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by

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Abstract

In this paper, I estimate the effect of mandatory greenhouse gas (GHG) emissions disclosure on corporate value. Using the introduction of mandatory GHG emissions reporting for firms listed on the Main Market of the London Stock Exchange as a source of exogenous variation, I find that firms most heavily affected by the regulation experience significantly positive valuation effects. Increases in value are strongest for large firms and for firms from carbon intensive industries (e.g., oil and gas). Valuation increases are driven by capital market effects such as higher liquidity and lower bid–ask spreads for the most affected firms.

"I am looking at this through the lens of risk — climate change is not only a risk to the environment but it is the single biggest risk that exists to the economy today."[2]

Henry M. Paulson Jr. - Former Secretary of the Treasury

An organizing principle of securities market regulation is the view that mandatory reporting requirements of firm specific information allow capital markets to function more efficiently. Typically, financial information such as audited balance sheets as well as income and cash flow statements represent the cornerstone of such requirements. In addition, security market regulators like the Securities and Exchange Commission (SEC) require publicly listed firms to include any information in their periodic regulatory filings (e.g., 10K's) that is deemed to be "material."[3] Overall, economists, accountants, and law makers seem to be in agreement about the relative merits of mandating the disclosure of financial information: For instance, academic studies have shown that investors value mandatory disclosure of financial information at the firm level (see Greenstone, Oyer, and Vissing-Jorgensen (2006), Ferrell (2007), or Leuz and Wysocki (2015)), cross-country studies find that mandatory disclosure requirements are related with higher equity valuations (see La Porta, Lopez-de Silanes, Shleifer, and Vishny (2002)), and securities laws in the US mandate publicly listed firms to disclose financial information at least since the Securities Act of 1933.[4]

In contrast, there is much more debate over whether firms should also be required to disclose standardized non-financial information on, for instance, how they manage the risks and opportunities related to climate change.[5] This debate is set, however, against the backdrop of ever more anecdotal evidence suggesting that investors increasingly demand such infor-

[2]Quote from a panel discussion at the Clinton Global Initiative Annual Meeting in September 2014. See `http://goo.gl/5KnGP6`

[3]Information is regarded as being material if "a substantial likelihood that the disclosure of the omitted fact would have been viewed by the reasonable investor as having significantly altered the "total mix" of information made available. (U.S. Supreme Court, TSC Indus. V. Northway, Inc., 426U.S. 438 (1976)) See `http://goo.gl/O0YLpl`

[4]See `http://www.sec.gov/about/laws/sa33.pdf`

[5]The SEC has so far shied away from mandating disclosure of climate change information and has only issued guidance as to how existing disclosure requirements apply to climate change matters (See SEC (2010)).

mation. For instance, *The Carbon Disclosure Project*[6] (CDP), an organization dedicated to collecting and disclosing corporate climate risk data of listed corporations worldwide, is supported by several hundreds of institutional investors representing trillions of USD in assets. In addition, shareholders increasingly engage with respect to climate change: CERES,[7] an NGO concerned with corporate environmental conduct and raising awareness of environmental issues among institutional investors published a report[8] recently suggesting that mutual fund companies showed record high support for climate change related shareholder resolutions during the 2013 proxy season. In a similar vein, data from Institutional Shareholder Services (ISS)[9] shows that climate Change was one of the most common topics for shareholder proposals in the proxy season 2014.[10] Also, institutional investors such as Yale's endowment fund, CALPERS, or Norges Bank Investment Management (NBIM), the arm of the Norwegian Central Bank responsible for managing the Government Pension Fund Global are nowadays pushing their managers and investee companies to evaluate their risk exposure to climate change. For example, Yale's chief investment officer David Swensen recently urged external managers to evaluate "the effects of climate change on the businesses in which they are or might be investing,"[11] and NBIM requires that the firms in which the Government Pension Fund Global invests "should disclose information on their climate change strategy, actions, and governance [and] manage risk associated with the causes and impacts of climate change."[12] Going further even, CALPERS CEO Anne Stausboll recently stressed the importance of mandatory corporate climate risk reporting, a statement which has been echoed by Mark Carney, the standing governor of the Bank of England[13].

[6] See `http://www.cdp.net/en-US/Pages/About-Us.aspx`

[7] See `http://www.ceres.org/about-us/coalition`

[8] `http://goo.gl/nMaHKT`

[9] ISS is the world's leading provider of corporate governance solutions for asset owners.

[10] Related, Dimson, Karakas, and Li (2015) show that successful climate change shareholder engagements generate positive risk adjusted abnormal returns for investors in a sample of private shareholder engagements.

[11] See `http://goo.gl/FlHpta`

[12] See `http://goo.gl/Uni5KL`

[13] See `http://goo.gl/1fZK4c`, `http://goo.gl/4ywBMH` and `http://goo.gl/Ob8IBA`

While such anecdotal evidence of heightened investor interest in climate change is interesting, it cannot sufficiently inform policy makers in the task of evaluating whether there is a case for increasing transparency with respect to how corporations address climate change. Instead, research providing clean identification and causal evidence on the impact of mandatory carbon disclosure requirements on firm value as well as other firm policies is required to inform the regulatory debate.

In this paper, I provide such causal evidence by using a difference-in-differences (DID) setting to examine how mandatory carbon disclosure requirements affect firm value. More specifically, I exploit a recent regulatory change in the corporate reporting environment in the United Kingdom (UK) as a quasi-natural experiment. *The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013* (The Act), which was passed into law in July 2013, now requires every UK quoted company[14] to report comprehensive data on their GHG emissions in their annual reports. The landmark introduction of this new law, which makes the UK the first country to introduce mandatory carbon reporting for publicly listed firms, provides an interesting and unique setting to study the economic and valuation effects of mandatory greenhouse gas emissions disclosure.

The main challenge in identifying the economic effects of the regulation on UK quoted companies arises from finding appropriate control group(s). In this paper, I use mainly two control groups. First, I use size and industry matched firms listed on other European exchanges as a control group. Since the law does not extend to other European countries, using European firms as a control group allows identifying a counterfactual. In a second set of tests, I directly compare UK quoted companies that did not report publicly prior to the regulation ("non–compliant") with firms that did ("quasi–compliant"). The idea in this second approach is that a UK based control group of quasi–compliant firms should be subject

[14]A UK quoted company is a company that is incorporated in the UK with equity share capital being listed on the Main Market of the London Stock Exchange, an European Economic Area State or admitted to trading on the New York Stock Exchange or Nasdaq.

to the same concurrent shocks as the non–compliant treatment group and that both groups should thus respond similarly to such concurrent shocks. In addition, the comparison of UK firms that had already been publicly disclosing climate change related information before the regulation with UK firms that had not been doing so allows for more nuanced tests of how the reporting requirements affect firm value. More specifically, quasi–compliant firms should be less or not affected by the new requirements, while non–compliant firms should be more strongly affected.[15] Taken together, both research designs, i.e., comparison of UK firms with matched European firms and comparison of non– and quasi–compliant firms, provide important insights into the valuation effects of mandatory carbon reporting, and thus the overall desirability of such regulation.

I start by showing that UK quoted companies (treatment) experience strong valuation increases with respect to matched European firms (control) after the regulation (difference-in-differences). To ensure that this constitutes a treatment effect and not simply unobservable or observable differences between firms listed on LSE's Main Market and the matched firms from other European countries, I split the treatment group in "early–reporters" (quasi–compliant) and "non–reporters" (non–compliant). I then separately compare the two groups with their matched European firms. The idea of splitting up the treatment group is that treatment should be stronger for non-compliant firms. In contrast, the regulation can be regarded as "pseudo-treatment" for early reporters because already compliant firms should be less affected by the new regulation.

Consistent with the idea of already compliant firms being less affected by the regulation, I show that quasi–compliant firms (i.e., firms that were already reporting publicly before the regulation) do not show valuation differences after the regulation when compared to firms on other European stock exchanges. In sharp contrast, however, the results show that non–

[15] Quasi–compliant firms might still be affected by the new regulation because the new regulation now requires disclosure and does no longer give firms a choice.

compliant UK quoted companies (i.e., firms that did not report publicly on climate change issues prior to the new requirements) experience highly significant valuation increases after the regulation relative to their size and industry matched European peers. This dichotomy in the treatment effect for non– and quasi compliant firms provides corroborating evidence that investors value mandatory transparency with respect to greenhouse gas emissions.

In the second series of tests, I focus directly on differences between non– and quasi–compliant firms. I document a positive average treatment effect when non-reporting UK firms (treatment) are compared to early-reporting ones (second control group). In other words, firm value increases more for non–compliant firms after the regulation than for already compliant ones. Again, the evidence suggests that investors value mandatory transparency with respect to carbon emissions positively.

In the next step, I explore the cross-sectional and time-series variation of the valuation impact of mandatory carbon information disclosure. Cross-sectionally, I show that the valuation differences are strongest for the largest firms in a given industry, consistent with the intuitive notion that climate change is a more important issue for larger firms. By the means of a triple difference (DDD) test, I also show that the DID estimate is highest for oil and gas companies and for firms belonging to the mining sector, highlighting the idea that investors value carbon transparency more in carbon intensive sectors with potentially stronger negative impacts on the climate. In terms of the time-series, I provide evidence that there are no valuation differences between control and treated firms prior to the time at which the likelihood of mandatory carbon reporting increased sharply. This is crucially important for identification since it confirms that the parallel-trends assumption is satisfied in the data and thus validates the DID approach.

Research in economics, finance, and accounting suggests at least two reasons for why mandatory (environmental) disclosure regulation would enhance firm value. The first view, which is rooted in environmental economics, argues that properly designed environmental

regulation does not necessarily have to be costly to firms. Among several reasons for why environmental regulation could enhance firm value is that regulation can signal about likely resource inefficiencies and make managers address inefficiencies through technological improvements. Correctly designed environmental regulation can then trigger innovation that may partially or more than fully offset the costs of complying with the regulation. One implication of what has become to be known as the Porter hypothesis (see Porter and Van der Linde (1995)) is that the regulation should result in real effects and one should observe that firm behavior of the mandated firms changes post regulation. For instance, the Porter hypothesis would suggest that mandated firms respond to the regulation by increasing investment or spending on research and development, which could increase operational efficiency (as measured, for instance, by return on assets).

The second view as to why mandatory environmental disclosure would matter for firm value is based on insights from information economics and suggests that mandatory disclosure reduces information asymmetries among investors (see, for instance, Verrecchia (2001) and Leuz and Wysocki (2015)). As a result of increased transparency and disclosure, the adverse selection problem in stock markets can be reduced and uninformed investors would become more inclined to trade and less inclined to exit the market. Thus, increased transparency with respect to carbon emissions could lead to higher liquidity suggesting that disclosure induced increases in valuation would come mainly through capital market benefits.

To distinguish between the Porter hypothesis and the view based on a reduction of information asymmetries, I calculate several additional outcome variables which can be thought of as capturing either capital market or real effects. I then apply the same DID framework to study before-after differences between non– and quasi–compliant firms for these outcome variables. The objective of these tests is to better understand why exactly firm value increases for the most affected firms. I provide evidence that treated firms are not subject to real effects (e.g., change in capital expenditures, R&D spending, or ROA): for these vari-

ables, the average treatment effect is always indistinguishable from zero. In contrast, the most affected firms show significant increases in liquidity and decreases in bid-ask spreads, suggesting that the increases in firm-value are mainly attributable to reductions in information asymmetries. Such capital-markets effects of mandatory disclosure, especially the strong effect on trading volume, are very much consistent with prior research on mandatory financial disclosure regulation (see Leuz and Wysocki (2015)).

