Voluntary Climate Action and Credible Regulatory Threat:

Evidence from the Carbon Disclosure Project*

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Abstract

This paper examines the role that regulatory pressure—specifically the U.S. Environmental Protection Agency's introduction of the Clean Power Plan, in conjunction with President Obama's executive actions on climate change—played in motivating the extensive and intensive margins of voluntary carbon disclosure by the Fortune Global 500 corporations during 2011-2015. Results from difference-in-differences and difference-in-difference-in-differences estimators nested in a two-stage endogenous binary-variable model—which accounts for the correlation between a firm's participation and intensity of participation decisions—show that both U.S. and non-U.S. based businesses acted preemptively in anticipation of a more stringent regulatory environment in the U.S. These firms were more likely to participate in voluntary carbon disclosure, and at higher levels, when they had installed managers dedicated to mitigating climate change risks, ceteris paribus. Empirical analysis includes controls for firm size, natural gas prices, and sector-specific market pressures and macro-economic and political economy dynamics. Results are robust to alternative specifications, including the Heckman selection model and sector-specific regressions.

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1 Introduction

Over 2000 companies from 145 countries representing $36.6 trillion USD in revenue—roughly equivalent to the combined GDPs of the U.S., China, Japan and Germany—have pledged proactive climate action, despite the fact that climate change mitigation or adaptation imposes substantial costs on firms (Hsu et al. 2016). Proactive climate action by corporations is a case of industry self-regulation, which includes voluntary commitments to reduce greenhouse gas (GHG) emissions, increase energy efficiency, invest in renewable energy sources, and disclose information about carbon management, among other activities that go beyond the law. Unlike existing studies, this paper investigates both the extensive and intensive margins of industry self-regulation in the climate change area. Many businesses "talk a good game," but under what conditions are they compelled to participate *and* participate at higher levels?

Toward this regard, this paper draws on the private provision of public goods, corporate social responsibility, and business management literatures to form hypotheses based on a rational political economy argument that there is a disparity in the willingness of companies to engage in voluntary climate action at different levels because of firm heterogeneity with respect to external political economy dynamics, internal firm management factors, and their interactions. In particular, this paper emphasizes the role of regulatory pressure—namely, the U.S. Environmental Protection Agency's (EPA) introduction of the Clean Power Plan (Section 111(d) of the Clean Air Act), in conjunction with President Obama's executive actions on climate change—and its interaction with executive and senior management inside the firm in motivating voluntary climate action by businesses. This paper argues and shows empirically that businesses will act preemptively in anticipation of a more stringent regulatory environment, and they will

more likely do so, and at higher levels, when there are favorable management structures and practices which involve the agency of corporate management.

Buchanan (1965) was the first scholar to define the joint provision of a public and private good as an "impure public good": in the equilibrium, firms sometime produce a public good or an externality jointly with their main task of providing private goods or services for consumption. Given incomplete contracts, a public good will be owned by the party that values the benefits generated by the related investments relatively more (Besley and Ghatak 2001; Grossman and Hart 1986; Hart and Moore 1990). In this setup, Besley and Ghatak (2007) and Kitzmueller and Shimshack (2012) explicitly link the private provision of public goods to corporate social responsibility (CSR). According to Besley and Ghatak (2007), CSR is the corporate provision of public goods or curtailment of public bads independent of legal benchmarks. CSR has also been referred to in the literature as "industry self-regulation," and as "corporate environmentalism" in the environmental area.

CSR arises in a "political economy" context with imperfect and asymmetric information (Kitzmueller and Shimshack 2012). This theoretical framework presupposes a broader set of attitudes, preferences, and calculations for considering prosocial or altruistic behavior by firms or individuals (Bénabou and Tirole 2003, 2006; Besley and Ghatak 2005; Graff and Small 2005; Arora and Gangopadhyay 1995). It is in this framework of CSR, as it is linked to the standard treatment of the private provision of public goods, that this paper considers proactive climate action by firms.

This paper's empirical analysis is based on panel data of the Fortune Global 500 firms' participation in the CDP (formerly known as the Carbon Disclosure Project) and their level of carbon disclosure over the period 2011-2015. The CDP is an ideal case study for examining the

extensive and intensive margins of industry self-regulation because the CDP—which was founded in 2000—is the oldest and largest nonprofit organization in the world that houses voluntary carbon disclosure by corporations (Winston 2010). At the behest of over 800 institutional investors, the CDP invites all Fortune Global 500 companies across a wide range of industries to disclose their entity-wide plans for measuring, reporting, and reducing GHG emissions, including the adoption of science-based, quantified emissions targets.

To distinguish the impact of regulatory pressure on corporations' participation and intensity of participation in voluntary carbon disclosure, and how regulatory pressure is mediated by internal management, this paper employs a unique research design: difference-in-differences (DD) and difference-in-difference-in-differences (DDD) estimators are nested in a two-stage endogenous binary-variable model. Unlike the extant literature, which typically models carbon disclosure as either a binary or continuous variable, this paper's nested two-stage endogenous binary-vary model allows for correlation between the unobservables that affect a firm's participation in voluntary carbon disclosure and the unobservables that affect the level of carbon disclosure. Furthermore, the DD and DDD set-up enables identification of the impact of the Clean Power Plan, while accounting for variation in internal management before and after the introduction of the Clean Power Plan. A vector of controls, including corporate revenues, natural gas prices, and emissions targets are included. Sector and year fixed effects control for time variant sector and macro-economic and macro-political developments in order to better isolate the effects of the Clean Power Plan and the role of executive and senior management dedicated to climate change.

Empirical findings show that regulatory pressure is a key driver of both the intensive and extensive margins of voluntary carbon disclosure when there exists dedicated managers

responsible for climate change. During 2011-2015, while U.S. companies were more likely to participate in voluntary carbon disclosure in response to the EPA's introductions of the Clean Power Plan, both U.S. and non-U.S. based companies that have installed in-house champions of climate change at the managerial and executive levels responded to the threat of impending climate change regulation in the U.S. by participating in voluntary carbon disclosure and disclosing at higher levels their existing practices and plans for managing climate change risks. These findings are robust to a series of alternative specifications, including a Heckman selection model and sector-specific regressions. While there is sector heterogeneity with respect to direct effects of regulatory pressure, what is largely consistent across industry sectors is that companies that have installed a climate change manager, ceteris paribus, responded to regulatory pressure in both their extensive and intensive margins of voluntary carbon disclosure.

The remainder of the paper proceeds as follows. Section 2 reviews the theory and presents hypotheses about regulatory pressure and how regulatory pressure interacts with firm-level management to motivate participation and intensity of participation in voluntary carbon disclosure by firms. Section 3 describes and justifies how the Clean Power Plan, in conjunction with President Obama's executive actions on climate change, constituted increased regulatory pressure and was viewed as a credible regulatory threat. In Section 4, data on the Fortune Global 500 firms and descriptive statistics are presented. Section 5 presents this paper's empirical approach and identification strategy. Empirical results and a discussion of these results are reported in Section 6. Section 7 concludes.

2 Conceptual Framework and Hypotheses

2.1 Regulatory Pressure

A rich literature spanning economics, public policy, and business management examines the external conditions under which firms will engage in corporate social responsibility (CSR) given that the production of public alongside private goods is costly (assuming a classic static environment). Both private politics (stakeholder activism by NGOs, including institutional investors) and public politics (actual or potential government interaction with firms via laws and regulation) have gained scholarly attention because of the plethora of empirical evidence that suggests political motivations are salient factors for explaining the emergence of CSR (Delmas and Toffel 2008; Doonan, Lanoie, and Laplante 2005; Innes and Sam 2008; Decker 2003; Shimshack and Ward 2008; Bandyopadhyay and Horowitz 2006; Lyon and Shimshack 2015).

At the center of firms and politics is the existence of information asymmetries between companies and the outside world. The mere possibility of being targeted by activists with negative publicity is sufficient to integrate CSR as part of corporate strategy because the threat of activism is an integral part of profit maximization on the cost side (Lyon and Maxwell 2004, 2008, 2011; Feddersen and Gilligan 2001; Innes 2006). At the equilibrium, ex ante agreements involving CSR are reached and coordinated by firms and industries (Kitzmueller and Shimshack 2012; Baron 2009; Baron and Diermeier 2007; Baron 2001). Thus, an implication is that CSR becomes a business strategy employed by firms to build reputation and avoid activism that could harm business conduct (Klein, Smith, and John 2004). Following from this, a key premise of this paper is that institutional investors can be seen as activists and they have empowered the CDP to serve on their behalf to target and invite Fortune Global 500 companies to proactively disclose climate change information. By this token, stakeholder politics is held constant in this paper's empirical analysis.

The incentive to engage in CSR could also be derived from the threat of *public* rather than private politics. Potential changes in regulation and related adjustment costs may lead firms to hedge against such an event and build a strategic "buffer zone" in the form of overcompliance (that is, CSR) (Kitzmueller and Shimshack 2012; Shimshack and Ward 2008; Maxwell, Lyon, and Hackett 2000; Innes and Sam 2008; Decker 2003; Khanna and Anton 2002; Henriques and Sadorsky 1996). In particular, Maxwell et al. (2000) extend the economic theory of regulation to allow for strategic self-regulation in the context of "corporate environmentalism, that is, voluntary adoption of cleaner products or processes" by firms (Maxwell, Lyon, and Hackett 2000, 584). A key implication of the authors' model is that firms will act preemptively in the face of increased regulatory threat: when the threat of regulation is high while the marginal cost of self-regulation is relatively low, it is the rational calculus of firms to engage in CSR as a form of deterrence.

Relatedly, CSR can be used to improve regulatory relations today with the aim of getting preferential treatment—for example, better permits or less enforcement—tomorrow. Corporate environmentalism involves cultivating and maintaining regulatory goodwill in anticipation of future regulation, especially in cases where "there is no plant compliance history to go on" (Decker 2003, 103), which is the case with carbon emissions in the U.S., as well as in a vast majority of countries where carbon emission has not (yet) been subject to regulation. As such, firms that engage in self-regulation are positioning themselves to influence the behavior of regulatory authorities toward their favor. Similarly, if firms expect stochastic shocks to their environmental or social performance, overcompliance today may reduce the risk of future noncompliance (Toffel and Short 2011).

The potential risk associated with regulators or regulation, whether now or in the future, is related to unacceptable process and product impacts. This results in regulatory changes, noncompliance penalties (when new regulations are in place), product elimination, substitution, phase-out, and the banning or restriction of raw materials. In the context of climate change, voluntary carbon disclosure is a form of industry self-regulation, which serves as a signal to regulators that corporations are taking action to address these potential risks. The following hypothesis summarizes the abovementioned literature for participation in voluntary carbon disclosure by firms.

> *Hypothesis 1: The likelihood of voluntary carbon disclosure increases when there is increased regulatory pressure for the firm to take into account the impact of its actions on carbon emissions.*

According to Karpoff et al. (2005), environmental violations are disciplined largely through legal and regulatory penalties, not through reputational penalties alone. Consequently, it would not be surprising that the intensive margin of participation—which is likely to be more costly compared to the binary decision of participation—is also a function of regulatory pressure. Khanna, Deltas and Harrington (2009) find that firms that face greater enforcement pressure and threat of anticipated regulations adopt higher levels of pollution prevention practices. In the context of climate change, Berthelot and Robert (2011) find that firms with significant political exposure are associated with higher levels of climate change disclosures in their annual reports.

> *Hypothesis 2: In the face of increased regulatory pressure, firms will engage in higher levels of voluntary carbon disclosure to deter future regulation.*

2.2 Regulatory Pressure and Firm Management

Aside from a focus on external factors, such as regulatory pressure, an established literature in business management and public policy argues that firm-level management structures and practices are drivers of CSR by firms (Strand 2013; Esty and Lubin 2010; Bromley and Powell 2012; Ramus and Montiel 2005; Westphal and Zajac 1998). There is less research, however, on how and the extent to which managerial factors mediate the effect of regulatory pressure on corporate environmentalism. This paper posits the looming threat of regulation is likely to hasten the efforts that managers dedicate to environmental sustainability, as a means of signaling to regulators the firm's ability to reduce its negative impacts on the environment. Managers will readily heed to regulatory pressure in an attempt to earn goodwill with regulators and avoid complex, inflexible and costly regulatory processes and legal liabilities (Khanna, Deltas, and Harrington 2009; Khanna et al. 2007). In other words, companies facing similar regulatory environments may not always respond in the same way. This may be because whether regulation is viewed as a business risk or opportunity depends, in part, on firm-specific factors, such as the existence of managers dedicated to responding to such risks and opportunities.

