Private Equity and Gas Emissions: Evidence from Electric Power Plants

Xuanyu Bai   Youchang Wu*

June 12, 2026

Abstract

We examine the effect of private equity buyouts on environmental performance of U.S. fossil fuel power plants. Output-scaled CO_2 emissions are, on average, 4.2% lower after buyouts, predominantly because of fuel-saving improvements in production efficiency. Emission intensities decline more significantly following buyouts backed by pro-ESG private equity, due to not only greater efficiency gains but also enhanced emission control. Our results suggest that while private equity firms are effective at implementing environmentally beneficial operational changes that also increase profitability, they do not have strong incentives to undertake environmentally beneficial changes that are privately costly, except for those with pro-ESG preferences.

---

*Bai, baix2261024@gmail.com, Oslo Metropolitan University Oslo Business School; and Wu (corresponding author), ywu2@uoregon.edu, University of Oregon Lundquist College of Business. We are grateful for comments and suggestions from Ran Duchin (Editor), an annonymous referee, Aleksandar Andonov (discussant), Aymeric Bellon, Thomas Boulton (discussant), Ioannis Branikas, Marco Ceccarelli, Diane Del Guercio, Caroline Flammer, Michael Goldstein, Bing Han, Sunwoo Hwang (discussant), Jinyoung Kim (discussant), Yanru Lee (discussant), Quentin Moreau (discussant), Charlotte Ostergaard (discussant), George Skiadopoulos, Zhi Wang, Michael Weisbach, Josef Zechner, Yang Zhao (discussant), and conference/seminar participants at the China International Conference in Finance 2024, Oxford Sustainable Private Markets Conference 2023, Boca-ECGI Corporate Finance & Governance Conference 2023, University of Massachusetts Boston Conference on Corporate Social Responsibility 2023, Shanghai-Edinburgh-London Green Finance Conference 2023, Private Markets Research Conference 2023, University of Luxembourg Sustainable Finance Conference 2023, China International Risk Forum in 2023, University of Nevada-Reno, Vienna University of Economics and Business, Central European University, University of Oregon, University of Piraeus, and University of Macau. We thank Craig Hillock and Sandeep Gill at the U.S. Environmental Protection Agency for answering our questions regarding the Power Sector Emissions Data.

I. Introduction

Private equity has become an important player in the economy. As such, its impact on firms' environmental performance, especially in terms of greenhouse gas emissions, has drawn increased attention. Due to their opaque business operations, high-powered profit motive, and relatively short investment horizons, private equity firms' acquisitions of high-emission (brown) assets such as fossil fuel power plants are viewed by many critics as a climate threat.[1] Meanwhile, some industry experts argue that private equity is well placed to take the lead in sustainability investing (Eccles, Shandal, Young, and Montgomery (2022)). Despite the strong public interest, research on the environmental impact of private equity remains sparse.

We investigate the effect of private equity ownership on the emissions of environmentally harmful gases by U.S. fossil fuel power plants. The electric power sector offers a unique opportunity to study the environmental impact of private equity. First, the sector, which generated 61.5% of electricity in the U.S. from fossil fuels in 2020, is a major emitter. It accounted for 30.5% of carbon dioxide (CO_2) emissions and 24.8% of total greenhouse gas emissions in the U.S. in 2020 (U.S. Environmental Protection Agency (2022)).[2] It is also an important emitter of two precursor greenhouse gases: sulfur dioxide (SO_2) and nitrogen oxides (NO_x, shorthand for NO and NO_2), contributing 58.4% and 11.3%, respectively, of their emissions from energy-related activities in the U.S. in 2020.[3] Second, private equity firms have become a major owner

---

[1] For example, Americans for Financial Reform Education Fund (2022) argues that private equity firms "pose unique climate and safety risks" as they "deploy a highly predatory playbook to rapidly extract value from the firms and assets they purchase."

[2] About 3/4 of U.S. gross greenhouse gas emissions are CO_2 emissions from fossil fuel combustion.