This paper is related to several different literatures. First of all, it relates to the literature on the valuation implications of mandatory reporting regulation (Greenstone, Oyer, and Vissing-Jorgensen (2006) or Ferrell (2007)) and corporate disclosure in general (see Leuz and Wysocki (2015)). Secondly, it contributes to literatures concerned with (asset) pricing implications of climate risk (see, e.g., Andersson, Bolton, and Samama (2014), Daniel, Litterman, and Wagner (2015), or Litterman (2013)), and the uncertainty about climate change parameters (see Freeman, Wagner, and Zeckhauser (2015)). It is also related to papers concerned with the financial effects of environmental regulation (see Porter and Van der Linde (1995), Palmer, Oates, and Portney (1995), or Ambec, Cohen, Elgie, and Lanoie (2013)). The paper also complements recent papers in accounting and finance that examine the value and cost of capital effects of *voluntary* greenhouse gas emission disclosure (see Matsumura, Prakash, and Vera-Muñoz (2013) and Kleimeier and Viehs (2015)). Finally, the paper is also somewhat related to the literature examining how shocks to governance arrangements, e.g., the Sarbanes Oxley Act (see Chhaochharia and Grinstein (2007)) or quotas on board composition (see Ahern and Dittmar (2012)), affect firm value.

The rest of the paper is organized as follows. Section 1 provides detailed background information on the *The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013*, the legislative change that is used to identify the effect of mandatory carbon disclosure on firm value. Section 2 discusses mandatory GHG disclosure from an environmental and disclosure regulation perspective. Section 3 provides background information on

voluntary climate change reporting and the Carbon Disclosure Project, the organization that provided some of the data used in this paper. Section 4 outlines the sample construction and shows summary statistics of important variables. Section 5 contains the empirical analysis and discusses the results while section 6 concludes. Finally, the Internet appendix[16] provides more background information on CDP, discusses descriptive statistics on the beliefs of the corporate sector when it comes to climate change risks, shows quantitative data on GHG emissions by industrial sector, and contains additional robustness tests.

1 Background on The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013

The main identification in this paper comes from the exogenous shock in climate change reporting induced by the passage of The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, a law that now requires a subset of listed UK firms to publicly report on their GHG emissions. The provisions of the Act concerning the GHG reporting requirements can be found in Part 7 Disclosures Concerning GHG Emissions of The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013.[17] This section provides some background information on the Act.

[Table 1 about here.]

1.1 Major Events Leading to the Legislation

Table 1 shows a chronology of important events that ultimately led to the Act. Writing in The Guardian, Deputy Prime Minister Nick Clegg announced on June 19, 2012 that the UK government was going to pass legislation forcing UK quoted companies to publish full

[16]Internet appendix available at `http://goo.gl/auPnra`

[17]The legislative text is available here `http://goo.gl/zaYLXU`.

details on their GHG emissions in their annual reports.[18] Speaking at the United Nations Conference on Sustainable Development *Rio+20* two days later, the deputy prime minister reiterated the UK government's intent of mandating corporate GHG reporting.[19]

The announcement had followed a public consultation that lasted from May 11, 2011 to July 5, 2011 during which the Department of Environment, Food & Rural Affairs (DEFRA), the UK government department responsible for policy and regulations on environmental, food, and rural issues, had sought views on the question of whether regulations should be introduced to make it mandatory for some UK companies to report on their GHG emissions (see DEFRA (2011c)). This broad consultation of about two thousand stakeholders (e.g., individuals, companies, trade associations, not for profit organizations, campaigning organizations, investors, local authorities, regulators, investors and members of parliament), sought to clarify whether the UK government should continue to encourage measurement and reporting of GHG emissions on a voluntary basis, or whether mandatory regulation should be introduced. More specifically, respondents were asked to express their views on potential policy options and to choose their preferred one among (0) business as usual (no change to the current policy position), (1) enhanced voluntary reporting: increasing awareness of reporting guidance and outreach, (2) mandate GHG reporting under Companies Act[20] for all quoted companies, (3) mandate GHG reporting under Companies Act for all large companies, or (4) mandate GHG reporting for all companies meeting an energy use criteria.

During the consultation period, respondents were also provided with an impact assessment (IA No.: DEFRA1334, see DEFRA (2011a)) published on January 17, 2011, which included background information on the different policy options, most notably detailed cost

[18] See `http://goo.gl/TdWlSF`

[19] See `http://goo.gl/tWrN4i` for a transcript of the speech by Nick Clegg at the RIO 20+ Summit.

[20] The Companies Act 2006 is an Act of the Parliament of the United Kingdom which forms the primary source of UK company law.

and benefit analyses for the different options. Preparing such impact assessments is common practice in the UK and the assessments are supposed to help policy-makers to understand the consequences of possible and actual government interventions in the public, private, and third sectors, but also as a tool to enable the government to weigh and present the relevant evidence on the positive and negative effects of such interventions. The public consultation orchestrated by DEFRA had been a direct result of The Climate Change Act 2008,[21] which made it the duty of the UK government to pass regulations by April 6, 2012 requiring the director's report[22] to include information about GHG emissions or to lay a report before parliament explaining why no such regulations had been made.

On August 31, 2011, DEFRA published a revised version of the initial impact assessment DEFRA1334 (see DEFRA (2011b)). Besides updated cost/benefit analyses and further background information on the different policy options, the new version now also included insights from the consultation process. Most importantly, the new version included information about DEFRA's preferred policy option, i.e., "mandatory GHG reporting under Companies Act 2006 for all quoted companies."[23] While this revised impact assessment was available to members of parliament and policy makers from August 31, 2011, it is unclear when exactly the content of the assessment became publicly available. If the document had not already been publicly available on August 31, 2011, i.e., the offical date of the report, there are several pieces of evidence suggesting that at least DEFRA's preferred policy recommendation became publicly available around that time: First, on September 15, 2011, *The Environmental Audit Committee*, a committee appointed by the House of Commons[24]

[21] The Climate Change Act 2008 is an Act of the Parliament of the United Kingdom. The Act makes it the duty of the Secretary of State to ensure that the net UK carbon account for all six Kyoto greenhouse gases for the year 2050 is at least 80% lower than the 1990 baseline, toward avoiding dangerous climate change. See, in particular, Section 85 of Climate Change Act 2008.

[22] A document produced by the board of directors under the requirements of UK company law, detailing the state of the company and its compliance with a set of financial, accounting and corporate social responsibility standards.

[23] See page 1 in DEFRA (2011b).

[24] The House of Commons is the lower house of the Parliament of the United Kingdom of Great Britain

to consider to what extent the policies and programmes of government departments and non-departmental public bodies contribute to environmental protection and sustainable development[25] published its *Seventh Report* titled *Carbon Budgets*.[26] Section 4 "The Carbon Plan" of the report contains explicit references not only to the DEFRA consultation process, but also to the preferred policy option from the revised impact assessment:

> "The Government consulted earlier this year on options to promote more widespread and consistent emissions reporting. [...] In order to aid transparency and illustrate the contributions that businesses are making, and need to make, to help tackle climate change, ***we recommend that the Government should introduce mandatory reporting by businesses at the earliest opportunity***."[27]

Second, around the completion of the DEFRA consultation in July 2011, several interest groups and companies that had participated in the consultation published their responses publicly. The majority of the organizations that spoke out publicly recommended mandatory disclosure. Institutions recommending mandatory disclosure included not only business lobbies such as The Confederation of British Industry (UK's premier business lobbying organization) or the Food and Drink Federation (Body representing the UK food and drink manufacturing industry), but also NGO's and companies such as the Climate Disclosure Project, Climate Disclosure Standards Group (consortium of global business and environmental NGOs.), the Aldersgate Group (a coalition of environment agencies, NGOs, think tanks and industry representatives), and Marks and Spencer's.

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and Northern Ireland which, like the House of Lords (the upper house), meets in the Palace of Westminster.

[25]Other functions of the Environmental Audit Committee include to report to the House of Commons on environmental policies and to audit the performance of environmental policies against targets as may be set for them by Her Majesty's Ministers.

[26]See the report which was ordered by the House of Commons to be printed on September 14, 2011. (`http://goo.gl/Gjub4N`)

[27]`http://goo.gl/6SlSzg`

These two pieces of evidence suggest that an informed investor could have anticipated not only the course of action of the government regarding the policy matter at hand, but also the likely design of the regulation at the end of the summer of 2011 and thus almost a year before the official announcement by the government in June 2012.

Since the UK government missed the April 2012 deadline that was stipulated in the Climate Change Act 2008 for passing regulation on corporate GHG emission reporting, pursuant to Section 85 of the Climate Change Act 2008, the government laid a report before parliament on March 27, 2012 outlining why no regulations had been introduced so far (see DEFRA (2012a)). The report showed that ministers were still debating the different policy options and the responses from the public consultation and had not reached their final decision. The formal announcement then came on June 20, 2012 alongside the publication of a detailed report (see DEFRA (2012b), which provided detailed information on the outcomes and results form the public consultation. The first draft of the legislative text became publicly available on July 25, 2012 and a period of consultation for the first draft ended on October 17, 2012. The text was laid before parliament on June 10, 2013 and the House of Commons approved the bill on July 16, 2013. The act has come into effect on October 1, 2013.

1.2 Which Companies Are Concerned by the Act?

The Act concerns all UK quoted companies. A quoted company is defined in section 385(2) of the Companies Act 2006 as a company that is UK incorporated and whose equity share capital is listed on the Main Market of the London Stock Exchange or on an exchange in an European Economic Area (EEA)[28] state, or admitted to trading on the New York Stock Exchange or Nasdaq.

[28]The EEA is a free trade area in Europe. It is made up of 30 member countries, which includes EU and non-EU countries.

The Act exempts certain firms from the reporting requirement, most notably small firms that meet at least two of the following requirements: (i) Turnover lower than £6.5m, (ii) balance sheet total lower than £3.26m or, (iii) average number of employees lower than 50.

1.3 What Needs to be Reported?

The legislation requires firms to report the annual quantity of emissions in metric tonnes of carbon dioxide equivalent (CO2e) resulting from activities for which a company is responsible including the combustion of fuel and the operation of any facility from the purchase of electricity, heat, steam, or cooling by the company for its own use. This is what the GHG protocol refers to as Scope 1 and 2 emissions.[29] In addition, firms must report at least one ratio which expresses the company's total annual emissions in relation to a quantifiable factor associated with the company's activities (e.g. sales, assets, etc.). In other words, firms need to report both absolute (quantity) and relative emissions (intensity).

Besides these measures, firms must also report the methodologies used to calculate emissions intensity and quantities. Furthermore, not only emissions information for the current financial year need to be reported, but also emissions information as disclosed in the report for the preceding financial year. Firms are also required to state if the period for which GHG emissions are reported differs from the financial year of the company.

1.4 Where Will the Information Be Disclosed?

The Act adds the Strategic Report as a new section to the Directors' Report. The Directors' Report, a document prepared annually by the board of directors under the requirements of UK company law, is the UK equivalent of SEC Form 10-K in the United States. The purpose of the Directors' Report is to assess how the directors have performed in their duty to

[29] See section 3 for more details.

promote the success of the company. The information on GHG emissions will need to be disclosed in the Directors' Report.