Prakash (2001) posits that two kinds of processes are at work for firms that adopt policies and engage in activities that go beyond the law: managers who are "policy supporters" (as opposed to "policy-neutrals and "policy-sceptics") either "capture" top management or induce consensus toward these policies and activities. Along this same logic, Liao, Luo, and Tang (2015) find that when a corporation's Board of Directors has a dedicated environmental committee the company's propensity for climate change disclosures is higher. Such variations at the firm level will result in how a company responds to regulatory pressure, which in turn shape a firm's decision about participation and intensity of participation in CSR activities related to environmental sustainability.

Hypothesis 3: In the face of regulatory pressure, firms that have a manager responsible climate change risks will more likely to engage in voluntary carbon disclosure than those without a dedicated manager.

Hypothesis 4: Firms facing regulatory pressure will engage in higher levels of voluntary carbon disclosure than those without a dedicated manager.

In the context of climate change, for firms that have made the necessary alignments in their management structures and practices toward a low-carbon economy, further incentivized by regulatory pressures, the marginal cost of disclosing information about their carbon management and carbon emissions is relatively low because they are more likely to be disclosing what they are already doing. Moreover, these firms safeguard their brand reputations and may even capture new markets because they are signaling to "caring" consumers about their corporate social responsibility (Graff and Small 2005; Dasgupta, Hettige, and Wheeler 2000; Arora and Gangopadhyay 1995; Navarro 1988).

3 Regulatory Pressure and the Clean Power Plan

A hallmark of the American federal government through the two Clinton administrations and the second Bush presidency has been a consistent inability to reach agreement on legislation related to environmental protection, energy, and other areas central to climate change (Rabe 2007, 431). Moreover, the U.S. did not ratify the Kyoto Protocol even though the U.S. under President Bush Sr. and President Clinton (during his first term) were involved in the initial negotiations. A large part of it was because it became clear that the U.S. Senate was against moving forward with the Kyoto Protocol (Rabe 2007, 2010). As such, federal policy deterred legislative options, mainly focusing on climate research and voluntary reduction. This focus on

research, voluntary reduction, and GHG intensity rather than outright growth in carbon emissions continued during the President Bush Jr.'s administration because of the divisiveness among senior officials about the seriousness of climate change (Rabe 2007; Meng 2017).

The inability of Congress to pass federal legislation on climate change was not due to lack of attempts, however, as shown in Figure 1. In fact, the first proposals for federal legislation on climate change took place over a decade ago; the McCain-Lieberman Climate Stewardship Act failed a Senate vote in 2003 and 2005, respectively. Senators Bernie Sanders and Barbara Boxer introduced The Global Warming Pollution Reduction Act of 2007, which died in committee, as did two more bills—the Climate Protection Act and Sustainable Energy Act, respectively, both of which were proposed in early 2013. On the House side, The American Clean Energy and Security Act of 2009, or the Waxman-Markey bill, as it was informally called, was approved by the House of Representatives in mid-2009 but did not survive the Senate due to a filibuster (Meng 2017).

[Figure 1 Here]

Given the contentious politics surrounding climate change, evidenced by the failures of the abovementioned legislative proposals in Congress, there was little expectation that federal regulation on climate change based on *new* legislation would be on the horizon in the U.S., particularly after 2010 when the Senate dropped deliberation over the Waxman-Markey bill. Rather, the end of legislative options arguably opened the door for climate regulation by "bureaucratic policy design" (Meckling and Nahm 2018). President Obama's delegation of climate policy making to the U.S. Environmental Protection Agency (EPA) shifted distributional conflict to autonomous bureaucracies, which according to Meckling and Nahm (2018), allows

for effective policy design, compared to "legislative policy design" where legislators have incentives to respond to vested interests.

President Obama first announced his climate change proposal on June 25, 2013,[1] in which he directed the EPA to work on carbon pollution standards for the power sector. Commonly known as the Clean Power Plan (CPP), the CPP was introduced in June 2014 by the EPA as a set of regulations under Section 111(d) of the Clean Air Act. The EPA's final standards for new coal- and natural gas-fired power plants (the "Carbon Pollution Standard for New Power Plants," an amendment to the Clean Air Act) were issued on August 3, 2015.[2] In this paper's empirical analysis, an indicator variable which is turned on after 2014 (covering 2014 and 2015 of the study period) serves as a proxy for the CPP.

Multiple events leading up to the CPP helped to boost its credibility with firms. The first was the U.S. Supreme Court's decision in Massachusetts vs. EPA (which was argued in November 2006 and decided in April 2007) that the Clean Air Act's protection encompasses greenhouse gas emissions.[3] Second, the EPA's own science-based determination showed that these climate destabilizing emissions endangered public health and welfare (US EPA 2019). As such, the CPP was arguably viewed by corporations as a credible regulatory threat with consequential adjustment costs, which likely led firms—particularly firms based in the U.S.—to hedge against impending regulation during the paper's study period (2011-2015) even before the CPP becomes enshrined in law.[4]

[1] Source: https://obamawhitehouse.archives.gov/the-press-office/2013/06/25/fact-sheet-president-obama-s-climate-action-plan (Retrieved March 16, 2017).
[2] Source: https://www.epa.gov/cleanpowerplan (Retrieved December 23, 2016)
[3] Source: https://en.wikipedia.org/wiki/Massachusetts_v._Environmental_Protection_Agency (Retrieved March 16, 2017).
[4] There may be reasons to believe that the "Carbon Pollution Standard for New Power Plants" may never come to fruition, given that the U.S. Supreme Court granted a stay, halting implementation of EPA's CPP in 2016 (Adler

While opposition to President Obama's climate change policy was strong (which eventually led to lawsuits that reached the Supreme Court), federal regulation on carbon emissions appeared imminent from the perspective of the private sector during 2014 and 2015, especially with the momentum of Paris Agreement on the rise, and with the U.S. and China playing an increasing role in galvanizing global climate action. As such, for corporations, by engaging in rational proactive climate action *today* they stood the chance of improving regulatory relations and signaling climate leadership with the aim of getting preferential treatment *tomorrow* when President Obama's proposed regulation becomes rule of law.

4 Data and Variables

Data for the empirical analysis are drawn from the CDP Climate Change Information Request questionnaire to 683 companies that were listed as a Global 500 company at least once between 2011 and 2015. On an annual basis, the CDP invites corporate executives to participate in the CDP Climate Change survey, which contains requests for information about corporate governance, climate change risks and opportunities, corporate strategies for climate risk management, and greenhouse gas emissions.[5]

Based on survey responses, the CDP grades firms on the comprehensiveness or the extent of their information disclosure by assigning disclosure scores (with a maximum score of 100; see

2016), and President Trump reversed President Obama's executive actions on climate change in 2017 (Greshko et al. 2018). That said, during the study period (2011-2015) there was little reason to expect a different regulatory world than the one that was emerging, which included impending mandatory standards on carbon emissions for new, modified and reconstructed power plants.

[5] The CDP Climate Change Information Request questionnaires can be found on the CDP website (source: https://www.cdp.net/CDP%20Questionaire%20Documents/CDP-Climate-Change-Information-request-2016.pdf). A company's disclosures on direct and indirect GHG emissions must be reported at the "entity level," so as to prevent the firm from reporting only on the outcomes of successful projects (CDP 2017, 2016a).

below for more details). The CDP's disclosure scores serve as this paper's proxy for the intensity of participation, or the level of voluntary carbon disclosure by firms.

All disclosure scores are public by default, but companies can request for privacy of their climate change information, including their disclosure scores. In 2011-2015, less than 5 percent of the Global 500 companies that disclosed to the CDP made this request.[6] To avoid making assumptions about the missing disclosure scores of the "private" responses, the paper's analysis consists of a panel of Global 500 companies in 2011-2015 excluding the 164 firm × year observations (<5 percent) in which a company has requested for privacy of its score.[7] The result is an unbalanced panel of 682 companies over five years, namely, 3251 firm × year observations.

4.1 Dependent Variables

There are two dependent variables in this paper: one for measuring the binary choice of participation in voluntary disclosure and the other for measuring the intensity of participation or the level of disclosure. The latter covariate is the outcome variable, whereas the former is the endogenous binary participation variable, both of which comprise the endogenous binary-variable model (see Section 5 for details about the paper's empirical model).

Participation is operationalized as 1 for participation and 0 for non-participation in voluntary carbon disclosure in a given year for a firm. A company chooses on an annual basis whether or not to participate in voluntary carbon disclosure; a firm can decide to participate in the CDP in

[6] According to Alex Cameron-Smith, CDP's Corporate Partnership Executive, "The scores are public by default, unless they request otherwise." This information is provided to the author via telephone interview and confirmed via email on November 17, 2015.

[7] A separate robustness check which includes the 164 firm × year observations (with disclosure scores coded as "0") shows that the paper's empirical results are robust to the exclusion of these observations (not shown but available upon request).

one year but not the next year.[8] The intensity of participation by a firm is measured by *Carbon Disclosure Score*, which is the degree to which a company is committed to a higher level of voluntary carbon disclosure; this variable can also be conceived as a measure of the level of detail and comprehensiveness of information disclosure.

Carbon Disclosure Score is a continuous variable that ranges from 0 to 100 (100 is the maximum score). This score is based on the number of points a company has been awarded for answering the CDP climate change survey regarding their climate change strategies and carbon emissions (the numerator), divided by the maximum number attainable (the denominator). This fraction is then converted to a percentage by multiplying by 100 and rounding to the nearest whole number. The higher the score, the more information a company has provided to the CDP about its carbon emissions and related management plans. Information about how the CDP scores individual company responses is in the Appendix.

I have coded "0" for C*arbon Disclosure Score* for companies that did not participate in the CDP's climate change survey during 2011-2015; as far as I know there are no other institutions that have built a more comprehensive international database of self-reported climate change information and have developed a reputation for impartiality (Winston 2010).[9] My coding scheme is robust to an alternative specification (Heckman selection model) in which non-participation is coded as missing values. Altogether there are 232 companies that did not disclose to the CDP at some point during 2011-2015, making up 903 company × year observations or close to 30 percent of the sample. By contrast, there are 532 companies in 2011-2015 that have a

[8] For example, there were 7 companies that disclosed their carbon emissions to the CDP in 2014 but not in 2015.
[9] The United Nation's database, NAZCA, for tracking climate commitments by investors, firms, cities, regions, and nonprofits partners with the CDP as its primary source of carbon management data. Source: http://climateaction.unfccc.int/

Carbon Disclosure Score greater than "0", making up 2348 company × year observations (72 percent of the sample).

Figure 2 shows the distribution of the voluntary disclosure scores of the Global 500 companies by year for 2011-2015. The increasingly thicker tail on the right side of the distribution from 2011 to 2015 suggests that while variation exists in the level of carbon disclosure there is an increasing bias toward higher levels of carbon disclosure amongst companies that report their carbon emissions and related information to the CDP. In fact, the disclosure scores take on an increasingly bimodal distribution with a concentration of zeros, as well as an increasing density of high scores. In 2011, the mean score was 47 with a median of 59. By 2015, the mean score was close to 60 and the median was close to 90.

[Figure 2 Here]

This is not particularly surprising: Lyon and Maxwell (2011) show that stakeholders punish "partial disclosure" rather than punish firms for being dangerous or dirty. That is to say, firms have the incentive to disclose at higher levels or not to disclose at all. This phenomenon may intensify over time as firms improve at carbon disclosure due to "learning" effects from peers, and/or due to the diffusion of technologies or socio-political norms that enable or demand better tracking of carbon emissions. The paper's main specification is robust to an alternative specification in which sector × year dummies are included to account for time variant sector-specific factors that may represent such learning and diffusion effects.

Despite the increasing upward bias in the distribution of disclosure scores over the period 2011-2015, the existing variation in scores represents the differential costs that these companies are willing to undertake in their voluntary carbon disclosure. This variation in scores is evident

between U.S. and non-U.S. based firms after the introduction of the Clean Power Plan by the EPA, in conjunction with the Obama Administration during 2014-2015. Figure 3 plots the time series of the average *Carbon Disclosure Score* for a Global 500 firm based in the U.S. (treatment group) next to the time series of the average *Carbon Disclosure Score* for a company with its headquarter outside of the U.S. (control group). The vertical dotted line represents the introduction of the CPP in 2014.

