,106**
Country-Sector Matching			
Less: missing cross-sectional data information	804	804	1,608
Matched Sample: Cross-sectional Analysis	**1,249**	**1,249**	**2,498**

This table presents the sample selection process. Panel A presents the available firms. Panel B presents the derivation of the univariate and cross-sectional treatment and matched control firm samples. Matching is done on the basis of (i) country of domicile, (ii) Global Industry Classification Standard (GICS) sector; (iii) market capitalization; and (iv) price-to-book ratio.

Table 4.2 Panel A (B) presents the country (sector) distribution across six alternative samples: in Column (1), the full cross-sectional sample; in Column (2), the EU-only sample; in Column (3), using only firms with 50%+ of revenue in their primary industry; in Column (4), performing the match on country-industry (versus country-sector); in Column (5), performing the match with an additional constraint on size; and in Column (6), performing the match without replacement. The rationale for each sample is discussed at the appropriate analysis below. The country distributions vary as expected based on the indicated samples. The sector distributions do not vary considerably across various samples.

Table 4.2: Distribution of observations

Matching:	**Country-Sector**		**Country-Sector**		**Country-Sector**		**Country-Industry**		**Country-Sector**		**Country-Sector**	
Sample:	**Full Cross-Sectional (*N* = 1,249)**		**EU-Domiciled Only (*N* = 491)**		**50% Sales in Primary Industry (*N* = 793)**		**Full Cross-Sectional (*N* = 857)**		**Size Difference Minimization (*N* = 746)**		**Without Replacement (*N* = 390)**	
	Unique firms	**%**	**Unique firms**	**%**	**Unique Firms**	**%**	**Unique firms**	**%**	**Unique firms**	**%**	**Unique firms**	**%**
	(1)		(2)		(3)		(4)		(5)		(6)	
Panel A. Frequency by Country												
Australia	61	4.9	0	0.0	42	5.3	29	3.4	45	6.0	35	9.0
Austria	4	0.3	4	0.8	0	0.0	1	0.1	4	0.5	0	0.0
Belgium	3	0.2	3	0.6	2	0.3	0	0.0	1	0.1	1	0.3
Bermuda	3	0.2	0	0.0	1	0.1	3	0.4	3	0.4	2	0.5
Denmark	15	1.2	15	3.1	14	1.8	2	0.2	1	0.1	2	0.5
Finland	14	1.1	14	2.9	3	0.4	4	0.5	0	0.0	4	1.0
France	54	4.3	54	11.0	18	2.3	4	0.5	1	0.1	3	0.8
Germany	55	4.4	55	11.2	22	2.8	13	1.5	11	1.5	8	2.1
Ireland	1	0.1	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0
Italy	35	2.8	35	7.1	14	1.8	2	0.2	4	0.5	8	2.1
Japan	69	5.5	0	0.0	69	8.7	49	5.7	56	7.5	55	14.1
Netherlands	21	1.7	21	4.3	7	0.9	0	0.0	5	0.7	5	1.3
Norway	13	1.0	0	0.0	13	1.6	5	0.6	2	0.3	4	1.0
Portugal	1	0.1	1	0.2	1	0.1	0	0.0	0	0.0	0	0.0
Spain	10	0.8	10	2.0	3	0.4	0	0.0	4	0.5	1	0.3
Sweden	36	2.9	36	7.3	36	4.5	12	1.4	6	0.8	8	2.1
Switzerland	10	0.8	0	0.0	7	0.9	2	0.2	5	0.7	10	2.6
United Kingdom	242	19.4	242	49.3	107	13.5	175	20.4	97	13.0	37	9.5
United States	602	48.2	0	0.0	434	54.7	556	64.9	501	67.2	207	53.1
Total	**1,249**	**100.0**	**491**	**100.0**	**793**	**100.0**	**857**	**100.0**	**746**	**100.0**	**390**	**100.0**

Table 4.2: Distribution of observations (continued)

Matching:	Country-Sector		Country-Sector		Country-Sector		Country-Industry		Country-Sector		Country-Sector	
Sample:	Full Cross-Sectional (N = 1,249)		EU-Domiciled Only (N = 491)		50% Sales in Primary Industry (N = 793)		Full Cross-Sectional (N = 857)		Size Difference Minimization (N = 746)		Without Replacement (N = 390)	
	Unique firms	%	Unique firms	%	Unique Firms	%	Unique firms	%	Unique firms	%	Unique firms	%
	(1)		(2)		(3)		(4)		(5)		(6)	
Panel B. Frequency by Sector												
Energy	72	5.8	15	3.1	55	6.9	66	7.7	58	7.8	24	6.2
Materials	101	8.1	39	7.9	53	6.7	71	8.3	54	7.2	37	9.5
Industrials	223	17.9	123	25.1	107	13.5	141	16.5	117	15.7	56	14.4
Consumer Disc	243	19.5	115	23.4	175	22.1	160	18.7	117	15.7	68	17.4
Consumer Stap	77	6.2	29	5.9	50	6.3	37	4.3	22	3.0	20	5.1
Health Care	87	7.0	19	3.9	68	8.6	66	7.7	55	7.4	32	8.2
Financials	231	18.5	85	17.3	136	17.2	148	17.3	178	23.9	80	20.5
Info Technology	148	11.9	39	7.9	106	13.4	127	14.8	107	14.3	59	15.1
Telecomm Srvs	13	1.0	6	1.2	9	1.1	10	1.2	5	0.7	4	1.0
Utilities	54	4.3	21	4.3	34	4.3	31	3.6	33	4.4	10	2.6
Total	**1,249**	**100.0**	**491**	**100.0**	**793**	**100.0**	**857**	**100.0**	**746**	**100.0**	**390**	**100.0**

This table presents the frequency distribution of observations by country (Panel A) and sector (Panel B). Six alternative samples are presented: in Column (1), the country-sector matched sample used in the primary analysis; in Column (2), the country-sector matched sample restricted to EU-domiciled firms; in Column (3), the country-sector matched sample including only firms with > 50% of revenue in their primary industry; in Column (4), the country-industry (versus sector) matched sample; in Column (5), the country-sector matched sample with additional size difference minimization between the treatment and control firms; and in Column (6), the country-sector matched sample performed without replacement.

4.5 Empirical results

4.5.1 Univariate analyses

We first examine the overall market reaction to the three sample events to assess whether investors perceive mandated nonfinancial reporting as net costly, on average (i.e., H_1). Table 4.3 presents the cumulative five-day raw stock return, centered and aggregated across our three events. Panel A presents the mean raw event returns (*5Day_Ret3Events*), size (*MCap*) and growth (*MTB*) characteristics of our treatment and control samples. Columns (1)–(2) present comparisons before matching; Columns (3)–(5) after matching but before imposing cross-sectional data requirements; and Columns (6)–(8) after matching and imposing cross-sectional data requirements. Prior to matching, we observe similar negative average market reactions: –0.0256 (–0.0260) for the treatment (control) firms in Column (1). However, after matching, we find a more negative market reaction for the treatment firms: –0.0250 for the treatment firms in Column (3), –0.0171 for the control firms in Column (4), and a significantly negative difference of –0.0079 (i.e., 0.79%) in Column (5) (*t*-stat = 2.74).

We then assess the robustness of this univariate difference. First, similar results obtain using the matched firms for the cross-sectional analyses in Column (8) (–0.0071, *t*-stat = 2.60). Next, we find similar results using *t*-statistics based on the standard deviations of the portfolio returns over non-event periods (e.g., Pincus 1997). Specifically, we randomly select 300 non-overlapping non-event dates from the sample period 2013-2014 (excluding the 10 days before/after our three event dates). We then calculate the five-day abnormal returns centered on these 300 non-event dates, deflating our market reaction averages by the standard deviation of these non-event abnormal returns. We find a *t*-stat = 3.50 for the difference of –0.0079 in Column (5) (*t*-stat = 3.13 for –0.0071 in Column (8)).

We note that our treatment firms appear larger than the control firms, with average market capitalization before matching of $7,782 ($1,538) million for the treatment (control) firms. However, this difference is attenuated across the matches: in the cross-sectional sample, it is $12,556 ($9,279) million for the treatment (control) firms. Further, differences in market-to-book ratios are insignificant across the matched firms, providing some validation of the control firms as appropriate benchmarks. Nonetheless, Panel B presents results of regressing the cumulative 5-day raw event returns on treatment versus control firms, after explicitly *controlling* for market capitalization and the market-to-book ratio. We find a negative market reaction of –1.01% (coefficient for *Treatment* = –0.0101, *t*-stat = 2.68) under matching before imposing the cross-sectional data requirements, and –1.20% (*Treatment* = –0.0120, *t*-stat = 2.72) under matching after imposing the cross-sectional data requirements.

To better understand these average returns, Panel C presents market reactions, conditioned on firms' pre-regulation ESG performance and disclosure. Using the sample after matching (*N* = 2,053), we identify 576 treatment firms with both above median pre-regulation ESG performance (averaged across all three pillars) and above median pre-regulation ESG disclosure. This subsample reveals the most positive differenced return (0,0049, *t*-stat = 2.10). Similarly, for the subsample of 580 firms having both below median pre-regulation ESG performance and below median pre-regulation ESG disclosure, we observe the most negative differenced return (–0.0149, *t*-stat = 2.46). Similar results obtain in the second row using the sample for cross-sectional analysis (i.e., *N* = 1,249).

Panel D then presents market reactions for each sample event. For Event 1, the average return is significantly negative (–0.0076, *t*-stat = 4.72); for Event 2, it is insignificant (0.0018, *t*-stat = 1.33); and for Event 3, it is significantly negative (–0.0021, *t*-stat = 2.03). Following prior

event studies (e.g. Armstrong et al. 2010), individual events can yield insignificant returns. As such, we view the events collectively, and find a significantly negative return across the three events (–0.0079, *t*-stat = 2.74), translating into a loss of $79M of market value, on average.

Table 4.3: Univariate analyses (test of H1)

Panel A. Average Effects

	Before Matching		**After Matching**			**Cross-Sectional Analyses**		
	Treatment Sample (*N* = 2,417)	**Control Sample (*N* = 9,745)**	**Treatment Sample (*N* = 2,053)**	**Control Sample (*N* = 2,053)**	**Difference**	**Treatment Sample (*N* = 1,249)**	**Control Sample (*N* = 1,249)**	**Difference**
	(1)	(2)	(3)	(4)	(5) = (3) – (4)	(6)	(7)	(8) = (6) – (7)
5DayRet_3Events	–0.0256	–0.0260	–0.0250	–0.0171	**–0.0079 (2.74 **)**	–0.0222	–0.0151	**–0.0071 (2.60 **)**
MCap	7,782	1,538	10,009	6,777	**3,232 (2.51 **)**	12,556	9,279	**3,227 (2.77 **)**
MTB	2.16	1.73	2.46	2.38	**0.08 (1.13)**	2.67	2.59	**0.08 (1.02)**

Panel B. Average Effects Controlling for Market Capitalization and Market-to-Book (Dependent Variable = *5DayRet_3Events*)

Variable	**Predicted Sign**	**Sample After Matching** Coefficient (*t*-statistic)	**Sample for Cross-Sectional Analyses** Coefficient (*t*-statistic)
		(1)	(2)
Intercept	?	–0.0714 (1.80 *)	–0.0496 (2.35 **)
Treatment	**+ / –**	**–0.0101 (2.68 **)**	**–0.0120 (2.72 **)**
Log(MCap)	+ / –	0.0025 (1.72 *)	0.0040 (1.89 *)
MTB	+ / –	0.0010 (2.81 **)	0.0016 (4.93 ***)
N		4,106 (2,053 x 2)	2,498 (1,249 x 2)
Adj-R^2		0.020	0.015

Table 4.3: Univariate analyses (test of H1) (continued)