2 Economic Perspectives on Mandating GHG Emissions Disclosure

The Act is a hybrid regulation since it contains both an environmental and a disclosure oriented regulatory component. While the Act directly regulates disclosure requirements by forcing firms to produce reliable and standardized information of their GHG emissions, the Act does not put a tax on emissions nor does it constrain the quantity of GHG emissions. However, requiring the measurement and periodic disclosure of GHG emissions regulates the environmental externality related to carbon emissions *indirectly* because mandating disclosure transforms GHG emissions into a potentially costly environmental liability. This is because the regulation generates verifiable records of the quantity of emissions for individual firms. As a result firms emitting more are likely to face higher total regulatory costs should quantity regulation be introduced in the future. This section explores the main economic perspectives on environmental and (financial) disclosure regulation.

2.1 Environmental Regulation

2.1.1 The Traditional View

Traditionally, regulation aimed at reducing the negative impact of firms on the environment is regarded as being costly to firms. This is because such regulatory actions force firms to allocate inputs (e.g., labor or capital) to complying with the regulation. Even though regulation might generate environmental or other societal benefits, the internalization of the environmental externality reduces firms' options and thus, by definition, also reduces

firms' profits. Accordingly, there is an important trade-off between the beneficial effects of a regulation and the private costs that are required to generate the desired benefits (see, for instance, Palmer, Oates, and Portney (1995)).

2.1.2 The Porter Hypothesis

In a controversial paper, Porter and Van der Linde (1995) challenge the traditional view and argue that properly designed environmental regulation does not necessarily have to be costly to firms. This is because if correctly designed, environmental regulation can trigger innovation that may partially or more than fully offset the costs of complying with the regulation. According to what has since become to be known as the Porter hypothesis, environmental regulation can thus be conducive to innovation that will add to profits, by for instance, bringing about improvements in energy or resource efficiency.

Porter and Van der Linde (1995) spell out several channels through which environmental regulation could positively impact business performance (see also Ambec, Cohen, Elgie, and Lanoie (2013)): First, regulation can signal about likely resource inefficiencies and potential technological improvements. Second, regulation focused on information gathering and disclosure can achieve major benefits by raising corporate awareness for potentially financially material issues. Third, environmental regulation reduces uncertainty that environmentally oriented investments will be valuable. Finally, environmental regulation creates pressure that motivates innovation and progress. All in all, the Porter hypothesis suggests that well-designed environmental regulation can lead to Pareto improvements. It assumes implicitly however, that managers might not always be profit maximizing.

2.2 Information Disclosure Regulation

As stated above, the Act constitutes mainly an accounting regulation by mandating changes to firms' reporting requirements. As a starting point, it is important to note that

the literature on corporate information disclosure and the regulation thereof (see Leuz and Wysocki (2015, 2008) for excellent reviews) focuses mainly on economic consequences of *financial* reporting and disclosure regulation. This is not surprising as financial information represents the cornerstone of the firm-specific information set available to investors and regulators. Typically, the literature distinguishes between mandatory and voluntary disclosure. The majority of research focuses on voluntary disclosure and reporting choices. This is true for both academic work on financial information disclosure (see Leuz and Wysocki (2015)) and disclosure of climate change related information (see Matsumura, Prakash, and Vera-Muñoz (2013) and Kleimeier and Viehs (2015)). While such studies are informative about the private costs and benefits of voluntary disclosure, thus providing micro-foundations, analysis of voluntary disclosure choices cannot deliver insights about the overall economic desirability, economic efficiency, or aggregate outcomes of mandatory reporting and disclosure regulation. In the words of Leuz and Wysocki (2008) "debates about disclosure and financial reporting regulation often incorrectly point to firm-specific (net) benefits of voluntary disclosure choices rather than focus on the aggregate effects of regulation." In their parlance, aggregate effects refer to effects on whole groups of firms. Leuz and Wysocki (2008) also note that there is generally less evidence on these aggregate economic and social consequences of reporting and disclosure regulation.

2.2.1 Firm Specific Benefits of Financial Information Disclosure

Leuz and Wysocki (2015) identify several channels through which disclosure can generate firm specific benefits. First, disclosure can mitigate the adverse selection problem in stock markets, enhancing liquidity thereby enhancing firm value (see also Verrecchia (2001)). Second, if disclosure leads to improved risk sharing in the sense of Merton (1987), it can also be beneficial for firm value. Apart from such capital market effects resulting from disclosure, firm value can also be impacted through the governance role of disclosure. Disclosure

can change managerial behavior and actions, which can directly change the distribution of future cash flows (see, e.g., the framework presented in Shleifer and Wolfenzon (2002)). A similar taxonomy of the benefits of disclosure is provided by Bushman and Smith (2001), who identify three channels for disclosure to have firm-level benefits: (i) better identification of good versus bad projects by managers and investors (project identification), (ii) discipline on project selection and expropriation by managers (governance role of disclosure), and (iii) reduction in information asymmetries among investors.

2.2.2 Firm Specific Costs of Financial Information Disclosure

Information disclosure is costly to corporations. Firms have to set up systems and processes to collect, measure, prepare, certify, and disseminate the information at hand. These costs are of direct nature and can involve both fixed (in the case of investing in reporting systems), or variable costs (in terms of paying for labor to run the systems). Besides these straightforward direct costs of information disclosure, there are also indirect costs from disclosing information. For instance, publicly disclosed information that otherwise would have remained private can be used at the disadvantage of the disclosing entity by various stakeholders such as competitors, labor unions, creditors, banks, regulators, investors, etc.). In short, there are numerous direct and indirect costs to information disclosure.

2.3 Is Mandatory Disclosure Desirable from a Regulatory Perspective?

From an environmental regulation perspective, the Porter hypothesis suggests that mandating GHG disclosure could be value enhancing and thus desirable. In fact, the four abovementioned channels through which environmental regulation would affect firm value seem to apply remarkably well to the case of GHG emissions disclosure. An important implication

of the Porter hypothesis is that firms subject to disclosure regulation should respond by changing economic behavior (e.g., by investing more, increasing economic efficiency, etc.). In contrast, the value implications are not clear from the traditional view on environmental regulation, since the value implications very much depend on the trade-off between societal and firm-level benefits as well as costs. From an environmental regulation perspective, it is thus not clear whether mandatory GHG disclosure is economically beneficial.

In a similar vein, the literature on mandatory disclosure regulation also makes conflicting predictions about the overall desirability of regulation. Leuz and Wysocki (2008) note that the costs and benefits of mandatory information disclosure are complex and argue that the net effect of disclosure regulation on a market or an economy is largely an empirical question. It is thus important to exploit the unique setting of the introduction of mandatory GHG disclosure in the UK to examine the overall desirability of regulating GHG emissions disclosure.

3 The Carbon Disclosure Project (CDP)

To evaluate the effect of mandatory GHG emissions disclosure on corporate value, I rely on data from the Carbon Disclosure Project. CDP is an independent not-for-profit organization backed by more than 767 institutional investors representing about US$92 trillion in assets. The Harvard Business Review has coined CDP "The Most Powerful Green NGO You've Never Heard Of."[30] Since 2003, CDP runs annual surveys asking publicly listed companies to report data and information to CDP on how they address climate change related issues. CDP maintains the by far most comprehensive database on corporate responses to climate change, and many data providers (e.g., Thomson Reuters, Bloomberg, MSCI, etc.) source their climate related data from CDP.

[30] See `http://blogs.hbr.org/2010/10/the-most-powerful-green-ngo/`

Using a questionnaire (information request), CDP requests information from companies in both emerging and developed markets. Typically, CDP tries to contact the largest publicly-listed firms in international capital markets. For their 2013 survey, CDP requested information from 5,521 different firms worldwide.[31]

[Figure 1 about here.]

Figure 1 shows a screenshot of the first page of the CDP 2013 information request. The first section of the request, parts of which are shown in the figure, contains mainly qualitative questions concerning the way climate change is integrated in the strategy or the corporate governance structures of the firm. Section A of the Internet appendix contains more detailed background information on the CDP questionnaire. Typically, the annual information request is sent out to corporations at the beginning of February of a given year. Corporations have to submit their response to CDP by the end of June. Submissions are made through an online response system.

3.1 The Response Permission

When submitting a response to CDP, the responding firm is asked to mark their response as either "Public" or "Private." This status is known as the "response permission." Private responses are made available to the requesting authority only. In the case of the *Investor CDP*,[32] the requesting authority are the signatory investors on behalf of which CDP sends out the information requests (i.e., those who are backing the CDP). Private responses are obviously also available to CDP itself. In contrast, public responses can also be accessed by the general public. Typically, public responses are made available through CDP's website in October of each year. An important difference between "Private" and "Public" responses is

[31] See section A of the Internet appendix for more information.

[32] CDP also runs other questionnaires, e.g., the CDP Supply Chain request. In the case of CDP Supply Chain it would be the procuring company (also known as a Supply Chain Member).

also that data from firms that choose to report privately will not be available to third party providers who source data from CDP (e.g., Bloomberg, Thomson Reuters).

3.2 Measuring Corporate GHG Emissions: A Primer

An important element of the CDP request is data on the quantities of GHG emissions. Consistent with The Kyoto Protocol,[33] companies typically report data for six greenhouse gases, i.e., (1) carbon dioxide (CO2), (2) methane (CH4), (3) nitrous oxide (N2O), (4) hydrofluorocarbons (HFCs) and the two groups of gases (5) perfluorocarbons (PFCs), and (6) sulphur hexafluoride (SF6). These six greenhouse gases have different "Global Warming Potential" (GWP). As an example Nitrous oxide has a GWP 268 times that of CO2.[34] GWP is a relative measure of how much heat a GHG traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide (CO2e). This is why emissions are typically measured in metric tons of CO2e, where CO2e stands for "CO2 equivalent". This procedure allows taking into consideration that some gases have higher global warming potential (GWP) than others, and they are made comparable by rescaling all emissions into GWP in terms of CO2 emissions. See also the Appendix of Andersson, Bolton, and Samama (2014) for further information on the measurement of CO2 emissions.

There are several standards regarding the measurement of GHG emissions that are currently employed by organizations to understand, quantify, and manage GHG emissions. The Greenhouse Gas Protocol (GHG Protocol) is the most widely used one.[35] It makes a distinction between *direct* and *indirect* emissions. Direct GHG emissions are defined as emissions from sources that are owned or controlled by the reporting entity. In contrast, indirect GHG emissions are emissions that are a consequence of the activities of the reporting entity, but

[33] See `http://unfccc.int/kyoto_protocol/items/2830.php`
[34] See `http://goo.gl/reUp0b`
[35] `http://www.ghgprotocol.org/`

occur at sources owned or controlled by another entity.

The GHG Protocol further classifies a company's GHG emissions into three "scopes:"

- Scope 1 emissions are direct emissions from owned or controlled sources.
- Scope 2 emissions are indirect emissions from the generation of purchased energy.
- Scope 3 emissions are all indirect emissions (not included in Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.

While a few firms report emissions up to the level of Scope 3 to CDP, the majority of firms report only up to Scope 2. The Companies Act 2006 Regulations 2013 requires firms to disclose emissions up to Scope 2.

4 Data and Summary Statistics

4.1 Data

4.1.1 Main Sample: UK Quoted Companies Listed on LSE's Main Market

To test the impact of the legislation on firm value, I construct a sample of firms that is affected by the regulation. The legislation concerns quoted companies, which are essentially firms listed on the Main Market of the London Stock Exchange. This is why I start with a list of all primary securities traded on the UK Main Market of the London Stock Exchange in June 2012.[36] The initial list of firms contains 1,038 different securities. I restrict the analysis to ordinary shares, which eliminates other types of securities, i.e., depository receipts, fixed interest securities, and warrants. This procedure reduces the list to 870 securities. I then

[36]The list is available here: `http://goo.gl/W6xUnY`

eliminate equity investment instruments and nonequity investment instruments as well as REITs, which leaves 518 firms.[37] For 484 of these firms, I manage to match accounting and stock market data from Datastream and Worldscope in at least one year during the sample period, which runs from 2008 to 2014. I then match the response permission from CDP, and where available, greenhouse gas emissions data from CDP (Scope 1 and Scope 2). To be included in the final LSE-Datastream-CDP sample, I require that accounting items (e.g., assets or liabilities) and stock market data (stock price and shares outstanding) for a given firm is available at least between 2009 and 2013. This procedure further reduces the number of firms to 418.