[Figure 3 Here]

From 2011-2013, the average level of voluntary carbon disclosure of a company based in the U.S. was approximately equal to that of a firm based outside of the U.S. The two *Carbon Disclosure Score* series diverged in 2014—which coincided with the introduction of the CPP—such that the average *Carbon Disclosure Score* for U.S. companies increased sharply relatively to that non-U.S. companies. This divergence in parallel trends in the post-treatment period, i.e., the post-CPP period, is confirmed with a formal parallel trends test (Autor 2003), where an indicator variable representing U.S. based firms is interacted with year dummies as regressors in an OLS regression of *Carbon Disclosure Score.* Results, which are reported in Table A1 of the Appendix, show that the coefficients associated with the 2012 and 2013 year dummies are statistically insignificant; this can be interpreted to mean that the outcome trends between the treatment and the control group are the same, which suggests that the difference in differences (which are explained in detail in the next section) is not significantly different between the U.S. and non-U.S. companies in the pre-treatment period or pre-CPP period.

4.2 Independent Variables

First, I construct a dummy variable, *Clean Power Plan* that is turned on in 2014 and thereafter to indicate the fact that in June 2014 the EPA, in conjunction with the Obama Administration, introduced a draft version of the Clean Power Plan and sought public comments. In August 2015, the EPA published its final standards on carbon emissions for new coal- and natural gas-fired power plants.

USA is a dummy that signifies whether a firm is based in the U.S. *USA* × *CPP* is an interaction term between *Clean Power Plan* and *USA,* which designates U.S. based firms in the years following the introduction of the CPP by the EPA. These three variables make up the difference-in-differences estimator, which is described in more detail in the next section.

Interaction terms between *USA, Clean Power Plan* and *Manager,* respectively, as well as the three variables interacted together in the form of *USA* × *CPP* × *Manager* make up the different regressors of the difference-in-difference-in differences estimator.

Manager is time-varying variable drawn from the CDP climate change survey between 2011 and 2015.[10, 11] *Manager* is coded 1 and 0 otherwise if a company houses a senior or executive level manager responsible for climate change, environmental sustainability, or environmental policy in a given year. *Manager* is also coded 1 if a firm has a committee responsible for setting vision and planning for climate risk management as part of its Board of Directors. The Appendix describes this paper's treatment of missing variables.

[10] The *Manager* variable is based on response to CC1.1 ("Where is the highest level of direct responsibility for climate change within your organization?").

[11] As part of a data reliability and validity check the author and a research assistant have conducted manual checks on firm responses to the CDP survey questions on *Manager* and *Target*, respectively, for separate draws of 100 randomly selected companies in the Fortune Global 500, using publicly available information on the internet (such as LinkedIn, corporate annual reports). The accuracy rate of self-reported information on *Manager* and *Target* was close to 100 percent.

4.3 Control Variables

This paper includes control variables that have been identified as drivers of voluntary carbon disclosure in existing empirical studies. To begin, the natural log of a firm's annual, fiscal year corporate *Revenues* in millions of dollars measures firm size. The natural log of a firm's corporate *Assets* in millions of dollar serves as an alternative specification in the robustness checks (see Tables A4 and A5). Prior scholarship has shown that larger firms are more likely to participate in voluntary environmental programs (Arora and Cason 1996; Henriques and Sadorsky 1996; DeCanio and Watkins 1998; Videras and Alberini 2000; Khanna et al. 2007; Stanny and Ely 2008), in part to mitigate the potential negative impacts of a tarnished public image due to an increased susceptibility to public scrutiny (Guenther et al. 2015; Luo, Lan, and Tang 2012; Aerts, Cormier, and Magnan 2008).

Furthermore, the empirical analysis includes the natural log of the annual average of the Dow Jones Commodity Index for Natural Gas (Total Returns), which is an index of monthly natural gas prices designed to track the natural gas market through futures contracts, for 2011-2015. *Natural Gas Price* allows for an alternative explanation of corporate voluntary carbon disclosure: since burning natural gas produces nearly half as much carbon dioxide per unit of energy compared to that of coal (Zielinski n.d.), the downward trend in natural gas prices in recent years could instead be a driver of voluntary climate action rather than regulatory pressure or internal firm management structure and practices.

Another control variable, *Target*, which is a proxy for whether a firm has integrated climate change risks into a firm's modus operandi, is coded 1 and 0 otherwise if a firm has adopted a

quantifiable emissions reduction target in a given year.[12] In the empirical analysis, *Target* serves as an exclusion variable to separately identify the participation and intensity of participation stages of the endogenous binary-variable model. When the creation of managerial positions that support a corporation's climate change activities are backed up with corresponding actions related to implementation, the gap between policy and practice will have been eliminated, leading to reduction of carbon emissions by corporations (Lyon and Montgomery 2015; Bromley and Powell 2012; Lyon and Maxwell 2011).

To account for sector heterogeneity, I include sector fixed effects.[13] The effect of sector heterogeneity has been mixed. Arora and Cason (1996) find that voluntary program participation rates are higher in industries with greater consumer contact. Recent studies have shown that firms operating in sectors that emit substantial amounts of greenhouse gases are more likely to engage in climate change disclosure and mitigation activities (M. Kotchen and Moon 2012; Haigh and Griffiths 2012; Kolk and Pinkse 2008; Cho and Patten 2007). Sector effects could also be important because of competitive pressures for proactive climate action—including carbon disclosure—among firms operating in the same sector.

Finally, I also include year fixed effects to control for exogenous factors that affect, in some unobserved way, all multinational companies in a given year.[14] These exogenous factors could include macroeconomic, political and institutional factors (for example, high levels of general

[12] The *Target* variable is based on responses to CC3.1 ("Did you have an emission reduction target that was active (ongoing or reached completion) in the reporting year?"). For companies that respond "Yes" to having an emissions reduction target that is active they are also requested to report information about "scope, % of emission in scope, % reduction from base year, base year, base year emissions, and target year," in addition to whether they have an absolute versus an intensity target. For the purpose of this paper, I do not differentiate between an absolute versus an intensity target.

[13] In one of the alternative specifications, I allow sector, year, and/or country fixed effects to enter the model separate. See the fourth model (4) in Tables A2-A3.

[14] An alternative specification to country of origin could be country of largest sales. The two measures are highly correlated (~0.82) for companies for which the country of sales data are available (two-thirds of the 683 companies).

commitment to climate change mitigation, protection of shareholder rights, favorable energy prices worldwide) that motivate a secular trend of proactive climate action for all firms.

4.4 Descriptive Statistics

Table 1 reports summary statistics for the covariates used in the empirical analysis for the pre-CPP and post-CPP periods, respectively. Panel A presents descriptive statistics for U.S. based companies and panel B reports descriptive statistics for the non-U.S. based firms.

[Table 1 Here]

On average between 70 percent to three-fourth of the Global 500 companies have participated in voluntary carbon disclosure at least once during 2011-2015. U.S. based firms participated at higher rates than non-U.S. based companies in the pre-CPP period and that gap widened in the post-CPP period; the gap between the two groups' level of voluntary carbon disclosure also increases during the latter period.

Table 2 presents the unconditional participation rates and mean and median disclosure scores across nine industry sectors in 2011-2015 and in 2011 and 2015 separately. Participation in the CDP is high across sectors, notably consumer staples and industrials. As in the pooled data, the mass of the distribution is skewed to the right. Moreover, there has been a ratcheting up of scores in recent years across all sectors with the exception of the utilities sector.

[Table 2 Here]

5 Empirical Methods and Identification Strategy

This paper's estimation strategy is based on the difference-in-differences (DD) framework with an extension to the difference-in-difference-differences (DDD) estimator that exploits the

difference in the firm's participation in voluntary carbon disclosure and level of carbon disclosure between the treatment and control groups. The DD and DDD estimators are nested within an endogenous binary-variable model to specify a firm's extensive and intensive margins of voluntary carbon disclosure.

Before explicating the endogenous binary-variable model, I explain the logic of the DD and DDD frameworks. Consider two groups of firms, U.S. and non-U.S. based companies. Neither group of firms receives the treatment in the first period and only one group of firms receives it in the second period. The idea is to calculate the change in the outcomes among the treated group or U.S. companies between the two periods and then subtract the change in outcomes among the untreated group or non-U.S. firms.

The DD estimator will produce a valid estimate of the average treatment effect under the assumption that in the absence of the treatment—which in this paper is the introduction of the CPP by the EPA in 2014—the outcome in the U.S. and non-U.S. firms, respectively, would have changed identically in the treatment and control firms between the two periods, that is, the pretreatment and posttreatment periods (Greenstone and Gayer 2009).

This assumption is nontrivial and could be invalid in some settings, especially when behavioral responses are possible. In this setting, the introduction of the CPP by the EPA affecting chiefly the U.S. based companies was an exogenous event as part of a regulatory process/or sanctioned by law rather than an initiative of individual firms in response to economic shocks. As such, the well-known "Ashenfelter [preprogram earning] dip" (Ashenfelter and Card 1985) is probably unlikely: it is reasonable to assume that the estimated change between the treatment and control group of firms—i.e., U.S. versus non-U.S. based firms, respectively—is the "impact" that can be attributable to the CPP.

A more precise model can be obtained by exploiting further variation that exists between the treatment and control firms. As hypothesized in section 2, a firm's affirmative response to impending regulation with respect to the extensive and intensive margins of voluntary carbon disclosure could be predicated by having favorable internal management factors, such as the installation of dedicated managers responsible for climate change risks. Table A2 in the Appendix shows the variation in the level of voluntary carbon disclosure for firms with and without a climate change manager in the pre and post-CPP periods, respectively. A simple difference in means test indicates that companies with a manager had a significantly higher *Carbon Disclosure Score* than those without a manager in both periods.

In the pre-CPP period, companies with a climate change manager disclosed more information about their carbon management (by 18 points) than companies without a climate change manager. This difference in the level of voluntary carbon disclosure persisted with a widening gap (20 points) between firms with a manager and without a manager, respectively, in the post-CPP period. Moreover, the increase in the level of carbon disclosure was 13 percent higher for companies with a manager than for companies without a manager before versus after the introduction of the CPP.[15] These calculations indicate that the variation in internal management factors matter, both directly on its own and indirectly through its interaction with regulatory pressure, in explaining the extent of voluntary carbon disclosure by firms.

Conceptually, to operationalize the DDD estimator, we subtract another "difference" from the difference-in-differences set up. The DDD estimator starts with the time change in averages (i.e., the difference in averages between the pretreatment and treatment periods) for the firms that

[15] [(89.6-77.9)/(69.8-59.5)]-1 = 13 percent

install a climate change manager in the treatment group of firms (U.S.) and then nets out the change in means for the firms that install a climate change manager in the control group of firms (non-U.S. firms) and the change in means for firms that do not have a manager in the treatment group of firms. As mentioned above, both the DD and DDD model specifications are nested within an endogenous binary-variable, which I explicate below.

The endogenous binary-variable model, also called the endogenous-switching model (Maddala 1983), is a linear potential-outcome model that allows for a specific correlation structure between the unobservables that affect a firm's decision to participate in voluntary carbon disclosure represented by the binary variable *Participation* and the unobservables that affect the potential outcome, that is, the level of carbon disclosure or *Carbon Disclosure Score*. Typically one such unobservable is regulatory pressure, which I explicitly model in this paper as *Clean Power Plan*, an indicator variable (see prior section). In essence, the average marginal effect and the other parameters of a linear regression model are augmented with endogenous binary participation variable.

The primary regression equation of interest is

$$Y_j = x_j\beta + \delta t_j + T\theta_j + \gamma_i + \epsilon_j \qquad (1)$$

where t_j is a binary participation variable that is assumed to stem from an unobserved latent variable:

$$t_j^* = w_j\gamma + u_j$$

In the outcome equation (1), x_j is a vector containing the nested DD or DDD estimator, as well as individual firm characteristics and controls explaining the level of voluntary carbon

disclosure by firm *j*. The DD estimator is made up of the following variables: *USA*, *Clean Power Plan*, *USA* × *CPP*, which are the explanatory variables of interest, *Revenues*, as well as *Natural Gas Price*, and *Target*. By contrast, the DDD estimator augments the DD estimator with additional variables and interactions: *Manager*, *USA* × *Manager*, *CPP* × *Manager*, and *USA* × *CPP* × *Manager*. The endogenous binary-participation treatment variable in both the DD and DDD versions of the endogenous binary-variable model, respectively, is a function of the same independent variables except for *Target*, which serves as an exclusion restriction; *Target* is postulated to explain the extent of carbon disclosure but not the decision about participation in voluntary carbon disclosure.[16]

T is a vector of time fixed effects that control for contemporaneous shocks in the world economy that affect all firms. γ_i represents a host of not readily observed factors in a firm's industry sector where $i = 1, \ldots 6, 8, 9$ for the nine GICS industry sectors excluding the Information Technology sector, which serves as the reference sector for comparison purposes.

