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The Real Effects of Mandatory CSR Disclosure on Emissions: Evidence from the Greenhouse Gas Reporting Program.
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ABSTRACT

We examine the real effects of the Greenhouse Gas Reporting Program (GHGRP) on electric power plants in the United States. Starting in 2010, the GHGRP requires both the reporting of greenhouse gas emissions by facilities emitting more than 25,000 metric tons of carbon dioxide per year to the Environmental Protection Agency and the public dissemination of the reported data in a comprehensive and accessible manner. Using a difference-in-difference research design, we find that power plants that are subject to the GHGRP reduced carbon dioxide emission rates by 7%. The effect is stronger for plants owned by publicly traded firms. We detect evidence of strategic behavior by firms that own both GHGRP plants and non-GHGRP plants. Such firms strategically reallocate emissions between plants to reduce GHGRP-disclosed emissions. We interpret this as evidence that the program is costly to the affected firms. Our results offer new evidence that public or shareholder pressure is a primary channel through which mandatory Corporate Social Responsibility (CSR) reporting programs affect firm behavior.

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1 Introduction

Traditional approaches to the management of market failure involve direct government intervention. Motivated, in part, by the recognition that regulatory approaches may be ineffective, incomplete, or infeasible, societies have increasingly relied on a common understanding of acceptable firm conduct to govern businesses' behavior. Broadly, this tack is referred to as Corporate Social Responsibility (CSR). To be effective, CSR measures must require the disclosure of firms' CSR-related behaviors. As yet, no such mandatory CSR reporting standards are in place on an economy-wide basis in the United States. As the reliance on CSR to affect change in firm performance gains momentum, an open question pertains to the consequences of large-scale, mandatory CSR reporting standards.

Recent events suggest that firms' response to broad-based CSR reporting requirements is a policy relevant consideration. In January of 2021, the Biden administration issued an executive order arguing for climate change-related disclosure in all economic sectors of the United States (U.S.) economy.[1] Further, in 2020, a Commissioner of the Securities and Exchange Commission (SEC) argued for a move toward standardized Environmental, Social, and Governance (ESG) disclosures.[2] And, most recently, the SEC has committed to review its ESG disclosure policies.

The present paper stands poised to inform this policy discussion. We offer causal evidence regarding the impact of mandatory CSR-relevant disclosure on firms' emission behavior. Specifically, we investigate whether a nation-wide mandatory reporting and disclosure requirement, the Greenhouse Gas Reporting Program (GHGRP), for plant level carbon dioxide (CO_2) emissions, a principal greenhouse gas (GHG), affects subsequent emissions. To answer this research question, we exploit differential disclosure requirements under the GHGRP. This regulation requires all facilities in the U.S. that emit more than 25,000 tons of CO_2 per year to report their CO_2 emissions to federal regulators who, in turn, release the data to the public in a comprehensive and accessible

[1]The executive order 14008 signed in January 2021 contains the language that the "Federal Government must drive assessment, disclosure, and mitigation of climate pollution and climate-related risks in every sector of our economy", which is interpreted as "[i]t now appears that U.S. regulators will consider playing a more central role in disclosure practices" by legal practitioners. See this HBS forum post: https://corpgov.law.harvard.edu/2021/02/07/esg-disclosures/

[2]In a 2020 speech, Commissioner Allison Heeren Lee remarked that "the time for silence has passed. It's time for the SEC to lead a discussion—to bring all interested parties to the table and begin to work through how to get investors the standardized, consistent, reliable, and comparable ESG disclosures they need to protect their investments and allocate capital toward a sustainable economy. ... We should partner with and leverage the great work that has already been done by private standard setters and others on many of these issues. See, e.g., SASB, TCFD, PRI, Global Reporting Initiative, International Integrated Reporting Council, and Partnership for Carbon Accounting Financials."

manner. Our research design exploits a unique data opportunity. For the U.S. utility sector, both pre- and post-GHGRP emissions data are available for all power plants (including those emitting less than the 25,000 ton threshold). This context facilitates the use of quasi-experimental econometric designs to assess the causal effect of the GHGRP disclosure on firm behavior. Specifically, we use a difference-in-differences (DID) specification to determine whether plants whose CO_2 emission reports are required to be publicly disclosed through the GHGRP behave differently than those not subjected to the program. We hypothesize a reduction in the emission rates for plants covered by the GHGRP relative to those not covered.

We construct a sample of U.S. power plants that spans the years 2004 to 2018. The GHGRP was enacted in 2010, with the first reported data becoming available in 2011. The Emissions and Generation Integrated Database (eGRID) [3] provides annual emissions of CO_2 as well as generation of electricity for all power plants in the U.S. Plant ownership information is provided by the U.S. Department of Energy's (DOE) Energy Information Administration (EIA).[4] Our primary outcome variable of interest is the plant level emission rate, defined as CO_2 (tons)/MWH.

Within the utility sector, our study focuses on the impact of a specific role of mandated environmental-related disclosure: *raising the profile of emission information to the public.* For the utility sector, emissions data prior to the GHGRP were collected and reported to the U.S. DOE, including those plants below the eventual GHGRP reporting threshold. These data were indeed available to the public but in a less accessible manner than under the GHGRP. Finding, cleaning, and analyzing these data prior to the establishment of GHGRP would have been considerably more costly than afterwards. The GHGRP provides more accessibility, standardization, comparability, higher frequency reporting or timeliness, and overall a higher national prominence of the emissions data reported by the treated plants. We describe these data and the reporting requirements in detail in Section 2 and 3, and in Appendix A. Thus, to the extent the DID results demonstrate causal evidence, the effect is caused by the *raised profile* of the emission information, not necessarily the creation of altogether *new* information.

Our central empirical results are summarized as follows. First, we detect a significant reduction in CO_2 emission rates for plants that are subject to the mandated disclosure requirements under the

[3] United States Environmental Protection Agency (EPA) (2020b)
[4] U.S. Energy Information Administration (2020a)

GHGRP. In our main specification, plants whose emission reports are disclosed through GHGRP reduced their CO_2 emission rates by 7% ($p < 0.01$). The model includes both county and year fixed effects to control for unobserved factors that may influence emission behavior. This result is robust to a number of different specifications. Second, the reduction in emission rates is larger in magnitude (10%, $p < 0.05$) for plants owned by publicly traded firms. In a triple difference specification, membership in the Standard and Poor's (S&P) 500 suggests an even larger effect of 11% ($p < 0.05$). These results are consistent with public or shareholder pressure to reduce emission intensities working through capital market channels. Finally, we find evidence of strategic behavior in firms that own multiple plants: companies that own facilities which are covered by the GHGRP, as well as facilities below the reporting threshold, reduce emission rates at plants covered by the GHGRP while increasing the CO_2 discharge rates at plants below the reporting threshold. This effect is large (emission rates increase at non-disclosure plants by between 25% and 56%). This form of emission leakage provides direct evidence that firms find GHGRP-disclosure costly.

The present study leverages the unique data context of the U.S. utility sector and the GHGRP in the following ways. First, because the GHGRP is the first nationwide mandatory GHG disclosure policy, it is an ideal setting in which to investigate the effect of large-scale CSR disclosure on firm behavior. Second, emissions data from power plants in the U.S. exist both before and after the enactment of the GHGRP. As discussed above, the emissions data prior to the GHGRP was costly to access, clean, and analyze. The GHGRP comprehensively organizes and disseminates this data, making it far more accessible to interested parties. Third, detailed data on the ownership of plants facilitates an empirical analysis of the channel through which disclosure affects firm behavior. That is, by either controlling for ownership or stratifying the sample by ownership of plants, we can test whether publicly traded firms with plants enrolled in the GHGRP behave differently.

Our study is closely related to recent work on the real effects of mandatory disclosure of GHG emissions. Specifically, using emission data at the installation level before and after the Mandatory Carbon Reporting (MCR) in the United Kingdom, Downar et al. (2020) compare the difference in emission behavior by UK-incorporated firms who are effected by MCR to non-UK-incorporated firms before and after the implementation of MCR, using a DID research design. The paper found significant GHG emssion reductions following the MCR among the treated firms relative to the control firms. Also in the context of MCR, but focusing on the set of firms who voluntarily disclosed

GHG information before the MCR, Grewal (2021) documents additional reductions in emissions for these voluntary disclosers after the MCR was enacted. In the U.S. setting, Tomar (2019) studies the impact of the GHGRP on the non-utility sectors for which pre-GHGRP emission data were generally unavailable. Further, the control facilities in Tomar (2019) are located in Canada under a different reporting regime. The pre-policy period includes only 2010, during which time plants were collecting emissions data for disclosure in 2011. The disclosure events studied in Matisoff (2013) are state-level mandatory requirements and firms' own voluntary disclosure via responses to surveys by the Carbon Disclosure Project (CDP). The paper's mixed-results raise the issue of how mandatory versus voluntary disclosure effects firm behavior (see Matisoff (2013) page 580).The present paper also pertains directly to prior work on the more general aspects of CSR and ESG disclosure covered by Christensen et al. (2019) and legal dimensions of extending the existing "safe harbor rule" to include CSR and ESG criteria (Hazen, 2021).[5]

There is also a literature in environmental economics that studies the impacts of disclosure on various measures of financial and environmental performance. Kanashiro (2020) studies the effect of the Toxic Release Inventory (TRI) on investments in environmental technology and the establishment of environmental governance boards. Belay and Jensen (2020) explore the effect of mandatory disclosure of antibiotic use in the agriculture sector and find reductions in use, conditional on firms' being required to disclose use. Fisk and Good (2019) examine the oil and gas extraction industry and the effects of required chemical use reporting. More broadly, Fraas and Lutter (2016) examine the use of disclosure laws across numerous federal agencies. The authors provide suggestions for improving their effectiveness. Delmas and Lessem (2014) distinguish between private and public information and explore the effect of providing the latter (a form of disclosure) on consumer behavior through the lens of cultivating a green reputation. Relatedly, Lyon and Maxwell (2011) probe the use of disclosure by firms as a strategic lever to manipulate or manage activists' perception of firm performance. Delmas et al. (2011) find that disclosure laws in the electricity sector (that pre-date the GHGRP) asymmetrically affect firm behavior, with cleaner firms becoming cleaner

[5]Hazen (2021) recommends that "The recommendations herein do not include a mandate that corporations be socially responsible. Rather, the recommendations include the ways in which the law can better accommodate the increasing number of observers and investors who want to promote corporate social responsibility. With respect to the securities laws, this means enhancing disclosures to enable investors who care about social responsibility to make more informed investment choices" (page 5) and a "safe harbor could have a significant impact on encouraging ESG disclosures without unduly exposing the company to risks of liability." (page 43)

and dirtier firms exhibiting limited change. Lastly, Lyon and Shimshack (2015) report that third party disclosure of environmental performance abnormally boosted the returns of firms in the top quintile of performance. Finally, aspects of our work relate to earlier papers studying emissions leakage in contexts where firms face binding regulation, not disclosure laws. Chen (2009) examines the relocation of CO_2 from capped to uncapped regions following a regional cap-and-trade program. Babiker (2005) finds the 1997 Kyoto Protocol could lead to significant carbon leakage due to relocation of production. Lastly, Fow (2020), Fischer and Fox (2012), and Böhringer et al. (2017) study the effectiveness of various environmental policies at mitigating carbon leakage.