Panel C. Market Reaction to Cumulative Events Conditional on Firm Type

		Pre-Regulation ESG Performance and Disclosure					
		Low Performance – Low Disclosure			**High Performance – High Disclosure**		
		Treatment	Control	Difference	Treatment	Control	Difference
5DayRet_3Events	**Sample after matching (*N* = 2,053)**	–0.0268	–0.0119	–0.0149 (2.46) ** (*N* = 580)	–0.0250	–0.0299	0.0049 (2.10) ** (*N* = 576)
5DayRet_3Events	**Sample for cross-sectional analyses (*N* = 1,249)**	–0.0234	–0.0080	–0.0154 (2.78) ** (*N* = 353)	–0.0229	–0.0281	0.0052 (2.39) ** (*N* = 348)

Panel D. Market Reaction to Individual and Cumulative Events

Event Date	**Description**	**Predicted Sign**	**Raw Return Treatment Firms**	**Raw Return Matched Control Firms**	**Abnormal Return Treatment Firms**	***t*-statistic**
April 16 2013	The EU Commission presents the Proposal for the Directive to require certain firms to disclose relevant nonfinancial information	+ / –	–0.0309	–0.0233	–0.0076	(4.72) ***
February 26 2014	The European Parliament and the European Council reach an agreement on the Proposal	+ / –	0.0100	0.0083	0.0018	(1.33)
April 15 2014	The European Commission adopts the Proposal	+ / –	–0.0041	–0.0021	–0.0021	(2.03) **
	Cumulative Abnormal Return across Events				**–0.0079**	**(2.74) ** **

Table 4.3: Univariate analyses (test of H1) (continued)

This table presents univariate comparisons. Panel A presents average effects of the aggregated market reactions to events affecting passage of the mandated nonfinancial disclosures in the European Union. Columns (1)–(2) present the samples *prior to matching*. Columns (3)–(4) present the samples used in the *univariate analysis after matching*. Columns (6)–(7) present the samples used in the *cross-sectional analyses after matching*. Columns (5) and (8) present differences between the matched treatment and control samples. The first row presents the average cumulative 5-day raw return (*5DayRet_3Events*) to the aggregated three sample events. The second row presents the average market capitalization (*MCap*), in $ millions at fiscal year-end. The third row presents the average market-to-book ratio (*MTB*), as of the end of the fiscal year. All variables are winsorized at the 1- and 99-percent levels. Panel B presents average effects controlling for (i) *Log(MCap)* (the log of market capitalization in $ millions at fiscal year-end) and (ii) *MTB* (the market-to-book ratio as of the fiscal year-end). The experimental variable is *Treatment*, an indicator variable equal to one if the firm is required to adopt the mandated nonfinancial disclosures in the EU (i.e., a treatment firm), and zero otherwise (i.e., a control firm). Standard errors are clustered by country. Panel C presents five-day (–2, +2) adjusted returns, partitioned by firms having low pre-regulation ESG performance and disclosure, versus those having high pre-regulation ESG performance and disclosure. Panel D presents five-day (–2, +2) adjusted returns centered on the three events identified as increasing the likelihood of the EU adopting mandatory nonfinancial reporting requirements. *Raw Return Treatment Firms* is the average raw return to the 2,053 treatment firms affected by the mandate. *Raw Return Matched Control Firms* is the average raw return to the 2,053 control (i.e., unaffected) firms. *Abnormal Return Treatment Firms* is the difference between *Raw Return Treatment Firms* and *Raw Return Matched Control Firms*. *Predicted Sign* relates to predictions for the sign of *Abnormal Return Treatment Firms*. *Cumulative Abnormal Return across Events* is the aggregate individual event returns. *t-statistic* (in parentheses) assesses whether each of the individual event Abnormal Returns, as well as the Cumulative Abnormal Return, is significantly different from zero. ***, **, * represent significance for two-tailed tests of differences. *t*-statistics are shown in parentheses.

4.5.2 Cross-sectional analyses

Table 4.4 presents descriptive statistics (Panel A) and Pearson correlations (Panel B) for the treatment observations (N = 1,249). All variables are measured as of 2013 calendar year-end, and winsorized at the 1% and 99% levels.[21] Panel A reveals average environmental performance is 5.473 (*EnvScore*), social performance is 4.627 (*SocScore*), and governance performance is 6.429 (*GovScore*). These scores range from 0–10; in the total MSCI sample, scores above 4.7 are above average ESG performance as of 2013. In addition, the mean nonfinancial disclosure score is 30.187 (*ESG_Discl*); prior research reveals increased ESG disclosure over time (Ioannou and Serafeim 2015), and that scores exceeding 10.5 (20.9) indicate above average levels of ESG disclosure in the total ESG Bloomberg universe (among ESG-disclosers). The average firm's shares outstanding are mostly owned by asset managers such as banks and mutual funds (*Asset_Mgr* = 75.979); less than 4% are held by asset owners such as pension funds and insurance companies (*Asset_Owner* = 3.884).

Table 4.5 presents the cross-sectional results.[22] As previously discussed, Column (1) presents the primary results for the full cross-sectional sample (1,249 firm-pairs). We also conduct five additional tests to assess the robustness of the results to alternative matching algorithms or sample constructions. Column (2) restricts the sample to firms domiciled in the EU; since this is an EU regulation, we conduct this analysis to assess the effects on a subset of firms we expect to be most affected by its passage (491 firm-pairs). This analysis also assesses the robustness of the results to excluding US firms, which have the highest representation in the primary sample (see

[21] Our first event is before the 2013 calendar year-end while the latter two events are after. Results are robust to measuring our variables in 2012; however, this restricts our sample due to a larger number of missing MSCI and Bloomberg data. Over time, both data providers have expanded their coverage.

[22] We further explore outlier returns by dropping the 26 observations having CAR_i at the 1st- and 99th-percentiles; univariate and cross-sectional results are unchanged. A second winsorization for the remaining observations at the 1st and 99th percentiles also reveals unchanged results. We conclude that outliers do not drive the results.

Table 4.2); we note that untabulated results are unchanged to excluding only the US firms.[23] Column (3) restricts the sample to firms with 50%+ of revenue in their primary industry. Such firms may result in suboptimal matching, if the market reactions reflect operations in segments not related to that used to match with the treatment firm. Accordingly, this sample mitigates potential bias arising from industrial diversification in our matching process, and reduces the sample to 793 firm-pairs. Column (4) performs the match on country-industry. Industry (with 67 classifications) is defined more narrowly than sector (with 10 classifications). Accordingly, it provides a more precise economic match of treatment and control firms; however, it is also more restrictive, leading to a reduced sample of 857 firm-pairs. Column (5) performs the match with an additional constraint on size: the difference between the market capitalization of the treatment and the control firm is limited to $5 billion (746 firm-pairs). This addresses concerns that remaining size differences in the primary sample could drive the results. Finally, Column (6) performs the match without replacement. Our primary matching process uses replacement, allowing a control firm that is similar to multiple treatment firms to be used multiple times; this makes the order of matching irrelevant, and provides the maximum available firm-pairs in the analysis. We alternatively use country-sector matching *without* replacement: as expected, the sample decreases significantly to 390 firm-pairs.[24]

[23] We also exclude the 90 firms that are already subject to nonfinancial disclosure regulation in their country of domicile. Untabulated results are unchanged to excluding these firms.

[24] We conduct a range of other matching techniques to ensure the robustness of our results. First, our primary matching process requires one-to-one matching between treatment and control firms; that is, for each treated firm we match one control firm. Results are unchanged to implementing one-to-multiple matching (i.e., having one treatment matched to two or more control firms), which can provide better estimates under certain conditions. Second, we also match on pre-regulation ESG disclosure and pre-regulation ESG performance. While the sample reduces to 380 treatment firms, results are again unchanged. Third, we implement a matching algorithm that matches on the relative distance of employees, total assets and revenues (the three explicit criteria indicated in the directive). Again, results are unchanged.

Table 4.4: Descriptive Statistics

Panel A. Descriptive Data (N = 1,249); all variables winsorized at 1- and 99-percent levels, and defined in Appendix B

Variable	Mean	Median	Std Dev	Variable	Mean	Median	Std Dev
CAR	–0.007	–0.006	0.088	*IndAdjROA*	0.838	0.244	3.573
EnvScore	5.473	5.400	2.205	*Asset_Mgr*	75.979	86.635	24.157
SocScore	4.627	4.500	1.781	*Asset_Owner*	3.884	3.086	6.115
GovScore	6.429	6.400	2.690	*MTB_TopQ*	0.250	0.000	0.433
ESG_Discl	30.187	27.273	16.742	*MCAP_BotQ*	0.250	0.000	0.433
EnvMat	0.505	1.000	0.500	*Loss*	0.099	0.000	0.299
SocMat	0.464	0.000	0.499	*ADR*	0.175	0.000	0.280
GovMat	0.340	0.000	0.296	*EPS_Volat*	0.376	0.221	0.513
R&D	0.050	0.031	0.051	*Accruals*	0.114	0.029	0.656

Panel B. Pearson Correlations (N = 1,249); bold indicates significance at 5%

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) *CAR*	1.00																
(2) *EnvScore*	0.03	1.00															
(3) *SocScore*	0.01	**0.12**	1.00														
(4) *GovScore*	**0.11**	-0.02	0.04	1.00													
(5) *ESG_Discl*	0.03	**0.08**	**0.16**	0.01	1.00												
(6) *EnvMat*	0.01	**-0.08**	-0.01	0.06	**-0.06**	1.00											
(7) *SocMat*	**0.06**	**0.13**	**-0.11**	**0.12**	**-0.14**	**0.08**	1.00										
(8) *GovMat*	0.03	**0.06**	-0.01	**-0.07**	-0.03	0.01	-0.03	1.00									
(9) *R&D*	**0.08**	**0.08**	0.02	-0.03	**0.15**	**-0.07**	**0.08**	**0.10**	1.00								
(10) *IndAdjROA*	0.04	0.01	0.03	**0.06**	-0.04	-0.01	0.05	-0.02	-0.02	1.00							
(11) *Asset_Mgr*	**0.07**	-0.02	**-0.15**	**0.14**	**-0.18**	0.00	**0.11**	-0.05	0.02	**0.05**	1.00						
(12) *Asset_Owner*	**0.07**	0.03	-0.01	0.01	**0.09**	**-0.08**	**0.06**	-0.03	0.04	-0.03	**-0.06**	1.00					
(13) *MTB_TopQ*	**0.06**	**0.06**	-0.04	**0.08**	**-0.08**	**-0.08**	**0.11**	0.04	0.05	**0.37**	**0.10**	-0.02	1.00				
(14) *MCAP_BotQ*	-0.01	**-0.12**	0.01	-0.02	-0.01	**0.19**	0.00	-0.01	**-0.09**	**-0.12**	**-0.12**	**-0.09**	**-0.09**	1.00			
(15) *Loss*	**-0.06**	**-0.09**	0.01	**-0.06**	0.02	**0.07**	-0.06	0.03	0.02	**-0.37**	**-0.07**	**-0.05**	**-0.14**	0.20	1.00		
(16) *ADR*	**-0.08**	**0.14**	**0.14**	0.01	**0.18**	0.01	-0.04	0.00	0.06	-0.01	**-0.15**	0.03	-0.04	**-0.13**	0.04	1.00	
(17) *EPS_Volat*	**-0.05**	0.00	0.03	-0.03	0.04	0.00	**-0.10**	-0.03	-0.02	-0.03	0.03	-0.01	**-0.13**	0.01	-0.03	0.05	1.00
(18) *Accruals*	-0.03	**-0.06**	-0.03	-0.02	**-0.11**	0.03	-0.02	0.02	**-0.11**	**0.12**	**0.07**	**-0.12**	**0.09**	0.04	-0.05	**-0.10**	-0.02

Table 4.5: Cross-sectional analyses (test of H2a and H2b)