[3] While not being direct greenhouse gases themselves, precursor greenhouse gases such as SO_2 and NO_x can indirectly affect the earth's radiative balance and contribute to the formation of greenhouse gases. SO_2 and NO_x can also harm human respiratory systems and contribute to acid rain that harms sensitive ecosystems.

of power plants. According to Andonov and Rauh (2024), private equity owns, on average, 14.5% of U.S. power plants with a nameplate capacity of at least 20MW in the period from 2005 to 2020. Third, a unique feature of electricity production, i.e., the homogeneity of input and output, together with the comprehensive and accurate data on power plant emissions and operations available from the regulators, allows us to separate the efficiency and non-efficiency components of environmental performance. This separation is a formidable task in other industries. Specifically, the emission intensity, defined as the volume of emissions scaled by electricity produced and referred to as the output emission rate, can be decomposed into two parts: the heat rate and the input emission rate. The former is the heat input per unit of electricity output, which inversely measures a plant's production or thermal efficiency. The latter is measured by the volume of emissions scaled by the heat input, which captures the effectiveness of a plant's emission control system.

We hypothesize that private equity buyouts should lead to a reduction in the heat rate, but their effect on the input emission rates is generally more ambiguous. Our hypothesis builds on a simple logic: while profit-maximizing private equity firms may have mixed incentives regarding socially beneficial but privately costly investments in the reduction of input emission rates, they should have a strong incentive to reduce the heat rate even in the absence of a prosocial preference, because a lower heat rate means lower fuel costs. We also hypothesize that environmental benefits should be larger for deals backed by pro-ESG (environmental, social and governance) private equity firms because of their prosocial motives.

To test these hypotheses, we obtain data on annual CO_2, SO_2, and NO_x emissions and operations of fossil fuel power plants from the Clean Air Markets Division

(CAMD) of the U.S. Environmental Protection Agency (EPA). Our sample includes 1,340 power plants with 4,181 unique electricity generating units (EGUs) from 2003 to 2021. The gross electricity generation by the plants in our sample totaled 2.04 million gigawatt-hours (GWh) in 2021, which was 80% of the U.S. electricity generation from fossil fuels in that year. For a subset of plants, we also obtain data on fuel cost, electricity price, operation & maintenance (O&M) expenditures and capital expenditures related to pollution abatement from the U.S. Energy Information Administration (EIA). By merging plant owners with targets of private equity buyout deals from PitchBook, we identify 137 power plants bought out by private equity firms for the first time. We focus on the first buyout deals because the private equity treatment effect may be diminished in subsequent deals.

We analyze the impact of private equity buyouts by running stacked difference-in-differences (DiD) regressions based on matched samples. To understand the nature of the potential selection effect, we first analyze private equity firms' choice of buyout targets. We find that the buyout probability is positively related to plant electricity generation capacity and negatively related to plant age, but it is not significantly related to the emission rates or the heat rate. Based on these results, and to further enhance comparability, we match each acquired plant to a control plant based on year, state, primary fuel type, and a Mahalanobis distance measure calculated using log capacity, capacity factor, log plant age, and the level and slope of log heat rate. Using this procedure, we identify 102 pairs of acquired and control plants. We stack all the pairs, referred to as cohorts, and run DiD regressions, controlling for both year-cohort and plant-cohort fixed effects. This approach allows us to exploit within-plant variation in each cohort, which largely mitigates the concern about unobservable differences between acquired and control plants driving our results.

We find strong evidence in support of our hypothesis. Our DiD analysis at the EGU level shows that, on average, the CO_2 and NO_x output emission rates decline by 4.2% and 9.0%, respectively following private equity buyouts. Given the large emission volumes of the U.S. electric power sector (1,439 million metric tons for CO_2 and 733 thousand tons for NO_x in 2020, according to U.S. Environmental Protection Agency (2022)), the economic magnitudes of these estimates are large. Importantly, the decline in the CO_2 output emission rate results almost entirely from a 4.0% decrease in the heat rate. In fact, our baseline analysis finds no statistically significant buyout effect on any input emission rate. Furthermore, the plant-level DiD analysis shows that while fuel costs per MWh of electricity output decline by 7.3% after buyouts, expenditures related to pollution abatement do not change significantly. These results are consistent with our hypothesis that while private equity firms are keen on increasing production efficiency, they generally do not have strong incentives to make costly investments to improve emission control.