The remainder of the paper is organized as follows: Section 2 provides background information on the regulation GHGRP and the regulatory background on the electric power industry. Section 3 outlines the data collection and descriptive statistics. Section 4 explains the research design and formulates our research questions. Section 5 presents the empirical results. Finally, Section 6 concludes.

2 Institutional Background

2.1 Greenhouse Gas Reporting Program (GHGRP)

In response to the FY2008 Consolidated Appropriation Amendment, EPA issued a proposed rule on March 10, 2009 that required "mandatory reporting of greenhouse gas emissions above appropriate thresholds in all sectors of the economy of the United States".[6] As directed by the Congress, the agency was also granted to "use its existing authority under the Clean Air Act"[6] to gather necessary information for the purpose of carrying out any provision of the Clean Air Act (CAA). The new reporting regulation calls on facilities that emit 25,000 metric tons or more of GHG emissions per year to submit an annual report to EPA starting in 2011 for the calendar year 2010. The rule requires reporting of annual emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFC_s), perfluorocarbons (PFC_s), and other fluorinated gases in metric tons. In addition, the agency provides detailed guidelines to ensure the accuracy of the reported data through monitoring and a multi-step verification process.[7]

[6] On April 10, 2009. the proposed rule was published in the Federal Register (www.regulations.gov) under Docket ID No. EPA-HQ-OAR-2008-0508:

[7] See Figure 3 in Appendix A for details.

Whether or not a facility must report was initially determined by the facility's emission level in the year of 2010. A reporting facility can cease reporting if its annual GHG emissions are either (1) less than 25,000 metric tons of CO_2 for five consecutive years or (2) less than 15,000 metric tons of CO_2 for three consecutive years. In addition, if the facility's annual GHG emissions subsequently increase to the 25,000 metric tons threshold in any calendar year, the facility must start reporting again to EPA annually. About 8,000 facilities are covered by this regulation and the total reported emission represents approximately half of total U.S. GHG emissions.[8]

The GHGRP is solely a reporting and dissemination requirement: eligible individual facilities are required to report their emission to the the federal regulators and the data are made available to the public in a comprehensive and accessible manner. It does not in any way regulate GHG emissions or require any emission reductions. The GHGRP provides EPA, other government agencies, and outside stakeholders with economy-wide data on facility-level GHG emissions. Although some existing regulations and voluntary programs collect and disclose emission data, these programs are different in nature from the GHGRP. Many of these programs are initiated at the state or regional level where annual emission reporting is rare and a long delay between data collection and reporting is often observed. Other programs cover specific industries or report emissions at a firm level instead of providing detailed emissions and production processes for individual facilities.[9] In contrast, the GHGRP encompasses all sectors in the U.S. economy and it delivers more timely and standardized emission data.

To encourage the broader dissemination of the collected data to external stakeholders, EPA publishes its collected data using an interactive online platform - the Facility Level Information on Greenhouse Gases Tool (FLIGHT).[10] FLIGHT allows users to create customized filters by facility, industry, location, or fuel type, and to view data in various formats including maps, tables, charts,

[8]Description of GHGRP coverage from the EPA's website states "total reported emissions from these facilities are about 3 billion metric tons CO2e, which is about 50 percent of total U.S. GHG emissions. Additional GHGs are accounted for by approximately 1,000 suppliers. In total, data covering 85-90 percent of U.S. GHG emissions are reported". See full report at https://www.epa.gov/ghgreporting/learn-about-greenhouse-gas-reporting-program-ghgrp

[9]For example, voluntary disclosure programs such as the Carbon Disclosure Project (CDP) runs a global environmental disclosure system that collects self-reported annual data from governments (cities, states, and regions) and corporations, and it does not collect facility-level emissions. Similarly, data providers such as Trucost generally gather firm-level emission data from individual CSR reports. By comparison, while eGrid provides detailed facility-level emission data, it only covers power plants, and the data is published every other year. We also provide a side-by-side comparison of the eGrid and GHGRP data in Appendix A.

[10]See Figure 2 in Appendix A for an example of visualization map

and graphs for individual facilities and groups of facilities. In addition, EPA also provides the data in downloadable formats and publishes detailed analyses of various industries that report under the program. According to the EPA, "information in the database can be used by communities to identify nearby sources of greenhouse gas emissions, help business track emissions and identify cost- and fuel-saving opportunities, inform policy at the state and local levels, and provide important information to the finance and investment communities."[11]

The primary goal of the GHGRP was to inform future climate change policies including emission standards, a carbon tax, or a cap-and-trade program. To date, no such policy stipulating binding emission limits exists. As discussed above, the emissions reporting threshold presents a unique econometric opportunity to causally identify the effect of the GHGRP on firm behavior. However, the 25,000 ton cutoff also raises the issue of emission leakage; incomplete regulation encourages firms to reallocate discharges outside the scope of a policy's jurisdiction. Several papers explore emission leakage and our work builds on this literature (Babiker, 2005, Böhringer et al., 2017, Chen, 2009, Fischer and Fox, 2012, Fow, 2020).[11]

2.2 The Electric Power Industry

In this paper, we focus on the electric power industry for the following reasons. First, the electric power industry is one of the largest sources of greenhouse gas emissions in the United States. Reports from EPA show that in 2018, the electricity sector was the second largest source of U.S. greenhouse gas emissions, accounting for 26.9 percent of the U.S. total greenhouse gas emissions.[12] Second, the data availability for power plants is generally superior to other economic sectors that feature large stationary point sources. Emissions of several pollutants have been closely tracked from power plants for several decades. Power output, plant characteristics, operations, fuel consumption, and environmental controls are also reported on a facility-level basis. This enables computation and tracking of emission rates. The existence of these data both before and after the GHGRP facilitates the implementation of DID models to test causal hypotheses related to firm behavior.

[11]See details on EPA's website https://www.epa.gov/ghgreporting/greenhouse-gas-reporting-program-and-us-inventory-greenhouse-gas-emissions-and-sinks

[12]The EPA collected and reported 2018 industry level emission data in the Inventory of US Greenhouse Gas Emissions and Sinks. See the full report at https://www.epa.gov/sites/production/files/2020-02/documents/us-ghg-inventory-2020-main-text.pdf

3 Data

3.1 Primary Sample Selection: the eGRID sample

We obtain data on plant-level CO_2 emissions and facility characteristics from eGRID, which is a comprehensive data source that provides plant-specific environmental information for U.S. electricity generating plants.[13] Since eGRID publishes data roughly every two years, we obtain data for the following years: 2004, 2005, 2007, 2009, 2010, 2012, 2014, 2016, and 2018.

From this sample of 62,552 plant-years, we drop 35,968 observations that are missing CO_2 emission rates or where the CO_2 emission rates are non-positive[14]. We also eliminate observations related to Combined Heat and Power (CHP) plants (8,136 plant-years) because CHP plants are less comparable to non-CHP plants. We restrict our analyses to plants that use coal, oil, and gas as their primary fuel types. Finally, we require plants in the sample to be actively deployed (i.e., not idling) both before and after the year of GHGRP implementation (2010). This yields a final sample of 16,075 plant-year observations. We determine a plant's GHGRP treatment status by matching facilities that reported to GHGRP by plant name and location.[15] We refer to this sample as the eGRID sample. It is our primary estimation data set.

To construct the firm-level panel dataset from the plant-level data, we use plant-ownership information provided in eGRID (2004-2012) and Form EIA-860 (2014-2018).[16] We then consolidate our observations at the firm-year level. We drop observations where ownership information is not available and merge this sample with Compustat data to obtain firms' financial information.[17] For each firm-year observation, we compute the total plants owned, the number of plants owned by treatment status and fuel type, average emission rates, and average emission rates by treatment

[13] eGRID reports annual information on electric generation, resources mix, emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), sulfur dioxide (SO_2), and other emission-related information at the plant-level. These data are self-reported by the plants to comply with regulations related to the three following reports, CAMD's Power Sector Emission Data, EIA-860, and EIA-923.

[14] A plant could report negative emission rates resulting from negative *net* generations. This occurs when the amount of station use electricity exceeds the total amount of electricity generated at the plant. However, these plants still have positive emissions and the negative reported emission rates do not fairly represent their emission performance. Hence, we decided to drop them in our empirical analysis.

[15] Alternatively, we could have determined a plant's treatment status using the general reporting threshold. Facilities are required to report under the GHGRP if their annual GHG emissions exceed 25,000 metric tons of CO_2. However, an additional requirement for the electric power industry requires facilities under special programs such as the Acid Rain Program also report to EPA regardless of its emission levels. Hence, using the general threshold method could misclassify some plants' treatment status and underestimate the number of plants treated.

[16] U.S. Energy Information Administration (2020a)

[17] Compustat Industrial Annual Data (2020)

status. The final firm-level sample contains 744 observations.

3.2 Alternative Measure of CO_2 Emissions: the EIA sample

To test whether our primary findings are an artifact of the self-reported emission data in eGRID, we construct an alternative measure of CO_2 emissions using fuel consumption data. We refer to this sample as the EIA sample. We obtain plant-level fuel consumption data from Form EIA-906/923 during the sample period 2006-2015.[18] The fuel consumption data are reported annually during our sample period as opposed to the bi-annual eGRID sample. The higher frequency of reporting results in a larger sample of 22,862 plant-year observations. We construct the estimated emissions output by multiplying fuel consumption (in physical units), heat input (in mmBtus per physical unit), and emission factors (in ton CO_2/mmBtu)[19].