Matching:	**Country-Sector**		**Country-Sector**		**Country-Sector**		**Country-Industry**		**Country-Sector**		**Country-Sector**	
Sample:	**Full Cross-Sectional**		**EU-Domiciled Only**		**50% Sales in Primary Industry**		**Full Cross-Sectional**		**Size Difference Minimization**		**Without Replacement**	
Variable	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**
	(1)		(2)		(3)		(4)		(5)		(6)	
Intercept	–0.0629	4.10 ***	–0.1127	3.63 ***	–0.0569	5.21 ***	–0.0505	2.05 *	–0.0564	1.50	–0.0286	0.84
***EnvScore* (+)**	**0.0018**	**1.30**	**0.0033**	**2.30** **	**0.0022**	**2.98** ***	**0.0022**	**2.36** **	**0.0022**	**1.23**	**0.0014**	**2.19** **
***SocScore* (+)**	**0.0003**	**0.40**	**0.0012**	**0.37**	**0.0029**	**1.51**	**–0.0010**	**0.37**	**0.0002**	**0.36**	**0.0007**	**0.33**
***GovScore* (+)**	**0.0035**	**2.37** **	**0.0054**	**4.68** ***	**0.0027**	**1.85** *	**0.0004**	**0.40**	**0.0026**	**1.99** *	**0.0047**	**2.34** **
***ESG_Discl* (+)**	**0.0003**	**2.41** **	**0.0004**	**2.23** **	**0.0004**	**2.09** *	**0.0004**	**4.47** ***	**0.0003**	**2.31** **	**0.0003**	**2.41** **
Asset_Mgr (?)	0.0001	0.74	0.0002	1.48	0.0002	0.95	0.0000	0.08	0.0003	0.57	–0.0002	0.59
Asset_Owner (?)	0.0008	2.64 **	0.0010	2.64 **	0.0006	2.26 **	0.0011	2.99 ***	0.0013	2.17 **	0.0006	1.18
MTB_TopQ (?)	0.0115	2.06 *	0.0205	2.19 **	0.0107	1.07	0.0087	0.71	0.0148	3.79 ***	0.0087	1.94 **
MCAP_BotQ (?)	0.0174	2.04 *	0.0116	0.98	0.0176	2.62 **	–0.0081	0.65	0.0193	2.74	0.0147	0.94
Loss (?)	–0.0123	1.31	–0.0245	2.89 **	0.0000	0.11	–0.0198	1.25	0.0059	0.31	–0.0181	0.69
ADR (?)	–0.0044	0.48	–0.0112	1.03	0.0039	0.34	–0.0016	0.19	–0.0168	1.62	–0.0121	0.47
EPS_Volat (?)	–0.0062	1.19	0.0005	0.13	–0.0142	2.34 **	–0.0004	0.14	–0.0069	2.05	0.0104	1.48
Accruals (?)	–0.0023	1.88*	–0.0151	0.33	–0.0018	2.95 ***	0.0015	2.27 **	–0.0003	0.48	–0.0007	0.73
Fixed Effects	Country, Industry		Country, Industry		Country, Industry		Country, Industry		Country, Industry		Country, Industry	
N	1,249		491		793		857		746		390	
Adjusted-R^2	6.7%		11.4%		4.0%		5.2%		6.7%		3.6%	

Table 4.5: Cross-sectional analyses (test of H2a and H2b) (continued)

This table presents results of multivariate analyses examining the cross-sectional determinants of the market reactions to events affecting passage of the mandated nonfinancial disclosures in the European Union (EU). We use the variables *EnvScore*, *SocScore*, and *GovScore* to test H2a; we use the variable *ESG_Discl* to test H2b. Results are presented for six alternative samples: in Column (1), the country-sector matched sample used as the primary analysis; in Column (2), the country-sector matched sample restricted to EU-domiciled firms; in Column (3), the country-sector matched sample including only firms with > 50% of revenue in their primary industry; in Column (4), the country-industry (versus sector) matched sample; in Column (5), the country-sector matched sample with additional size difference minimization between the treatment and control firms; and in Column (6), the country-sector matched sample performed without replacement. Across all regressions, the dependent variable is CAR_i, the cumulative abnormal return for firm *i* to the aggregated three events identified as affecting the likelihood of passage for the directive mandating increased nonfinancial disclosures in the EU. Each firm *i* return is adjusted for that from a matched control firm per above.

All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix B. ***, **, * represent significance for the indicated one- or two-tailed tests. All regressions include country and industry fixed effects, with standard errors clustered by country.

Results are quite consistent across these six specifications. Focusing on the three proxies for ESG performance, we first observe significantly positive coefficients on *EnvScore* in 4 of 6 specifications; a one-standard deviation increase reflects an increased market reaction of 0.4–0.7%. Results for *SocScore* are insignificant. Finally, we find significantly positive coefficients on *GovScore* in 5 of 6 specifications; a one-standard deviation increase reflects an increased market reaction of 0.7–1.6%. This provides strong support for H_{2a} from performance related to environmental and governance factors. Moving to ESG disclosure, we observe significantly positive coefficients on *ESG_Discl* in all six specifications. Using Column (1), a one-standard deviation increase in *ESG_Discl* reflects an increased market reaction of 0.5–0.6%. This provides strong support for H_{2b}. Results on the control variables are as expected. Overall, these results are consistent with the observed market reaction to events mandating the nonfinancial disclosures being less negative for firms with stronger governance or environmental performance as well as better (existing) ESG disclosures.

Interaction Effects

We next conduct analyses to provide stronger identification for the above cross-sectional tests. First, we assess whether the ESG performance-related results are accentuated for those firms for which ESG is most material (i.e., re-examine H_{2a}). That is, we re-estimate the regressions of Table 4.5, now interacting indicator variables that equal one if the firm has above average risk exposure within its industry to the indicated ESG pillar.[25] Specifically, we include interaction terms with *EnvScore* (the interaction indicator variable is *EnvMat*), *SocScore* (*SocMat*), and *GovScore* (*GovMat*). Table 4.6 presents the results. Overall, we find strong evidence that the

[25] Risk exposure variables are from MSCI, and reflect an assessment of the company's risk exposure to ESG issues, relative to peers. These measures are often based on the firms' types of products/services, geographic locations or operations, type of physical assets, size of workforce, and other relevant factors.

positive association between *EnvScore*, *SocScore*, and *GovScore* increases as a function of that pillar's importance: we find significantly positive coefficients on *EnvScore* x *EnvMat* (*SocScore* x *SocMat*) [*GovScore* x *GovMat*] in four (three) [four] of the six specifications. Economically, increasing all variables by one standard deviation (i.e., both disclosure and performance scores that obtain significant coefficients) reflects an increased market reaction of 2.3–3.4%. These results provide confirmatory evidence in support of H_{2a}. Specifically, these results provide further support of the competitive effects due to differential ESG performance: as ESG issues become more relevant for the valuation of a firm, the contribution of the firm's ESG performance to the observed market reaction increases.

Second, we investigate whether the ESG disclosure-related results are accentuated for those firms having higher expected costs of disclosure (i.e., we re-examine H_{2b}). We focus on two key costs that we predict are associated with these market reactions: expected proprietary costs (proxied for using R&D scaled by sales, *R&D*); and expected political costs (proxied for using industry-adjusted ROA, *IndAdjROA*). In particular, firms having higher R&D are predicted to have higher proprietary costs; thus, firms having low (high) pre-directive ESG disclosure levels are expected to have more negative (less negative) price reactions to mandated reporting when proprietary cost concerns are higher (i.e., if they have higher R&D).[26] Similarly, firms having higher industry-adjusted ROA are predicted to have higher political costs; thus, firms having low (high) pre-directive ESG disclosure are more likely to have a more negative (less negative) price response to mandated reporting when political costs are higher (i.e., if they have a higher industry-adjusted ROA). Our assumption is that investors expect the disclosure mandate will constrain

[26] We use R&D as a proxy for the extent to which a firm is competing on the basis of innovation, and thereby disclosures related to employees, environmental productivity, and product attributes (such as safety) can reveal competitive information.

firms to reveal information that will be harmful to their competitiveness, or that will make them a target for political action, and that these costs will be more pronounced among low disclosure firms, given the pressure they will likely face to improve disclosure relative to high disclosure firms. Accordingly, we add an interaction of *ESG_Discl* with *R&D*, as well as an interaction of *ESG_Discl* with *IndAdjROA*, predicting the coefficients on both interactions to be positive. Table 4.7 presents the results. The interaction of *ESG_Discl* x *R&D* is significant in four out of six specifications; the interaction of *ESG_Discl* x *IndAdjROA* also is significant in four out of six specifications. This not only provides additional support for H_{2b}, but also provides additional insights into the sources of the costs of this disclosure mandate for low-disclosure firms. [27]

[27] In untabulated analysis we separate firms into samples from home countries with weak versus strong pre-directive ESG regulations based on whether the country of domicile has existing ESG disclosure mandates or ESG performance regulation (for example, CSR reporting mandate in France and cap-and-trade scheme for carbon emissions in Japan). Our results appear driven by firms in countries with relatively weak pre-directive ESG regulations, where almost 80% of our observations come from.

Table 4.6: Cross-sectional analyses including interactive effects for ESG performance (additional test of H2a)

Matching:	Country-Sector		Country-Sector		Country-Sector		Country-Industry		Country-Sector		Country-Sector	
Sample:	Full Cross-Sectional		EU-Domiciled Only		50% Sales in Primary Industry		Full Cross-Sectional		Size Difference Minimization		Without Replacement	
Variable	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**
	(1)		(2)		(3)		(4)		(5)		(6)	
Intercept	–0.0749	6.21 ***	–0.1076	5.31 ***	–0.0648	5.41 ***	–0.0320	1.24	–0.0695	1.94 *	–0.0497	1.21
EnvScore (+)	0.0020	1.72 *	0.0025	0.54	0.0018	1.73	0.0012	1.33	0.0029	1.59	0.0013	0.67
SocScore (+)	0.0015	1.01	0.0012	0.67	0.0030	1.46	–0.0018	0.99	–0.0011	1.04	0.0008	1.17
GovScore (+)	0.0036	2.26 **	0.0058	4.15 ***	0.0024	1.61	–0.0001	0.37	0.0031	2.14 **	0.0059	1.73
EnvMat (?)	0.0020	1.88 *	0.0019	2.08 *	0.0096	2.21 **	–0.0165	2.00 *	0.0302	1.77	0.0074	0.48
SocMat (?)	0.0025	1.00	0.0080	0.37	0.0077	0.66	–0.0308	1.22	–0.0048	0.45	0.0259	1.88 *
GovMat (?)	0.0061	1.87 *	0.0086	1.49	0.0012	1.96 *	0.0027	2.16 *	0.0162	1.93 *	0.0603	1.55
***EnvScore* x *EnvMat* (+)**	**0.0026**	**2.41** **	**0.0030**	**0.79**	**0.0031**	**2.27** **	**0.0036**	**2.27** **	**0.0021**	**1.77**	**0.0044**	**2.23** **
***SocScore* x *SocMat* (+)**	**0.0003**	**1.18**	**0.0015**	**2.28** **	**0.0014**	**1.19**	**0.0028**	**2.08** *	**0.0038**	**2.78** **	**0.0001**	**1.27**
***GovScore* x *GovMat* (+)**	**0.0015**	**1.83** *	**0.0014**	**3.22** ***	**0.0033**	**2.73** **	**0.0019**	**1.22**	**0.0019**	**2.20** **	**0.0034**	**1.78**
ESG_Discl (+)	0.0003	2.86 **	0.0003	2.36 **	0.0004	1.90 *	0.0003	4.42 ***	0.0002	2.30 **	0.0003	2.26 **
Asset_Mgr (?)	0.0001	0.74	0.0002	1.38	0.0002	1.09	0.0000	0.10	0.0002	0.44	–0.0002	0.63
Asset_Owner (?)	0.0007	2.28 **	0.0010	2.96 ***	0.0006	1.75	0.0012	3.27 **	0.0012	2.12 **	0.0006	1.02
MTB_TopQ (?)	0.0114	2.10 **	0.0195	2.05 **	0.0107	1.17	0.0087	0.69	0.0158	3.35 ***	0.0081	1.89 *
MCAP_BotQ (?)	0.0167	2.11 **	0.0139	1.20	0.0188	2.68 **	–0.0083	0.68	0.0171	2.27 **	0.0151	0.89
Loss (?)	–0.0127	1.30	–0.0279	2.34 **	0.0009	0.04	–0.0187	1.08	0.0061	0.31	–0.0159	0.61
ADR (?)	–0.0045	0.50	–0.0097	0.94	0.0042	0.38	–0.0016	0.21	–0.0160	1.51	–0.0134	0.52
EPS_Volat (?)	–0.0061	1.22	0.0010	0.23	–0.0142	2.30 **	0.0008	0.28	–0.0058	1.64	0.0104	1.30
Accruals (?)	–0.0019	1.54	–0.0054	0.11	–0.0015	2.74 **	0.0020	3.60 ***	0.0001	0.09	–0.0004	0.35
Fixed Effects	Country, Industry		Country, Industry		Country, Industry		Country, Industry		Country, Industry		Country, Industry	
N	1,249		491		793		857		746		390	
Adjusted-R^2	6.9%		11.1%		3.8%		5.4%		6.8%		3.4%	

Table 4.6: Cross-sectional analyses including interactive effects for ESG performance (additional test of H2a) (continued)

This table presents results of multivariate analyses examining the cross-sectional determinants of the market reactions to events affecting passage of the mandated nonfinancial disclosures in the European Union (EU), now incorporating interactive effects for ESG performance. Results are presented for six alternative samples, paralleling those presented in Table 4.5. The interactive effects relate to indicator variables that equal one if the firm has above-average risk exposure to environmental (*EnvMat*), social (*SocMat*), or governance (*GovMat*) issue relative to all firms in its industry, and zero otherwise. Across all regressions, the dependent variable is CAR_i. Each firm *i* return is adjusted for that from a matched control firm per the column description above. All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix B. ***, **, * represent significance for the indicated one- or two-tailed tests. All regressions include country and industry fixed effects, with standard errors clustered by country.