4.1.2 Matched Firms from Other European Stock Exchanges

In the empirical analysis, I compare corporate valuation of UK quoted companies to size and industry matched firms listed from other European countries. To do so, I build a sample of all primary equity securities in Datastream that were listed at some point in Ireland, Belgium, Denmark, France, Germany, Italy, Luxembourg, Netherlands, Norway, Sweden, Switzerland, Austria, Portugal, Spain, and Finland (6,700 different firms). To retain a firm, I require that stock market and accounting data is available between 2009 and 2013. In total, this leaves me with 4,089 different firms between 2008 to 2014. I match on firm size (assets) and industry. I rely on stratified nearest neighbor matching without replacement: For each UK quoted company, I thus simply select the European firm from the same industry that is most similar in terms of asset size in 2010.

[37] I eliminate these sectors by excluding firms with Industry Classification Benchmark (ICB) sub-sector codes 8995, 8985, 8671, 8672, 8674 or 8675.

4.2 Summary Statistics

Table 2 shows basic summary statistics for the three samples used in the paper. Panel A focuses on the main sample, i.e., the sample of UK quoted companies. The average UK quoted company has a market capitalization of about £4 billion, 17,193 employees, and assets worth about £17 billion.

[Table 2 about here.]

The average firm is responsible for about 2.3 billion MTCO2e in Scope 1 and 735 million MTCO2e of Scope 2 emissions. Contrasting the mean and median emissions figures, it appears that the emissions distribution is highly skewed, with a few firms with extremely high emissions. Section B of the Internet appendix shows information on GHG emissions by industrial sector. Panel B shows descriptive statistics (expressed in £) of the size matched European Firms, which, when compared to UK quoted firms, have quite similar characteristics.

5 Empirical Analysis

5.1 Size and Industry Matched Firms Listed on Other European Exchanges

5.1.1 Baseline Analysis

To analyze whether mandatory carbon disclosure requirements affect the valuation of UK quoted companies, I rely on a DID approach. DID analysis consists of comparing the pre-post difference in an outcome (e.g., firm value) between a treatment and a control group. This approach has the advantage over simply comparing the outcome before and after the

regulatory shock because there might be before-after differences in the outcome that are due to broader trends. This is why having a comparison group, unexposed (or less exposed) to the law, allows capturing this trend and thus better estimate a counterfactual. For an applied treatment of the DID framework see Remler and Van Ryzin (2014).

I start the analysis by assigning all UK quoted firms to the treatment group. The control group consists of size and industry matched firms listed on other European stock exchanges (Ireland, Belgium, Denmark, France, Germany, Italy, Luxembourg, Netherlands, Norway, Sweden, Switzerland, Austria, Portugal, Spain, and Finland). I rely on stratified nearest neighbor matching without replacement. In other words, I simply match each UK quoted company with the European firm belonging to the same industry that is most similar to the UK firm in terms of assets in 2010. I measure corporate value using Tobin's q and estimate the following cross-sectional DID equation

$$q_{it} = \alpha_1 + \beta_1 Treat_i + \beta_2 After_t + \beta_3 Treat_i \times After_t + \eta_t + \epsilon_{it}, \tag{1}$$

where q_{it} is firm i's Tobin's q in year t and $Treat_i$ is a dummy variable marking all-firm year observations belonging to treated, i.e. UK quoted, companies. $After_t$ is a dummy variable marking all years of the post-regulation period (i.e., 2011 to 2014), η_t is a set of year dummies, and ϵ_{it} is an error term.

Even though the law was publicly announced in 2012, I choose the before-treatment (pre-regulation) period to end in 2010, and the after-treatment (post-regulation) period to start in 2011. I do so because information circulated publicly as early as August 2011 that the UK government would introduce mandatory GHG reporting (see the discussion of major events leading to the legislation in Section 1 and Table 1 for more details).

The coefficient of interest in equation (1) is β_3, which measures the difference-in-differences, that is the difference in the before-after difference of Tobin's q between the treatment (UK

quoted companies exposed to mandatory greenhouse gas reporting) and the control group (Industry and size matched European firms unexposed to the regulation). In contrast, β_1 measures the difference in Tobin's q between the treatment and control group during the pre-period and β_2 measures the difference in Tobin's q between the post- and pre-periods for the control group. Thus, focusing on the DID coefficient β_3 removes biases in post period comparisons between the treatment and control group that could be due to permanent differences between the control and treatment groups, as well as biases resulting from comparisons over time in the treatment group that could be the result of trends.

[Table 3 about here.]

The results from estimating this standard DID equation are reported in column 1 of Table 3. Standard errors are clustered at the firm level. The coefficient estimate for β_3 is positive and statistically significant, suggesting that corporate value of treated firms increased more strongly after the regulation than the value of firms that are not exposed to the law. In other words, a positive and significant coefficient is evidence in favor of the view that investors welcome mandated transparency with respect to corporate climate change information.

To ensure that the observed differences in Tobin's q reflect a treatment effect rather than underlying differences between the treatment and control groups in terms of company size, I now include *ln(Assets)* as a control variable and estimate the following equation

$$q_{it} = \alpha_1 + \beta_1 Treat_i + \beta_2 After_t + \beta_3 After_t \times Treat_i + \beta_4 ln(Assets)_{it} + \epsilon_{it}. \qquad (2)$$

Controlling for size also allows accounting for the possibility that firm size is changing differently for the control and treatment group during the period of study. The results are reported in column 2 of Table 3 and continue to show a significantly positive DID coefficient estimate. Note that even though the size control is strongly statistically significant, neither

the magnitude nor the standard error of the DID coefficient changes substantially. I choose not to use further control variables (e.g., capital expenditures, return on assets, etc.) because these variables are also outcome variables and as such "bad controls" in the sense of Angrist and Pischke (2008):

> *"Some variables are bad controls and should not be included in a regression model even when their inclusion might be expected to change the short regression coefficients. Bad controls are variables that are themselves outcome variables in the notional experiment at hand. That is, bad controls might just as well be dependent variables too. Good controls are variables that we can think of as having been fixed at the time the regressor of interest was determined."*

In column 3, I add industry–year fixed effects δ_{jt} in the spirit of Gormley and Matsa (2014) to the specification and estimate an equation that controls for yearly industry–specific shocks:

$$q_{ijt} = \alpha_1 + \beta_1 Treat_i + \beta_2 After_t + \beta_3 Treat_i \times After_t + \beta_4 ln(Assets)_{it} + \eta_t + \delta_{jt} + \epsilon_{it} \quad (3)$$

Again, the magnitude of the coefficient estimate is virtually unchanged. In column 4, I include firm fixed-effects α_i to control for unobservable firm specific heterogeneity. Given that the treatment dummy has no within–firm variation, it is not identified and I drop it from the equation before estimating the within transformation of the following firm fixed-effects specification

$$q_{it} = \alpha_i + \beta_2 After_t + \beta_3 Treat_i \times After_t + \beta_4 ln(Assets)_{it} + \eta_t + \epsilon_{it}. \quad (4)$$

With respect to the model controlling for industry shocks, the DID coefficient hardly

changes in terms of size and precision of estimation. In column 5, I control for both firm- and industry-year fixed effects and estimate

$$q_{ijt} = \alpha_i + \beta_2 After_t + \beta_3 Treat_i \times After_t + \beta_4 ln(Assets)_{it} + \eta_t + \delta_{jt} + \epsilon_{it}, \qquad (5)$$

which continues to produce a highly significant average treatment effect. Overall, the analysis in Table 3 suggest that investors value mandatory greenhouse gas reporting positively.

5.1.2 Cross Sectional Variation in Treatment

One of the key ideas I use to identify the effect of mandatory carbon emission disclosure on firm value is the notion that the new requirements did not affect all UK quoted companies equally. More specifically, firms that had already been compliant with the requirements at the time when the regulation became likely (i.e., early–reporters or quasi–compliant firms) should be less affected than companies that were non–compliant. Hence, the cross-section of the pre-regulation reporting status allows building two homogeneous groups of firms that were differentially affected by the change in the reporting rules. Examining separately how the valuation of these two groups change compared to European control firms allows drawing more nuanced inferences about whether mandatory disclosure of carbon emissions affects firm value. In addition, carrying out such comparisons separately allows ruling out the view that the statistically significant average treatment effect of Table 3 is simply due to unobservable or observable differences between UK quoted companies and their matched European peers.

To separate firms according to their ex-ante compliance with the new regulation, I require a measure of firms' pre-regulation reporting status. To obtain this information, I rely on CDP's variable *Response Permission*. As explained in section 3, CDP records for each contacted firm whether the firm responded publicly, privately, or did not respond at all. The response permission reported in CDP is thus "Public," "Private," or "NA."[38] Panel A of

[38]If a firm is not available in the CDP database but satisfies the sample selection criteria for Datastream,

Table 4 shows the number of firms per CDP response permission for each year between 2009 and 2014. In Panel B, I tabulate the fraction of sample firms per response permission by year.

[Table 4 about here.]

Several observations can be made from Table 4: First, the number of public responses increases monotonically between 2009 and 2014. In a similar vein, the number of firms not replying to CDP decreases monotonically by about 27 % between 2009 and 2014 (from 232 in 2009 to 169 in 2014). Interestingly, the number of privately submitted responses increases between 2009 and 2010, but starts decreasing from 2011, the year in which the likelihood of mandatory GHG emissions disclosure increased sharply. Panel B of Table 4 shows that in 2011, 164 (39%) of the sample firms responded publicly to CDP, 72 (17%) privately, and the remaining 182 (44%) firms did not respond at all to the CDP request in 2011.

I assign firms that report publicly to CDP in 2011 (response permission "Public") to the group of "early–reporters" (quasi–compliant firms), whereas firms with response permission "Private" or "NA" are assigned to the group of firms of non–compliant firms. I then re-estimate all five DID specifications from Table 3 separately for both groups. The control group in both panels are the same size and industry matched firms used previously.

[Table 5 about here.]

The results show a striking dichotomy: I find no significant DID coefficient when the treatment group is made up of firms that were already quasi-compliant with the law (see Panel A, Table 5), whereas the analysis of non–compliant firms (i.e., firms with response permission "Private" or "NA" in 2011) produces a highly significant and positive average treatment effect (see Panel B, Table 5). In other words more heavily affected firms experience significant value increases with respect to control firms whereas quasi–compliant firms do not.

i.e., accounting and stock market data availability between 2009 and 2013, I set the response permission to "NA."

5.2 Comparing Non– and Quasi–Compliant Firms Directly

One concern with the previous results is that the positive average treatment effect might simply reflect differences between UK companies and firms from other European countries. While the dichotomy in the average treatment effect for quasi– and non–compliant firms already somewhat addresses this concern, I now move on to directly comparing early–reporting (quasi–compliant) and not–reporting (non–compliant) firms. The idea of using quasi–compliant firms as a control group is that a UK based control group is subject to the same concurrent shocks (e.g., general time trends, other macroeconomic events, or other institutional changes) as the treatment group and that both groups are expected to respond similarly to such concurrent shocks.