3.3 Descriptive Statistics

Table 1 presents the summary statistics for our plant-level sample. Panel A shows summary statistics from the eGRID sample with self-reported emission rates. The variable GHGRP is an indicator variable which assumes a value of one if a plant is covered by GHGRP in a given year and zero otherwise. Plant fuel type variables and plant ownership variables are defined as indicator variables. The sample is almost evenly split between GHGRP plants and non-GHGRP plants, 56% of plants are GHGRP plants. The mean net generation in the sample is 1,319,306 MWh and the mean CO_2 emission rate is 2,044 lb/MWh. Panel B shows summary statistics using the estimated CO_2 emissions from fuel consumption. While the EIA sample is larger, key variables such as the CO_2 emission rate, net generation, and GHGRP treatment status are comparable between the two samples. We winsorize all continuous plant-year variables at the 1 percent and 99 percent levels.

Table 2 reports the descriptive statistics at the firm-year level. Firms in the sample own up to 21 plants, while an average firm owns between five and six power plants. In Table 2, GHGRP is an indicator variable which assumes a value of one if a firm owns at least one GHGRP plant and zero otherwise. The mean weighted average CO_2 emission rate at the firm level is 2,299 lb/MWh, which is slightly higher than the plant-level average. Fuel type data shows approximately half of

[18] U.S. Energy Information Administration (2020b)

[19]See https://www.eia.gov/tools/faqs/faq.php?id=73t=11

the plants in a firm's portfolio use gas as their primary fuel, a third of the plants use coal as primary fuel, and the rest use oil. Lastly, we present the common financial reporting variables from firms' 10K through the Compustat database.

Table 1: Plant-level Summary Statistics

Panel A: eGrid Sample

(N of Plants = 2,055)	N	Mean	Stdev	Median	Q1	Q3
CO_2 Emission Rate (lb/MWh)	16,075	2,044	1,729	1,713	1,302	2,262
Net Generation (MWh)	16,075	1,319,306	2,751,623	40,715	505	1,221,177
GHGRP	16,075	0.560	0.496	1	0	1
Plant Fuel Type						
Gas	16,075	0.487	0.500	0	0	1
Coal	16,075	0.202	0.401	0	0	0
Oil	16,075	0.311	0.463	0	0	1
Plant Ownership						
Owned by Public Firms	14,357	0.300	0.458	0	0	1
Owned by S&P Member Firms	14,357	0.225	0.418	0	0	0

Panel B: EIA Sample

(N of Plants = 2,522)	N	Mean	Stdev	Median	Q1	Q3
CO_2 Emission Rate (lb/MWh)	22,862	2,196	18,129	1,701	1,298	2,215
Net Generation (MWh)	22,862	858,156	1,727,425	35,419	872	606,463
Fuel Consumption (mmBtu)	22,862	1,366,432	2,875,486	103,943	914	973,201
GHGRP	22,862	0.479	0.500	0	0	1

This table presents summary statistics for the sample of power plants. Data in Panel A are sourced from eGrid. We report key plant-level characteristics including emission rates, generations, and indicator variables GHGRP status, fuel types, and ownership information. Our sample period is from 2004 to 2018, where years 2006, 2008, 2011, 2013, 2015, and 2017 are not reported. Panel B includes fuel consumption data, the computed carbon emission rates, generation, and treatment status. We retrieve the annual data from EIA Form EIA-906/923 during 2006-2015.

4 Research Design

4.1 Real effects of the GHGRP

To examine the real effects of mandatory disclosure on GHG emissions, we test for a causal relationship between a plant's GHGRP treatment status and its emission rates. We employ a DID design and conduct our main empirical test at both the plant-level and the firm-level, as described

Table 2: Firm-level Summary Statistics

	N	Mean	Stdev	Median	Q1	Q3
Total Plants Owned	744	5.38	3.69	4	3	7
GHGRP Plants Owned	744	3.98	2.98	3	2	6
Firm-level GHGRP indicator	744	0.93	0.26	1	1	1
CO_2 Emission Rate (lb/MWh)	744	2,299	12,370	1,846	1,308	2,178
Plant by Fuel Type						
Gas	744	0.54	0.34	0.50	0.30	0.83
Coal	744	0.30	0.32	0.22	0	0.50
Oil	744	0.16	0.27	0	0	0.25
Financial Performance						
Total Assets *(in millions $)*	744	12,192	15,631	6,437	3,339	14,253
Revenue *(in millions $)*	744	3,927	4,573	2,097	1,202	4,730
Profitability (%)	742	9.61	3.03	9.35	8.11	10.87
ROA (%)	744	2.76	6.64	2.85	2.14	3.46
Operating Cash Flow (%)	742	6.32	2.35	6.21	5.20	7.29
CAPEX (%)	742	7.46	3.85	6.83	5.27	8.88
Fixed Assets (%)	744	71.56	11.14	73.72	65.87	79.11
Inventory (%)	734	2.64	1.71	2.28	1.59	3.17
Cash (%)	744	1.61	2.61	0.59	0.15	1.86
Book Leverage (%)	744	33.63	9.77	31.96	28.43	36.87
Net Leverage (%)	744	32.01	9.34	31.19	27.28	35.70
Interest (%)	742	1.98	0.84	1.81	1.46	2.23

This table presents the firm-level summary statistics from 2004 to 2018. Plant characteristics are sourced from eGrid, hence we do not collect financial accounting variables for the following years: 2006, 2008, 2011, 2013, 2015, and 2017. We collect firms' financial reporting variables from Compustat. Variable definitions are provided in Appendix B in 1a and 1b, respectively:

$$log(CO_2Rate)_{it} = \beta_0 + \beta_1 \text{GHGRP}_{it} + \beta_2 \text{Post}_{it} + \beta_3 \text{Post}_{it} \times \text{GHGRP}_{it} + \alpha_t + \delta_c + u_{it} \quad (1a)$$

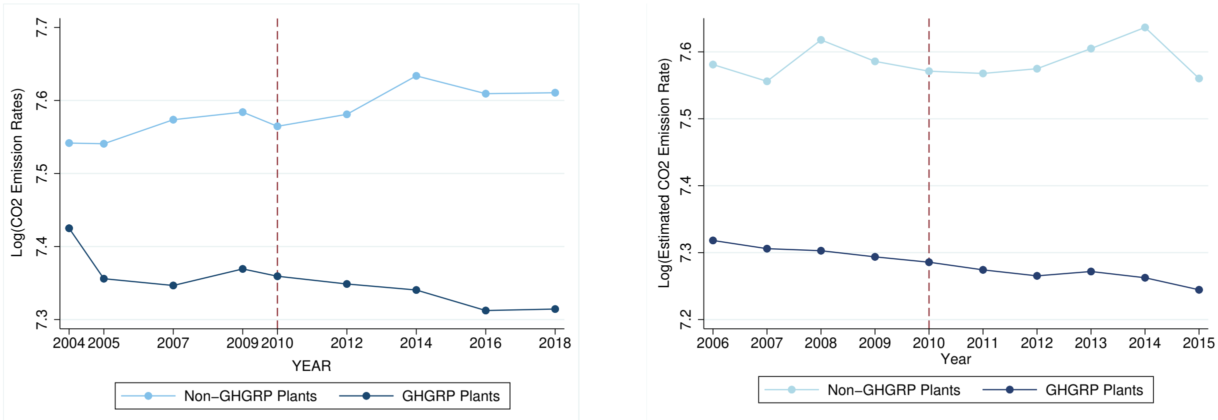
$$log(CO_2Rate)_{ft} = \beta_0 + \beta_1 \text{GHGRP}_{ft} + \beta_2 \text{Post}_{ft} + \beta_3 \text{Post}_{ft} \times \text{GHGRP}_{ft} + \alpha_t + \gamma_f + \epsilon_{ft} \quad (1b)$$

where t indicates the year, i indexes the plant, and f represents the firm. Post is an indicator variable that equals one if the observation is in the post-GHGRP period (i.e., 2010 and after), and 0 otherwise. In Equation 1a, the treatment variable GHGRP_{it} assumes the value of one only if the plant was ever subject to the mandatory disclosure requirement under the GHGRP. A firm is considered treated (i.e. GHGRP_{ft} =1) if it owns at least one GHGRP plant.

Our primary outcome variable of interest is the logarithm of plant annual CO_2 emission rates (in lb/MWh). This measure captures emission changes normalized by output levels. We define the firm-level annual CO_2 emission rates (in lb/MWh) by taking the weighted average emission rates of all plants owned by a firm. Standard errors are clustered at the plant level in Equation 1a and firm level in Equation 1b. Our main specification in Equation 1a includes year fixed effects α_t and county fixed effects δ_c to account for county-level, time-invariant confounders and common time-varying factors affecting the response variable of interest. We also test several alternative specifications. To ensure our results are not influenced by state regulations, we include year and state fixed effects.[20] In another specification, we include plant fixed effects to control for any unobserved, time-invariant plant-specific characteristics. Similarly, in Equation 1b, we include firm and year fixed effects.

In the DID context, causal inference relies on the assumption that CO_2 emission trends for GHGRP plants and non-GHGRP plants were parallel prior to the GHGRP. In Figure 1, we plot the year fixed effects coefficients from Equation 1a. These figures generally show common pre-trends in emission rates for GHGRP plants and non-GHGRP plants. We argue that the firms could not have anticipated or manipulated their treatment status prior to the regulation. The initial announcement of the regulatory threshold of 25,000 metric tons $\text{CO}_{2\text{e}}$ was published in the Federal Register in a Proposed Rule in April 2009. The EPA selected the reporting threshold

[20]Matisoff (2013) finds no real effects of mandatory GHG reporting on emission performance for power plants subject to state-level programs.



(a) Estimated Emission using eGRID Data

(b) Estimated Emission using Fuel Consumption Data

Figure 1: Parallel Trends

Panel (a) shows the change in estimated CO_2 emissions for GHGRP plants and non-GHGRP plants by year using data from eGrid. Panel (b) shows same using fuel consumption data from Form EIA906/923.

specifically for the GHGRP by evaluating the number of reporters and the coverage of emissions under several alternative thresholds.[21] In Appendix C, Figure 7 reports density plots of CO_2 emission rates around the reporting threshold. We do not observe any discontinuities in emissions for years before and after the adoption of GHGRP. This provides evidence against the widespread manipulation of emissions data.