Table 4.7: Cross-sectional analyses including interactive effects for ESG disclosure (additional test of H2b)

Matching:	**Country-Sector**		**Country-Sector**		**Country-Sector**		**Country-Industry**		**Country-Sector**		**Country-Sector**	
Sample:	**Full Cross-Sectional**		**EU-Domiciled Only**		**50% Sales in Primary Industry**		**Full Cross-Sectional**		**Size Difference Minimization**		**Without Replacement**	
Variable	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**	**Coeff**	***t*-stat**
	(1)		(2)		(3)		(4)		(5)		(6)	
Intercept	–0.0608	4.59 ***	–0.0961	4.00 ***	–0.0619	5.57 ***	–0.0566	1.99 *	–0.0548	1.49	–0.0279	0.83
EnvScore (+)	0.0019	1.40	0.0035	2.37 **	0.0025	3.03 ***	0.0025	2.47 **	0.0023	1.26	0.0011	2.18 **
SocScore (+)	0.0002	0.27	0.0014	0.44	0.0029	1.88 *	–0.0009	0.36	–0.0002	0.29	0.0006	0.29
GovScore (+)	0.0034	2.31 **	0.0055	4.07 ***	0.0026	1.56	–0.0006	0.61	0.0025	1.84 *	0.0047	2.09 **
ESG_Discl (+)	0.0003	1.98 *	0.0003	2.31 **	0.0004	2.39 **	0.0004	2.81 **	0.0002	2.10 *	0.0003	1.87 *
R&D (?)	0.2162	2.40 **	0.2017	1.47	–0.0708	1.75 *	0.0582	1.56	–0.0240	0.71	0.0307	0.38
***ESG_Discl* x *R&D* (+)**	**0.0041**	**3.06** ***	**0.0168**	**2.57** **	**0.0044**	**2.93** **	**0.0035**	**3.24** ***	**0.0012**	**0.49**	**0.0022**	**0.91**
IndAdjROA (?)	0.0003	0.31	–0.0251	1.57	0.0133	1.13	0.0124	1.41	–0.0017	1.69	–0.0013	0.58
***ESG_Discl* x *IndAdjROA* (+)**	**0.0002**	**2.28** **	**0.0004**	**1.92** *	**–0.0002**	**0.54**	**–0.0003**	**1.17**	**0.0001**	**2.84** **	**0.0001**	**2.31** **
Asset_Mgr (?)	0.0001	0.82	0.0002	1.81 *	0.0002	0.94	0.0000	0.04	0.0003	0.54	–0.0002	0.62
Asset_Owner (?)	0.0008	2.87 **	0.0010	2.75 **	0.0007	2.38 **	0.0010	2.62 **	0.0013	2.39 **	0.0006	1.11
MTB_TopQ (?)	0.0100	1.56	0.0218	2.06 *	0.0093	0.84	0.0067	0.55	0.0120	3.14 ***	0.0070	1.16
MCAP_BotQ (?)	0.0185	2.17 **	0.0111	0.97	0.0179	2.57 **	–0.0065	0.50	0.0192	2.53 **	0.0147	0.99
Loss (?)	–0.0110	1.33	–0.0293	5.52 ***	0.0046	0.22	–0.0190	1.25	0.0082	0.45	–0.0192	0.65
ADR (?)	–0.0050	0.56	–0.0161	1.62	0.0037	0.31	–0.0002	0.02	–0.0161	1.96 *	–0.0129	0.49
EPS_Volat (?)	–0.0060	1.31	–0.0009	0.24	–0.0130	1.98 *	–0.0006	0.20	–0.0059	1.67	0.0109	1.44
Accruals (?)	–0.0026	2.11 **	0.0011	0.02	–0.0019	2.94 **	0.0010	1.50	–0.0010	1.80 *	–0.0013	0.91
Fixed Effects	Country, Industry		Country, Industry		Country, Industry		Country, Industry		Country, Industry		Country, Industry	
N	1,249		491		793		857		746		390	
Adjusted-R^2	6.9%		12.0%		4.0%		4.9%		7.2%		3.5%	

Table 4.7: Cross-sectional analyses including interactive effects for ESG disclosure (additional test of H2b) (continued)

This table presents results of multivariate analyses examining the cross-sectional determinants of the market reactions to events affecting passage of the mandated nonfinancial disclosures in the European Union (EU), now incorporating interactive effects for ESG disclosure. Results are presented for six alternative samples, paralleling those presented in Table 4.5. The interactive effects relate to variables that proxy for the extent to which the firm has proprietary costs (*R&D*) and political costs (*IndAdjROA*). Across all regressions, the dependent variable is CAR_i. Each firm *i* return is adjusted for that from a matched control firm per the column description above. All variables are winsorized at the 1- and 99-percent levels, and defined in Appendix B. ***, **, * represent significance for the indicated one- or two-tailed tests. All regressions include country and industry fixed effects, with standard errors clustered by country.

4.5.3 Other analyses

We next examine if weak ESG performance firms start to invest in strengthening their ESG performance and adopt more extensive disclosures, even before the mandate comes into effect 2017. We expect such anticipation behavior to be more pronounced for low ESG disclosure/performance firms (a) relative to high ESG disclosure/performance firms and (b) their matched low ESG disclosure/performance firms outside of the regulatory scope. We calculate the annual average ESG disclosure and performance scores (where ESG performance is an average across all three pillars) over 2013-2016 for the firms with below-median and above-median pre-regulation disclosure and performance. Untabulated analyses reveal that firms with weak pre-regulation ESG disclosure (performance) improve their scores by 10% (20%), versus 4% (1%) for peers having high disclosure (performance). Next, we examine whether weak ESG disclosure and performance treatment firms improve disclosure and performance relative to matched low ESG disclosure/performance control firms. Untabulated results confirm that, among a matched sample, firms with weak pre-regulation ESG disclosure (performance) improved their scores by 14% (7%), versus 1% (1%) for peers having high disclosure (performance). These results are not mirrored by the above-median disclosure and performance firms, suggesting that the weak ESG firms are most affected.

We conduct two additional tests to assess the robustness of our results. First, we conduct a placebo test using non-event dates. Specifically, we examine if the coefficients observed in our multivariate regression may arise on any given day; that is, if our analyses reflect normal cross-sectional variation in returns not unique to the sample events. Following Armstrong et al. (2010), we: (i) randomly select three non-event dates; (ii) compute the five-day *CAR* aggregated across these three non-event dates; (iii) estimate model (1), storing the non-event coefficient estimates;

(iv) repeat steps (i) – (iii) 500 times to construct a distribution of non-event coefficients; and (v) derive a *p*-value assessing how the event-date coefficients fit within this latter distribution. Untabulated results reveal the event date coefficients consistently differ from those for the non-event dates (all significant at 1%), consistent with the observed effects in the Table 4.5 cross-sectional analyses being event-specific.

Finally, we re-estimate the regressions using as the dependent variable *CAR_MarketModel*, defined as firm *i*'s cumulative return to the three events, less the corresponding market index return for firm *i*'s country of domicile. While simpler to implement, this measure makes fewer restrictions in deriving the abnormal return—and thus increases the potential for incomplete removal of non-event related market changes in prices. Nonetheless, results are unchanged to this alternative specification.

4.6 Conclusion

This paper examines market perceptions of mandated nonfinancial disclosure. Specifically, we examine the equity market reaction to three aggregated events (occurring during 2013–2014), assessed as increasing the likelihood of regulation mandating nonfinancial disclosure for affected firms. This regulation principally would affect firms with operations and/or financial listings in the European Union. To isolate the market reaction attributable to the regulation and remove equity market changes attributable to non-regulation factors, we define the abnormal return as the difference between the observed stock returns for our treatment firms with that for control firms matched by country, sector, market capitalization, and price-to-book ratio. We predict an on average negative market reaction to the sample events, motivated by our expectation that equilibrium conditions will constrain firm choices, resulting in costs exceeding benefits for firms affected by the disclosure mandate. We also predict that the observed market reaction is a function

of firms' pre-existing nonfinancial performance and nonfinancial disclosure. Anticipating increased use of ESG information by market and non-market participants following mandated disclosure, we predict investors will update their beliefs regarding the importance of ESG issues for firm value during the regulation's passage, and will anticipate higher expected costs for weak firms to maintain poor ESG performance or to shift to improved performance. These revised expectations will cause investors to further price ESG differences across firms with strong versus poor ratings of ESG performance. Similarly, anticipating increased ESG disclosure, investors will price expected proprietary and/or political costs of disclosure, beyond expected informational and monitoring benefits of disclosure.

Our empirical results confirm these expectations. In particular, we document an average negative market reaction of 0.79% of market value (or $79M on average) across our sample events, which is less (more) negative for firms with higher (lower) pre-directive ESG performance and disclosure. These univariate results are consistent with investors anticipating costs of the directive to outweigh benefits (on average), but also with the costs being concentrated in firms having weaker pre-directive ESG performance and disclosure. An alternative (but not mutually exclusive) explanation for the on average negative market returns is that the directive itself does not impose direct costs, but signals stringent future regulations that trigger the negative market reaction (i.e., principally indirect costs). While possible, we note evidence that appears consistent with the disclosure directive generating a direct effect: the positive association between ESG disclosure and stock price returns is moderated by proxies for the proprietary costs (as captured by R&D) and political costs (as captured by industry-adjusted ROA) of disclosure. We also document a less negative market reaction for firms having better ESG performance (particularly in the areas of environmental and governance), as well as having stronger current ESG disclosures. Further

analyses reveal that the latter results are accentuated for firms having the most material environmental and governance issues (with limited evidence in support of social issues). These results are consistent across a battery of regressions that (i) allow for alternative matching algorithms to derive the abnormal return; (ii) use alternative samples to ensure a focus on the firms most affected by the regulation; and (iii) include various firm-level control variables; and (iv) employ a placebo test to ensure results are not driven by normal cross-sectional variation in the returns.

Overall, we conclude that the equity market perceives that this regulation mandating the provision of nonfinancial information would lead to net costs (benefits) for firms with weak (strong) nonfinancial performance and disclosure. Future research can examine the real effects as the regulation takes place, such as changes in nonfinancial and financial performance, and other firm- and country-level drivers of variation in disclosure quality.