Hence, I now assign firms that did not report publicly to CDP in 2011 (response permission "Private" or "NA") to the treatment group, whereas firms with response permission "Public" are now assigned to the control group. The idea is again that firms that responded to CDP and made their responses public (response permission "Public") were already quasi-compliant with the new regulation and should thus be less or not affected by the new rules. In contrast, firms that chose to disclose their information only to the CDP (response permission "Private") or did not respond to the CDP request at all (permission "NA") should be more heavily affected by the new law. Since the latter firms will have to publicly disclose information that they chose to keep private or did not produce at all prior to the new requirements, we should observe a significant and positive treatment effect for these firms. Accordingly, the variable $Treat$ now marks all firm-year observations corresponding to firms that did not report publicly in 2011.

[Table 6 about here.]

In Panel A, Table 6 I re-estimate the previous five specifications, which continue to show a positive and significant treatment effect. Only the specification that involves both firm

and industry-year fixed effects shows a marginally significant treatment effect. There are, however, several potential explanations for the marginally significant average treatment effect in specification 5 of Panel A, Table 6. First, even though fixed effects models are more robust in identifying coefficients consistently, this happens at an efficiency loss resulting in larger and thus more conservative standard errors.[39] Second, and most importantly, it is known that although fixed effects control for omitted variable bias, fixed effects are also notoriously susceptible to attenuation bias from measurement error.[40] If the treatment status (i.e., CDP's pre-regulation response permission) is measured with error, such measurement error would imply that fixed effects estimates obtained through within transformation of the model should produce smaller coefficient estimates than coefficients obtained from estimating the model as a pooled cross section.

To provide evidence consistent with this measurement error argument, I now perform the analysis for a subsample for which the treatment status is likely to be more precisely measured. In doing so, I re-estimate all five models restricting the sample to firms for which CDP reports the response permission in 2011. As explained previously, I set the response permission to "NA" whenever a UK quoted company is not available in the CDP database. Imputing treatment status in this way is likely to introduce measurement error in the treatment dummy because it potentially introduces noise. In practice, this concerns 98 firms and I thus discard about 700 firm-year observations in the restricted estimation of Panel B. Consistent with the measurement error view, Panel B, Table 6 shows that all five DID coefficient estimates are larger compared to estimations using all UK quoted companies (Panel A).

[39] See, for instance, the discussion on p771 of Cameron and Trivedi (2005).
[40] See, for instance, page 225 of Angrist and Pischke (2008).

5.3 Cross-sectional Variation in the DID Coefficient

I now explore whether the relationship uncovered in Panel A and B of Table 6 varies cross-sectionally along certain observable dimensions. I focus on comparing quasi– and non–compliant UK firms.

5.3.1 Firm Size

It seems plausible that the effect of the law should be strongest for the largest sample firms. One explanation for a strong average treatment effect for the largest firms is closely related to the measurement error argument outlined in the previous subsection. It seems likely that the response permission is most precisely measured for the largest sample firms, which would result in more consistent estimates of the average treatment effect for this subset of firms. More importantly, however, the DID coefficient is also expected to be stronger for the largest firms because climate change issues are potentially more relevant for larger firms. One explanation for this is simply that emissions tend to increase with the scale of a firm's operations, making large firms more vulnerable to greenhouse gas related regulation. Secondly, larger firms are also more likely to be adversely affected by climate change simply because more assets are exposed to the effects of climate risk (e.g., severe adverse weather events). Hence, I expect the GHG disclosure requirements to matter most for the largest firms (high average treatment effect). In Panel C, Table 6, I restrict the sample to the largest 50 percent of firms in each sector. I use market capitalization at the beginning of the year as the size measure and re-estimate all the previous specifications using the sample which contains only the largest firms. All specifications show higher DID coefficient estimates than those resulting from the whole sample (Panel A) and the sample restricted to firms for which CDP reports the response permission in 2011 (Panel B). Overall, this provides support in favor of the view that the valuation implications of the new reporting requirements are

strongest for the largest firms.

5.3.2 Carbon Intensive Industries

I now explore another cross-sectional dimension along which the DID estimate could vary. As section B of the Internet appendix shows, there is substantial industry variation in GHG emissions. Hence, some sectors have a stronger climate impact. For instance, both the Oil and Gas and the Basic Materials sectors are subject to higher absolute (i.e., quantity) and relative GHG emissions (i.e., intensity) than other sectors. I thus expect that the average treatment effect is strongest in such carbon intensive sectors. To examine this hypothesis, I estimate a difference-in-difference-in-differences (DDD) equation in which the DID term is interacted with industry dummies. I use the ICB (Industry Classification Benchmark)[41] system to measure a firm's industry affiliation. ICB maintains four levels of granularity, i.e., 10 Industries, 19 Supersectors, 41 Sectors, and 114 Subsectors. Due to the relatively small size of the sample, I opt for the lowest level of granularity, i.e., ICB Industries. In addition, I require at least 50 firm-year observations per industry for the industry to be included in the estimation of the DDD equation. Unfortunately, regulated industries with relatively few firms such as the Utilities or the Telecommunications industries do not fulfill these criteria, and I drop them from the sample. In the case of the Utilities sector this is particularly unfortunate, since this sector is highly carbon intensive. Too low a number of observations, however, would not allow to identify the average treatment effect per industry in a statistically meaningful way.

[Figure 2 about here.]

In estimating the DDD equation, I also restrict myself to a subsample of firms for which the CDP response permission has been only "Private" or "Public" throughout the sample

[41] See `http://www.icbenchmark.com/`

period. I do so because dropping firms for which the response permission is "NA" reduces noise in measuring the reporting status. Figure 2 shows the DDD coefficient estimates for each industry alongside 95% confidence intervals. The coefficients are obtained from estimating a DDD specification that controls for size, industry-year shocks, firm fixed-effects, and obviously all additional base and interaction effects that result from interacting the treatment dummy, the post-period dummy, and all industry dummies.

Consistent with the view that the value implications of the regulation are stronger in more carbon intensive sectors, the DDD estimates are strongest in the basic materials (i.e., mining) as well as the oil and gas sector. This is particularly interesting since the results show the largest treatment effects for sectors that supply energy (Oil and gas) and a sector that is a particularly strong consumer of energy (Mining). While the point estimate of the average treatment effect is highest for the basic materials sector, it seems as if it is not as precisely estimated as the effect in the oil and gas sector (tighter confidence intervals).

5.4 Time-series Variation in the DID Coefficient

I now explore the time pattern of the average treatment effect. This is crucially important for ensuring that the DID approach is valid. Instead of simply interacting the treatment dummy with the post-period dummy, I interact the treatment dummy with each year dummy. I drop the dummy for 2008 (base year) and focus on the sample consisting of the largest firms. The results are reported in Table 7.

[Table 7 about here.]

In all five specifications, the interaction term between the treatment dummy and the year dummy is insignificant prior to 2011. This shows that there are no significant differences between the control and treatment groups in the pre-treatment period (i.e., 2008 to 2010).

Insignificant differences between the treatment and control group in the pre-treatment period suggest that the identifying parallel trends assumption is satisfied in the data, which, in turn, validates the DID approach. In contrast, the yearly average treatment effects are highly significant starting in 2011. In terms of economic magnitude, the data show a cumulative valuation effect with a strong increase between 2011 and 2012, the years in which the legislation became likely and the year in which it was officially announced. As outlined in section 1, the likelihood of mandatory GHG reporting regulation increased sharply in 2011, and the significant average treatment effect in 2011 suggests that some of the valuation effects concerning non-compliant firms happened already before the official announcement.

5.5 Economic Effects of the Regulation

While the evidence of a positive valuation impact of mandatory greenhouse gas emission disclosure regulation is interesting, it seems equally important to better understand how exactly mandatory carbon disclosure affects firm value. To do so, I now examine how the requirements affect several other firm characteristics. More specifically, I distinguish between capital market (e.g., liquidity) and real effects (e.g., capital expenditures). I apply the same DID framework to study before–after differences between non– (treatment group) and quasi–compliant (control group) firms for these additional outcome variables. I use quasi–compliant UK firms as a control group because this group of firms is likely to be exposed to the same concurrent shocks as treated UK firms.

5.5.1 Capital market effects

One of the firm-specific benefits of (mandatory) *financial* disclosure best supported by both theoretical and empirical research is the effect of disclosure on both stock liquidity and information asymmetries (see Verrecchia (2001); Leuz and Verrecchia (2000); Leuz and Wysocki (2015)). Given prior evidence on the effects of mandatory *financial* information

disclosure, I start by examining whether mandatory carbon disclosure regulation has an impact on market liquidity and measures of information asymmetries. Specifically, I use both trading volume and bid-ask spreads as dependent variables. The measure of market liquidity is the natural logarithm of annual trading volume, i.e., *ln(Volume)* and *Bid-Ask* is the yearly median daily bid-ask spread, where the daily bid-ask spread is defined as

$$Bid - Ask = \frac{P_{ask} - P_{bid}}{0.5(P_{ask} - P_{bid})}. \tag{6}$$

I now estimate the equivalent of equation (5) using both liquidity and the bid-ask spread as dependent variables. I also add the natural log of market capitalization as a control variable. The results are reported in columns 1 and 2 of Table 8.

[Table 8 about here.]

I find a significantly positive average treatment effect for volume and a negative average treatment effect for the bid-ask spread. The treatment effects are both highly statistically significant, suggesting that the disclosure regulation had a strong impact on both market liquidity and information asymmetries.

As pointed out in Leuz and Wysocki (2015), the impact of disclosure on liquidity and information asymmetries could also manifest directly in a lower cost of capital. Constantinides (1986) and Amihud and Mendelson (1986) show that illiquidity and bid-ask spreads impose trading costs on investors, for which investors need to be compensated in equilibrium. In columns 3 and 4, I test directly if treated firms are subject to lower volatility and lower equity betas post–regulation. However, the DID coefficients for these dependent are not distinguishable from zero. Thus, the evidence does not support a direct link between mandatory carbon disclosure regulation and the equity cost of capital, but rather an impact on firm value through higher liquidity and lower information asymmetries.[42]

[42] A contemporaneous paper by Kleimeier and Viehs (2015) examines the impact of *voluntary* greenhouse

5.5.2 Real effects

I now move on to test whether the regulation had real effects by examining whether observable corporate behavior changes post–regulation. Above all, the Porter hypothesis would suggest changes in corporate behavior due to environmental regulation. More specifically, I examine whether treated firms invest differently or spend more on research and development post regulation. I also examine if operating efficiency increases, an effect that the Porter hypothesis would imply. The results are reported in columns 5–8 of Table 8. The treatment effects for Investment, R&D, and ROA are all indistinguishable from zero, suggesting that treated firms are not subject to real effects. Overall, it appears thus as if the increases in firm value are mainly attributable to capital market and not real effects. Such capital-market effects of mandatory disclosure legislation, especially the strong effect on trading volume and bid ask spreads, are very much consistent with prior research on mandatory *financial* disclosure regulation (see Leuz and Wysocki (2015)).

5.6 Falsification Tests

In this last section I perform several falsification tests aimed at validating the main result of disclosure on firm value.

5.6.1 Placebo Law Change in 2004

In Panel A and B of Table 9, I re-estimate the main specifications for the time period 2001–2007, assuming that a change in reporting requirement had taken place in 2004. The dependent variable is Tobin's q. The dummy $Treat$ marks all firms that were not reporting publicly in 2011. The control group is made up of early–reporting firms. Panel A shows DID estimates for all firms and Panel B limits the sample to the largest firms in each industry.

gas disclosure on the cost of debt. The authors provide evidence of a negative relationship.

[Table 9 about here.]