4.2 Central Hypothesis

We hypothesize that the GHGRP encouraged plants to reduce their CO_2 emission rates. We test this central hypothesis using the structure in equations 1a and 1b. Irrespective of the direction of the effect, we expect that the GHGRP changed emission behavior for the following reasons. First, in contrast to state reporting programs where "data must be obtained from state energy offices and may not be complete, up to date, or available online" (Matisoff, 2013), the GHGRP collects emission reports by facilities and it also publishes the reported data annually in a comprehensive and accessible manner. It also develops an interactive online tool that allows users to search, view, and download data. Second, this reporting program increased the profile of carbon emission disclosure.[22]

[21] Details published in Regulatory Impact Analysis for the Mandatory Reporting of Greenhouse Gas Emissions Proposed Rule (GHG Reporting) in March 2009.

[22] See Table 10 in Appendix A for a data profile comparison between GHGRP and eGrid.

The regulation has media coverage that explains the details and significance of the program.[23] Hence, even for the electric power industry, where power plants were historically monitored by regulators, we expect the program to affect emission behavior because it provides new, improved, and most importantly, more widely disseminated information to the public. Our position that the GHGRP reporting requirements will affect firm behavior is grounded in the prior literature. Michelon et al. (2015) question whether CSR reporting can affect change due to its lack of relevance and credibility. The mandatory nature of the GHGRP coupled with its implementation by the EPA speaks directly to this concern. Further, CSR disclosure differs from traditional financial disclosure because it requires additional expertise to interpret the information. Therefore, it is critical that the information is collected and disclosed in a way that is relevant, timely, accessible, and understandable (Weil et al., 2006). We argue that the structure and mandatory nature of the GHGRP satisfies these criteria.

The previous accounting literature documents several economic effects of corporate disclosure. Disclosure can mitigate problems associated with information asymmetries and agency costs. This, in turn, leads to several tangible capital market benefits, including lower cost of capital and increased firm value (Dhaliwal et al., 2011, Marshall et al., 2009, Plumlee et al., 2015, Matsumura et al., 2014). Christensen et al. (2019) consider a potential widespread mandatory adoption of CSR reporting standards analyzed in the extant academic research. The authors argue that CSR reporting mandates may induce real effects on firms' CSR activities through a feedback channel, as firms respond to stakeholder and societal pressure. Christensen et al. (2019) point out that such mandates could also induce negative real effects if firms attempt to manage the disclosed information. The papers that focus on voluntary disclosure provide mixed results on the association between CSR disclosure and CSR performance (Clarkson et al., 2008, Patten, 2002).

Despite these ambiguous results from the existing literature, we contend that the GHGRP will induce reductions in emission rates because of the nature of emissions disclosure that it provides and because of the mounting evidence that market participants are increasingly attuned to firms' environmental performance.

[23] We have collected some media coverage on GHGRP, see Figures 4,5,6 in Appendix A for details.

4.3 Mechanism

Several channels can potentially explain why firms that own power plants might respond to the GHGRP. If the GHGRP increased public awareness about environmental performance, then reputation concerns, shareholder pressure, regulatory threats, and lobbying from other special interest groups could incentivize plants to improve on their GHG emission controls (Reid and Toffel, 2009, Saeidi et al., 2015). Among the possible channels described above, we test two possible mechanisms: public or shareholder pressure and the threat of future regulatory actions. Both are discussed here in turn.

We conduct two sets of tests to examine whether public or shareholder pressure motivates plants to respond to the GHGRP. First, we test whether the effect of GHGRP is significantly different for plants owned by publicly traded firms by including a triple interaction term as shown in Equation 2. Here, the coefficient of interest is β_7. This allows for a differential impact of the GHGRP on CO_2 emission rates for publicly traded firms.

$$\begin{aligned} log(CO_2Rate)_{it} = \beta_0 &+ \beta_1 \text{GHGRP}_{it} + \beta_2 \text{Post}_{it} + \beta_3 \text{Post}_{it} \times \text{GHGRP}_{it} \\ &+ \beta_4 \text{Public}_{it} + \beta_5 \text{Public}_{it} \times \text{Post}_{it} + \beta_6 \text{Public}_{it} \times \text{GHGRP}_{it} \\ &+ \beta_7 \text{Public}_{it} \times \text{Post}_{it} \times \text{GHGRP}_{it} + \alpha_t + \delta_c + u_{it} \end{aligned} \tag{2}$$

In a related test, we partition the sample according to whether the plant is owned by a publicly-traded firm. For each sub-sample, we estimate the regression model in Equation 1a.

We also test the possibility that future regulatory threats affect firms' behavior by examining emission rates before and after the Clean Power Plan (CPP) was repealed. The CPP was initially coupled with the GHGRP as binding regulation that would have limited firms' CO_2 emissions. However, the CPP was repealed in 2017, before its emission limits ever took effect. If firms reduced emissions in anticipation of the CPP limits, we argue that CO_2 would have rebounded after its repeal. The empirical results of this test are presented in Appendix C Table 11.

4.4 Robustness

One potential threat to the validity of our identification strategy arises if firms' emission behavior is driven by another major regulation (aside from the CPP treated above) that differentially affects GHGRP plants and non-GHGRP plants. We explore this issue as it pertains to the CAA. Under the CAA, EPA has the authority to set National Ambient Air Quality Standards for common air pollutants (not CO_2) and to monitor ambient pollution levels. A geographic area that meets the standard qualifies as an attainment area, and areas that fail to comply with the standard are stipulated as nonattainment areas. We obtain annual county-level compliance status data during our sample period from the EPA's Green Book.[24] We add CAA attainment status to Equation 1a in a triple-difference specification as shown in Equation 3. This tack compares the effect of the GHGRP for plants in attainment areas, and plants in nonattainment areas:

$$\begin{aligned} log(CO_2Rate)_{it} = \beta_0 + \beta_1 \text{GHGRP}_{it} + \beta_2 \text{Post}_{it} + \beta_3 \text{Post}_{it} \times \text{GHGRP}_{it} \\ + \beta_4 \text{CAA}_{ct} + \beta_5 \text{CAA}_{ct} \times \text{Post}_{it} + \beta_6 \text{CAA}_{ct} \times \text{GHGRP}_{it} \\ + \beta_7 \text{CAA}_{ct} \times \text{Post}_{it} \times \text{GHGRP}_{it} + \alpha_t + \delta_c + u_{it} \end{aligned} \tag{3}$$

In Equation 3, CAA_{ct} is an indicator variable that is equal to 1 if the plant is located in a county that is designated as a non-attainment area in that year. Fixed effects enter Equation 3 as described previously. The coefficient of interest is β_7. This tests whether firms in non-attainment areas respond differently to the GHGRP than those in attainment areas.

5 Empirical Results

5.1 Real Effects on Plant-level Emissions

Table 3 presents the results from estimating Equation 1a. Columns (1) through (4) use the eGRID sample. Columns (5) and (6) use the EIA sample. Column (1) reports the results of our preferred specification which includes year and county fixed effects. Consistent with our hypothesis and previous research on the effects of mandatory carbon emission disclosure (Downar et al., 2020, Tomar, 2019), we find that relative to non-GHGRP plants, plants that are subject to the GHGRP

[24] United States Environmental Protection Agency (EPA) (2020a)

reduced annual CO_2 emission rates by 7.1% after the regulation ($p < 0.01$). For an average GHGRP plant prior to the regulation, this reduction in the post-GHGRP period is equivalent to about 130 lb/MWh carbon emission.

Our results are robust across several alternative specifications. In Column (2), we use year and state fixed effects to address potential concerns with various carbon disclosure policies at the state level (Matisoff, 2013). Columns (3) and (6) include year and plant fixed effects to control for plant-specific determinants of emission rates. Column (4) uses year and owner fixed effects to control for firm-specific characteristics. In Column (5), county fixed effects are excluded due to data availability. Across these specifications, the coefficient on the interaction term between GHGRP and Post is negative and significant ($p < 0.01$). The estimated emission reductions range between just under 4% to just over 10%. Using the EIA sample yields smaller reduction estimates than the eGRID sample. Collectively, our results in Table 3 corroborate our hypothesis that power plants reduced their carbon emission rates in response to the GHGRP.

5.1.1 Fuel Switching

Next, we study how plants subject to the GHGRP reduced emission rates by changing the type of fuel used. Different fuels produce different CO_2 emission rates.[25] One channel for power plants to achieve lower emission rates is to switch from dirtier fuels such as coal to cleaner fuels such as gas. Plants in the sample use oil, gas, or coal as primary fuels. First, we construct a binary variable which indicates whether a plant changed its primary fuel type after the GHGRP. This binary variable is substituted for CO_2 emission rates as the dependent variable in Equation (1a). We then fit this model using a logit estimator. We present the results of this exercise in Columns (1) and (2) in Table 4. In Column (1), the coefficient on the interaction between GHGRP and Post is 0.441, with a z-statistic of 2.14. Comparing to non-GHGRP plants, the odds that a GHGRP plant switches its primary fuel type in the post-regulation period are 55.4% greater. A similar result manifests in Column (2). These results suggest that GHGRP plants are more likely to switch

[25] Reports from the EIA show that the amount of CO_2 emitted (in pounds) per unit of energy output or heat content for coal (anthracite), diesel fuel, and natural gas are 228.6, 161.3, and 117. See the full report at https://www.eia.gov/tools/faqs/faq.php?id=73t=11

Table 3: Effects of the GHGRP on Plant-level Emissions Rates

	log(CO_2 Emission Rate)					
	eGRID Reported Emissions				EIA Est. Emissions	
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{GHGRP}_{i,t}$	-0.149***	-0.091***		-0.249***	-0.280***	
	(-4.45)	(-3.73)		(-6.67)	(-16.25)	
$\text{Post}_{i,t}$	0.011	0.029	0.006	0.007	-0.028**	0.018
	(0.70)	(1.59)	(0.34)	(0.33)	(-1.99)	(1.20)
$\text{GHGRP}_{i,t}$	-0.071***	-0.106***	-0.050***	-0.080***	-0.037***	-0.042***
$\times$ $\text{Post}_{i,t}$	(-4.75)	(-6.64)	(-3.27)	(-4.22)	(-3.08)	(-3.35)
N	16,075	16,075	16,075	13,486	22,862	22,862
Adj.R^2	0.388	0.100	0.663	0.345	0.080	0.625
Year FE	Y	Y	Y	Y	Y	Y
County FE	Y	N	N	N	N	N
State FE	N	Y	N	N	N	N
Plant FE	N	N	Y	N	N	Y
Owner FE	N	N	N	Y	N	N

This table presents results on the effects of the GHGRP on plant-level carbon emission rates. Columns (1) - (4) use reported annual CO_2 emission rates from eGrid in the sample period 2004-2018 with missing observations for years 2006, 2008, 2011, 2013, 2015 and 2017. Columns (4) and (5) use estimated annual CO_2 emission rates with fuel consumption data from Form EIA906/923 in the sample period 2006-2015. The outcome variables are winsorized at 1 and 99 percentiles for each year. Standard errors are clustered by plants, and t-statistics are shown in the parentheses below the coefficient estimates. $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

primary fuel types following the regulation.