The decision to participate in voluntary carbon disclosure is made according to the rule

$$t_j = \begin{cases} 1, & if\ t_j^* > 0 \\ 0, & otherwise \end{cases}$$

where ϵ and u are bivariate normal with mean zero and covariate matrix

$$\begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix}$$

[16]A Hausman specification test for overidentification (i.e., no exclusion restriction vs. overidentified version) indicates that the null, which is that the difference in coefficients is not systematic, can be rejected with a χ^2 value of 1208.50 with probability $\geq\chi^2$ is 0.

Interactions between x_j and the participation treatment t_j are also allowed in (1). The likelihood function for this model is given in Maddala (1983, 122). Greene (2000, 180) discusses the standard method of reducing a bivariate normal to a function of a univariate normal and correlation ρ. The following is the log likelihood for observation j,

$$\ln L_j = \begin{cases} \ln \Phi\left\{\dfrac{w_j\gamma + (y_j - X_j\beta - \delta)\rho/\sigma}{\sqrt{1-\rho^2}}\right\} - \dfrac{1}{2}\left(\dfrac{y_j - X_j\beta - \delta}{\sigma}\right)^2 - \ln(\sqrt{2\pi}\sigma) & t_j = 1 \\ \ln \Phi\left\{\dfrac{-w_j\gamma - (y_j - X_j\beta)\rho/\sigma}{\sqrt{1-\rho^2}}\right\} - \dfrac{1}{2}\left(\dfrac{y_j - X_j\beta}{\sigma}\right)^2 - \ln(\sqrt{2\pi}\sigma) & t_j = 0 \end{cases}$$

Where $\Phi(\cdot)$ is the cumulative distribution function of the standard normal distribution. In the maximum likelihood estimation, σ and ρ are not directly estimated. Rather $\ln \sigma$ and $atanh\rho$ are directly estimated, where

$$atanh\rho = \frac{1}{2}\ln\left(\frac{1+\rho}{1-\rho}\right)$$

The standard error of $\lambda = \rho\sigma$ is approximated through the delta method, which is given by

$$Var(\lambda) \approx DVar\{(atanh\rho \ln \sigma)\}D'$$

where D is the Jacobian of λ with respect to $atanh\rho$ and $\ln \sigma$.

The estimation is done in Stata using the "etregress" command, which fits the endogenous binary-variable model using the maximum likelihood estimator. Robust standard errors with firm level cluster correction are included to correct for heterogeneity and serial correlation in the empirical analysis.[17]

[17] The Swamy-Arora method for unbalanced panels derived by Baltagi and Chang (1994) is implemented for estimating the variance components, which make adjustment for small samples. The resulting standards are robust to any kind of serial correlation or heteroscedasticity (Wooldridge 2010).

Finally, a Fisher type panel unit root test (Choi 2001) has been conducted on *Carbon Disclosure Score* for U.S. firms and non-U.S. firms to confirm that the nested DD and DDD estimators in the endogenous binary-variable model do not lead to spurious results in the regression analysis. See Table A3 in the appendix for the test results.

6 Empirical Results and Discussion

6.1 Main Results

Table 3 presents estimation results based on the DD and DDD estimators, which are nested in the endogenous binary-variable model, as described above. The DD specification is represented by Model 1, whereas Model 2 is the DDD specification. Both models include sector and year fixed effects. Robust standard errors with firm-level cluster correction are reported. These results are confirmed by extensive robustness checks, which are reported in A4 and A5 in the Appendix.

[Table 3 Here]

The empirical results suggest substantial evidence for Hypotheses 2-4. Results for Model 1, which follows the DD setup, show that regulatory pressure is positively associated with the intensive margin of voluntary carbon disclosure, i.e., the level of voluntary carbon disclosure. By contrast, regulatory pressure is not a correlate of a firm's decision about participation in the first stage of the endogenous binary-variable model, which is primarily a function of firm size.

That being said, once we account for the role of a dedicated manager responsible for climate change in Model 2, as part of a DDD specification, results show that after the introduction of the CPP, U.S. based firms were more likely to participate in the CDP. Engaging in industry self-regulation through the CDP was one way for the U.S. based firms to proactively signal their climate change mitigation readiness in the face of regulatory threat. While not (yet) codified in

law, the introduction of the CPP by the EPA, in conjunction with the Obama Administration, was generally viewed by U.S. based firms as a credible harbinger of impending regulation given reasons described in Section 3 of the paper, including the fact that the CPP was part of the Clean Air Act, which is a legal binding legislation with a broad jurisdiction encompassing greenhouse gas emissions. Nonetheless, the positive, direct effect of *CPP* is moderated slightly for U.S. companies in the presence of a dedicated manager (at the 10 percent significance level); this may be because managers served as an internal firm monitor making sure that any form of industry self-regulation, which voluntary carbon disclosure is a case, would be viewed as a positive signal of climate change readiness rather than greenwashing behavior in the post-CPP world.

Model 2 results also show that firms with a dedicated manager on climate change responded to impending regulation (i.e., post-CPP) by increasing their likelihood of participation and their extent of voluntary carbon disclosure, respectively, relatively to firms without a manager.[18] The marginal cost of disclosing climate change information was likely to be relatively low for these firms given that they were more equipped to do so than their counterparts without a *Manager* in the post-CPP period. In fact, the *CPP*'s overall positive effect on voluntary carbon disclosure is primarily through its interaction effect with *Manager*. Otherwise, on its own, *CPP* has a slightly perverse effect on participation; this could be because firms were wary of disclosing "bad news" post-CPP. Rather than disclose bad news, they opted not to disclose at all (Kim and Lyon 2011b, 2011a; Lyon and Maxwell 2011), except if they had a dedicated manager to help them navigate the new regulatory regime.

[18] Since firms are being scored on whether or not they disclose information about whether they have an executive or senior manager dedicated to climate change and whether they possess an emissions targets, and these characteristics are driving their CDP score for firms that participate in voluntary carbon disclosure, this paper's focus is on how managers and integration of climate risks interact with regulatory threat.

Of note, the fact that *CPP* and *CPP* × *Manager* in Model 1 and Model 2, respectively, were both positive and statistically significant on their own without an *USA* interaction term suggests that on balance non-U.S. based companies also responded to regulatory pressure originating in the U.S. in their decisions about participation and the extent of participation in voluntary carbon disclosure. Over a quarter of non-U.S. based Fortune Global 500 firms generate their largest or second largest sales in the U.S.[19] It is thus not surprising that these companies had paid close attention to regulatory developments in the U.S. Furthermore, the Obama Administration's executive actions on climate change articulated a vision for increased global leadership in addition to directing the EPA to promulgate regulation as part of the Clean Air Act. Therefore, multinational companies and shareholders worldwide recognized and anticipated that the U.S. was very likely to play a significant role at the Paris Climate Agreement at year-end 2015.

Confirming prior results in the literature, the control variables on balance produced expected results. Across both Models 1 and 2, large firms were more likely to participate in voluntary carbon disclosure and to disclose at higher levels than smaller firms. Companies that have established quantitative targets on carbon emissions (which serves as an exclusion variable between the participation and disclosure regressions in the endogenous binary-variable model) disclosed at higher levels by 14-18 points (out of 100 points) than their counterparts without the concrete tool for climate mitigation. Moreover, by and large, firms responded to economic incentives in their intensive margins of participation: when natural gas prices fell, it became less costly for firms to invest in voluntary carbon disclosure, so they disclosed at higher levels. That said, the paper's results show that firms chose to participate in the CDP even when natural gas prices were increasing (and thus relatively more expensive to reduce emissions); this may be

[19] This is based on author's calculations using sales data from Mint Global. Calculations are available upon request.

because firms participated in the CDP to signal their climate leadership, which is relatively inexpensive compared to the expensive endeavor of disclosing at high levels.

Finally, participation in the previous year in the CDP accounted for a substantial amount of firms' disclosure scores; this is a feature of the endogenous binary-variable model, which allows for correlation between the extensive and intensive margins of voluntary carbon disclosure. Prior participation represents a form of "learning effects": Matisoff et al. (2013) suggest that firms may not participate fully in the CDP during the first year that they join, but once they participate they start collecting climate change information and modifying their behavior, which allows them to increase their scores in future years.

6.2 Robustness Checks

As a robustness check to the main specifications (Models 1 and 2), Tables A4 and A5 in the Appendix present the results of four alternative specifications for the nested DD and DDD estimators, respectively. First, I include an alternative specification that replaces *Revenues* (log) with *Assets* (log), which has also been used in the literature to control for firm size. In the second alternative specification, I replace the Dow Jones Natural Gas Index with the S&P GSCI Natural Gas Index as an alternative measure of natural gas prices. The third alternative specification includes *Sector* × *Year*, along with sector and year fixed effects. This latter specification controls for time variant sector-specific market structure and competitive pressures from rival firms in the same sector, such as variation in the intensity of carbon disclosure by rival firms from one year to another.

Finally, as a fourth alternative specification I employ the standard Heckman Selection (HS) model. The HS model includes the same covariates as Model 1 and Model 2 in Table 4 except it

replaces the dependent variable *Score* with an alternative measure of the level of voluntary carbon disclosure that codes non-participants as missing values. This allows for the possibility that some of the non-participants may have only disclosed their carbon management activities outside of the CDP framework. This could be true (albeit to varying degrees) for companies originating from different countries and regions. As noted above, however, as far as I know there are no other institution that have built a more comprehensive database of self-reported climate change information as the CDP (Winston 2010). On balance, the paper's empirical results are robust to these alternative specifications.

Tables A6 and A7 show that while there is sector heterogeneity with respect to the direct effects of regulatory pressure by the way of the *CPP*, what is consistent across industry sectors with the exception of the Consumer Discretionary sector is the statistically significant and positive response to regulatory pressure by companies that have installed a *Manager* with respect to both their extensive and intensive margins of voluntary carbon disclosure. In fact, firms with dedicated managers operating in GHG-intensive sectors—Energy, Utilities, and Materials sectors—were two to three times more likely to participate in voluntary carbon disclosure and disclosed at higher levels (8-18 points) in the post-CPP period than firms without managerial leadership capacity to address climate change risks in these sectors.

7 Conclusion

This paper examines the role that the introduction of the Clean Power Plan (CPP) by the U.S. Environmental Protection Agency, in conjunction with the Obama Administration, which increased the likelihood of climate change regulation in the U.S., plays in the extensive and intensive margins of voluntary carbon disclosure via the CDP (formerly the Carbon Disclosure

Project) by the Fortune Global 500 firms. Empirical results based on difference-in-differences (DD) and difference-in-difference-in-differences (DDD) estimators nested in the endogenous binary-variable model, which accounts for the correlation between a firm's participation and intensity of participation decisions, show that businesses will act preemptively in anticipation of a more stringent regulatory environment. They will more likely do so and at higher levels when there are conducive internal-firm management structures and practices, such as senior and executive level managers dedicated to climate change mitigation and quantifiable emissions targets. Empirical results are robust to alternative specifications, including a Heckman selection model.

The paper's results show that managers played dual roles: On one hand, managers represented managerial capacity and capability for climate change mitigation. On the other hand, managers served as internal firm monitors to ensure that any form of industry self-regulation, which voluntary carbon disclosure is a case, would be viewed by the markets, including shareholders, as a positive signal of climate change readiness rather than greenwashing behavior in the post-CPP world.

Furthermore, both the DD and DDD estimation results indicate that companies based outside the U.S. also responded to regulatory pressure originating in the U.S. The U.S. is a major market for the Fortune Global 500 firms. As such, it is not surprising that these firms paid close attention to regulatory developments in the U.S. Moreover, a prominent feature of the Obama Administration's executive actions on climate change, which the CPP was a component, was a vision for increased global leadership. Companies worldwide recognized that the U.S. was likely to play a significant role at the Paris Climate Agreement and responded proactively to impending U.S. climate regulation by participating in voluntary carbon disclosure and at higher levels.

Several implications for future research follow from this paper. First, while this paper does not directly test corporate greenwashing behavior, there are implications for greenwashing. A benefit of modeling both the intensive and extensive margins of industry self-regulation is that we can differentiate the incentives facing firms at both levels because it is relatively less expensive to participate (which is a binary decision), whereas marginal cost increases with the intensity of participation. The paper's results suggest that while firms did not disclose climate change information at higher levels unless it was relatively cheap to do so (i.e., when natural gas prices were low), they participated in voluntary carbon disclosure even when natural gas prices were elevated. This seemingly unintuitive result suggests that participation in proactive climate action is a relatively inexpensive means of signaling climate leadership without actually having to exert effort, which is a separate (but related) decision.