The DID coefficients are not significant neither for the whole sample, nor for the sample restricted to the largest firms. In fact, the average treatment effect in this Falsification test is extremely close to zero in every single specification.

5.6.2 Pseudo Treatment

In Panel C, I construct a pseudo-treatment dummy by randomly separating UK firms into a treatment and a control group. Given that about 60 percent of the UK firms in 2011 are treated firms (i.e., firms that report privately or do not report at all), I code a dummy variable that randomly marks 60 percent of the firms in 2011. I estimate all five specifications for the periods 2007 to 2014. Again, the average treatment effect is zero and insignificant in all five specifications.

6 Conclusion

In this paper, I estimate the effect of mandatory GHG emissions disclosure on corporate value in a DID setting. Using the introduction of mandatory GHG emission disclosure requirements for firms listed on the Main Market of the London Stock Exchange as a source of exogenous variation in disclosure policies, I find that firms most heavily affected (i.e., non–compliant firms) experience significantly positive valuation effects. The positive valuation effect is robust not only to controlling for both unobserved firm heterogeneity and industry-year shocks, but also to falsification tests and to using a variety of different control groups such as, for instance, size and industry matched firms from other European countries.

Consistent with the notion that climate change is more relevant to larger firms and to firms belonging to carbon intensive industries, I show that the average treatment effect is highest for the largest sample firms and for firms operating in the oil and gas and the

mining industries. Overall, the evidence suggests that investors value increased transparency regarding corporate climate change risks, in particular when such increases in transparency concern large firms, or firms operating in carbon intensive sectors.[43]

Examining the channel through which mandatory carbon disclosure affects firm value, I show that the valuation increases are driven by capital market as opposed to real effects. As such, mandatory carbon disclosure increases market liquidity (higher trading volume) and lowers information asymmetries (lower bid-ask spreads) for the most affected firms.

Overall, the results have important implications for security markets regulation in other jurisdictions, e.g., the United States, since they suggest that there might be case for mandating firms to report more comprehensively on the risks and opportunities related to climate change.[44]

[43]See section B of the Internet appendix for more information on carbon intensities by industrial sector.

[44]As per 2015, the SEC has only provided guidance as to how existing reporting requirements apply to climate change risks (See SEC (2010))

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Figures

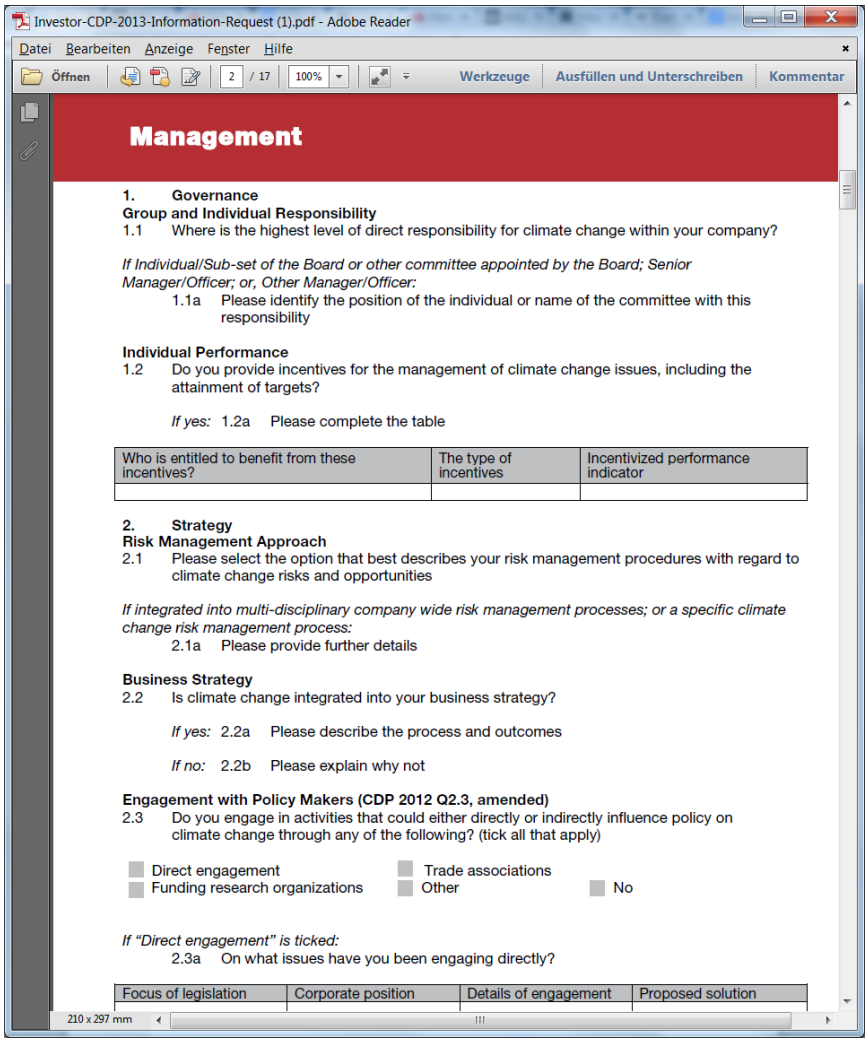

Figure 1. CDP Request This figure shows a screenshot of the first page of the questionnaire of the CDP Climate Change request.

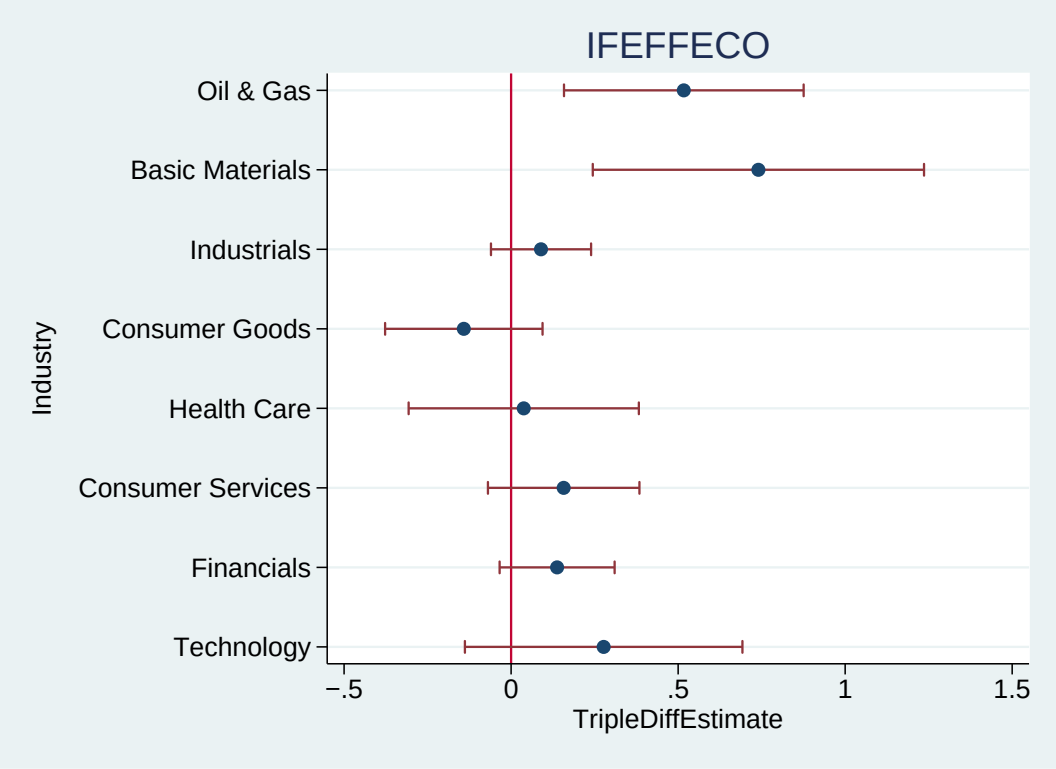

Figure 2. Difference-in-Difference-in-Differences (DDD) This figure shows DDD estimates alongside 95 percent confidence intervals. DDD estimates are esentially DID estimates by industry. I obtain the DDD coefficients by estimating an equation in which the DID term is interacted with industry dummies. The DDD specification controls for size, industry-year shocks, firm fixed-effects, and obviously all additional base and interaction effects that result from interacting the treatment dummy, the post-period dummy, and the industry dummies.

Tables

Table 1
Important Events Leading to The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013

This table provides dates and descriptions of important events that eventually led to the passage of The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013.

Stage	Date	Comment
The Companies Act 2006	November 8, 2006	The Companies Act 2006 is an Act of the Parliament of the United Kingdom which forms the primary source of UK company law.
Climate Change Act 2008	November 26, 2008	The Climate Change Act 2008 (c 27) made it the duty of the Secretary of State to ensure that the net UK carbon account for all six Kyoto greenhouse gases for the year 2050 is at least 80% lower than the 1990 baseline, toward avoiding dangerous climate change. Section 85 of the Climate Change Act 2008 requires the Government to make regulations, under the Companies Act 2006, by 6 April 2012 requiring the directors report of a company to include information about GHG emissions as is specified in regulations, or to lay a report before Parliament explaining why no such regulations have been made.
First version of "Impact Assessment of Options for Company GHG Reporting (IA No: DEFRA1334)"	January 17, 2011	An impact assessment (IA) is a document that helps the policy-maker to fully think through and understand the consequences of possible and actual Government interventions in the public, private and third sectors; and a tool to enable the Government to weigh and present the relevant evidence on the positive and negative effects of such interventions.The first version of the IA DEFRA1334 presented cost/benefit analysis and background information on the four possible policy options, i.e., (0) Business as usual (no change to the current policy position), (1) Enhanced voluntary reporting: increasing awareness of reporting guidance and outreach; (2) Mandate GHG reporting under Companies Act for all quoted companies;(3) Mandate GHG reporting under Companies Act for all large companies;(4) Mandate GHG reporting for all companies meeting an energy use criteria.

Continued on next page

Table 1 – continued from previous page

Stage	Date	Comment
Start of the consultation by the Department for Environment, Food & Rural Affairs (DEFRA)	May 11, 2011	Public consultation seeking views on whether regulations should be introduced to make it mandatory for some UK companies to report on their GHG emissions or whether the Government should continue to encourage measuring and reporting of GHG emissions on a voluntary basis. A diverse range of respondents (e.g., NGO's, companies, individuals, Investors, regulators, trade associations/professional bodies, etc.) were asked to express their views on the five potential policy options that were outlined in the impact assessment and choose their preferred one.
End of DEFRA consultation	July 5, 2011	
Final version of Impact Assessment of Options for Company GHG Reporting (IA No: DEFRA1334)	August 31, 2011	The final version of the Impact Assessment is signed off by DEFRA and made available to ministers and to members of parliament. The final impact assessment includes a reference to the preferred policy "(2) Mandate GHG reporting under Companies Act for all quoted companies." Even though the impact assessment is dated 31 August 2011, it is unclear when exactly it became publicly available
Environmental Audit Committee publishes Seventh Report *Carbon Budgets*	September 14, 2011	Environmental Audit Committee publishes *Seventh Report Carbon Budgets*, in which an explicit statement to the preferred option of mandatory GHG reporting: "In order to aid transparency and illustrate the contributions that businesses are making, and need to make, to help tackle climate change, we recommend that the Government should introduce mandatory reporting by businesses at the earliest opportunity." The Environmental Audit Committee is appointed by the House of Commons to consider to what extent the policies and programs of government departments and non-departmental public bodies contribute to environmental protection and sustainable development; to audit their performance against such targets as may be set for them by Her Majesty's Ministers; and to report thereon to the House.
Report to parliament "Company reporting of GHG emissions"	March 27, 2012	Report presented to Parliament pursuant to Section 85 of the Climate Change Act 2008 outlining why no regulations had been introduced so far.