To test whether the beneficial effects described above are unique to first buyouts backed by private equity, we conduct the same analysis for M&A deals not backed by private equity as well as secondary private equity buyout deals. We do not find any significant change in either production efficiency or emission rates following those deals.

Our results confirm the importance of private equity firms' ESG preferences in driving the buyout effect. While buyouts backed by private equity with no stated preference for ESG investments are followed by a decline of 2.7% in the CO_2 output emission rate, which is almost entirely attributable to the decline in the heat rate, the decline in this emission rate following buyouts backed by private equity with such a preference is larger by a factor of three. Buyouts backed by pro-ESG private equity are also associated with a 16.6% decline in NO_x input emission rate. Furthermore, plants acquired by pro-ESG private equity from non-ESG private equity show a marginal improvement in the CO_2 input emission rate after the SBO. These results suggest that deals backed by pro-ESG private equity generate larger environmental benefits not only through greater increases in production efficiency, but also through improvement in emission control.

We also explore other potential mechanisms underlying the private equity buyout effects. Regulatory and social environments appear to play an important role. The efficiency gains following private equity buyouts are concentrated in target plants operating in the deregulated and thus more competitive markets, which are characterized by the existence of an independent system operator (ISO) serving as the balancing authority. The improvement in environmental performance is also more significant in the states where public support for government action in lowering power plant emissions is above the median level across states. In addition, it is more significant in acquired plants with above-median nameplate capacity, plants acquired through corporate divestiture deals, and plants held by the acquiring private equity firms for more than four years. We also find that private equity buyouts have no significant effect on the scales of input, output, and operating time, and that controlling for the output scale has little impact on the estimated buyout effects on production efficiency and emission rates.

The EGU-level data allow us to investigate whether the improvement in production efficiency arises from within-EGU variation or changes in the EGU composition. We find that for coal- or oil-fired power plants, which constitute a small fraction of our sample, the efficiency improvement arises mainly from changes in EGU composition. In contrast, for natural gas-fired plants, the improvement comes almost entirely from increased efficiency of existing EGUs.

We conduct a series of robustness tests. Specifically, we use a 7-year instead of 11-year event window, a 1-to-4 instead of 1-to-1 treatment-to-control ratio, and three alternative sets of matching variables. Our results remain largely the same in all these alternative tests. To further address the concern about the sensitivity of our results to the matching methods, we also perform panel DiD regressions using the full sample, controlling for a variety of fixed effects. The results are slightly stronger than those from the stacked DiD regressions, suggesting that our baseline estimates are conservative.

Our paper is one of a few recent studies on the effect of private equity ownership on environmental performance.[4] Shive and Forster (2020) find that public firms and private equity-backed private firms are more likely to pollute than independent private firms, while there is no significant difference between the pollution levels of the former two groups. Bellon (2025) studies the effect of private equity ownership on toxic pollution released by U.S. oil and gas companies. He finds that private equity buyouts reduce pollution of the target firm when the environmental liability risks are high but increase pollution when such risks are low. Kumar (2024) finds that private equity acquisitions of fossil fuel power plants facilitate the development of solar energy. Our work differs from these studies by focusing on a homogeneous sample of electricity generating plants and examining the differential impacts of private equity ownership on the efficiency and non-efficiency components of environmental performance. We also show a rich set of cross-sectional variation in private equity buyout effects, especially between deals backed by pro-ESG and non-ESG firms.

---

[4] See Wu (2023) for an overview of this topic with a focus on carbon footprint.

Our paper is related to two studies contemporaneous with ours on ownership changes in the electricity sector. Andonov and Rauh (2024) document a significant increase in the power plant ownership by private equity, institutional investors, and foreign corporations in the U.S. (from 7% in 2005 to 24% in 2020). They show that these investors facilitate energy transition in deregulated markets by creating more efficient plants and improving the efficiency of acquired plants. Demirer and Karaduman (2024) study the mergers and acquisitions of U.S. power plants and document a 2% average increase in efficiency for acquired plants. Our paper differs from these studies in several important aspects. First, while these studies focus primarily on production efficiency, we focus on the environmental effect of power plant ownership changes. Although production efficiency is an important determinant of environmental performance, the relation is not one-to-one, as we show for SO_2 and NO_x output emission rates and for buyouts backed by pro-ESG private equity firms. Second, while these studies do not distinguish between private equity-backed buyouts and other M&As, we focus on buyouts backed by private equity, which are at the center of public debates. Our stacked DiD analysis shows that private equity-backed buyouts lead to a production efficiency increase twice as high as the estimate reported by Demirer and Karaduman (2024), while M&As not backed by private equity have no significant effect.