Second, the existing literature shows that private and public provisions of public goods are imperfect substitutions (Calveras, Ganuza, and Llobet 2007). This implies that increased self-regulation could crowd out formal government regulation when society gets a free ride on a small group of activist consumers, investors, or producers. Yet, this study shows that regulatory pressure—in the form of public politics—cannot be underestimated in propelling firms to act proactively in climate change mitigation, especially when formal government regulation lags behind climate science because of contentious politics. On the contrary, the lack of public politics—including silence or anti-climate change rhetoric or actions by government officials—could be significant disincentives for climate change mitigation by firms.

Finally, questions remain about the link between the scope of participation and effectiveness with respect to environmental outcomes. Mattisoff (2012) finds evidence to suggest that the CDP does not have an effect on carbon emissions, and in fact, participation is associated with an

increase in carbon intensity. That being said, Matisoff (2012) acknowledges that his analysis does not account for the intensity of participation (that is, the level of carbon disclosure), which this paper emphasizes is related but distinct from the binary decision of participation. As such, an implication of this paper is that in addressing the link between participation and firm-level and industry-wide behavior, evaluation studies on firms' carbon footprints must account for both the extensive and intensive margins of climate action because it is likely that those who participate more intensely are likely to reduce more carbon emissions than those who do not. Ultimately, these are the corporate leaders in climate change mitigation.

References

Adler, Jonathan H. 2016. “Opinion | Supreme Court Puts the Brakes on the EPA’s Clean Power Plan.” *Washington Post*, February 9, 2016, sec. The Volokh Conspiracy Opinion Opinion A column or article in the Opinions section (in print, this is known as the Editorial Pages). https://www.washingtonpost.com/news/volokh-conspiracy/wp/2016/02/09/supreme-court-puts-the-brakes-on-the-epas-clean-power-plan/.

Aerts, Walter, Denis Cormier, and Michel Magnan. 2008. “Corporate Environmental Disclosure, Financial Markets and the Media: An International Perspective.” *Ecological Economics* 64 (3): 643–59. https://doi.org/10.1016/j.ecolecon.2007.04.012.

Arora, Seema, and Timothy N. Cason. 1996. “Why Do Firms Volunteer to Exceed Environmental Regulations? Understanding Participation in EPA’s 33/50 Program.” *Land Economics* 72 (4): 413–32. https://doi.org/10.2307/3146906.

Arora, Seema, and Shubhashis Gangopadhyay. 1995. “Toward a Theoretical Model of Voluntary Overcompliance.” *Journal of Economic Behavior & Organization* 28 (3): 289–309. https://doi.org/16/0167-2681(95)00037-2.

Ashenfelter, Orley, and David Card. 1985. “Using the Longitudinal Structure of Earnings to Estimate the Effect of Training Programs.” *The Review of Economics and Statistics* 67 (4): 648–60. https://doi.org/10.2307/1924810.

Autor, David H. 2003. “Outsourcing at Will: The Contribution of Unjust Dismissal Doctrine to the Growth of Employment Outsourcing.” *Journal of Labor Economics* 21 (1): 1–42. https://doi.org/10.1086/344122.

Baltagi, Badi H., and Young-Jae Chang. 1994. “Incomplete Panels: A Comparative Study of Alternative Estimators for the Unbalanced One-Way Error Component Regression Model.” *Journal of Econometrics* 62 (2): 67–89. https://doi.org/10.1016/0304-4076(94)90017-5.

Bandyopadhyay, Sushenjit, and John Horowitz. 2006. “Do Plants Overcomply with Water Pollution Regulations? The Role of Discharge Variability.” *Topics in Economic Analysis & Policy* 6 (1). https://doi.org/10.2202/1538-0653.1486.

Baron, David P. 2001. “Private Politics, Corporate Social Responsibility, and Integrated Strategy.” *Journal of Economics & Management Strategy* 10 (1): 7–45.

Baron, David P. 2009. “A Positive Theory of Moral Management, Social Pressure, and Corporate Social Performance.” *Journal of Economics & Management Strategy* 18 (1): 7–43. https://doi.org/10.1111/j.1530-9134.2009.00206.x.

Baron, David P., and Daniel Diermeier. 2007. “Strategic Activism and Nonmarket Strategy.” *Journal of Economics & Management Strategy* 16 (3): 599–634.

Bénabou, Roland, and Jean Tirole. 2003. “Intrinsic and Extrinsic Motivation.” *The Review of Economic Studies* 70 (3): 489–520. https://doi.org/10.1111/1467-937X.00253.

———. 2006. “Incentives and Prosocial Behavior.” *American Economic Review* 96 (5): 1652–78. https://doi.org/10.1257/aer.96.5.1652.

Berthelot, Sylvie, and Anne-Marie Robert. 2011. “Climate Change Disclosures: An Examination of Canadian Oil and Gas Firms.” *Issues in Social and Environmental Accounting* 5 (1/2): 106–23.

Besley, Timothy, and Maitreesh Ghatak. 2001. “Government Versus Private Ownership of Public Goods.” *The Quarterly Journal of Economics* 116 (4): 1343–72. https://doi.org/10.1162/003355301753265598.

———. 2005. “Competition and Incentives with Motivated Agents.” *The American Economic Review* 95 (3): 616–36. https://doi.org/10.1257/0002828054201413.
———. 2007. “Retailing Public Goods: The Economics of Corporate Social Responsibility.” *Journal of Public Economics* 91 (9): 1645–63.
Bromley, Patricia, and Walter W. Powell. 2012. “From Smoke and Mirrors to Walking the Talk: Decoupling in the Contemporary World.” *Academy of Management Annals* 6 (1): 483–530. https://doi.org/10.1080/19416520.2012.684462.
Buchanan, James M. 1965. “An Economic Theory of Clubs.” *Economica*, New Series, 32 (125): 1–14.
Calveras, Aleix, Juan-JosÉ Ganuza, and Gerard Llobet. 2007. “Regulation, Corporate Social Responsibility and Activism.” *Journal of Economics & Management Strategy* 16 (3): 719–40. https://doi.org/10.1111/j.1530-9134.2007.00155.x.
CDP. 2016. “Accounting of Scope 2 Emissions: Technical Notes for Reporting to CDP Climate Change and Supply Chain in 2016.” CDP. https://www.cdp.net/Documents/Guidance/2016/CDP-technical-note-Accounting-of-Scope-2-Emissions-2016.pdf.
———. 2017. “Guidance for Companies Reporting on Climate Change on Behalf of Investors & Supply Chain Members 2017.” https://b8f65cb373b1b7b15feb-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/guidance_docs/pdfs/000/000/224/original/CDP-Climate-Change-Reporting-Guidance.pdf?1478542692.
Cho, Charles H., and Dennis M. Patten. 2007. “The Role of Environmental Disclosures as Tools of Legitimacy: A Research Note.” *Accounting, Organizations and Society* 32 (7–8): 639–47. https://doi.org/10.1016/j.aos.2006.09.009.
Choi, In. 2001. “Unit Root Tests for Panel Data.” *Journal of International Money and Finance* 20 (2): 249–72. https://doi.org/10.1016/S0261-5606(00)00048-6.
Dasgupta, Susmita, Hemamala Hettige, and David Wheeler. 2000. “What Improves Environmental Compliance? Evidence from Mexican Industry.” *Journal of Environmental Economics and Management* 39 (1): 39–66.
DeCanio, Stephen J., and William E. Watkins. 1998. “Investment in Energy Efficiency: Do the Characteristics of Firms Matter?” *Review of Economics and Statistics* 80 (1): 95–107. https://doi.org/10.1162/003465398557366.
Decker, Christopher S. 2003. “Corporate Environmentalism and Environmental Statutory Permitting.” *The Journal of Law & Economics* 46 (1): 103–29. https://doi.org/10.1086/345586.
Delmas, Magali, and Michael W. Toffel. 2008. “Survey Questionnaire on Environmental Management Practices: Summary of Results by Industry and Practices,” May. http://www.hbs.edu/faculty/Pages/item.aspx?num=34534.
Doonan, Julie, Paul Lanoie, and Benoit Laplante. 2005. “Determinants of Environmental Performance in the Canadian Pulp and Paper Industry: An Assessment from inside the Industry.” *Ecological Economics* 55 (1): 73–84. https://doi.org/10.1016/j.ecolecon.2004.10.017.
Esty, David A., and Lubin. 2010. “The Sustainability Imperative.” Harvard Business Review. 2010. https://hbr.org/2010/05/the-sustainability-imperative.
Feddersen, Timothy J., and Thomas W. Gilligan. 2001. “Saints and Markets: Activists and the Supply of Credence Goods.” *Journal of Economics & Management Strategy* 10 (1): 149–171. https://doi.org/10.1111/j.1430-9134.2001.00149.x.

Graff, Zivin Joshua, and Arthur Small. 2005. “A Modigliani-Miller Theory of Altruistic Corporate Social Responsibility.” *The B.E. Journal of Economic Analysis & Policy* 5 (1). https://doi.org/10.1515/1538-0653.1369.

Greene, W.H. 2000. *Econometric Analysis*. 4th ed. Upper Saddle River, NJ: Prentice Hall.

Greenstone, Michael, and Ted Gayer. 2009. “Quasi-Experimental and Experimental Approaches to Environmental Economics.” *Journal of Environmental Economics and Management* 57 (1): 21–44.

Greshko, Michael, Laura Parker, Brian Clark Howard PUBLISHED May 11, and 2018. 2018. “A Running List of How Trump Is Changing the Environment.” *National Geographic News*, May 11, 2018. https://news.nationalgeographic.com/2017/03/how-trump-is-changing-science-environment/.

Grossman, Sanford J., and Oliver D. Hart. 1986. “The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration.” *Journal of Political Economy* 94 (4): 691–719.

Guenther, Edeltraud, Thomas Guenther, Frank Schiemann, and Gabriel Weber. 2015. “Stakeholder Relevance for Reporting Explanatory Factors of Carbon Disclosure.” *Business & Society*, March, 0007650315575119. https://doi.org/10.1177/0007650315575119.

Hahn, Rüdiger, Daniel Reimsbach, and Frank Schiemann. 2015. “Organizations, Climate Change, and Transparency Reviewing the Literature on Carbon Disclosure.” *Organization & Environment* 28 (1): 80–102. https://doi.org/10.1177/1086026615575542.

Haigh, Nardia, and Andrew Griffiths. 2012. “Surprise as a Catalyst for Including Climatic Change in the Strategic Environment.” *Business & Society* 51 (1): 89–120. https://doi.org/10.1177/0007650311427425.

Hart, Oliver, and John Moore. 1990. “Property Rights and the Nature of the Firm.” *Journal of Political Economy* 98 (6): 1119–58.

Henriques, Irene, and Perry Sadorsky. 1996. “The Determinants of an Environmentally Responsive Firm: An Empirical Approach.” *Journal of Environmental Economics and Management* 30 (3): 381–95. https://doi.org/10.1006/jeem.1996.0026.

Hsu, Angel, Kaiyang Xu, Amy Weinfurter, Ross Rauber, Aadit Gupta, Udit Jain, Cameron Yick, and Ryan Thomas. 2016. “Taking Stock of Global Climate Action.” Yale University: Yale Data-Driven Environmental Solutions Group. http://campuspress.yale.edu/datadriven/files/2016/11/Data_Driven_Yale_Taking-Stock-of-Global-Climate-Action-1d1hp46.pdf.

Innes, Robert. 2006. “A Theory of Consumer Boycotts under Symmetric Information and Imperfect Competition*.” *The Economic Journal* 116 (511): 355–81. https://doi.org/10.1111/j.1468-0297.2006.01084.x.

Innes, Robert, and AbdoulG Sam. 2008. “Voluntary Pollution Reductions and the Enforcement of Environmental Law: An Empirical Study of the 33/50 Program.” *Journal of Law and Economics* 51 (2): 271–96.

Karpoff, Jonathan M., Jr. Lott John R., and Eric W. Wehrly. 2005. “The Reputational Penalties for Environmental Violations: Empirical Evidence.” *The Journal of Law and Economics* 48 (2): 653–75. https://doi.org/10.1086/430806.

Khanna, Madhu, and William Rose Q. Anton. 2002. “Corporate Environmental Management: Regulatory and Market-Based Incentives.” *Land Economics* 78 (4): 539–58. https://doi.org/10.2307/3146852.

Khanna, Madhu, George Deltas, and Donna Harrington. 2009. “Adoption of Pollution Prevention Techniques: The Role of Management Systems and Regulatory Pressures.” *Environmental and Resource Economics* 44 (1): 85–106. https://doi.org/10.1007/s10640-009-9263-y.