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Table 1 – continued from previous page

Stage	Date	Comment
First announcement that the UK Government will make GHG disclosure mandatory for firms listed on the London Stock Exchange	June 19, 2012	Writing in The Guardian, Deputy Prime Minister Nick Clegg announce the UK's intent to pass legislation requiring UK quoted companies to disclose GHG emissions figures in their annual reports.
Plenary Address RIO 20+	June 21, 2012	The intent of the UK government to make climate change related information disclosure mandatory was is reiterated in a keynote speech by UK's Deputy Prime Minister Nick Clegg at the United Nations Conference on Sustainable Development \textitRio+20.
Summary report of DEFRA consultation	July 2012	DEFRA publishes the report "Measuring and reporting of GHG emissions by UK companies" which provides detailed information on the outcome of the public consultation.
First draft of the regulations are published	July 25, 2012	The first draft of the legislative text concerning GHG disclosure under The Greenhouse Gas Emissions (Directors Reports) Regulations 2013 Act is published for consultation.
End of consultation	October 17, 2012	
Draft laid before parliament	June 10, 2013	
Revised draft	June 11, 2013	
Approved by the House of Commons	July 16, 2013	
The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 takes effect	October 1, 2013	

Table 2

Summary Statistics

This table reports summary statistics of firm-level variables. The sample period runs from 2008–2014. *Market cap* is Worldscope item *wc08001*. *Employees* is Worldscope item *wc07011*. *Assets* is item *wc02999*. *ln()* is the natural logarithm. Tobin's q is defined as (Market cap+Book value of total liabilities)/(Book value of common equity + Book value of total liabilities)=(wc08001+wc03351)/(wc03501+wc03351). *ln(Volume)* is the logarithm of total annual trading volume (Datastream item *VO*). Bid-Ask is the yearly median daily bid-ask spread, where the bid-ask spread is defined as $\frac{P_{ask}-P_{bid}}{0.5(P_{ask}-P_{bid})}$. *Volatility* is the stock return volatility calculated using 52 weekly return observations in each year. *Beta* is the yearly slope coefficient from a market model regression using weekly return data. *Investment* is capital expenditures over total assets (Worldscope item *wc04601* devided by *wc02999*). R&D is R&D spending (*wc01201*) over total assets (*wc02999*). ROA is EBIT (*wc18191*) over total assets. All ratio variables are winsorized at the 95 and 5 percent level. Financial variables are measured in British pounds and expressed in million units. Scope 1 and Scope 2 are the firms' annual greenhouse gas emissions, which are measured in metric tonnes of CO2 equivalent (MTCO2e). For more background information on greenhouse gas emissions, see section B of the Internet appendix. *Treat* is a dummy variable marking all firm year observations of treated firms, i.e., firms that did not provide a public response to CDP in 2011. LSE stands for London Stock Exchange. SD displays the standard deviation, P25 the first and P75 the third quartile of the respective variable. Panel A shows the statistics for the main sample, i.e., UK quoted companies listed on LSE's Main Market. Panel B shows statistics for size and industry matched firms from other European countries.

Panel A: UK Quoted Companies Listed on LSE's Main Market						
	Mean	Median	SD	P25	P75	N
Market cap	4,172.02	467.74	13,872.95	116.56	1,819.18	2,918
Employees	17,193.34	2,791.00	52,375.92	719.00	11,441.00	2,623
Assets	17,155.13	586.36	118,359.13	165.83	2,452.10	2,710
ln(Assets)	13.42	13.28	2.28	12.02	14.71	2,710
Tobin's q	1.54	1.29	0.76	1.01	1.87	2,709
ln(Volume)	11.37	11.65	2.49	10.04	13.03	2,908
Bid-Ask	0.02	0.00	0.03	0.00	0.02	2,909
Volatility	0.05	0.04	0.03	0.03	0.06	2,884
Beta	0.79	0.74	0.62	0.37	1.16	2,884
Investment	0.04	0.02	0.04	0.01	0.05	2,688
R&D	0.04	0.01	0.06	0.00	0.05	1,035
Return on Assets	0.08	0.07	0.08	0.03	0.12	2,654
Scope 1 emissions	2,354.91	42.37	9,366.79	5.15	317.73	904
Scope 2 emissions	735.76	51.02	2,853.18	8.61	254.97	897
Treat	0.61	1.00	0.49	0.00	1.00	2,926
Panel B: Industry and Size Matched Firms Listed on Other European Exchanges						
	Mean	Median	SD	P25	P75	N
Market cap	3,801.09	436.78	11,464.95	102.37	1,818.68	2,647
Employees	18,245.40	2,539.50	48,362.47	602.00	11,880.00	2,550
Assets	17,521.92	802.47	105,957.43	163.77	3,852.22	2,652
ln(Assets)	13.63	13.60	2.45	12.01	15.16	2,652
Tobin's q	1.41	1.14	0.69	0.98	1.58	2,646

Table 3

Effect of the The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on Tobin's q

This table shows DID estimates of the effect of the The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on the average Tobin's q of UK quoted companies relative to size and industry matched firms listed on other European exchanges as a control group. Matched firms from other European countries are exempt from the UK disclosure regulation. The dependent variable is Tobin's q. $Treat$ is a dummy variable marking all firm-year observations of UK quoted firms. $After$ is a dummy variable marking the post-treatment period (2011–2014). Standard errors (in parentheses) are clustered at the firm level. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

	(1)	(2)	(3)	(4)	(5)
ln(Assets)		-0.054***	-0.040***	-0.157***	-0.160***
		(0.009)	(0.010)	(0.040)	(0.038)
Treat	0.032	0.019	0.023		
	(0.043)	(0.043)	(0.042)		
After	0.324***	0.322***	0.028	0.247***	0.066
	(0.045)	(0.045)	(0.099)	(0.023)	(0.092)
After × Treat	0.130***	0.128***	0.128***	0.110***	0.109***
	(0.027)	(0.027)	(0.026)	(0.025)	(0.025)
Observations	5,488	5,488	5,488	5,488	5,488
R^2	0.028	0.060	0.117	0.121	0.173
Year Fixed Effects	YES	YES	YES	YES	YES
Industry*Year Fixed Effects	NO	NO	YES	NO	YES
Firm Fixed Effects	NO	NO	NO	YES	YES

Table 4

CDP Response Permission by Year (UK Quoted Companies)

When submitting climate change related data to the CDP, the firms are asked to mark the response as either "Public" or "Private". This status is known as the *Response Permission*. "Private" responses are made available only to the CDP and the institutions on whose behalf CDP is requesting information, while "Public" responses are also made available to the general public. "NA" marks firms that did not respond to the request of the CDP. If a firm is not contacted by CDP, I set the response permission to "NA." Panel A tabulates the number of sample firms per response status against years. Panel B shows the relative distribution of response status by year.

Panel A: Number of Firms per Response Permission							
	2009	2010	2011	2012	2013	2014	Total
Public	130	159	164	174	181	206	1,014
Private	56	75	72	64	65	43	375
NA	232	184	182	180	172	169	1,119
Total	418	418	418	418	418	418	2,508
Panel B: Fraction of Firms per Response Permission							
	2009	2010	2011	2012	2013	2014	Total
Public	31.10	38.04	39.23	41.63	43.30	49.28	40.43
Private	13.40	17.94	17.22	15.31	15.55	10.29	14.95
NA	55.50	44.02	43.54	43.06	41.15	40.43	44.62
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 5

Effect of the The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on Tobin's q: Conditional on Ex-Ante Compliance

This table shows DID estimates of the effect of the The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on average Tobin's q of UK quoted companies conditional on their pre–regulatory GHG emissions disclosure status. The control group is composed of size and industry matched firms listed on other European exchanges. Matched firms from other European countries are exempt from the UK disclosure regulation. The dependent variable is Tobin's q. In Panel A, $Treat$ is a dummy variable marking all firm-year observations of firms that provided a public response to CDP in 2011 ("quasi–compliant" firms). These regressions are estimated using exclusively firm-year observations of firms with reporting permission "Public" in 2011 and their size-industry matched European peers. In Panel B, $Treat$ is a dummy variable marking all firm-year observations of firms that did not provide a public response to CDP in 2011 ("non–compliant" firms). These regressions are estimated using exclusively firm–year observations of firms with response permission "Private" or "NA" in 2011 and their size–industry matched European peers. $After$ is a dummy variable marking the post-treatment (2011–2014) period. Standard errors (in parentheses) are clustered at the firm level. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

Panel A: CDP Response Permission - "Public"					
	(1)	(2)	(3)	(4)	(5)
ln(Assets)		-0.093***	-0.075***	-0.186***	-0.196***
		(0.016)	(0.017)	(0.065)	(0.069)
Treat	0.118*	0.094	0.100		
	(0.068)	(0.066)	(0.064)		
After	0.333***	0.326***	-0.425***	0.268***	0.136
	(0.071)	(0.072)	(0.154)	(0.036)	(0.129)
After × Treat	0.044	0.049	0.049	0.057	0.056
	(0.039)	(0.040)	(0.039)	(0.038)	(0.037)
Observations	2,094	2,094	2,094	2,094	2,094
R^2	0.031	0.099	0.175	0.120	0.199
Year Fixed Effects	YES	YES	YES	YES	YES
Industry*Year Fixed Effects	NO	NO	YES	NO	YES
Firm Fixed Effects	NO	NO	NO	YES	YES
Panel B: CDP Response Permission - "Private" or "NA"					
	(1)	(2)	(3)	(4)	(5)
ln(Assets)		-0.080***	-0.061***	-0.147***	-0.160***
		(0.014)	(0.015)	(0.047)	(0.045)
Treat	-0.021	-0.039	-0.035		
	(0.056)	(0.055)	(0.054)		
After	0.318***	0.320***	-0.047	0.237***	0.017
	(0.057)	(0.058)	(0.152)	(0.029)	(0.130)
After × Treat	0.182***	0.176***	0.177***	0.144***	0.142***
	(0.036)	(0.035)	(0.035)	(0.034)	(0.033)
Observations	3,394	3,394	3,394	3,394	3,394
R^2	0.029	0.077	0.130	0.126	0.180
Year Fixed Effects	YES	YES	YES	YES	YES
Industry*Year Fixed Effects	NO	NO	YES	NO	YES
Firm Fixed Effects	NO	NO	NO	YES	YES

Table 6

Effect of The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on Tobin's q: Comparing Non– and Quasi–Compliant Firms

This table shows DID estimates of the effect of The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on Tobin's q by comparing non– and quasi–compliant firms. The dependent variable is Tobin's q. The sample period is 2008 to 2014. $Treat$ is a dummy variable marking all firm year observations of treated firms (non–compliant), i.e., UK firms that did not provide a public response to CDP in 2011. Accordingly, the control group is composed of all UK firms that did provide a public response to CDP in 2011 (quasi–compliant). $After$ is a dummy variable marking the post-regulation period, i.e., years 2011 to 2014. Panel A uses the whole sample. In Panel B, I restrict the regressions to a sample of firms for which the response permission in 2011 is either "Private" or "Public." Panel C estimates the relationship using only the 50 percent largest firms in each sector. The standard errors (in parentheses) are clustered at the firm level. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