Our paper contributes to the growing literature on the interaction between finance and ESG performance. Previous studies have examined various channels through which finance can affect firms' environmental behavior, including cost of capital (Heinkel, Kraus, and Zechner (2001), Pástor, Stambaugh, and Taylor (2021)), financial constraints (Bartram, Hou, and Kim (2022), Xu and Kim (2022)), shareholder engagement and activism (Dimson, Karakaş, and Li (2015), Akey and Appel (2019)), and lender monitoring (Houston and Shan (2021)). Duchin, Gao, and Xu (2025) study the asset market for pollutive plants, focusing primarily on non-financial buyers and sellers in manufacturing industries. They find that pollution levels of those plants do not decrease after they are divested. Hartzmark and Shue (2023) show that relaxing financial constraints of brown firms has large environmental benefits, which is consistent with our finding of a positive buyout effect on power plant environmental performance.

Our study also contributes to the literature on the real effect of private equity ownership. The post-buyout increase in production efficiency we document resonates with the positive efficiency effect of private equity ownership found in the literature (e.g., Davis, Haltiwanger, Handley, Jarmin, Lerner, and Miranda (2014)). Our finding of a post-buyout decrease in emission intensity adds to the literature on the effect of private equity on non-financial stakeholders. The evidence on this aspect of private equity is more mixed (see the literature review by Sorensen and Yasuda (2023)). For example, Gupta, Howell, Yannelis, and Gupta (2024) find that private equity ownership in nursing homes reduces the quality of patient care, while Gao, Kim, and Sevilir (2025) find that healthcare quality does not deteriorate at hospitals acquired by private equity. Eaton, Howell, and Yannelis (2020) find that private equity buyouts in higher education lead to worse education outcomes and higher school profits.

II. Hypotheses

Since the volume of emissions naturally increases with production scale, to allow more meaningful comparisons between plants of different sizes, it is useful to normalize emissions by output size. We use emissions scaled by electricity produced, referred to as the output emission rate, as our measure of emission intensity. Previous studies have used emissions scaled by sales or dollar values of output to measure emission intensity (e.g., Hartzmark and Shue (2023), Bolton and Kacperczyk (2021), Shive and Forster (2020), Shapiro (2020)). Our quantity-based measure has the advantage of not being affected by output price, which can be influenced by firms' market power.

How will private equity ownership affect emission intensity? On the one hand, a lower emission intensity can reduce the cost of capital by reducing a firm's exposure to environmental risk; it can also improve a firm's reputation and social capital.[5] Therefore, private equity firms may have an incentive to reduce emission intensity for both financial and non-financial considerations. On the other hand, measures used for emission control and mitigation are costly. Thus, private equity firms may have an incentive to cut them back to improve short-term profitability, especially because they typically do not hold the plants for a long time. Which of these two forces is stronger is an empirical question.

However, sharper predictions can be made if we look further into the components of the emission intensity. The output emission rate of a gas can be expressed as the product of its input emission rate and the heat rate, the former defined as the emissions per unit of heat input and the latter as the heat input per unit of electricity produced:

$$\underbrace{\frac{Emission}{Electricity\ Output}}_{Output\ Emission\ Rate} = \underbrace{\frac{Emission}{Heat\ Input}}_{Input\ Emission\ Rate} \times \underbrace{\frac{Heat\ Input}{Electricity\ Output}}_{HeatRate}, \tag{1}$$

where the heat input is equal to the quantity of fuel used in electricity production times the fuel's heat content. It follows that the log output emission rate can be fully

---

[5] Because of its high emissions, Utility (including Electric, Gas & Sanitary Services) tops the list of economic sectors ranked by exposure to climate risks according to both Sautner, van Lent, Vilkov, and Zhang (2023) and Li, Shan, Tang, and Yao (2024). Recent studies have shown that higher emissions lead to higher cost of capital (see, for example, Fernando, Sharfman, and Uysal (2017), Bolton and Kacperczyk (2021), Bolton and Kacperczyk (2023), Hsu, Li, and Tsou (2023)).