Does fuel switching contribute to the lower emission rates for plants enrolled in the GHGRP? To answer this, we split the sample into two groups based on their primary fuel types; gas-fired plants are placed in one group, and coal and oil plants are placed in the second group. We then re-estimate the logit regression model described above. Table 4 Column (3) shows GHGRP plants that use gas are less likely to switch fuels. The coefficient on the interaction term is -0.913, with a z-statistic of -2.77. In contrast, Column (4) shows GHGRP plants that used dirtier fuels (i.e. coal and oil) as their primary fuel are more likely to switch fuels. The coefficient of interest is 2.021, with a z-statistic of 5.49.

These results cannot conclusively rule out that coal and oil plants switched fuels for reasons other than (or in addition to) enrollment in the GHGRP. For example, natural gas became inexpensive relative to coal over the sample period. However, the fact that GHGRP enrollment was defined at an arbitrary threshold (25,000 tons) suggests that being in the program did affect the propensity for coal and oil plants to switch fuels. That is, why would a coal-fired plant just above the reporting threshold be more likely to switch to gas than a similar plant below the threshold?

Table 4: Effects of the GHGRP on Plant Primary Fuel

	Dummy Variable: *Fuel Change*			
	Full Sample		Gas Plants	Non-Gas Plants
	(1)	(2)	(3)	(4)
$\text{GHGRP}_{i,t}$	-0.331			
	(-1.52)			
$\text{Post}_{i,t}$	16.428	16.828	15.832	15.164
	(0.03)	(0.02)	(0.03)	(0.03)
$\text{GHGRP}_{i,t} \times \text{Post}_{i,t}$	0.441**	0.533**	-0.913***	2.021***
	(2.14)	(2.45)	(-2.77)	(5.49)
N	16,075	16,075	7,654	8,421
Year FE	Y	Y	Y	Y
County FE	Y	N	N	N
Plant FE	N	Y	Y	Y

This table presents results on the effects of the GHGRP on plants' fuel change decisions. Columns (1) and (2) include all observations. Column (1) includes both year and county fixed effects, and Columns (2) - (4) use year and plant fixed effects. Next, we divide our sample into two sub-samples, gas plants and non-gas (coal and oil) plants. We estimate the logit regression on these two sub-samples and present the results in Columns (3) and (4). And z-statistics are shown in the parentheses below the coefficient estimates. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

5.1.2 Additional Robustness Tests

Table 5: Robustness Test: Clean Air Act

	log(CO_2 Emission Rate)	
	(1)	(2)
$\text{GHGRP}_{i,t}$	-0.140***	-0.103**
	(-3.58)	(-2.58)
$\text{Post}_{i,t}$	0.008	0.013
	(0.44)	(0.75)
$\text{CAA}_{c,t}$	-0.014	0.051
	(-0.33)	(1.05)
$\text{CAA}_{c,t} \times \text{Post}_{i,t}$	0.013	-0.006
	(0.41)	(-0.18)
$\text{CAA}_{c,t} \times \text{GHGRP}_{i,t}$	-0.015	-0.128**
	(-0.28)	(-2.27)
$\text{GHGRP}_{i,t} \times \text{Post}_{i,t}$	-0.072***	-0.082***
	(-3.90)	(-4.78)
$\text{GHGRP}_{i,t} \times \text{Post}_{i,t} \times \text{CAA}_{c,t}$	-0.007	0.021
	(-0.19)	(0.52)
N	16,075	16,075
Adj.R^2	0.388	0.389
Year FE	Y	Y
County FE	Y	Y

This table examines whether another major environmental regulation, the Clean Air Act (CAA), induces GHGRP plants to reduce carbon emissions and presents results on the triple difference regressions in Equation 3. We define our second treatment variable, CAA, as the non-attainment status of a county. Column (1) defines all partially non-attainment counties as treated, and Column (2) defines only fully non-attainment counties as treated. The outcome variables are winsorized at 1 and 99 percentiles for each year. Standard errors are clustered by plants, and t-statistics are shown in the parentheses below the coefficient estimates. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

To ensure our results are robust to other major environmental policies in place during the sample period, we examine whether the effect of the GHGRP is differentially affected by CAA attainment status. Plants located in non-attainment areas, where air pollution exceeds allowable limits, are often required to reduce emissions of air pollution. This may affect CO_2 emission rates. We test whether the findings in Table 3 are affected by CAA attainment status using the triple difference regression in Equation 3. We present the results in Table 5. In Column (1), the non-attainment indicator assumes a value of one if a county is designated as non-attainment for at least one pollutant. And in Column (2), the non-attainment indicator assumes a value of one if a county is out of attainment for all pollutants with ambient limits stipulated by the CAA. In both columns, the coefficient on the triple interaction term $GHGRP_{i,t} \times Post_{i,t} \times CAA_{c,t}$ is insignificant and close to zero. And the $GHGRP_{i,t} \times Post_{i,t}$ term is similar in magnitude to that reported in Table 3. Collectively, these results suggest the findings in Table 3 are not affected by air quality regulations.

5.2 Public or Shareholder Pressure

In this section, we examine public or shareholder pressure as one plausible mechanism through which disclosure affects power plants' emission behavior. We test the shareholder pressure hypothesis using Equation 2. Table 6 presents the results. Power plants in our sample are owned by a mix of private investors, federal, state, or municipal government, and public shareholders. We use public ownership as the empirical proxy for shareholder pressure. Column (1) shows public ownership is strongly and positively associated with CO_2 emission rates. We present the results of fitting Equation 2 in Column (2). Consistent with our previous findings, the coefficient on $Post_{it} \times GHGRP_{it}$ is -0.066 ($p < 0.01$). The coefficient on the triple interaction term is negative but not significant. Next, we separate our sample into two groups based on ownership type: public and non-public ownership. We re-estimate Equation 1a using both samples and the results are shown in Columns (3) and (4), respectively. Column (3) shows a 9.9% reduction in CO_2 emission rates for GHGRP plants owned by publicly traded firms ($p < 0.05$). Column (4) indicates the GHGRP effect for plants owned by governments and private investors is 6% ($p < 0.01$). We interpret the difference in the effect of the GHGRP between the two samples as indicative of the effect due to shareholder pressure.

In Table 7, we refine our approach by including an indicator for whether plants are owned by firms on the S&P 500. We argue that shareholder pressure should be a more tangible force for firms that are included in the S&P Index since such firms are larger in size and receive more investor attention. In Column (2), we present the triple difference regression model, which shows a significant and negative coefficient on the triple interaction term. This result indicates that plants in the GHGRP owned by firms on the S&P 500 reduce their emission rates by 11% more than plants owned by S&P firms not in the GHGRP and GHGRP plants not owned by firms on the S&P 500. Columns (3) and (4) present findings that are consistent with Column (2); firms listed

Table 6: Effects of the GHGRP and Publicly Traded Firms

	log(CO_2 Emission Rate)			
	Full Sample		Sub-Sample	
			Public	Non-Public
	(1)	(2)	(3)	(4)
GHGRP$_{i,t}$	-0.145***	-0.160***	-0.145	-0.168***
	(-3.94)	(-4.37)	(-1.57)	(-3.95)
Post$_{i,t}$	0.010	0.008	-0.031	0.013
	(0.57)	(0.45)	(-0.70)	(0.65)
GHGRP$_{i,t}\times$ Post$_{i,t}$	-0.084***	-0.066***	-0.099**	-0.060***
	(-5.36)	(-3.88)	(-2.31)	(-3.47)
Owned by Public$_{i,t}$	0.091***	0.072		
	(3.43)	(1.10)		
Owned by Public$_{i,t}$		0.008		
$\times$ Post$_{i,t}$		(0.20)		
Owned by Public$_{i,t}$		0.052		
$\times$ GHGRP$_{i,t}$		(0.72)		
GHGRP$_{i,t}\times$ Post$_{i,t}$		-0.056		
$\times$ Owned by Public$_{i,t}$		(-1.22)		
N	14,357	14,357	4,311	10,046
Adj.R^2	0.390	0.390	0.470	0.425
Year FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y

This table presents results on the effects of the GHGRP on plant-level outcomes for plants owned by publicly traded firms. Column (1) adds the Owned by Public indicator variable as an additional control in our main DiD model. Column (2) presents the triple difference regression described in Equation 2 with Owned by Public as a second treatment variable. In Columns (3) and (4), we sort our sample into two groups based on whether the plant is owned by a publicly-traded firm, and estimate Equation 1a. The outcome variables are winsorized at 1 and 99 percentiles for each year. Standard errors are clustered by plants, and t-statistics are shown in the parentheses below the coefficient estimates. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 7: Effects of the GHGRP and S&P Member Firms

	log(CO_2 Emission Rate)			
	Full Sample		Sub-Sample	
			S&P Member	Non-S&P Member
	(1)	(2)	(3)	(4)
GHGRP$_{i,t}$	-0.141***	-0.169***	-0.095	-0.169***
	(-3.78)	(-4.74)	(-0.62)	(-4.54)
Post$_{i,t}$	0.017	0.005	0.025	0.017
	(1.00)	(0.29)	(0.43)	(0.91)
GHGRP$_{i,t}\times$ Post$_{i,t}$	-0.077***	-0.059***	-0.140**	-0.056***
	(-4.96)	(-3.51)	(-2.54)	(-3.30)
S&P Member$_{i,t}$	0.029	-0.102		
	(0.98)	(-1.19)		
S&P Member$_{i,t}$		0.097*		
$\times$ Post$_{i,t}$		(1.78)		
S&P Member$_{i,t}$		0.161*		
$\times$ GHGRP$_{i,t}$		(1.73)		
GHGRP$_{i,t}\times$ Post$_{i,t}$		-0.111**		
$\times$ S&P Member$_{i,t}$		(-1.96)		
N	14,357	14,357	3,234	11,123
Adj.R^2	0.388	0.389	0.559	0.380
Year FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y

This table presents results on the effects of GHGRP on plant-level outcomes for plants owned by firms included in the S&P Index. Column (1) adds the S&P Member indicator variable as an additional control in our main DID model. Column (2) presents the triple difference regression described in Equation 2 with S&P Member as a second treatment variable. In Columns (3) and (4), we sort our sample into two groups based on whether a plant is owned by a firm that is included in the S&P Index and estimate Equation 1a. The outcome variables are winsorized at 1 and 99 percentiles for each year. Standard errors are clustered by plants, and t-statistics are shown in the parentheses below the coefficient estimates. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

on the S&P 500 exhibit larger emission reductions than other plant owners. We contend that shareholder pressure is driving this additional reduction in CO_2 emission rates.