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Appendix

Appendix Table I: List of Forward-Looking Terms for Chapter 2

also aim	and forecast	are seeking	company believes
also aims	and forecasts	are sought	company commits
also anticipate	and foresee	are targeted	company estimates
also anticipates	and foresees	are targeting	company expects
also assume	and hope	are willing	company forecasts
also assumes	and hopes	assume	company foresees
also believe	and intend	assumes	company hopes
also believes	and intends	believe	company intends
also commit	and plan	believes	company plans
also commits	and plans	but aim	company projects
also estimate	and project	but aims	company seeks
also estimates	and projects	but anticipate	company targets
also expect	and seek	but anticipates	corporation aims
also expects	and seeks	but assume	corporation anticipates
also forecast	and target	but assumes	corporation assumes
also forecasts	and targets	but believe	corporation believes
also foresee	and will	but believes	corporation commits
also foresees	anticipate	but commit	corporation estimates
also hope	anticipates	but commits	corporation expects
also hopes	are aimed	but estimate	corporation forecasts
also intend	are aiming	but estimates	corporation foresees
also intends	are anticipated	but expect	corporation hopes
also plan	are anticipating	but expects	corporation intends
also plans	are assumed	but forecast	corporation plans
also project	are assuming	but forecasts	corporation projects
also projects	are believed	but foresee	corporation seeks
also seek	are believing	but foresees	corporation targets
also seeks	are committed	but hope	currently aim
also target	are committing	but hopes	currently aimed
also targets	are estimated	but intend	currently aiming

Appendix Table I: List of Forward-Looking Terms for Chapter 2 (Continued)

currently committed	expect	firm projects	management forecasts
currently committing	expects	firm seeks	management foresees
currently estimate	firm aims	firm targets	management hopes
currently estimated	firm anticipates	foresee	management intends
currently estimates	firm assumes	foresees	management plans
currently estimating	firm believes	intend	management projects
currently expect	firm commits	intends	management seeks
currently expected	firm estimates	is aimed	management targets
currently expecting	firm expects	is aiming	normally aim
currently expects	firm forecasts	is anticipated	normally aims
currently forecast	firm foresees	is anticipating	normally anticipate
currently forecasted	firm hopes	is assumed	normally anticipates
currently forecasting	firm intends	is assuming	normally assume
currently forecasts	firm plans	is believed	normally assumes
currently foresee	now aim	is believing	normally believe
currently foreseeing	now aimed	is committed	normally believes
currently foreseen	now aiming	is committing	normally commit
currently foresees	now aims	is estimated	normally commits
currently hope	now anticipate	is estimating	normally estimate
currently hoped	now anticipated	is expected	normally estimates
currently hopes	now anticipates	is expecting	normally expect
currently hoping	now anticipating	is forecasted	normally expects
currently intend	now assume	is forecasting	normally forecast
currently intended	now assumed	is foreseeing	normally forecasts
currently intending	now assumes	is foreseen	normally foresee
currently intends	now assuming	is hoped	normally foresees
currently plan	now believe	is hoping	normally hope
currently planed	now believed	is intended	normally hopes
currently planning	now believes	is intending	normally intend
currently plans	now believing	is planed	normally intends
currently project	now commit	is planning	normally plan
currently projected	now commits	is projected	normally plans

Appendix Table I: List of Forward-Looking Terms for Chapter 2 (Continued)

currently projecting	now committed	is projecting	normally project
currently projects	now committing	is seeking	normally projects
currently seek	we expect	is sought	normally seek
currently seeking	we forecast	is targeted	normally seeks
currently seeks	we foresee	is targeting	normally target
currently sought	we hope	is willing	normally targets
currently target	we intend	management aims	normally will
currently targeted	we plan	management anticipates	we aim
currently targeting	we project	management assumes	we anticipate
currently targets	we seek	management believes	we assume
currently will	we target	management commits	we believe
currently willing	we will	management estimates	we commit
	will	management expects	we estimate

Appendix Table II: Variable Definitions for Chapter 2

Variable	Definition
GreenRevenues	Percentage of total revenues that are generated from low-carbon goods, products and services, for firm *i* in year *t* from FTSE Russell's Green Revenues data model. Ranges from 0 to 100%,
GreenOppDisc	A sentence containing a forward-looking term (e.g., "next year", "company expects" or "plans to") and a Green Product term (e.g., "3M Glass Bubbles", "Accenture's Green Technology Suite", "solar inverters", "LED Lighting Solutions", "electric vehicle", etc.). Green Product terms are obtained from FTSE Russell's Low Carbon Economy (LCE) data module. The full list of forward-looking terms are provided in the Internet Appendix.
GRdum	Indicator equal to 1 if firm *i* has non-zero green revenues in year *t*.
10KGreenOpp	Indicator equal to 1 if the MD&A section of the annual report (10-K) contains a green opportunity sentence for firm *i* in year *t*.
SustGreenOpp	Indicator equal to 1 if the sustainability disclosure (ie. sustainability report and/or Carbon Disclosure Project survey response) contains a green opportunity sentence for firm *i* in year *t*.
ESGDisc	A Bloomberg variable that scores from 0–100 and measures the quantity of ESG disclosures made by firm *i* in year *t*.

Appendix Table II: Variable Definitions for Chapter 2 (Continued)

ESGPerf	The average of three MSCI (Morgan Stanley Capital International) variables: Environmental Score (measures the performance of firm *i* in relation to energy and climate change, natural resource consumption and waste management issues in year *t*), Social Score (measures the performance of firm *i* in relation to human capital, health and safety, products and services, and supply chain issues in year *t*), and Governance Score (measures the quality of firm i's governance processes and structure in year *t*).
10KFwdLooking	Indicator equal to 1 if the MD&A section of the 10-K contains a forward-looking sentence for firm *i* in year *t*.
10KDelay	Difference between the year of the first 10-K green opportunity disclosure for firm *i* and the year of the first sustainability report green opportunity disclosure for firm *i.*
Leverage	Total debt divided by total shareholders' equity for firm *i* in year *t*, obtained from Worldscope.
R&D	Total research and development expenditures scaled by total revenues for firm *i* in year *t,* obtained from Worldscope.
PTB	Ratio of the stock price to the book value per share for firm *i* in year *t*, from Worldscope.
RetVol	Standard deviation of day to day logarithmic historical price changes over the year for firm *i* in year *t*, obtained from Worldscope.
ROA	Return on assets for firm *i* in year *t*, obtained from Worldscope.
Sales1YrGrowth	The percent increase or decrease of sales revenue by comparing current year with prior year for firm *i* in year *t*, obtained from Worldscope.
AnnualRet	Annual stock price return for firm *i* in year *t*, obtained from Worldscope.
TotalAssets	Natural logarithm of total assets for firm *i* in year *t*, from Worldscope.
StdDev(Green Revenues)	Standard deviation of green revenues for firm *i* in the years subsequent to year *t*.
EPS or *Revenue Surp*	Actual earnings-per-share or revenue-per-share minus I/B/E/S median analyst forecast 8 months prior to end of forecast period, deflated by stock price.

Appendix Table III: Green Opportunity Disclosure Examples

Company: Caterpillar Inc.

"We expect demand for energy-efficient engines to increase…CAT's ACERT Technology will ensure emissions reductions…" (FY 2010 MD&A, p. 127).

"CAT is committed to helping our customers reduce emissions with ACERT-equipped engines that improve efficiency without sacrificing reliability or performance." (2010 Sustainability Report, p. 18).

Appendix Table III: Green Opportunity Disclosure Examples (Continued)

Company: 3M Company

"We are developing solutions that will help our customers address their sustainability challenges, such as 3M Greener Products" (FY 2008 Sustainability Report, p. 33).

"…3M Greener Products will help building manufacturers meet internationally recognized environmental certifications such as LEED…" (FY 2011 MD&A, p. 94).

*Forward-looking terms and green product terms have been underlined.

Appendix Table IV: Variable Definitions for Chapter 3

$TotalGHG_{it}$	Natural logarithm of scope 1 and scope 2 greenhouse gas emissions in metric tons of carbon dioxide equivalent for firm *i* in year *t.*
$EmissionsProductivity_{it}$	Ratio of total revenues to scope 1 and scope 2 greenhouse gas emissions in metric tons of carbon dioxide equivalent firm *i* in year *t.* Revenue is obtained from Worldscope.
$MarketCap_{it}$	Natural logarithm of market capitalization for firm *i* in year *t*, from Worldscope.
$Assets_{it}$	Natural logarithm of total assets for firm *i* in year *t*, from Worldscope.
$Revenue_{it}$	Natural logarithm of total revenues for firm *i* in year *t*, from Worlscope.
ROA_{it}	Ratio of income before extraordinary items over total assets for firm *i* in year *t*, expressed as a percentage and computed using data from Worldscope.
PTB_{it}	Market to book value for firm *i* in year *t*, expressed as a percentage and obtained from Worldscope.
$Leverage_{it}$	Ratio of total liabilities to total assets for firm *i* in year *t*, expressed as a percentage and obtained from Worldscope.
$Capex_{it}$	Ratio of capital expenditures to sales revenues for firm *i* in year *t*, expressed as a percentage and obtained from Worldscope.
$SalesGrowth_{it}$	Sales revenues for firm *i* in year *t* divided by sales revenues for firm *i* in year *t-4*, reduced to a compound annual rate.
$GridCarbonIntensity_{ct}$	Average amount of carbon dioxide emitted to produce electricity for country *c* in year *t*. Measured in grams of carbon dioxide equivalent per kilowatt hour of electricity (gC02e/kWh) and averaged over year *t* across regions in country *c*. Obtained from the International Energy Agency's publication *Emissions factors* (2017 edition).
GDP_{ct}	Gross Domestic Product for country *c* in year *t,* in trillions. Obtained from World Development Indicators.
$Treat_i$	Indicator equal to 1 for firms affected by Mandatory Carbon Reporting in matched sample, and 0 otherwise.
$Post_t$	Indicator equal to 1 in years after Mandatory Carbon Reporting comes into effect (i.e. years 2013-2015) and 0 otherwise (i.e. years 2006-2012).

Appendix Table V: Summary of Confounding Regulations, U.K. and Non-U.K. firms

Confound	Affected Firms	Description	Strategy to control for confound
Financial incentive to reduce emissions	U.K. firms	Carbon Price Floor (CPF) was introduced in April 2013. CPF is a top-up tax imposed on power generators in the U.K., paid to the U.K. treasury. It exists to address low carbon prices in the European Union Emissions Trading Scheme.	Remove energy producers in the U.K. from sample (GICS codes 551010-551050).
Financial incentive to reduce emissions	EU firms	The European Union Emissions Trading Scheme (EU ETS) is the largest mandatory trading and reporting scheme in the world. Began in 2005 and affects power generation and manufacturing operators in the EU. Several changes occurred in the sample period.	Remove firms that are covered by the EU-ETS.
Financial incentive to reduce emissions	U.K. firms	Climate Change Levy (CCL) is an energy consumption tax on U.K. companies (0.554 pence per kwh) since 2001. Energy-intensive companies get a discount if voluntarily commit to & meet gov't-agreed energy targets. In 2013, the discount increased from 65% to 90% of the CCL rate.	Perform within-UK test (described in Section 4.2). CCL and discount applies to both UK firms affected by MCR and UK firms unaffected by MCR.
Financial incentive to reduce emissions	U.K. firms	Carbon Reduction Commitment Energy Efficiency Scheme began in 2009 and is a mandatory scheme to improve energy efficiency among certain large organizations that are not part of the EU Emissions Trading Scheme (EU ETS). Covered organizations must report emissions and buy allowances for every ton of carbon they emit. The price increased from £12.00/tCO2 to £16.40/tCO2 in 2014.	Perform within-UK test (described in Section 4.2). CRC applies to both UK firms affected by MCR and UK firms unaffected by MCR.
Financial incentive to reduce emissions	Non-U.K. firms	Carbon taxes and emissions cap-and-trade schemes came into effect during the sample period in other countries.	Remove firms from: Australia, Ireland, Japan, New Zealand, Switzerland.
Mandatory Carbon Reporting	Non-U.K. firms	Regulations to mandate emissions reporting came into effect in other countries during the sample period.	Remove firms from: South Korea, USA.
Mandatory ESG reporting mandates	Non-U.K. firms	Regulations to mandate ESG reporting came into effect in other countries during the sample period.	Remove firms from: Brazil, France, India, Norway, Taiwan.