Khanna, Madhu, Patricia Koss, Cody Jones, and David Ervin. 2007. “Motivations for Voluntary Environmental Management.” *Policy Studies Journal* 35 (4): 751–772. https://doi.org/10.1111/j.1541-0072.2007.00246.x.

Kitzmueller, Markus, and Jay Shimshack. 2012. “Economic Perspectives on Corporate Social Responbility.” *Journal of Economic Literature* 50 (1): 51–84.

Klein, Jill Gabrielle, N. Craig Smith, and Andrew John. 2004. “Why We Boycott: Consumer Motivations for Boycott Participation.” *The Journal of Marketing* 68 (3): 92–109.

Kolk, Ans, and Jonatan Pinkse. 2008. “A Perspective on Multinational Enterprises and Climate Change: Learning from ‘an Inconvenient Truth’?” *Journal of International Business Studies* 39 (8): 1359–78. https://doi.org/10.1057/jibs.2008.61.

Kotchen, M., and JJ Moon. 2012. “Corporate Social Responsibility for Irresponsibility.” *The B.E. Journal of Economic Analysis & Policy* 12. http://www.degruyter.com/view/j/bejeap.2012.12.issue-1/1935-1682.3308/1935-1682.3308.xml.

Liao, Lin, Le Luo, and Qingliang Tang. 2015. “Gender Diversity, Board Independence, Environmental Committee and Greenhouse Gas Disclosure.” *The British Accounting Review* 47 (4): 409–24. https://doi.org/10.1016/j.bar.2014.01.002.

Luo, Le, Yi-Chen Lan, and Qingliang Tang. 2012. “Corporate Incentives to Disclose Carbon Information: Evidence from the CDP Global 500 Report.” *Journal of International Financial Management & Accounting* 23 (2): 93–120. https://doi.org/10.1111/j.1467-646X.2012.01055.x.

Lyon, Thomas P., and John W. Maxwell. 2004. *Corporate Environmentalism And Public Policy*. Cambridge University Press.

———. 2008. “Corporate Social Responsibility and the Environment: A Theoretical Perspective.” *Review of Environmental Economics and Policy* 2 (2): 240–60. https://doi.org/10.1093/reep/ren004.

Lyon, Thomas P, and John W Maxwell. 2011. “Greenwash: Corporate Environmental Disclosure under Threat of Audit.” *Journal of Economics & Management Strategy* 20 (1).

Lyon, Thomas P., and A. Wren Montgomery. 2015. “The Means and End of Greenwash.” *Organization & Environment* 28 (2): 223–49. https://doi.org/10.1177/1086026615575332.

Lyon, Thomas P., and Jay P. Shimshack. 2015. “Environmental Disclosure Evidence From Newsweek’s Green Companies Rankings.” *Business & Society* 54 (5): 632–75. https://doi.org/10.1177/0007650312439701.

Maddala, G. S. 1983. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge University Press.

Matisoff, Daniel C. 2012. “Privatizing Climate Change Policy: Is There a Public Benefit?” *Environmental and Resource Economics* 53 (3): 409–33. https://doi.org/10.1007/s10640-012-9568-0.

Matisoff, Daniel C., Douglas S. Noonan, and John J. O’Brien. 2013. “Convergence in Environmental Reporting: Assessing the Carbon Disclosure Project.” *Business Strategy and the Environment* 22 (5): 285–305. https://doi.org/10.1002/bse.1741.

Maxwell, John W, Thomas P Lyon, and Steven C Hackett. 2000. “Self-Regulation and Social Welfare: The Political Economy of Corporate Environmentalism.” *Journal of Law and Economics* 43 (2): 583–617.
Meckling, Jonas, and Jonas Nahm. 2018. “The Power of Process: State Capacity and Climate Policy.” *Governance*, February, n/a-n/a. https://doi.org/10.1111/gove.12338.
Meng, Kyle C. 2017. “Using a Free Permit Rule to Forecast the Marginal Abatement Cost of Proposed Climate Policy.” *American Economic Review* 107 (3): 748–84. https://doi.org/10.1257/aer.20150781.
Navarro, Peter. 1988. “Why Do Corporations Give to Charity?” *Journal of Business* 61 (1): 65.
Prakash, Aseem. 2001. “Why Do Firms Adopt ‘beyond-Compliance’ Environmental Policies?” *Business Strategy and the Environment* 10 (5): 286–99. https://doi.org/10.1002/bse.305.
Rabe, Barry G. 2007. “Beyond Kyoto: Climate Change Policy in Multilevel Governance Systems.” *Governance* 20 (3): 423–44. https://doi.org/10.1111/j.1468-0491.2007.00365.x.
———. 2010. “The Aversion to Direct Cost Imposition: Selecting Climate Policy Tools in the United States.” *Governance* 23 (4): 583–608. https://doi.org/10.1111/j.1468-0491.2010.01499.x.
Ramus, Catherine A., and Ivan Montiel. 2005. “When Are Corporate Environmental Policies a Form of Greenwashing?” *Business and Society; Chicago* 44 (4): 377–414.
Shimshack, Jay P., and Michael B. Ward. 2008. “Enforcement and Over-Compliance.” *Journal of Environmental Economics and Management* 55 (1): 90–105. https://doi.org/10.1016/j.jeem.2007.05.003.
Stanny, Elizabeth, and Kirsten Ely. 2008. “Corporate Environmental Disclosures about the Effects of Climate Change.” *Corporate Social Responsibility and Environmental Management* 15 (6): 338–48. https://doi.org/10.1002/csr.175.
Strand, Robert. 2013. “The Chief Officer of Corporate Social Responsibility: A Study of Its Presence in Top Management Teams.” *Journal of Business Ethics* 112 (4): 721–34. http://dx.doi.org.ezproxy1.lib.asu.edu/10.1007/s10551-012-1568-z.
Toffel, Michael W., and Jodi L. Short. 2011. “Coming Clean and Cleaning Up: Does Voluntary Self-Reporting Indicate Effective Self-Policing?” *The Journal of Law and Economics* 54 (3): 609–49. https://doi.org/10.1086/658494.
US EPA, OA. 2019. “Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Section 202(a) of the Clean Air Act.” Reports and Assessments. US EPA. December 2019. https://www.epa.gov/ghgemissions/endangerment-and-cause-or-contribute-findings-greenhouse-gases-under-section-202a-clean.
Videras, J, and A Alberini. 2000. “The Appeal of Voluntary Environmental Programs: Which Firms Participate and Why?” *Contemporary Economic Policy* 18 (4): 449–60. https://doi.org/10.1111/j.1465-7287.2000.tb00041.x.
Westphal, James D., and Edward J. Zajac. 1998. “The Symbolic Management of Stockholders: Corporate Governance Reforms and Shareholder Reactions.” *Administrative Science Quarterly* 43 (1): 127–53. https://doi.org/10.2307/2393593.
Winston, Andrew. 2010. “The Most Powerful Green NGO You’ve Never Heard Of.” Harvard Business Review. 2010. https://hbr.org/2010/10/the-most-powerful-green-ngo.
Wooldridge, Jeffrey M. 2010. *Econometric Analysis of Cross Section and Panel Data*. MIT Press.

Zielinski, Sarah. n.d. “Natural Gas Really Is Better Than Coal.” Smithsonian. Accessed December 15, 2016. http://www.smithsonianmag.com/science-nature/natural-gas-really-better-coal-180949739/.

Figure 1. Timeline of President Obama's Clean Power Plan and Other (Failed) Climate Change Proposals in Congress

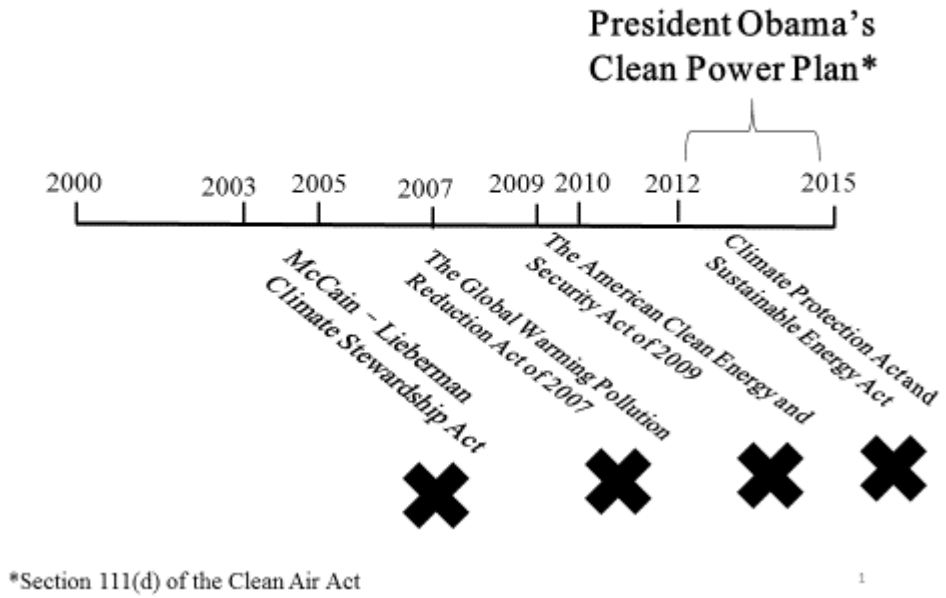
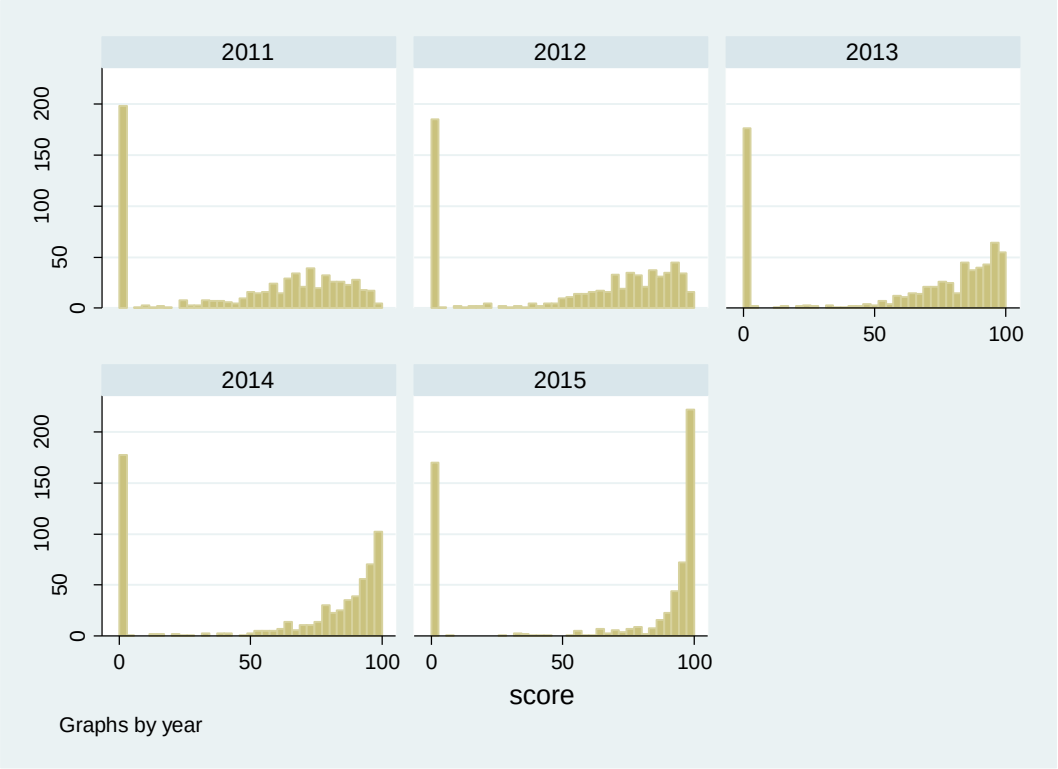


Figure 2. Distribution of Disclosure Scores for the Global 500, 2010-2015

(Score: 0-100)



Source: CDP.