5.3 Firm-Level Strategic Behavior

In this section, we study firms' strategic behavior in response to the GHGRP. To do so, we estimate Equation 1b. The results are shown in Table 8. Columns (1) and (2) appear to contradict the plant-level outcomes; we do not find evidence that treated firms change emission rates across their portfolio of plants. In light of the negative and significant effect of the GHGRP on plant emission rates evident in Table 3, the null effect of the GHGRP at the firm-level must mean that emissions rates for non-GHGRP plants owned by GHGRP firms increased significantly in the post-regulation period. Hence, we suspect that firms with both GHGRP and non-GHGRP plants are strategically reallocating emissions from treated to untreated plants.

We explore this behavior by estimating Equation 1b with emission rates at non-GHGRP plants as the outcome variable. The results are shown in Columns (3) and (4) of Table 8. The coefficient on the interaction term is the effect of firm enrollment in the GHGRP on non-GHGRP plants' CO_2 emission rates, relative to plants owned by firms that do not report to the GHGRP at all. The results corroborate our hypothesis that firms strategically manage their emissions between GHGRP plants and non-GHGRP plants. In Column (3), we find a large (nearly 56%) and significant ($p < 0.05$) treatment effect on CO_2 emission rates at GHGRP firms' non-GHGRP plants. In Column (4) the effect is smaller but still indicates an economically significant increase in CO_2 emission rates for GHGRP firm's non-GHGRP plants.

Table 8 suggests that while we find a significant reduction in plant-level emission rates, the overall effect on emissions is limited because firms can strategically manage their portfolio of plants to attenuate total emission reductions by substituting CO_2 emissions between GHGRP plants and non-GHGRP plants. In Appendix C Table 12, we show that our plant-level emission reduction results remain significant even after we control for this strategic behavior.[26]

The evidence of strategic behavior among firms required to disclose their emissions is especially important to the design of CSR disclosure programs. The efficacy of CSR disclosure laws in

[26] Specifically, we remove non-reporting plants owned by reporting firms and rerun the main DID specification. The estimated β_2 is -6.4% and remains significant. See details in Appendix C Table 12.

changing firms' behavior is adversely affected when firms can simply move economic activity, and emissions, outside the scope of disclosure. Moving emissions to non-disclosing plants is a form of leakage, previously discussed in the context of binding regulations (Babiker, 2005, Böhringer et al., 2017, Chen, 2009, Fischer and Fox, 2012, Fow, 2020). We argue that leakage is direct evidence that firms with exposure to the GHGRP view disclosure as costly. Assuming that firms maximize profits given available information, a decision to reallocate production and emissions to plants outside the purview of the GHGRP must reflect firms' expectations that profits will be adversely affected by disclosure of current emissions. Alternatively, companies would not elect to respond to the GHGRP by reallocating emissions to plants outside the scope of the program if they did not anticipate future benefits in the form of higher firm values from the perspective of outside investors, stronger customer loyalty, or avoided future regulatory penalties.

Table 8: Effects of the GHGRP on Firm-level Emissions

	log(CO_2 Emission Rate)			
	Firm Average		Non-GHGRP Plants' Average	
	(1)	(2)	(3)	(4)
GHGRP$_{f,t}$	-0.086	-0.386**	-0.377*	-0.125
	(-0.81)	(-1.81)	(-1.65)	(-0.94)
Post$_{f,t}$	-0.266**	-0.320***	0.159	-0.092
	(-2.06)	(-3.38)	(0.52)	(-0.46)
GHGRP$_{f,t}\times$ Post$_{f,t}$	0.154	0.072	0.556**	0.247*
	(1.39)	(0.99)	(2.42)	(1.69)
N	744	744	407	407
Adj.R^2	0.301	0.605	0.003	0.607
Year FE	Y	Y	Y	Y
Firm FE	N	Y	N	Y
Firm Controls	Y	N	Y	N

This table presents results on the effects of the GHGRP on firm-level carbon emissions rates using Equation 1b. The outcome variable in Columns (1) and (2) is the weighted average of all plants owned by a firm. In Columns (3) and (4), we take the weighted average of all non-GHGRP plants owned by a firm as the outcome variable, hence the observation size drops from 744 to 408 due to the exclusion of firms with no GHGRP plants. Columns (1) and (3) use year fixed effects and control for the following firm characteristics, firm size, leverage ratio, number of plants owned, number of gas plants owned, and number of coal plants owned. Columns (2) and (4) include both year and firm fixed effects. All continuous variables are winsorized at 1 and 99 percentiles for each year, and t-statistics are shown in the parentheses below the coefficient estimates. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

5.4 Firm Financial Performance

In this section of the analysis, we examine the change in firms' financial position before and after the GHGRP. There are two central reasons why we suspect firms' financial indicators may change in response to the GHGRP. First, as argued above, disclosure is costly for firms because the reporting facility must allocate resources to collect, monitor, and prepare the information requested. Second, previous sections show that GHGRP plants respond to the program by reducing CO emission rates. This likely stimulates a reallocation of resources relative to the case where inputs are optimized for profit maximization.

We present the results of firms' financial performance in Table 9. We employ t-tests comparing the means of several measures of firms' financial position for GHGRP and non-GHGRP firms. In the spirit of our DID approach, we assess mean performance before and after the GHGRP was enacted. We elect not to use DID models here because the parallel trends assumption, critical to causal inference, is violated for many of the financial variables.

Table 9: T-tests on Firm Financial Performance

	GHGRP Firm				Non-GHGRP Firm			
	Mean				Mean			
	Pre	*Post*			*Pre*	*Post*		
	(1)	(2)	(2-1)	t	(3)	(4)	(4-3)	t
Profitability (%)	10.23	9.07	-1.16	-5.97	10.69	10.35	-0.34	-0.19
Log(Rev)	7.58	7.86	0.28	3.93	7.97	8.40	0.43	1.37
Operating CF (%)	6.43	6.15	-0.28	-1.83	6.30	7.64	1.34	1.00
ROA (%)	3.02	2.61	-0.41	-0.91	3.50	1.95	-1.54	-1.54
CAPEX (%)	7.58	7.50	-0.08	-0.29	5.17	7.31	2.14	2.00
PP&E (%)	71.23	73.56	2.33	3.02	55.84	59.81	3.97	0.89
Inventory (%)	2.82	2.45	-0.37	-3.13	2.33	3.85	1.52	1.40
Cash (%)	1.67	1.49	-0.18	-0.90	2.47	2.04	-0.43	-0.52
Book Leverage (%)	34.24	33.96	-0.28	-0.36	30.12	26.46	-3.66	-1.93
Net Leverage (%)	32.56	32.47	-0.09	-0.13	27.66	24.42	-3.24	-1.40
Interest (%)	2.20	1.86	-0.34	-5.07	2.11	1.47	-0.64	-4.56

This table employs t-test results comparing the means of firms' financial reporting variables before and after the GHGRP. A firm is treated as a GHGRP firm if it owns at least one GHGRP plant, otherwise it is treated as a non-GHGRP firm. We report the means and t-statistics separately for GHGRP firms and non-GHGRP firms. See Appendix B for variables definitions.

Overall, Table 9 suggests firms exposed to the GHGRP exhibited inferior financial performance relative to firms that do not own plants in the GHGRP. For GHGRP firms, revenues increased by 28% ($p < 0.01$) after the enactment of the program. However, this increase is less than that for non-GHGRP firms (43%) though the latter effect is imprecisely estimated. Operating cash flow fell for GHGRP firms. It increased for non-GHGRP firms. While profitability decreased for both groups of companies, the decline was over three times greater for GHGRP firms. Similarly, capital expenditures and inventories expanded for companies without GHGRP plants. These measures fell, or were essentially flat for GHGRP firms. While both groups of firms exhibit falling leverage, GHGRP firms show considerably smaller reductions in both book and net leverage than companies without exposure to the GHGRP. Finally, interest expenses decreased nearly two times as much for non-GHGRP firms relative to GHGRP firms.

We are not claiming that the changes in firms' relative or absolute financial position due to exposure to the GHGRP are a causal relationship. We nonetheless argue that Table 9 provides compelling evidence that the GHGRP adversely affected firms' financial outcomes. The earlier results in the paper, which we do claim are the result of a causal relationship, indicate that firms (especially large, publicly-traded firms) substantially change their production decisions, as evidenced both by reduced emission rates at GHGRP plants and increased discharges at facilities outside the scope of the GHGRP. We argue that the results in Table 9 are the financial signature of these changes made in response to the GHGRP.

6 Conclusion

As corporate social responsibility gains momentum, an important open question pertains to the consequences of mandatory CSR reporting. We explore this topic by examining the real effect of a nation-wide mandatory reporting program for greenhouse gas emissions. We initially hypothesize that the program would cause emission rates to fall because the GHGRP enhanced the accessibility and timeliness of previously hidden information and that investors, shareholders, and other market participants would value firms with lower emission rates. Consistent with our hypothesis, we find a significant reduction in emission rates by reporting facilities. On average, plants covered by GHGRP reduced CO_2 emission rates by 7%, relative to the non-reporting plants. We contend that this effect was at least partially driven by public or shareholder pressure, or firms' anticipation of the pressure, in light of the disclosure. Support for this mechanism evinces in the much larger reduction in emission rates for plants owned by firms on the S&P 500.

Attenuating the estimated reduction in emission rates is a form of leakage which we detect when analyzing firm-level outcomes. Specifically, we find evidence, for firms that own both GHGRP and non-GHGRP plants, that emission rates at these firms' non-reporting plants increased significantly compared to non-reporting firms' plants. Leakage is evidence that firms view disclosure as bearing costs or risk. That is, since reallocating emissions from GHGRP to non-GHGRP plants is itself costly, it must be the case that firms anticipate some benefit from avoiding disclosure.