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations

MANDATED ESG/CSR reporting, emissions reporting, and explicit emissions reduction schemes/taxes.

	Country	Year law passed	Year law comes into effect	Type of mandate	Firms affected	Description	Include/ exclude as control firms	Reason for inclusion/exclusion
1	Argentina - Buenos Aires only	2007	2008	CSR disclosure	Large companies operating in city of Buenos Aires	Buenos Aires City Council passes Law 2594 requiring all local and international companies in the city with over 300 employees to generate annual sustainability reports. At minimum, companies are required to produce their reports in accordance with the Ethos Reporting Initiative's G3 indicators and the Accountability 1000 standard.	Include	Mandate relates to general CSR, with no specific requirement to disclose GHGs. In addition, mandate comes into effect outside of the confound period (i.e., 2011-2015). Thus, no particular reason why time-trend of GHGs should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).
2	Australia	2011	2012	Carbon tax	All individuals and organizations	Australia instituted a carbon tax on July 1, 2012 and repealed it two years later, on July 17, 2014.The tax was broadly based and paid by all those who consume fossil fuels in the country at $19.60 USD/ ton of CO2	Exclude	Mandate imposes explicit incentives for firms to reduce GHGs, and overlaps with sample period.
3	Australia	2007	2008	Emissions disclosure	Large emitters	Under the National Greenhouse and Energy Reporting (NGER) Act, corporations emitting more than 125 000 tons CO2 equivalent per annum started to report on their energy and greenhouse gas emissions to the Government in October 2009 for financial year 2008/2009	Exclude (see item #2)	Australia is omitted from potential control firms due to the Australian carbon taxation (See item #2).

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

4	Australia	2010	2012	CSR disclosure	Large firms	Australia introduces its new ethical disclosure requirements under the Financial Services Reform Act (FSRA). Issuers of financial products are obliged to disclose the extent to which "labor standards or environmental, social or ethical considerations are taken into account in the selection, retention or realization of an investment." Product issuers are required to make two separate Product Disclosure Statements (PDS): the first on labor standard considerations and the second concerning environmental, social and ethical deliberations.	Exclude (see item #2)	Australia is omitted from potential control firms due to the Australian carbon taxation (See item #2).
5	Brazil	2011	2012	CSR disclosure	Listed companies	Bovespa releases 'comply or explain' requirements for all listed companies, encouraging them to state whether they publish a regular sustainability report and where it is available, or explain why not.	Exclude	Overlaps with confound period (i.e., 2011-2015). Disclosure of general CSR includes GHGs, which may result in a different time trend for Brazilian firms compared to UK firms.

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

6	Canada	1995	1999	Emissions disclosure	Large emitters	The Canadian Environmental Protection Act requires companies to provide information on specific pollutant emissions for inclusion in the National Pollutant Release Inventory (NPRI). The act was expanded five years later to include the GHGs Reporting Program, which requires Canadian Large Emitters to report GHGs.	Include	Mandate relates to GHGs but came into prior to the sample period. As such, any effect on emissions would likely stabilize prior to the start of the sample period.
7	Canada - B.C. only	2005	2008	Carbon tax	All individuals and organizations	British Columbia's carbon tax has been in place since 2008 and the final scheduled increase took effect on July 1, 2012 (the tax was $30/metric ton of C02 in 2012, where it remains today). It adds additional carbon taxes to fossil fuels burned for transportation, home heating, and electivity, and reduces personal income taxes and corporate taxes by roughly equal amount. The initial tax rate was relatively low and has increased gradually to allow families and businesses time to reduce their emissions. The tax is also intentionally broadly based and paid by all those who consume fossil fuels in the province.	Include	Mandate imposes explicit incentives in one Canadian province to reduce GHGs, but came into effect 3 years prior to the confound period. Thus, no particular reason why time-trend of GHGs should differ significantly from UK firms, given that the price of carbon stabilized in 2012. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

8	Chile	2016	2018	Carbon tax	Large factories and the electric sector	Chile's tax of $5 USD/metric ton of CO2, which targets large factories and the electricity sector, will cover about 55 percent of the nation's carbon emissions	Include	Mandate imposes explicit incentives for firms to reduce GHGs, but comes into effect after the sample period. Thus, no particular reason why time-trend of GHGs should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).
9	China	2007	2008	CSR disclosure	Large and listed	In China, the Shanghai Stock Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE) mandated certain listed firms to disclose ESG information starting for financial years ending Dec 31 2008.	Include	Mandate relates to general CSR, with no specific requirement to disclose GHGs. In addition, mandate comes into effect prior to the confound period. Thus, no particular reason why time-trend of GHGs should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).
10	Denmark	2008	2009	CSR disclosure	Large and listed	As of 2009, large businesses are required to disclose CSR information in their annual reports or explicitly state that they do not have any CSR policies.	Include	Mandate relates to general CSR, with no specific requirement to disclose GHGs. In addition, mandate comes into effect prior to the confound period. Thus, no particular reason why time-trend of GHGs should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).
11	European Union	2014	2017	CSR disclosure	Large and listed	Starting in 2017 EU listed firms must disclose CSR performance.	Include	Mandate comes into effect after sample period.

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

12	European Union	2001	2005	Cap-and-trade	Certain sectors (power generation and manufacturing)	The European Union Emission Trading Scheme (or EU ETS) is the largest multi-national, greenhouse gas emissions trading scheme in the world. The EU ETS operates in the 28 EU countries, covers around 45% of the EU's GHGs, and focuses on emissions from the power generation and manufacturing industries.	Include	Mandate imposes explicit incentives to reduce GHGs, but came into effect prior to the sample period. Thus, no particular reason why time-trend of GHGs should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).
13	Finland	2010	2011	CSR disclosure	State-owned and non-listed	The Finnish government adopts a resolution asking non-listed state-owned companies and state majority-owned companies to report their sustainability performance.	Include	Mandate affects state-owned and non-listed firms, which are not part of my sample due to data constraints. Thus, include publicly-listed Finnish firms.
14	Finland	1985	1990	Carbon tax	Individuals and certain sectors	Finland enacted a carbon tax in 1990, the first country to do so. The current tax is $24.39 USD per ton of CO2 in U.S. dollars.	Include	Mandate imposes explicit incentives to reduce GHGs, but came into effect several years prior to the sample period.
15	France	2010	2012	CSR disclosure	Large and listed	The Grenelle II Act is passed, requiring companies to include ESG information in their annual report. Large companies are to comply in their 2012 reports, and smaller companies (defined as having fewer than 500 employees and total assets or net annual sales of €100 million) are to comply by 2014.	Exclude	Overlaps with confound period (i.e., 2011-2015). Disclosure of general CSR includes GHGs, which may result in a different time trend for French firms compared to UK firms.

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

16	India	2011	2012	CSR disclosure	The 100 largest listed companies	The Securities and Exchange Board of India mandated in 2011 large firms to start producing sustainability reports in 2012. The new rule is immediately applicable only to the top 100 companies (by market capitalization) and will subsequently be phased in for the remaining companies.	Exclude	Overlaps with confound period (i.e., 2011-2015). Disclosure of general CSR includes GHGs, which may result in a different time trend for Indian firms compared to UK firms.
17	Indonesia	2008	2010	CSR disclosure	Listed	The government of Indonesia adopts a law that requires listed companies to report on the effects of their activities on society and the environment. Failure to do so necessitates an explanation for not disclosing this information.	Include	Mandate relates to general CSR, with no specific requirement to disclose GHGs. Mandate comes into effect prior to confound period. Thus, no particular reason why time-trend of GHGs should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect.
18	Ireland	2008	2010	Carbon tax	All individuals and organizations	Ireland's carbon tax (at €20/ton since 2012) covers nearly all of the fossil fuels used by homes, offices, vehicles and farms, based on each fuel's CO2 emissions. The Irish carbon tax was designed to fill gaps left by the European Union Emissions Trading Scheme (EU ETS), which addresses only large polluting firms and accounts for only roughly 40% of emissions sources.	Exclude	Mandate imposes explicit incentives for firms to reduce GHGs, and overlaps with sample period.
19	Japan	2008	2010	Cap-and-trade	Top 1,400 emitters	Scheme launched in April 2010	Exclude	Mandate imposes explicit incentives for firms to reduce GHGs, and overlaps with sample period.

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

20	Japan	2005	2006	Emissions disclosure	Large emitters	Japan introduced in 2005 (effective in April 2006) the Mandatory Greenhouse Gas Accounting and Reporting System based on the revised Act on Promotion of Global Warming Countermeasures (Act No. 117 of 1998). This system requires specified entities (which emit GHGs above a defined threshold) to calculate their GHGs and report the results to the Government.	Exclude (see Item #19)	Japan is excluded due to a confounding carbon regulation (see Item #19)
21	Malaysia	2007	2008	CSR disclosure	Listed	In Malaysia, the stock exchange Bursa Malaysia made sustainability disclosure a listing requirement for all listed firms starting in 31st of December 2007.	Include	Mandate relates to general CSR, with no specific requirement to disclose GHGs. In addition, mandate comes into effect prior to the confound period. Thus, no particular reason why time-trend of GHGs should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).
22	Netherlands	2009	2010	CSR disclosure	Listed	CSR reporting became mandatory for publicly traded Dutch companies in 2010.	Include	Mandate relates to general CSR, with no specific requirement to disclose GHGs. In addition, mandate comes into effect prior to the confound period. Thus, no particular reason why time-trend of GHGs should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

23	New Zealand	2009	2010	Cap-and-trade	Certain sectors	The NZ ETS covers forestry, energy, industry and waste but not pastoral agriculture. Participants in the NZ ETS must surrender one emission unit (either an international 'Kyoto' unit or a New Zealand-issued unit) for every two tons of carbon dioxide equivalent emissions reported or they may choose to buy NZ units from the government at a fixed price of NZ$25.	Exclude	Mandate imposes explicit incentives for firms to reduce GHGs, and overlaps with sample period.
24	Norway	2012	2013	CSR disclosure	Large and listed	The Norwegian government passes legislation which requires large companies to disclose information on how they integrate social responsibility into their business strategies. The regulation endorses the GRI Guidelines and UN Global Compact Principles; it exempts companies that already publish CSR reports using these frameworks. The government's 2009 White Paper on CSR had similarly promoted GRI's guidelines.	Exclude	Overlaps with confound period (i.e., 2011-2015). Disclosure of general CSR includes GHGs, which may result in a different time trend for Norwegian firms compared to UK firms.

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

25	South Africa	2009	2010	CSR disclosure	Listed	In South Africa, the Johannesburg Stock Exchange (JSE) mandated the disclosure of sustainability information starting in the 2010 financial year.	Include	Mandate relates to general CSR, with no specific requirement to disclose GHGs. In addition, mandate comes into effect prior to the confound period. Thus, no particular reason why time-trend of GHGs should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).
26	South Korea	2009	2011	Emissions disclosure	Large emitters	South Korea's Basic Act on Low Carbon Green Growth includes mandatory rules that require energy-intensive companies and/or companies emitting GHGs over a certain amount to report their emissions and energy consumption to the Government with effect as of 14 April 2010. The controlled entities were to submit their first GHG emission statement to the ministry in charge by the end of May, 2011.	Exclude	Mandate relates to GHGs and overlaps with sample period.
27	South Korea	2015	2016	Cap-and-trade	Certain sectors	South Korea's national emissions trading scheme officially launched on 1 January 2015, covering 525 entities from 23 sectors. The Korean emissions trading scheme is part of the Republic of Korea's efforts to reduce greenhouse gas emissions by 30% compared to the business-as-usual scenario by 2020	Exclude (see item 26)	South Korea excluded due to emissions disclosure mandate (see item 26)

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

28	Spain	2011	2012	CSR disclosure	State-owned and non-listed	A 2011 law requires state-owned and limited companies to disclose specific CSR information	Include	Mandate only affects state-owned and non-listed firms, which are not part of my sample due to data constraints. Thus, no particular reason why time-trend of GHGs for publicly-listed Spanish firms should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).
29	Sweden	2007	2009	CSR disclosure	State-owned and non-listed	The Swedish government announced that by 2009 all state-owned companies will be required to produce an annual sustainability report in accordance with the GRI G3 guidelines.	Include	Mandate only affects state-owned and non-listed firms, which are not part of my sample due to data constraints. Thus, no particular reason why time-trend of GHGs for publicly-listed Swedish firms should differ significantly from UK firms. Further, no reason why a bias would exist in the year that the UK carbon mandate came into effect (2013).
30	Sweden	1985	1991	Carbon tax	Individuals and certain sectors	The tax was initially set at a general level of US$133 per ton of carbon. In 2009, the country's standard tax rate was the equivalent of US$105 per metric ton CO2 and for industry it was at US$23 per metric ton, where it remains today.	Include	Mandate imposes explicit incentives to reduce GHGs, but came into effect several years prior to the sample period.