decomposed into two parts:

$$(2)\qquad ln(Output\ Emission\ Rate) = ln(Input\ Emission\ Rate) + ln(Heat\ Rate).$$

The heat rate inversely measures the thermal efficiency of the electricity production process, which can be viewed as the efficiency component of emission intensity. The input emission rate inversely measures the effectiveness of emission control, which can be viewed as the non-efficiency component of emission intensity. To reduce the output emission rate, a firm can invest either in measures and technologies that improve production efficiency or in those that reduce emissions per unit of heat input.

From the private equity firm's perspective, the two alternative approaches have very different profit implications. The reduction of the heat rate means a lower fuel consumption rate and thus lower production costs, which improves not only a plant's environmental performance but also its gross margin. In other words, it is profit-boosting. Since the societal and private benefits are well aligned in this component of environmental performance, even if a private equity firm has no prosocial preference, it should still have a strong incentive to reduce the heat rate. Given that private equity firms are known for their ability to improve operational efficiency, we expect the heat rate to decline after they take over. In contrast, investments in measures to reduce the input emission rate, while socially beneficial, are expenditures that reduce short-term profits (i.e., profit-draining). Therefore, private equity firms may not be keen on undertaking such efforts, unless they have a strong commitment to social responsibility. Based on these considerations, we hypothesize that private equity buyouts should, on average, lead to a reduction in the heat rate, but their effect on the input emission rate is generally ambiguous.

For the subset of private equity firms that embrace ESG objectives in their investment policy, we expect their prosocial preference to reinforce their profit motive to bring about more significant reductions in the heat rate. Furthermore, it is likely that they are more willing to spend resources on improving emission control, which leads to further reductions in emission intensities via lower input emission rates.

III. Data and Summary Statistics

A. Sample Construction

1. Power Plant Emissions and Operating Data

We obtain the annual emissions and operating data of U.S. fossil fuel power plants from the Clean Air Markets Division (CAMD) of the EPA. Title 40 Code of Federal Regulations Part 75 established requirements for large electricity generating units with nameplate capacity greater than 25 MW burning fossil fuel(s) for sale to continuously measure emissions and report them, along with operating data, to the EPA. The EPA and state agencies use these data to assess compliance with emission trading programs and other air quality programs. These data, collectively referred to as CAMD's Power Sector Emissions Data, are publicly available on the EPA website.

The CAMD data are at the electricity generating unit (EGU) level. An EGU is a combination of one or more generators and associated apparatus within a power plant for which input, output, and emissions can be separately metered. An average power plant (or facility) in our sample has three EGUs. The key data items include the raw quantities of carbon dioxide (CO_2), sulfur dioxide (SO_2), and nitrogen oxides (NO_x) emissions; heat input; electricity generated (referred to as Gross Load in the database); and the owner and primary fuel type(s) of each unit.[6] We exclude unit-years with

---

[6] Coal-fired EGUs are also required to report mercury emissions. We do not include mercury emissions

missing emissions or electricity output data (including those with a recorded quantity of zero). Most observations with missing electricity data are about units generating steam instead of electricity. A very small number of units generate simultaneously both steam and electricity. We exclude those units as well to maintain the homogeneity of output.

While we do most of our analysis at the EGU level, we also conduct some analysis at the plant level, and our matching of the acquired and control plants is based on plant-level data. We aggregate the data from the EGU to the plant level using the facility ID associated with each EGU. We exclude plant-years with aggregate electricity output less than 1 GWh. We record plant ownership at the year-end and exclude units/plants with multiple owners at a given time (about 6% of the observations).[7] Since the name of the same plant owner may be recorded slightly differently in different years, we manually create an owner ID that is consistent across years. Although the emission data are available from 1995 to 2021, the ownership information is only available since 2003. Thus, our sample period is from 2003 to 2021.

Our final sample includes 4,181 unique EGUs in 1,340 plants owned by 1,007 owners, with a total of 56,575 annual observations. In 2021, the gross electricity generation by the plants in our sample is 2.04 million GWh. According to U.S. Energy Information Administration (2022), the net electricity generation (i.e., generation excluding electricity used for power plant operations) from fossil fuels was 2.51 million GWh in 2021. Assuming a commonly-used net-to-gross electricity generation ratio of 0.98, our sample covers 80% of the U.S. electricity generation from fossil fuels in 2021.