Our results are likely to be of interest to both academics and policymakers. We contribute to the literature examining the effect of disclosure on environmental performance. This paper also highlights that how information disclosure occurs matters. First, we demonstrate that a nationwide disclosure program affects firm behavior. Second, the paper shows that reporting thresholds present the opportunity for leakage which attenuates net emission reductions. Third, the behavioral changes observed herein firmly support the notion that companies expect relevant stakeholders to respond to new information in ways that the firms would like to avoid. As such, our paper makes the case that standardized, mandatory CSR reporting (without thresholds) has the potential to induce large-scale changes in firm behavior that may have appreciable social benefits.

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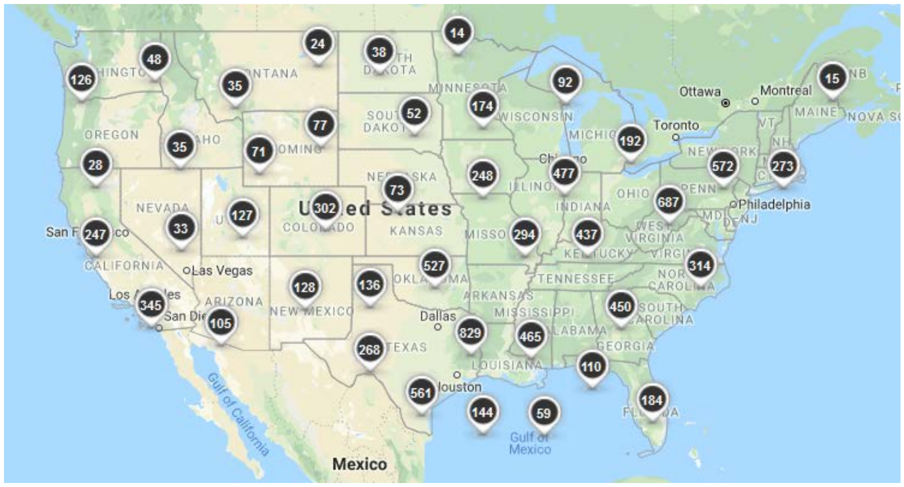
A Appendix: Additional GHGRP Information

Table 10: Data Profile Comparison

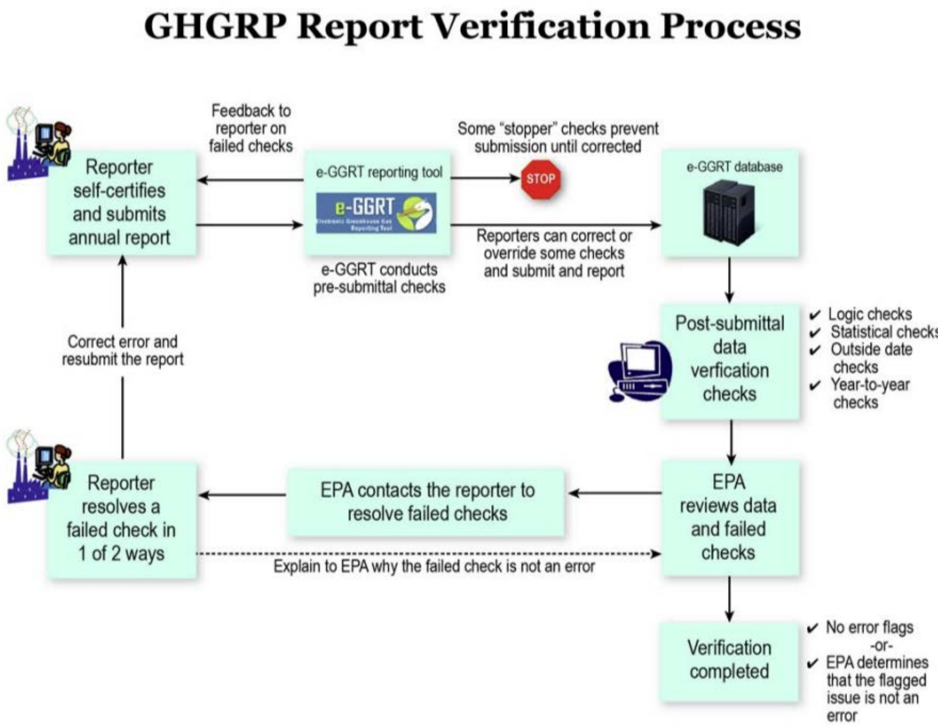
	eGrid	**GHGRP**
Accessibility		
Frequency	Bi-Annually(1)	Annually
Data Formats	Raw data in spreadsheets (2)	FLIGHT: An interactive website with mapping features;(3) Data highlights: A high-level summary of reported data by industry; Downloadable data files
Initial Data	1996	2010
Informativeness		
Scope	A comprehensive inventory of environmental attributes of electric power system that integrates data from EIA Forms EIA-860 and EIA-923 and EPA's Clean Air Markets Program	Facilities that emit 25,000 metric tons of carbon dioxide equivalent (CO2e) per year in 41 industries are required to report GHG emissions
Verification	Varies depending on the data source. eGrid makes some adjustments to deal with missing and ambiguous data	Multi-step data verification (4)
Authority	Varies depending on the data source.	Clean Air Act
Usefulness		
Intended Use	Typically used for GHG registries and inventories, carbon footprints, consumer information disclosure, emission inventories and standards, power market changes, and avoided emission estimates	Identify nearby sources of GHG emissions; track emissions and identify cost-saving opportunities; inform policy at the state and local levels; provide important information to the finance and investment communities

Source: EPA's website
(1) eGrid publishes data approximately every other year. See details on EPA's website.
(2) eGrid has recently updated the layout of their website and added maps and graphs under eGrid Explorer.
(3) See Figure 2
(4) See Figure 3



Source: EPA

Figure 2: Facility Level Information on Greenhouse Gases Tool (FLIGHT)



Source: EPA

Figure 3: GHGRP Report Verification Process

EPA proposes GHG reporting program

By Susanne Retka Schill

Large emitters of greenhouse gases (GHGs) will have to file their first annual GHG emissions reports with the U.S. EPA in 2011, if a new rule is adopted as proposed. EPA held about 100 meetings with more than 250 stakeholders, including trade associations, industries, environmental groups, and state and regional governments, during the development of the rule. Hearings were scheduled for April 6 and 7 in Washington, D.C., and April 16 in Sacramento, Calif. Written comments will be accepted for 60 days after the official publication of the proposed rule in the Federal Register. To read the text of the proposal and supporting information visit the Web site at www.epa.gov/climatechange/emissions/ghgrulemaking.

In general, the EPA proposed the new rule for suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more of carbon dioxide equivalent per year. The GHGs covered by the proposed rule are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and other fluorinated gases including nitrogen trifluoride and hydrofluorinated ethers.

The EPA estimated approximately 13,000 facilities will be covered under the rule, accounting for 85 percent to 90 percent of U.S. GHG emissions. The threshold is roughly equivalent to the annual GHG emissions from 4,500 passenger vehicles, 58,000 barrels of oil consumed or 131 railcars filled with coal. The vast majority of small businesses will fall well below the threshold and thus not be required to report. The EPA estimated that it will cost the private sector $160 million for the first year and $127 million in each subsequent year to comply with the new reporting requirement.

In most cases, the required data will come from the facility level, with a few exceptions where the reporting will be done at the corporate level. Among the exceptions are vehicle and engine manufacturers, fossil fuel importers and exporters, and local gas distribution companies. Under the EPA proposal, the first emissions report would be due on March 31, 2011, for emissions that occured during calendar year 2010. At that time, reporters would need to present total annual GHG emissions as an aggregate as well as separate emissions data for each source and supply category identified by the EPA. Fuel use and feedstock inputs used to generate emissions are to be reported, but not emissions from land-use changes or carbon storage.

EPA has published information sheets for each of the source categories covered in the proposed rule on its Web site under the resources link. In addition to manufacturers of chemicals and gases, the source categories include energy-intensive industries such as refineries, coal mines, electrical generation, cement production, electronics

Figure 4: Media Coverage of GHGRP (1)

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Register

EPA issues final rule requiring petroleum and natural gas systems to measure and report greenhouse gas emissions

King & Spalding LLP

KING & SPALDING

USA | November 9 2010

Final Rule Retains Aggregation Requirements that Catch More Businesses in the Regulatory Net

On November 8, 2010, the U.S. Environmental Protection Agency (EPA) issued its final rule for reporting of greenhouse gas (GHG) emissions from petroleum and natural gas systems. Affected businesses must begin collection of emissions data on January 1, 2011, and the first annual reports are due March 31, 2012.

The Targets - Who Must Report?

The rule impacts businesses in the following categories:

- Petroleum and natural gas production, both offshore and onshore
- Natural gas processing, transmission compression, and underground storage
- Liquefied natural gas (LNG) storage and import/expert
- Natural gas distribution

Impacted businesses that emit 25,000 metric tonnes (MT) or more of CO2 equivalent per year (or roughly 1,000 MT or more of methane) must report annually. GHGs under the rule include methane, carbon dioxide (CO2), and nitrous oxide. Sources to be measured include equipment leaks, venting, flaring, combustion, and drilling rigs, to name a few examples.

The Catch - Aggregation for Production and Distribution

EPA considers production and distribution "unique" and has defined a single "facility" for these businesses through aggregation of sources:

- Natural gas distribution - All pipelines and stations operated by a Local Distribution Company (LDC).
- Onshore petroleum/natural gas production - All equipment on or associated with a well pad (including enhanced oil recovery) under common ownership or control located in a single hydrocarbon basin.

These definitions are unlike any other definitions of "facility" in the GHG Reporting Rules or other Clean Air Act provisions.

The Crunch - Getting Ready to Monitor by January 1

What happens if facilities cannot get ready to monitor by January 1 (i.e., in the next six weeks)? For certain sources, facilities may use best available monitoring methods (BAMM) for a portion of 2011. EPA may also consider petitions to use BAMM for other sources, and the rule outlines the procedures for obtaining clearance to use BAMM.

The Unknown - Will EPA Protect Sensitive Business Information from Public Disclosure?

EPA has not finalized the rule for confidential business information (CBI) the Agency proposed in July 2010. Consequently, this final rule does not address whether any information utilized in determining the quantities of GHG emissions to report will receive CBI treatment.