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

31	Switzerland	2006	2008	Emissions trading scheme	Large, energy-intensive entities	The Swiss ETS started in 2008 with a five-year voluntary phase as an alternative option to the CO2 levy on fossil fuels. Revised regulations entered into force on 1 January 2013. The scheme subsequently became mandatory for large, energy-intensive entities, while medium-sized entities may join voluntarily. It now covers about 10% of the country's total GHGs. In the 2013-2020 mandatory phase, participants in the ETS are exempt from the CO2 levy.	Exclude	Mandate imposes explicit incentives for firms to reduce GHGs, and overlaps with sample period.
32	Taiwan	2015	2016	CSR disclosure	Certain listed companies	The Taiwan Stock Exchange Corporation (TWSE) requires specified listed companies to start mandatory corporate social responsibilities (CSR) reporting annually from 2016. These include companies from food processing, financial and chemical sectors, as well as companies which have over 50% of their total revenue coming from food & beverage businesses; large enterprises with paid-in capital no less then NT$10bn or US$310m also need to comply.	Exclude	Overlaps with confound period (i.e., 2011-2015). Disclosure of general CSR includes GHGs, which may result in a different time trend for Taiwanese firms compared to UK firms.

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

33	United Kingdom	2012	2013	Emissions disclosure	Listed	The Deputy Prime Minister announces that London Stock Exchange Listed companies will be required to report their annual greenhouse gas emissions, effective April 2013. The UK is the first nation to establish mandatory inclusion of businesses' emissions data in their annual reports. Previously, the Carbon Reduction Commitment (CRC) of 2010 had required companies that use more than 6,000MWh per year to measure and report on all their emissions related to energy use to the Environmental Agency or face financial or other penalties.	N/A	N/A - this is the mandate under study
34	United Kingdom	2006	2007	CSR disclosure	Listed	The British Companies Act mandates that companies listed on the London Stock Exchange disclose, in their annual Business Review, information on environmental, workplace, social and community matters "to the extent that they are important to understanding the company's business."	N/A	Mandate relates to general CSR, with no specific requirement to disclose GHGs, and came into effect 6 years prior to UK carbon disclosure mandate.

Appendix Table VI: Mandatory ESG Reporting and Emissions Regulations (Continued)

35	United States	2008	2009	Emissions disclosure	Large emitters	The Mandatory Reporting of Greenhouse Gases rule requires large emitters of greenhouse gases to collect and report data with respect to their greenhouse gas emissions. Facilities that emit 25,000 metric tons or more per year of GHGs are required to submit annual reports to the EPA, who will verify the data. This reporting requirement is expected to cover 85 percent of the nation's greenhouse gas emissions generated by roughly 10,000 facilities. The purpose of the rule is to collect accurate and timely GHG data to inform future policy decisions.	Exclude	Mandate relates to GHGs and overlaps with sample period.
36	United States - California only	2011	2013	Cap-and-trade	Large emitters that operate facilities within California	The largest businesses in the state—defined as those that emit more than 25,000 tons of carbon dioxide a year—have to get permits from the state government for those emissions. Businesses in high-emitting industries are covered, including refineries, food processors, manufacturers and utilities.	Exclude	Mandate imposes explicit incentives for firms to reduce GHGs, and overlaps with sample period.

Appendix Table VII: Robustness Regressions

This table summarizes the sensitivity of my results. In the first column I describe each robustness test. *N* equals the number of observations, *Treat x Post* is the OLS coefficient of my main variable of interest. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Robustness Test	N	Treat x Post
1. Alternative Matching		
TotalGHGs		
-Table 8 (3): Full Sample (unmatched)	6,237	-0.0921 [0.0295]***
-Table 8 (3): UK matched to Germany	1,910	-0.1144 [0.0531]**
-Table 8 (3): UK matched to the Netherlands	2,034	-0.0883 [0.0506]*
-Table 8 (3): Corsened Exact Matching UK to Non-UK	2,216	-0.1002 [0.0434]**
Robustness Test	N	Treat x Post
2. Alternative Dependent Variable		
TotalGHGs		
-Table 8 (3): Scope1+2 Greenhouse gas emissions in metric tons of carbon dioxide equivalent (not in logarithm form)	2,401	-209,443 [92,175]**
Robustness Test	N	Treat
3. Alternative Climate Change Risk Perceptions		
Physical Climate Change Risks		
-Table 11 (3): Δ Number Risks	342	0.2184 [0.3783]
-Table 11 (3): Δ Magnitude Impact	342	0.4683 [0.3630]
-Table 11 (3): Δ Timeframe	342	0.1202 [0.1684]
-Table 11 (3): Δ Likelihood	342	0.7435 [0.4334]*

Appendix Table VIII: Within-Country Regressions

This table reports the coefficients of OLS regressions estimating the effect of mandatory carbon reporting on carbon emissions for the sample of listed UK and non-listed UK firms. The dependent variable *CRC emissions* is the natural logarithm of a firm's carbon dioxide emissions in a given year. The key explanatory variable *Treat x Post* is an indicator equal to one beginning in year 2013, in which mandatory carbon reporting becomes effective for the sample of publicly-traded UK firms. Robust standard errors clustered by firm and year in brackets; *** p<0.01, ** p<0.05, * p<0.10. Unit of analysis is a firm.

Sample: UK listed (publicly-traded) firms and matched unlisted (private) UK firms			
Post=2013, 2014, 2015	Dependent Variable: *CRC emissions*		
	(1)	(2)	(3)
Treat x Post	-0.1224 [.0618]**	-0.1713 [.0628]***	-0.1224 [.0619]**
Post	-0.0484 [.0272]*		
Treat	0.0095 [.0307]		0.0095 [.0307]
CRCemissions_1yrlag	1.0192 [.0152]***		1.0191 [.0150]***
constant	-0.2939 [.1557]*	9.9041 [.0280]***	-0.2925 [.1537]*
Firm fixed effects	No	Yes	No
Year fixed effects	No	Yes	Yes
Lagged Dependent Variable	Yes	No	Yes
Time-varying firm controls	No	No	No
Observations (firm-years)	1,576	1,970	1,576
R-squared	0.8605	0.8584	0.8604

Notes: Robust standard errors clustered by firm and year in brackets; *** p<0.01, ** p<0.05, * p<0.10. Unit of analysis is a firm.
Post is a dummy variable equal to 1 in the period that the mandate is in effect (i.e. years 2013, 2014 & 2015).

Appendix Table IX: Details of Directive for Chapter 4

Details of Directive 2014/95/EU on nonfinancial information disclosure for large companies in the European Union

Below are direct excerpts taken from Directive 2014/95/EU. The excerpts are chosen to highlight key requirements of the mandated disclosures being proposed under the Directive.

Excerpt 1: Overview of the reporting obligation

Large undertakings…shall include in the management report a non-financial statement containing information to the extent necessary for an understanding of the undertaking's development, performance, position and impact of its activity, relating to, as a minimum, environmental, social and employee matters, respect for human rights, anti-corruption and bribery matters, including:

(a) a brief description of the undertaking's business model;

(b) a description of the policies pursued by the undertaking in relation to those matters, including due diligence processes implemented;

(c) the outcome of those policies;

(d) the principal risks related to those matters linked to the undertaking's operations including, where relevant and proportionate, its business relationships, products or services which are likely to cause adverse impacts in those areas, and how the undertaking manages those risks;

(e) non-financial key performance indicators relevant to the particular business.

Where the undertaking does not pursue policies in relation to one or more of those matters, the non-financial statement shall provide a clear and reasoned explanation for not doing so.

The non-financial statement shall also, where appropriate, include references to, and additional explanations of, amounts reported in the annual financial statements.

Excerpt 2: Specific items to be reported (emphasis added)

Where undertakings are required to prepare a non-financial statement, that statement should contain, as regards environmental matters, details of the current and foreseeable **impacts of the undertaking's operations on the environment**, and, as appropriate, on **health and safety, the use of renewable and/or non-renewable energy, greenhouse gas emissions, water use and air pollution**. As regards social and employee-related matters, the information provided in the statement may concern the actions taken to ensure **gender equality**, implementation of fundamental conventions of the **International Labour Organization**, **working conditions, social dialogue, respect for the right of workers** to be informed and consulted, **respect for trade union rights, health and safety at work** and the **dialogue with local communities**, and/or the actions taken to ensure the **protection and the development of those communities**. With regard to human rights, anti-corruption and bribery, the non-financial statement could include information on the **prevention of human rights abuses and/or on instruments in place to fight corruption and bribery**.

Excerpt 3: Assurance requirements and guidelines

Member States shall ensure that the statutory auditor or audit firm checks whether the non-financial statement has been provided. Member States may require that the information in the non-financial statement be verified by an independent assurance services provider.

Appendix Table IX: Details of Directive for Chapter 4 (Continued)

Excerpt 4: Exceptions and omissions

Member States may allow information…to be omitted in exceptional cases where, in the duly justified opinion of the members of the administrative, management and supervisory bodies, acting within the competences assigned to them by national law and having collective responsibility for that opinion, the disclosure of such information would be seriously prejudicial to the commercial position of the undertaking, provided that such omission does not prevent a fair and balanced understanding of the undertaking's development, performance, position and impact of its activity.

Sources: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013L0034
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0095
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0207:FIN:EN:PDF

Appendix Table X: Variable Definitions for Chapter 4

Dependent Variables	
CAR_i	the cumulative 5-day abnormal return for firm *i* to the aggregated three events identified as affecting the likelihood of passage for the directive mandating increased nonfinancial disclosures in the EU; abnormal return is derived by subtracting the corresponding return for a control firm matched on country, industry, market capitalization, and price-to-book ratio.
Experimental Variables	
$EnvScore_i$	a MSCI variable that scores from 0–10 and measures the *performance* of firm *i* in relation to energy and climate change, natural resource consumption and waste management issues in 2013.
$SocScore_i$	a MSCI variable that scores from 0–10 and measures the *performance* of firm *i* in relation to human capital, health and safety, products and services, and supply chain issues in 2013.
$GovScore_i$	a MSCI variable that scores from 0–10 and measures the *quality* of firm *i*'s governance processes and structure in 2013.
ESG_Discl_i	a Bloomberg variable that scores from 0–100 and measures the *quantity* of ESG disclosures made by firm *i* in 2013.
$EnvMat_i$	an indicator variable equaling one if firm *i* has above-average risk exposure to environmental issues relative to all firms in firm *i*'s industry *m*. The risk exposure to environmental issues is a firm-level variable from MSCI.
$SocMat_i$	an indicator variable equaling one if firm *i* has above-average risk exposure to social issues relative to all firms in firm *i*'s industry *m*. The risk exposure to social issues is a firm-level variable from MSCI.
$GovMat_i$	an indicator variable equaling one if firm *i* has above-average risk exposure to governance issues relative to all firms in firm *i*'s industry *m*. The risk exposure to governance issues is a firm-level variable from MSCI.
$R\&D_i$	research and development expenditures scaled by total sales of firm *i* at the end of 2013, calculated using Worldscope data.