Table 1. Descriptive Statistics

	Pre-CPP (2011-2013)		Post-CPP (2014-2015)	
Variable	Mean	SD	Mean	SD
	A. Treatment Group – U.S. based Companies			
Participation in the CDP (% share)	73.25%	44.30%	76.01%	42.75%
Disclosure Score (0-100)	53.83	37.01	65.83	39.69
Revenues (mil. US $)	$ 31,314.31	$ 50,409.89	$ 34,180.55	$ 50,107.94
Assets (mil. US $)	$ 93,423.17	$ 266,454.00	$ 104,216.90	$ 282,618.50
Manager (% share)	71.33%	45.25%	79.62%	40.33%
Target (% share)	53.36%	49.92%	63.06%	48.32%
Natural Gas Price Index (Dow Jones)	2.51	0.89	1.65	0.47
Natural Gas Price Index (S&P GSCI)	81.09	28.81	53.33	15.30
N	729		471	
	B. Control Group - non-U.S. based Companies			
Participation in the CDP (% share)	71.37%	45.22%	70.77%	45.51%
Disclosure Score (0-100)	53.90	37.54	63.47	42.72
Revenues (mil. US $)	$ 33,197.01	$ 46,496.79	$ 33,138.29	$ 46,108.47
Assets (mil. US $)	$ 180,874.90	$ 415,481.40	$ 185,062.90	$ 396,438.70
Manager (% share)	63.72%	48.10%	73.53%	44.15%
Target (% share)	55.90%	49.67%	65.50%	47.57%
Natural Gas Price Index (Dow Jones)	2.51	0.89	1.65	0.47
Natural Gas Price Index (S&P GSCI)	81.26	28.86	53.43	15.29
N	1254		797	

Table 2. Sector Heterogeneity

Sector	Share of Global 500	Participation in Voluntary Disclosure	Mean Disclosure Score, 2011-2015	Median Disclosure Score, 2011-2015	Mean Disclosure Score, 2011	Mean Disclosure Score, 2015
Consumer Discretionary	12%	65%	51.9	65.0	39.8	61.0
Consumer Staples	8%	81%	66.2	80.0	54.6	78.5
Energy	10%	67%	50.4	63.5	41.1	56.0
Financials	23%	70%	55.9	74.0	46.7	63.2
Health Care	8%	70%	54.6	69.0	46.33	64.9
Industrials	10%	82%	65.3	77.0	54.5	77.9
Information Technology	15%	75%	60.7	75.5	48.5	71.2
Materials	9%	75%	63.7	82.0	54.5	71.9
Utilities	5%	63%	55.5	78.5	55.7	56.2

Table 3. Endogenous Binary-Variable Model

	Model 1		Model 2	
	Participation in Voluntary Carbon Disclosure	Level of Voluntary Carbon Disclosure	Participation in Voluntary Carbon Disclosure	Level of Voluntary Carbon Disclosure
	b/se[1]	b/se[1]	b/se[1]	b/se[1]
USA	0.121	-0.098	0.057	-0.932
	(0.11)	(1.05)	(0.17)	(1.64)
Clean Power Plan (CPP)	0.067	5.934***	-0.446***	-0.568
	(0.06)	(0.93)	(0.13)	(1.21)
USA × CPP	0.058	-0.024	0.456***	1.805
	(0.07)	(0.90)	(0.17)	(1.73)
Manager			2.037***	5.135***
			(0.14)	(1.72)
USA × Manager			-0.291	0.449
			(0.22)	(1.95)
CPP × Manager			0.518***	9.103***
			(0.12)	(1.10)
USA × CPP × Manager			-0.384*	-2.743
			(0.22)	(2.06)
Revenues (log)	0.425***	1.968***	0.304***	1.343***
	(0.05)	(0.36)	(0.05)	(0.35)
Natural Gas Price (log)	0.055	-7.363***	0.405***	-6.456***
	(0.05)	(0.73)	(0.09)	(0.75)
Target		15.272***		13.847***
		(1.48)		(1.46)
Participation Last Year		62.683***		61.748***
		(1.82)		(2.06)
constant	-3.424***	-12.721***	-3.640***	-9.710***
	(0.49)	(3.64)	(0.55)	(3.60)
athrho	0.281***		0.185***	
constant	(0.03)		(0.03)	
lnsigma	2.641***		2.614***	
constant	(0.03)		(0.03)	
χ^2	10239.141***		20202.868***	
N	3209		3209	

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

[1] Robust standard errors with sector-level cluster correction.

Appendix

Additional Information About the CDP's Weights for Carbon Disclosure Scores

In scoring corporation's comprehensiveness in carbon disclosure, the CDP gives more weight to company responses in some categories of the 2011-2015 Climate Change questionnaire than others. The weights are based on the importance of a question to climate change mitigation (as determined by the CDP, along with stakeholder inputs) and the amount of data requested.[1] For example, the three "highest points" attainable responses are those about a firm's climate change risks and opportunities (27 points) and information on a firm's GHG emissions, namely boundary for GHG inventory, global Scope 1 and 2 emissions, exclusions, and sources of uncertainty in data gathering, handling, and calculations (25 points). By contrast, the "lowest points" attainable responses are those about a corporation's climate change communications (3 points) and Scope 1 and 2 emissions breakdowns (4 points). Information about corporate governance and adoption of emission targets are allocated a maximum score of 5 and 15 points, respectively. More information can be found on the CDP's website (https://www.cdp.net/en/guidance) and in this video (https://vimeo.com/121236413).

Treatment of Missing Data

There are two types of missing data for the variables (*Manager* and *Target*) drawn from the CDP climate change survey data: 1) companies that respond to the CDP about their management structure and practices during some years but not others and 2) companies that do not participate in the CDP during 2011-2015. In my treatment of both incidences of missing data, rather than impute missing data statistically, I utilize secondary information gathered from corporate websites and published reports, such as a company's standard annual reports or their Corporate Social Responsibility reports during 2011-2015 to code missing data.

For *Manager* and *Target*, coding was straightforward: *Manager* is coded 1 and 0 otherwise if there exists a senior or executive level manager responsible for climate change, environmental sustainability, or environmental policy and/or if there exists a Board of Directors committee devoted to addressing these issues in year 2011, 2012, 2013, 2014, and 2015, respectively. *Target* is coded 1 and 0 otherwise when a company has adopted an emissions target in a given year of the study period.

[1] Source: https://www.cdp.net/Documents/Guidance/2015/CDP-climate-change-scoring-methodology.pdf (Retrieved September 7, 2017)

Appendix

Table A1. Formal Test of Common Trends Assumption

	(1)	(2)	(3)
	b/se[1]	b/se[1]	b/se[1]
USA × 2012	-2.18	1.669	1.669
	(2.51)	(1.87)	(1.87)
USA × 2013	2.516	0.14	0.14
	(2.64)	(1.79)	(1.79)
USA× 2014	6.120**	2.404	2.404
	(2.62)	(1.89)	(1.89)
USA× 2015	12.536***	3.813*	3.813*
	(2.79)	(2.13)	(2.13)
constant	56.600***	68.717***	42.750***
	(0.82)	(3.98)	(2.86)
Year Effects		YES	YES
Company Effects		YES	
Sector Effects			YES
r2	0.008	0.897	0.897
N	3251	3251	3251

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

[1] Robust standard errors.

Appendix

Table A2. Level of Voluntary Carbon Disclosure by Manager, Pre- and Post-CPP

	Manager		Difference in Means
	Yes	No	t-test
Pre-CPP	77.9	59.5	-12.923***
Post-CPP	89.6	69.8	-8.967***
average	82.4	61.5	-17.390***

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

Appendix

Table A3. Fisher-Type Unit Root Tests

Panel Data Series	Inverse χ^2 Statistics
U.S. based Companies	2935.140***
Non-U.S. based Companies	5089.169***

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

Appendix

Table A4. Robustness Checks on Model 1 (Difference-in-Differences)

	(1) b/se[1]	(2) b/se[1]	(3) b/se[1]	(4) b/se[1]
Participation in Voluntary Carbon Disclosure				
USA	0.170	0.121	0.123	0.123
	(0.11)	(0.11)	(0.11)	(0.11)
Clean Power Plan (CPP)	0.05	0.067	0.156	0.05
	(0.06)	(0.06)	(0.13)	(0.06)
USA × CPP	0.051	0.058	0.057	0.061
	(0.07)	(0.07)	(0.07)	(0.07)
Assets (log)	0.418***			
	(0.06)			
Revenues (log)		0.425***	0.427***	0.422***
		(0.05)	(0.05)	(0.05)
Natural Gas Price (log)	0.072		0.071	0.068
	(0.05)		(0.13)	(0.05)
Natural Gas Price - GSCI Index (log)		0.055		
		(0.05)		
constant	-3.597***	-3.615***	-3.508***	-3.402***
	(0.57)	(0.55)	(0.53)	(0.49)
Level of Voluntary Carbon Disclosure				
USA	0.012	-0.098	-0.019	-0.157
	(1.06)	(1.05)	(1.05)	(1.35)
Clean Power Plan (CPP)	5.873***	5.937***	7.102***	8.530***
	(0.93)	(0.93)	(2.11)	(1.24)
USA × CPP	-0.018	-0.024	-0.256	-1.063
	(0.90)	(0.90)	(0.89)	(1.06)
Assets (log)	1.648***			
	(0.39)			
Revenues (log)		1.968***	1.967***	2.194***
		(0.36)	(0.36)	(0.49)
Natural Gas Price (log)	-7.309***		-8.651***	-10.105***
	(0.73)		(1.73)	(0.93)
Natural Gas Price - GSCI Index (log)		-7.360***		
		(0.73)		
Target	15.299***	15.272***	15.312***	17.818***
	(1.50)	(1.48)	(1.48)	(1.68)
Participation Last Year	62.453***	62.683***	62.670***	
	(1.83)	(1.82)	(1.81)	

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constant	-10.481***	12.867***	-12.316***	47.350***
	(3.99)	(4.95)	(4.03)	(5.57)
athrho				
constant	0.306***	0.281***	0.280***	0.090***
	(0.03)	(0.03)	(0.03)	(0.03)
lnsigma				
constant	2.646***	2.641***	2.638***	2.712***
	(0.03)	(0.03)	(0.03)	(0.03)
Year Effects	YES	YES		YES
Sector Effects	YES	YES		YES
χ^2	9270.960***	10239.141***	10896.187***	1233.313***
N	3212	3209	3209	3207

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

[1] Robust standard errors with sector-level cluster correction.

Appendix

Table A5. Robustness Checks on Model 1 (Difference-in-Difference-Differences)

	(1) b/se[1]	(2) b/se[1]	(3) b/se[1]	(4) b/se[1]
Participation in Voluntary Carbon Disclosure				
USA	0.062	0.057	0.058	0.032
	(0.17)	(0.17)	(0.17)	(0.17)
Clean Power Plan (CPP)	-0.480***	-0.446***	-0.629***	-0.434***
	(0.13)	(0.13)	(0.23)	(0.13)
USA × CPP	0.436***	0.456***	0.464***	0.469***
	(0.17)	(0.17)	(0.17)	(0.17)
Manager	2.005***	2.037***	2.054***	2.053***
	(0.14)	(0.14)	(0.14)	(0.14)
USA × Manager	-0.252	-0.291	-0.297	-0.256
	(0.22)	(0.22)	(0.22)	(0.22)
CPP × Manager	0.546***	0.518***	0.530***	0.474***
	(0.13)	(0.12)	(0.12)	(0.12)
USA × CPP × Manager	-0.360*	-0.384*	-0.389*	-0.397*
	(0.22)	(0.22)	(0.22)	(0.22)
Assets (log)	0.288***			
	(0.06)			
Revenues (log)		0.304***	0.307***	0.298***
		(0.05)	(0.06)	(0.05)
Natural Gas Price (log)	0.412***		0.208	0.413***
	(0.09)		(0.19)	(0.09)
Natural Gas Price - GSCI Index (log)		0.405***		
		(0.09)		
constant	-3.649***	-5.047***	-3.887***	-3.620***
	(0.60)	(0.69)	-0.61	(0.56)
Level of Voluntary Carbon Disclosure				
USA	-1.281	-0.932	-0.849	-5.037
	(1.64)	(1.64)	(1.65)	(4.81)
Clean Power Plan (CPP)	-0.639	-0.565	-0.374	8.717**
	(1.20)	(1.21)	(2.19)	(4.27)
USA × CPP	1.702	1.805	1.698	-0.865
	(1.70)	(1.73)	(1.74)	(6.87)
Manager	5.035***	5.135***	5.158***	6.158**
	(1.71)	(1.72)	(1.74)	(2.69)
USA × Manager	0.953	0.449	0.444	4.861
	(1.95)	(1.95)	(1.95)	(4.86)
CPP × Manager	9.157***	9.103***	9.144***	-0.464

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	(1.09)	(1.10)	(1.09)	(4.31)
USA × CPP × Manager	-2.604	-2.743	-2.883	-0.181
	(2.04)	(2.06)	(2.07)	(7.01)
Assets (log)	0.947***			
	(0.35)			
Revenues (log)		1.343***	1.349***	1.905***
		(0.35)	(0.35)	(0.50)
Nat. Gas Price (log)	-6.428***		-8.566***	-9.633***
	(0.75)		(1.70)	(0.91)
Natural Gas Price - GSCI Index (log)		-6.453***		
		(0.75)		
Target	13.898***	13.847***	13.881***	15.574***
	(1.48)	(1.46)	(1.46)	(1.75)
Participation Last Year	61.980***	61.748***	61.665***	
	(2.06)	(2.06)	(2.07)	
constant	-6.617*	12.724**	-12.066***	46.853***
	(3.74)	(5.05)	(4.17)	(5.88)
athrho				
constant	0.187***	0.185***	0.187***	0.005
	(0.03)	(0.03)	(0.03)	(0.03)
lnsigma				
constant	2.616***	2.614***	2.611***	2.700***
	(0.03)	(0.03)	(0.03)	(0.03)
Year Effects				
Sector Effects				
χ^2	18905.340***	20202.871***	22333.382***	1263.066***
N	3212	3209	3209	3207

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

[1] Robust standard errors with sector-level cluster correction.