King & Spalding LLP - Cynthia A.M. Stroman

Figure 5: Media Coverage of GHGRP (2)

BLOG POST | 03.09.2009 | LAURA POCKNELL

New EPA Rule Establishes Mandatory Greenhouse Gas Reporting

EPA is creating a nationwide database of greenhouse gas emissions, an important first step on the path to reducing U.S. emissions.

The Environmental Protection Agency released a proposed Mandatory Greenhouse Gas Reporting Rule for sixty days of public comment, with a final rule expected in late 2009. The proposal would cover 85 to 90 percent of US greenhouse gas emissions. This process is the result of legislation passed in December, 2007 that directed the EPA to design a national, mandatory GHG emissions registry. EPA's work on a national registry lagged under the previous administration, but has received fast-track priority under incoming Administrator Lisa Jackson.

The plan would require 13,000 facilities to report their emissions. Facilities that emit 25,000 metric tons of greenhouse gases annually would be covered, and small businesses will be exempt. Reporting for sectors such as the utilities, oil and gas producers, and chemical refineries would start in 2011, while automobile manufacturers will start up on their 2011 models.

Welcome Milestone

A national greenhouse gas registry is a major development in U.S. climate change policy, because it is the cornerstone of cap-and-trade, or indeed, any policy to measure and reduce emissions. Before the government can implement emission reduction policies, they first need to have solid and reliable emissions data. Otherwise, there would be no way to ensure that emissions sources—such as power plants and factories—are achieving reductions.

The EPA previously had no comprehensive way to track emissions data at the individual facility or business level. An EPA national registry will provide transparency and support a variety of climate change policies and programs at the national,

Figure 6: Media Coverage of GHGRP (3)

B Appendix: Additional Variable Definitions

Variable	**Definition**
Size	Log of Total Assets
Profitability	Operating Income Before Depreciation / Lagged Assets $\times$ 100%
Log(Rev)	Log of Total Revenue
Operating Cash Flow	(Operating Income Before Depreciation - Interest and Related Expense - Total Income Taxes) / Lagged Assets $\times$ 100%
ROA	Income Before Extraordinary Items / Total Assets $\times$ 100%
CAPEX	Capital Expenditures / Lagged Assets $\times$ 100%
PP&E	Property, Plant and Equipment / Total Assets $\times$ 100%
Inventory	Total Inventories / Total Assets $\times$ 100%
Cash	Cash and Short-Term Investments / Total Assets $\times$ 100%
Book Leverage	(Long-Term Debt + Debt in Current Liabilities) / Total Assets $\times$ 100%
Net Leverage	(Long-Term Debt + Debt in Current Liabilities - Cash and Short-Term Investments) / Total Assets $\times$ 100%
Interest	Interest and Related Expense / Lagged Assets $\times$ 100%

C Appendix: Additional Tables and Figures

Table 11: Effects of the Clean Power Plan Nullification on Plant-level Emissions Rates

	log(CO_2 Emission Rate)			
	Full Sample		Post-GHGRP Sample	
	(1)	(2)	(3)	(4)
$\text{GHGRP}_{i,t}$	-0.149***		-0.218***	
	(-4.45)		(-5.81)	
$\text{Post}_{i,t}$	0.001	-0.003		
	(0.08)	(-0.15)		
$\text{CPP}_{i,t}$	0.033*	0.018	0.034*	0.011
	(1.83)	(1.01)	(1.67)	(0.54)
$\text{GHGRP}_{i,t}\times$ $\text{Post}_{i,t}$	-0.063***	-0.046***		
	(-4.13)	(-2.99)		
$\text{GHGRP}_{i,t}\times$ $\text{CPP}_{i,t}$	-0.049**	-0.021	-0.043**	-0.010
	(-2.39)	(-1.04)	(-2.08)	(-0.46)
N	16,075	16,075	8,798	8,798
Adj.R^2	0.388	0.663	0.407	0.722
Year FE	Y	Y	Y	Y
County FE	Y	N	Y	N
Plant FE	N	Y	N	Y

This table presents results on the effects of the Clean Power Plan (CPP) Nullification on plant-level carbon emission rates. CPP is defined as a binary variable that is equal to one if the observation is from 2017 and after. Columns (1) and (2) include all observations, whereas Columns (3) and (4) only include observations after 2010. All continuous variables are winsorized at 1 and 99 percentiles for each year, and t-statistics are shown in the parentheses below the coefficient estimates. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 12: Effects of the GHGRP on Plant-level Emissions Rates

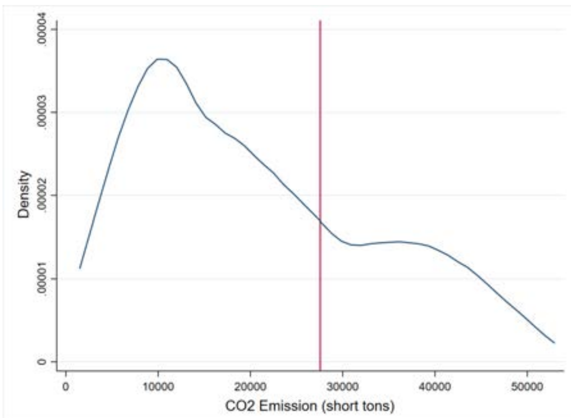
	log(CO_2 Emission Rate)			
	(1)	(2)	(3)	(4)
GHGRP$_{i,t}$	-0.125***	-0.238***	-0.082***	-0.233***
	(-3.28)	(-6.22)	(-1.73)	(-2.75)
Post$_{i,t}$	-0.005	-0.015	-0.016	-0.010
	(-0.25)	(-0.73)	(-0.78)	(-0.45)
GHGRP$_{i,t}\times$ Post$_{i,t}$	-0.064***	-0.059***	-0.055***	-0.077***
	(-3.91)	(-3.13)	(-2.92)	(-3.63)
N	13,423	13,423	12,396	12,396
Adj.R^2	0.400	0.373	0.390	0.382
Year FE	Y	Y	Y	Y
County FE	Y	N	Y	N
Owner FE	N	Y	N	Y

This table presents results on the effects of the GHGRP on plant-level carbon emission rates excluding non-reporting plants owned by GHGRP firms. Columns (1) and (2) exclude such plants that are owned by publicly traded firms, and Columns (3) and (4) extend these plants to all ownership types. All continuous variables are winsorized at 1 and 99 percentiles for each year, and t-statistics are shown in the parentheses below the coefficient estimates. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

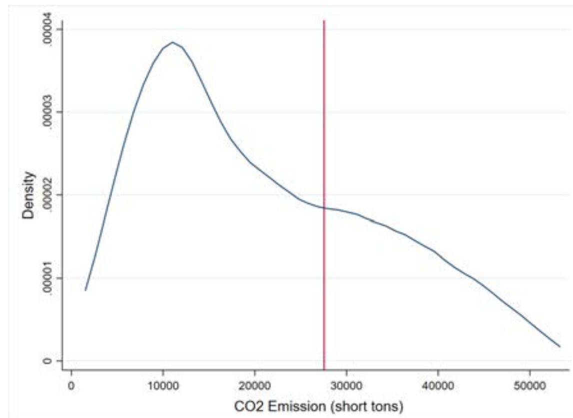
Table 13: T-test on Firm Financial Performance

	Firm with both GHGRP and non-GHGRP Plants			
	Mean			
	Pre	*Post*		
	(1)	(2)	(2-1)	*t*
Profitability (%)	10.34	9.34	-1.00	-3.88
Log(Rev)	7.73	8.07	0.34	3.35
Operating CF (%)	6.44	6.29	-0.15	-0.74
ROA (%)	3.18	2.53	-0.65	-2.20
CAPEX (%)	7.53	7.72	0.19	0.50
PP&E (%)	70.38	73.31	2.93	2.99
Inventory (%)	2.96	2.50	-0.46	-2.69
Cash (%)	1.20	1.44	0.24	0.99
Book Leverage (%)	34.15	33.73	-0.42	-0.39
Net Leverage (%)	32.94	32.29	-0.65	-0.67
Interest (%)	2.22	1.82	-0.40	-4.05

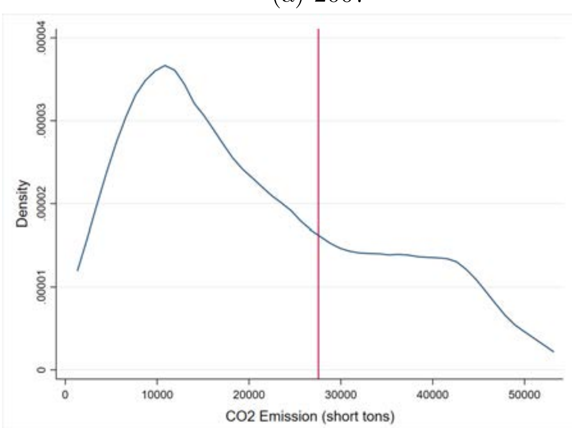
This table employs t-test results comparing the means of firms' financial reporting variables before and after the GHGRP. We restrict the sample to firms that own both GHGRP and non-GHGRP plants. See Appendix B for variables definitions.



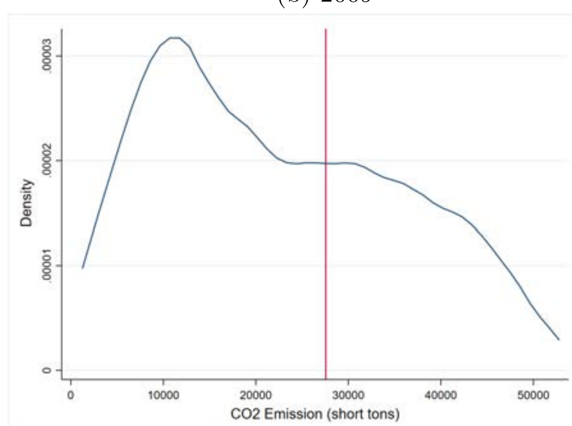
(a) 2007



(b) 2009



(c) 2010



(d) 2012

Figure 7: Density Plots

Panels (a) through (d) show the density plots of CO_2 emissions in short tons around the reporting threshold for years before and after the adoption of the GHGRP in 2010. The vertical reference line represents the reporting threshold of 25,000 metric tons. We do not observe any discontinuity around the threshold both before and right after the adoption of GHGRP.