Appendix Table X: Variable Definitions for Chapter 4 (Continued)

$IndAdjROA_i$	return on assets of firm *i* in excess of the average return on assets in firm *i*'s industry *m* in 2013, calculated using Worldscope data.

Control Variables

$Asset\_Mgr_i$	the percentage of outstanding shares of firm *i* held by asset managers, defined as investment advisors, mutual funds and hedge funds (calculated using 2013 Bloomberg data).
$Asset\_Owner_i$	the percentage of outstanding shares of firm *i* held by asset owners, defined as pension funds, insurance companies and bank trusts (calculated using 2013 Bloomberg data).
MTB_TopQ_i	an indicator variable equaling one if firm *i* is in the top quartile of market-to-book ratio at the end of 2013, and zero otherwise.
$MCap\_BotQ_i$	an indicator variable equaling one if firm *i* is in the bottom quartile of market capitalization at the end of 2013, and zero otherwise.
$Loss_i$	an indicator variable equaling one if firm *i* reports negative earnings in 2013, and zero otherwise.
ADR_i	an indicator variable equaling one if non-U.S. firm *i* also trades in U.S. markets through American Depositary Receipts (ADR) programs during the year, and zero otherwise.
EPS_Volat_i	natural logarithm of time-series standard deviation of EPS over the past 5 years.
$Accruals_i$	scaled accruals for firm *i* computed as: $\Delta CA - \Delta CL - \Delta CASH + \Delta STD - DEP + \Delta TP)/lag(TA)$, where ΔCA is the change in total current assets from 2012 to 2013; ΔCL is the change in total current liabilities from 2012 to 2013; $\Delta CASH$ is the change in cash from 2012 to 2013; ΔSTD is the change in the current portion of long-term debt included in total liabilities from 2012 to 2013; DEP is depreciation and amortization expense in 2013; ΔTP is the change in income taxes payable from 2012 to 2013; and lag(TA) is total assets at the end of 2012.

Appendix Table XI: Events for Chapter 4

Event	Date	Description of Event	Include/ Exclude	Rationale for Exclusion
1	May 30 2001	The EC adopts Recommendation 2001/453/EC to encourage firms to recognize, measure and disclose environmental issues in the annual reports	Exclude	A
2	June 18 2003	Directive 2003/51/EC of the EP and EC sets forth the recommendation for enterprises to voluntarily disclose in their annual reports environmental and employee-related information	Exclude	A
3	April 13 2011	The EC states in a communication to the EP that it is considering the development of a legislative proposal on the transparency of the social and environmental information, and that it will adopt a Proposal on corporate social responsibility (CSR) to encourage companies to pursue social and environmental activities	Exclude	B
4	April 14 2011	Royal Dutch Shell expresses strong opposition to additional mandatory disclosure requirements in its response to the "Public consultation on disclosure of non-financial information by companies"	Exclude	C
5	July 11 2011	First meeting of the Expert Group on disclosure of non-financial information by EU companies, established for impact assessment by the EC on disclosure of non-financial information by companies	Exclude	C
6	September 12 2011	Second meeting of the Expert Group on disclosure of non-financial information by EU companies	Exclude	C
7	September 30 2011	Third meeting of the Expert Group on disclosure of non-financial information by EU companies	Exclude	C
8	October 25 2011	The EC presents a communication to the EP recommending improved transparency of the social and environmental information provided by companies, and improved social and environmental practices by companies	Exclude	B
9	January 24 2012	Fourth meeting of the Expert Group on disclosure of non-financial information by EU companies.	Exclude	C
10	February 6 2013	The EP plenary session adopts two non-legislative Resolutions on CSR	Exclude	B
11	**April 16 2013**	**The EU Commission proposes an amendment to accounting legislation to improve the transparency of certain social and environmental matters**	**Include**	
12	December 19 2013	News release of how Member States of the EU adopted the position of wanting to subject only listed companies to any of the proposed nonfinancial reporting requirements.	Exclude	C, D (event 11)
13	February 7 2014	News release of how several member states (Germany, UK, Belgium, Ireland, the Czech Republic, Hungary, Poland, Latvia, Estonia, Malta and Slovakia) wish to limit the scope to listed businesses only.	Exclude	C, D (event 11)

Appendix Table XI: Events for Chapter 4 (Continued)

14	February 13 2014	News release describing the February 11 meeting between the EP, EC, and the Council on the issue of non-financial reporting	Exclude	C, D (event 11)
15	February 17 2014	News release of how negotiations between the EP and Council might lead to a deal in the coming days or weeks on the proposal for a directive on the disclosure of non-financial information	Exclude	C, D (event 11)
16	**February 26 2014**	**The EP and the Council agree on an amendment to existing accounting legislation to improve the transparency of certain large companies on social, environmental and diversity matters**	**Include**	
17	March 11 2014	News release of how the agreement was reached on EU nonfinancial reporting requirements	Exclude	C, D (event 16)
18	April 9 2014	News release of how listed companies will for the first time be required to report on key human rights and environmental issues following a last-minute compromise between EU member states and the EP	Exclude	C, D (event 16)
19	**April 15 2014**	**The EP adopts the Directive on disclosure of non-financial information**	**Include**	
20	April 15 2014	News release of the formal adoption of the Directive to mandate non-financial reporting	Exclude	C, D (event 19)
21	September 29 2014	EU Member States go through procedural step to formally adopt the Directive on disclosure of non-financial information following the EP's adoption on April 15, 2014	Exclude	C, D (event 19)

This appendix presents the 21 dates considered for the analysis, the three events included in the final sample (indicated in bold), and the rational for the exclusion of the 18 other dates. Abbreviations: EC is the European Commission; EP the European Parliament; and EU is the European Union.

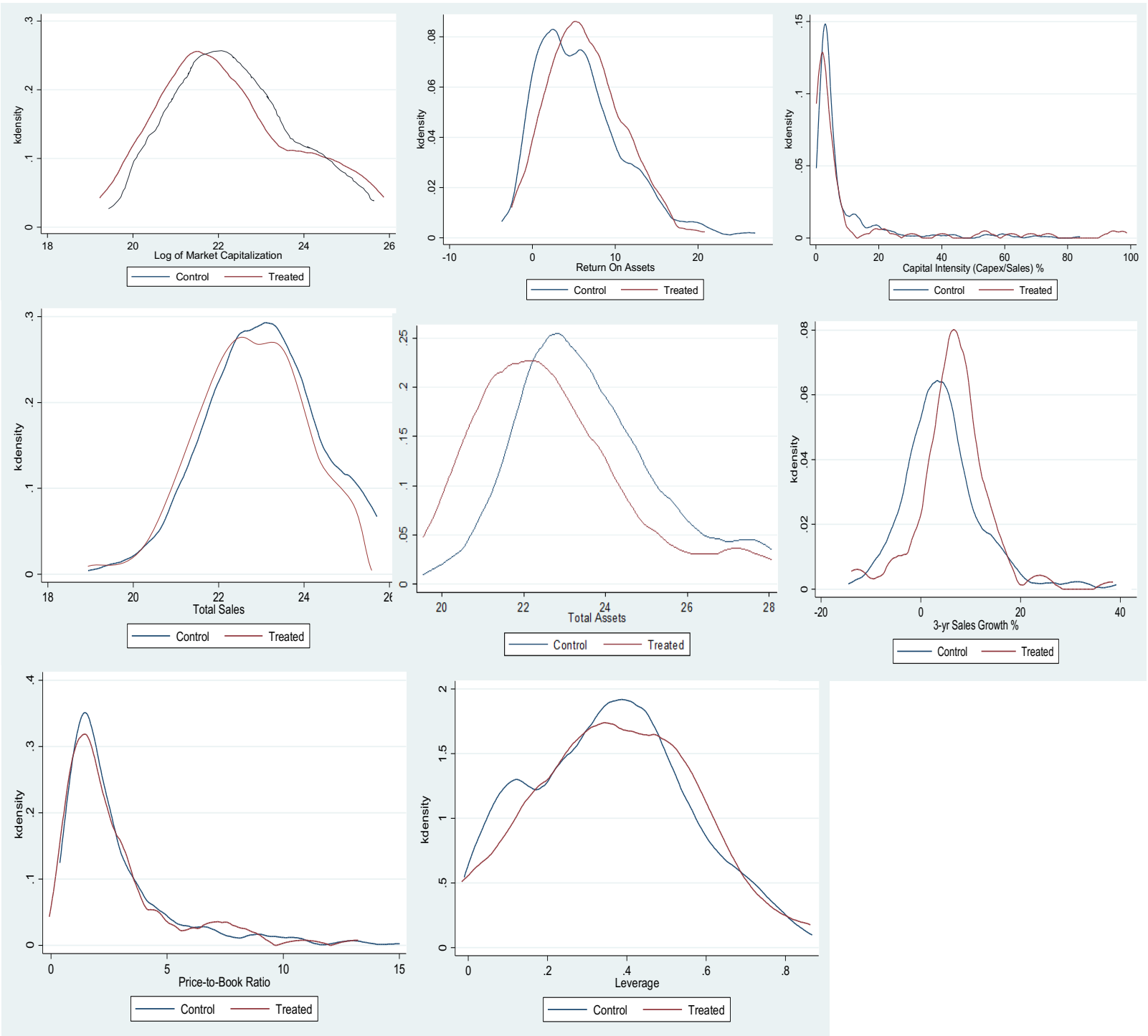
Rational for Exclusion includes the following reasons:

- A Pertains to voluntary (not mandatory) nonfinancial disclosure.
- B Confounded event; pertains to both nonfinancial disclosure and other non-disclosure matters related to ESG.
- C Assessed as not significant enough for a major effect on the likelihood of mandated nonfinancial reporting in the EU.
- D Confirms a prior event (with the previous event indicated in parentheses).

Appendix Figure A

Tests of the overlap assumption - Kernel Density Graphs

These figures plot the kernel density of the eight matching covariates. In all cases, the estimated densities of the treated and control group share most of their respective masses in regions in which they overlap each other.



Appendix Figure B: Plotted Climate Change Risk Perceptions over Time

These figures plot the average climate change risk perceptions for matched treated and control firms relative to when mandatory carbon reporting comes into effect (t=0).

Figure B1: Regulatory Risk Perceptions

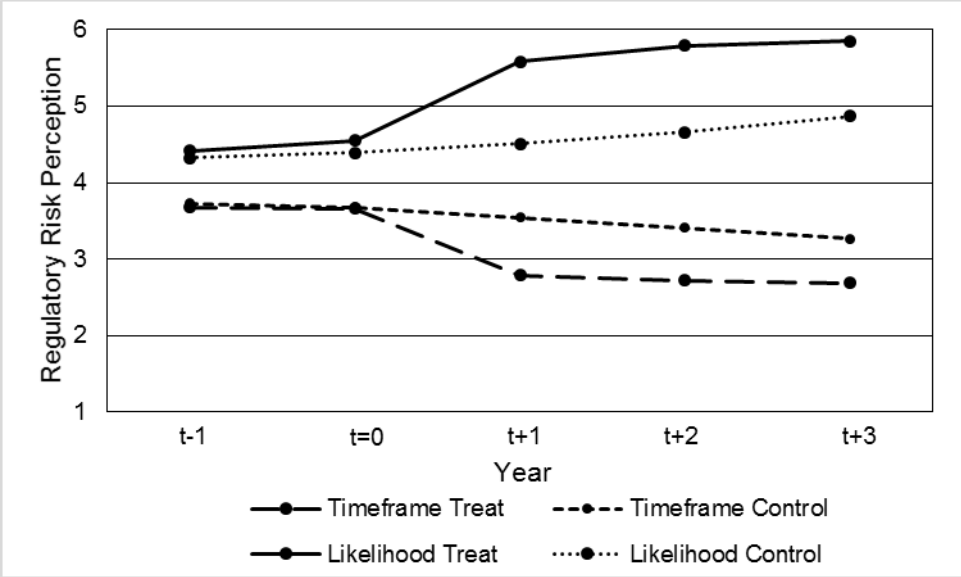


Figure B2: Reputation Risk Perceptions