Appendix

Table A6. Robustness Checks on Model 1 - Sectoral Variation

	Consumer Discretionary	Consumer Staples	Energy	Financials	Health Care	Industrials	IT	Materials	Utilities
	b/se[1]	b/se[1]	b/se[1]	b/se[1]	b/se[1]	b/se[1]	b/se[1]	b/se[1]	b/se[1]
Participation in Voluntary Carbon Disclosure[2]									
USA	-0.053	0.029	-0.333	0.193	-0.543	0.038	0.522*	6.708***	-0.125
	(0.31)	(0.43)	(0.31)	(0.23)	(0.36)	(0.36)	(0.31)	(0.29)	(0.43)
Clean Power Plan (CPP)	-0.351	-0.337	0.332	0.151	0.112	0.216	0.197*	0.079	-0.285
	(0.25)	(0.21)	(0.24)	(0.13)	(0.28)	(0.20)	(0.11)	(0.19)	(0.21)
USA × CPP	0.426**	0.474	-0.031	0.048	0.049	0.062	-0.045	0.424*	-0.25
	(0.21)	(0.41)	(0.19)	(0.14)	(0.24)	(0.24)	(0.18)	(0.23)	(0.25)
Revenues (log)	0.896***	0.661***	0.075	0.510***	0.552***	0.412**	0.322***	0.204	0.366*
	(0.17)	(0.21)	(0.11)	(0.10)	(0.20)	(0.20)	(0.12)	(0.14)	(0.20)
Nat. Gas Price (log)	-0.15	-0.419*	0.301**	0.246**	0.096	0.044	0.069	-0.127	-0.003
	(0.28)	(0.23)	(0.14)	(0.11)	(0.29)	(0.15)	(0.12)	(0.18)	(0.03)
constant	-8.042***	-5.255**	-0.615	-4.502***	-4.242**	-3.298*	-2.678**	-1.334	-2.938
	(1.63)	(2.08)	(1.07)	(0.98)	(1.94)	(1.94)	(1.22)	(1.28)	(1.97)
Level of Voluntary Carbon Disclosure[2]									
USA	-2.012	-3.767	4.423	1.011	-1.532	-0.362	0.264	4.086	-3.316
	(2.75)	(2.87)	(2.72)	(2.35)	(3.38)	(4.11)	(2.48)	(3.83)	(3.64)
Clean Power Plan (CPP)	6.950***	2.971	8.259**	4.918**	9.056***	5.962*	7.120***	2.467	10.914***
	(2.60)	(2.63)	(3.87)	(1.97)	(3.07)	(3.33)	(2.23)	(3.03)	(2.54)
USA × CPP	3.537	0.972	-5.830**	2.969	-3.822	1.777	-1.052	-2.592	-2.498
	(2.40)	(2.34)	(2.96)	(1.94)	(3.57)	(2.91)	(2.17)	(3.52)	(3.26)
Revenues (log)	3.645***	2.414*	1.074	1.484*	1.579	2.951	2.303***	2.234**	0.841
	(1.41)	(1.31)	(1.05)	(0.88)	(1.24)	(1.87)	(0.77)	(1.07)	(1.17)
Nat. Gas Price (log)	-4.344*	-10.815***	-8.223***	-5.694***	-6.124**	-9.347***	-8.477***	-10.974***	-1.644
	(2.23)	(2.14)	(2.88)	(1.54)	(2.65)	(2.26)	(1.70)	(2.47)	(1.41)
Target	17.764***	13.317***	13.001***	17.104***	22.017***	16.717***	18.972***	6.944**	3.563
	(4.57)	(4.31)	(3.30)	(3.22)	(5.68)	(5.50)	(4.44)	(2.89)	(2.53)
Participation Last Year	58.652***	63.642***	59.601***	63.105***	50.721***	60.257***	58.463***	69.950***	85.417***

Appendix

	(5.97)	(4.63)	(4.88)	(3.46)	(8.67)	(6.58)	(5.69)	(5.11)	(3.61)
constant	-33.590***	-10.799	-4.733	-9.697	-4.761	-21.413	-14.678*	-7.326	-13.126
	(12.24)	(11.34)	(11.08)	(8.07)	(10.16)	(17.83)	(7.64)	(10.35)	(12.32)
athrho									
constant	0.206	0.369**	0.398***	0.216***	0.465**	0.267***	0.306**	0.408*	0.076
	(0.14)	(0.15)	(0.11)	(0.05)	(0.19)	(0.09)	(0.13)	(0.23)	(0.09)
lnsigma									
constant	2.628***	2.444***	2.681***	2.654***	2.634***	2.761***	2.612***	2.531***	2.262***
	(0.10)	(0.07)	(0.09)	(0.08)	(0.12)	(0.09)	(0.07)	(0.10)	(0.10)
Year Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
χ^2	1865.676***	1397.572***	499.063***	3545.564***	710.850***	757.319***	859.657***	792.292***	4303.473***
N	392	276	311	725	257	316	473	282	177

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

[1] Robust standard errors with sector-level cluster correction.

[2] Variables are dropped to ensure variance matrix is symmetric.

Appendix

Table A7. Robustness Checks on Model 2 – Sectoral Variation

	Consumer Discretionary	Consumer Staples	Energy	Financials	Health Care	Industrials	IT	Materials	Utilities
	b/se[1]	b/se[1]	b/se[1]	b/se[1]	b/se[1]	b/se[1]	b/se[1]	b/se[1]	b/se[1]
Participation in Voluntary Carbon Disclosure[2]									
USA	-0.093	0.125	-0.39	0.442	-1.177***	-0.331	0.739	6.426***	-0.094
	(0.42)	(0.42)	(0.31)	(0.31)	(0.44)	(0.54)	(0.49)	(0.33)	(0.43)
Clean Power Plan (CPP)	-0.719*	-2.635***	-1.031**	-0.618*	-0.555	0.047	-0.664**	-1.991***	-1.451***
	(0.41)	(0.62)	(0.43)	(0.33)	(0.39)	(0.42)	(0.32)	(0.59)	(0.45)
USA × CPP	0.593			0.182	1.011*	0.767	0.601	-0.643**	
	(0.52)			(0.31)	(0.52)	(0.49)	(0.41)	(0.31)	
Manager	1.511***			2.572***		2.080***	2.245***		
	(0.42)			(0.39)		(0.48)	(0.41)		
USA × Manager	-0.11			-1.030**	0.943**	-0.093	-0.446		
	(0.61)			(0.51)	(0.44)	(0.72)	(0.57)		
CPP × Manager	0.299	3.040***	2.575***	0.551	1.871***	0.25	0.681***	2.894***	2.128***
	(0.39)	(0.59)	(0.45)	(0.36)	(0.62)	(0.31)	(0.23)	(0.55)	(0.47)
USA × CPP × Manager	-0.23	0.078	-0.229	0.171	-1.796**	-0.829	-0.908	0	-0.17
	(0.78)	(0.66)	(0.38)	(0.45)	(0.74)	(0.51)	(0.55)	(.)	(0.57)
Revenues (log)	0.553***	0.657***	0.058	0.345***	0.457**	0.302	0.232**	0.205	0.414**
	(0.18)	(0.21)	(0.10)	(0.13)	(0.21)	(0.20)	(0.11)	(0.15)	(0.19)
Nat. Gas Price (log)	0.097	-0.335	0.815***	0.615**	0.577*	0.545	0.263*	0.035	0.433***
	(0.31)	(0.33)	(0.26)	(0.26)	(0.33)	(0.40)	(0.15)	(0.28)	(0.16)
constant	-5.681***	-5.353**	-1.099	-4.299***	-3.988*	-3.537*	-3.059***	-1.554	-3.988**
	(1.64)	(2.11)	(0.99)	(1.31)	(2.15)	(2.06)	(1.09)	(1.42)	(1.94)
Level of Voluntary Carbon Disclosure[2]									
USA	-0.237	-2.909	4.207*	-4.436	-5.536	-5.661	3.93	4.297	-3.16
	(4.29)	(2.82)	(2.46)	(2.98)	(4.01)	(6.92)	(4.88)	(3.98)	(3.24)
Clean Power Plan (CPP)	3.846	-5.026	-4.82	-1.896	1.735	-1.311	-0.839	-7.537**	5.778***
	(3.29)	(4.15)	(4.70)	(2.55)	(5.75)	(4.83)	(2.61)	(3.59)	(2.06)

Appendix

USA × CPP	2.873			6.451*	-1.334	3.792	2.197	-5.357	
	(5.06)			(3.37)	(6.51)	(6.25)	(4.25)	(3.45)	
Manager	-0.753			5.311		-1.886	11.523*		
	(6.27)			(3.57)		(5.03)	(6.02)		
USA × Manager	-2.818			8.290**	5.445	7.655	-6.002		
	(5.56)			(3.85)	(4.20)	(8.29)	(5.25)		
CPP × Manager	5.47	11.273***	18.570***	9.679***	12.930**	11.752***	9.352***	13.244***	7.847***
	(4.28)	(4.23)	(3.53)	(2.05)	(6.25)	(4.48)	(2.56)	(3.43)	(2.26)
USA × CPP × Manager	0.669	-2.201	-7.446**	-6.659	-3.767	-4.435	-4.193	0	-2.582
	(6.64)	(2.46)	(3.44)	(4.49)	(7.35)	(6.62)	(5.21)	(.)	(3.87)
Revenues (log)	3.394***	1.927	0.817	0.866	0.483	2.053	1.929**	2.133**	0.898
	(1.05)	(1.33)	(0.96)	(0.92)	(1.31)	(1.80)	(0.78)	(1.05)	(1.16)
Nat. Gas Price (log)	-3.893*	-10.144***	-7.121**	-5.119***	-3.651	-7.886***	-8.220***	-10.513***	-0.639
	(2.24)	(2.11)	(3.05)	(1.66)	(3.25)	(2.47)	(1.61)	(2.62)	(1.40)
Target	18.077***	12.866***	12.542***	15.350***	20.458***	15.049**	16.042***	6.631**	4.014
	(5.47)	(4.39)	(3.21)	(3.44)	(5.38)	(6.61)	(3.41)	(2.90)	(2.75)
Participation Last Year	59.467***	64.947***	60.673***	57.980***	52.091***	62.486***	56.115***	69.504***	84.747***
	(5.65)	(4.99)	(5.43)	(4.03)	(7.85)	(6.43)	(7.45)	(4.61)	(2.83)
constant	-32.143***	-7.853	-4.028	-3.147	1.992	-13.859	-15.209*	-6.545	-14.871
	(10.00)	(11.68)	(10.27)	(8.40)	(11.81)	(17.84)	(7.79)	(10.27)	(12.50)
athrho									
constant	0.195**	0.214	0.231	0.282***	0.358**	0.180*	0.146*	0.331*	0.003
	(0.10)	(0.13)	(0.16)	(0.05)	(0.17)	(0.10)	(0.08)	(0.20)	(0.06)
lnsigma									
constant	2.619***	2.418***	2.629***	2.634***	2.597***	2.739***	2.561***	2.508***	2.243***
	(0.10)	(0.07)	(0.08)	(0.09)	(0.11)	(0.09)	(0.07)	(0.10)	(0.10)
Year Effects									
χ^2	4070.193***	2480.427***	847.131***	5253.527***	1511.878***	1947.857***	4818.727***	2692.558***	5981.223***
N	392	276	311	725	257	316	473	282	177

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

[1] Robust standard errors with sector-level cluster correction.

[2] Variables are dropped to ensure variance matrix is symmetric.