Panel A: All UK Quoted Companies Listed on LSE's Main Market in June 2012					
	(1)	(2)	(3)	(4)	(5)
ln(Assets)		-0.056***	-0.041**	-0.203***	-0.188***
		(0.016)	(0.019)	(0.065)	(0.061)
Treat	-0.152**	-0.295***	-0.265***		
	(0.064)	(0.076)	(0.077)		
After	0.374***	0.376***	0.513**	0.301***	0.008
	(0.057)	(0.057)	(0.237)	(0.041)	(0.119)
Treat × After	0.120***	0.115***	0.095**	0.091**	0.070*
	(0.045)	(0.044)	(0.045)	(0.043)	(0.042)
Observations	2,709	2,709	2,709	2,709	2,709
R^2	0.034	0.053	0.104	0.149	0.232
Year Fixed Effects	YES	YES	YES	YES	YES
Industry*Year Fixed Effects	NO	NO	YES	NO	YES
Firm Fixed Effects	NO	NO	NO	YES	YES
Panel B: UK Quoted Firms with Response Permission "Public" or "Private" in 2011					
	(1)	(2)	(3)	(4)	(5)
ln(Assets)		-0.118***	-0.097***	-0.241***	-0.199***
		(0.018)	(0.022)	(0.074)	(0.070)
Treat	-0.042	-0.242***	-0.205***		
	(0.074)	(0.075)	(0.076)		
After	0.422***	0.430***	0.006	0.346***	0.063
	(0.063)	(0.062)	(0.107)	(0.043)	(0.118)
Treat × After	0.147***	0.146***	0.117**	0.122***	0.092*
	(0.049)	(0.048)	(0.049)	(0.047)	(0.047)
Observations	2,068	2,068	2,068	2,068	2,068
R^2	0.038	0.106	0.154	0.173	0.267
Year Fixed Effects	YES	YES	YES	YES	YES
Industry*Year Fixed Effects	NO	NO	YES	NO	YES
Firm Fixed Effects	NO	NO	NO	YES	YES
Panel C: Sample Restricted to 50 Percent Largest UK Quoted Firms in Each Industry					
	(1)	(2)	(3)	(4)	(5)
ln(Assets)		-0.186***	-0.183***	-0.274***	-0.249***
		(0.023)	(0.031)	(0.083)	(0.083)
Treat	0.114	-0.178*	-0.122		
	(0.107)	(0.098)	(0.101)		
After	0.390***	0.423***	0.373	0.386***	0.018
	(0.081)	(0.078)	(0.399)	(0.055)	(0.161)
Treat × After	0.217***	0.225***	0.180***	0.220***	0.176***
	(0.064)	(0.062)	(0.061)	(0.062)	(0.060)
Observations	1,335	1,335	1,335	1,335	1,335
R^2	0.056	0.214	0.256	0.197	0.307
Year Fixed Effects	YES	YES	YES	YES	YES
Industry*Year Fixed Effects	NO	NO	YES	NO	YES
Firm Fixed Effects	NO	NO	NO	YES	YES

Table 7

Dynamics of the Effect of The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on Tobin's *q*

This table shows DID estimates of the effect of The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on Tobin's q for each year of the sample period. The dependent variable is Tobin's q. $Treat$ is a dummy variable marking all firm year observations of treated firms, i.e., firms that did not provide a public response to CDP in 2011. Accordingly, the control group is composed of all firms that did provide a public response to the CDP in 2011. $Year = t$ are year dummies. $Treat \times Year = t$ are interaction terms between the treatment dummy and the respective year dummies. The base category is 2008, which is why the year dummy and the interaction term for this year are dropped. Standard errors (in parentheses) are clustered at the firm level. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

	(1)	(2)	(3)	(4)	(5)
ln(Assets)		-0.186***	-0.183***	-0.273***	-0.249***
		(0.023)	(0.031)	(0.084)	(0.083)
Treat	0.061	-0.226**	-0.168		
	(0.111)	(0.101)	(0.105)		
Year = 2009	0.078*	0.086**	0.211	0.089**	0.118
	(0.041)	(0.040)	(0.255)	(0.039)	(0.228)
Year = 2010	0.203***	0.227***	0.246	0.238***	0.154
	(0.046)	(0.046)	(0.186)	(0.047)	(0.125)
Year = 2011	0.091*	0.127***	0.065	0.144***	-0.028
	(0.047)	(0.048)	(0.185)	(0.048)	(0.078)
Year = 2012	0.145***	0.187***	0.238	0.206***	0.144***
	(0.052)	(0.052)	(0.168)	(0.053)	(0.043)
Year = 2013	0.281***	0.328***	0.470**	0.350***	0.635**
	(0.059)	(0.059)	(0.188)	(0.060)	(0.268)
Year = 2014	0.361***	0.395***	0.158	0.481***	0.084
	(0.100)	(0.095)	(0.465)	(0.077)	(0.349)
Treat × Year = 2009	0.034	0.030	0.035	0.027	0.034
	(0.073)	(0.072)	(0.071)	(0.072)	(0.070)
Treat × Year = 2010	0.124	0.116	0.104	0.112	0.101
	(0.079)	(0.080)	(0.081)	(0.081)	(0.081)
Treat × Year = 2011	0.195***	0.194***	0.161**	0.194***	0.161**
	(0.073)	(0.073)	(0.079)	(0.074)	(0.079)
Treat × Year = 2012	0.298***	0.301***	0.256***	0.302***	0.257***
	(0.085)	(0.085)	(0.088)	(0.086)	(0.088)
Treat × Year = 2013	0.306***	0.314***	0.240**	0.317***	0.243**
	(0.102)	(0.101)	(0.102)	(0.101)	(0.102)
Treat × Year = 2014	0.292*	0.298**	0.279	0.229*	0.228*
	(0.154)	(0.146)	(0.170)	(0.124)	(0.132)
Observations	1,335	1,335	1,335	1,335	1,335
R^2	0.057	0.215	0.256	0.201	0.310
Year Fixed Effects	YES	YES	YES	YES	YES
Industry*Year Fixed Effects	NO	NO	YES	NO	YES
Firm Fixed Effects	NO	NO	NO	YES	YES

Table 8

Economic Effects of the The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013

This table shows DID estimates of the effect of the The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on several firm-level outcome variables which capture capital market and real effects. *Treat* is a dummy variable marking all firm year observations of treated firms (non–compliant), i.e., UK firms that did not provide a public response to CDP in 2011. Accordingly, the control group is composed of all UK firms that did provide a public response to CDP in 2011 (quasi–compliant). *After* is a dummy variable marking the post-regulation period, i.e., years 2011 to 2014. *ln(Volume)* is the logarithm of total annual trading volume. Bid-Ask is the yearly median daily bid-ask spread. *Volatility* is the stock return volatility calculated using 52 weekly return observations in each year. *Beta* is the yearly slope coefficient from a market model regression using weekly return data. *Investment* is capital expenditures over total assets. R&D is research and development spending over total assets. ROA is EBIT over total assets. All specifications include year, industry–year, and firm fixed effects. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

	Capital markets effects				Real effects		
	ln(Volume)	Bid–Ask	Volatility	Beta	Investment	R&D	ROA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(Assets)	0.128	-0.004**	0.008**	0.089*	0.002	-0.014***	-0.026***
	(0.093)	(0.002)	(0.004)	(0.045)	(0.003)	(0.004)	(0.009)
ln(Market Cap)	0.030	-0.007***	-0.012***	0.105**	0.002	0.002	0.045***
	(0.047)	(0.001)	(0.002)	(0.041)	(0.001)	(0.002)	(0.004)
After	-0.874***	0.004***	-0.028***	-0.026	-0.007***	0.004	-0.008*
	(0.050)	(0.001)	(0.002)	(0.037)	(0.002)	(0.003)	(0.005)
Treat × After	0.479***	-0.006***	0.001	-0.014	0.001	0.001	0.002
	(0.063)	(0.001)	(0.002)	(0.039)	(0.002)	(0.003)	(0.005)
Observations	2,694	2,694	2,674	2,674	2,687	1,035	2,654
R^2	0.958	0.900	0.649	0.598	0.803	0.945	0.714

Table 9

Falsification Tests

This table shows several falsification tests focusing on comparisons between quasi– and non–compliant UK firms. In Panel A and B, I reestimate the main specifications for the time period 2001–2007, assuming that a change in reporting requirement had taken place in 2004. Panel A shows DID estimates for all firms and Panel B limits the sample to the largest 50 percent of firms in each industry. In Panel C, I reestimate the main specifications for the time period 2008–2014 but instead of using CDP's pre-regulation response permission to assign firms to the control and treatment group, I use a pseudo treatment dummy which randomly assigns 60 percent of the sample firms in 2011 to the control group. The dependent variable in all regressions is Tobin's *q*. In Panels A and B, $Treat$ is a dummy variable marking all firm year observations of treated firms, i.e., firms that did not provide a public response to CDP in 2011. Accordingly, the control group is composed of all firms that did provide a public response to the CDP in 2011. In Panel C, $Treat$ is a dummy variable randomly marking 60 percent of the firms in 2011. In Panels A and B, $After$ is a dummy variable marking years 2004–2007 and in Panel C years 2011–2014. The standard errors (in parentheses) are clustered at the firm level. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

Panel A: Placebo Law Change in 2004 (All Firms)					
	(1)	(2)	(3)	(4)	(5)
ln(Assets)		0.050***	0.046***	0.002	0.005
		(0.005)	(0.005)	(0.016)	(0.017)
Treat	-0.095***	0.037*	0.022		
	(0.022)	(0.022)	(0.021)		
After	0.037***	0.012	-0.026	0.015	-0.023
	(0.010)	(0.011)	(0.035)	(0.010)	(0.032)
Treat × After	0.002	0.003	0.001	-0.001	-0.003
	(0.011)	(0.012)	(0.011)	(0.011)	(0.011)
Observations	2,571	2,571	2,571	2,571	2,571
R^2	0.049	0.241	0.328	0.021	0.071
Year Fixed Effects	YES	YES	YES	YES	YES
Industry*Year Fixed Effects	NO	NO	YES	NO	YES
Firm Fixed Effects	NO	NO	NO	YES	YES
Panel B: Placebo Law Change in 2004 (Largest Firms)					
	(1)	(2)	(3)	(4)	(5)
ln(Assets)		0.042***	0.033***	-0.010	-0.007
		(0.007)	(0.005)	(0.019)	(0.020)
Treat	-0.053*	0.032	0.011		
	(0.030)	(0.029)	(0.026)		
After	0.036***	0.015	-0.005	0.021**	0.019
	(0.011)	(0.013)	(0.070)	(0.010)	(0.039)
Treat × After	0.002	0.003	0.005	-0.002	-0.001
	(0.015)	(0.016)	(0.016)	(0.014)	(0.015)
Observations	1,351	1,351	1,351	1,351	1,351
R^2	0.019	0.173	0.382	0.024	0.077
Year Fixed Effects	YES	YES	YES	YES	YES
Industry*Year Fixed Effects	NO	NO	YES	NO	YES
Firm Fixed Effects	NO	NO	NO	YES	YES
Panel C: Random Treatment Dummy					
	(1)	(2)	(3)	(4)	(5)
ln(Assets)		-0.028**	-0.016	-0.210***	-0.193***
		(0.014)	(0.016)	(0.064)	(0.060)
Treat	0.061	0.064	0.041		
	(0.065)	(0.065)	(0.064)		
After	0.444***	0.440***	0.525**	0.354***	0.038
	(0.054)	(0.053)	(0.241)	(0.039)	(0.120)
Treat × After	-0.000	0.000	-0.004	0.009	0.004
	(0.047)	(0.046)	(0.043)	(0.044)	(0.041)
Observations	2,709	2,709	2,709	2,709	2,709
R^2	0.031	0.038	0.091	0.145	0.230

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