---

in our analysis because this item is only widely available for years after 2017.

[7] When a unit/plant has multiple owners, it is not clear to what extent the control shifts to the acquirer when only one of them is bought out. Therefore, we exclude those observations from our sample.

2. Power Plant Financial Data

We obtain limited plant-level financial data for a subset of plants from Form EIA-923 filings available from the EIA website. Starting from 2008, EIA-923 contains (in Schedule 2) transaction-level data on fuel costs, which include all costs incurred in the purchase and delivery of the fuel to the plant. Thermoelectric power plants with a total steam turbine capacity of 100 megawatts or greater are also required to report (in Schedule 8) the total operation and maintenance (O&M) expenditures associated with collection and disposal of combustion by-products (such as fly and bottom ash) and related pollution abatement activities. These plants are also required to report annual capital expenditures on pollution abatement, such as the expenditures on new structures and/or equipment purchased to reduce, monitor, or eliminate airborne or waterborne pollutants. Starting in 2011, non-utility power plants, defined as plants that, instead of selling electricity at regulated rates, sell electricity in wholesale markets or directly to consumers at market prices, are required to report quantity and revenues of electricity sales in wholesale markets. This allows us to calculate the electricity wholesale price for such plants.

3. Private Equity Buyout Data

We construct our sample of power plants bought out by private equity using the December 2021 version of the PitchBook database. We focus on the completed Buyout/LBO deals in the Private Equity deal class where the target firm is headquartered in the U.S. We first match the target companies to plant owners by name using a fuzzy matching algorithm. We then manually check the algorithm-generated matches to identify the correct matches, using deal- and plant-related information gathered from both databases and the internet. We read the PitchBook deal synopses and related news articles from the internet to identify the plant(s) sold in each deal, as some deals may include only a subset of an owner's plants. A plant can be bought by a private equity firm and sold to another multiple times. To examine the private equity treatment effect, we focus on a plant's first buyout deal in our baseline analysis, as the effect of subsequent ones is likely diminished. For comparison, we also collect data on the subsequent buyout deals, referred to as secondary buyouts (SBOs).

Among the 1,340 power plants in our emission sample, we identify 137 that are bought out by private equity for the first time, through 80 deals involving 90 plant owners. Figure 1 shows the breakdown of the number of such deals by year. The first deal occurred in 2003, which coincides with the start year of our emission data.[8] We also identify 22 secondary buyout deals involving 30 plants.

[**Insert Figure 1 About Here**]

4. Mergers and Acquisitions Data

To compare the private equity-backed buyout deals with mergers and acquisitions (M&As) deals not backed by private equity, we construct a sample of power plants acquired by non-private equity firms using the M&A database from PitchBook. Because PitchBook's coverage of M&A deals is not as complete as their coverage of private equity buyout deals, we supplement it with the M&A database from the S&P Capital IQ. To avoid confounding the effect of PE buyout with mergers, we require that merger deals do not occur within 5 years before or after a private equity buyout. We also require that at least 50% of the target's ownership share is acquired by the acquirers

---

[8] There were a few power plant owners bought out by private equity before 2003 according to PitchBook, but none of those acquired owners owned a plant in our sample of emission data.

and that the deal is recorded as being completed. Using the procedures described above, we identify a total of 66 unique M&A deals involving 111 power plants in our sample.

B. Variables and Summary Statistics

The EGU electricity generation capacity is measured in Megawatts (MW). It represents the maximum electricity output an EGU is capable of producing on a steady state basis. The capacity factor is a measure of an EGU's actual utilization relative to its full capacity. The raw emission quantities are measured in short tons, the heat input in million British thermal units (MMBtu), and the electricity output in megawatt hours (MWh). We convert them into metric tons, billion British thermal units (BBtu), and gigawatt hours (GWh), respectively.[9] We scale the emissions by electricity produced to obtain our output emission rates $\mathrm{CO_2/E}$, $\mathrm{SO_2/E}$, and $\mathrm{NO_x/E}$, measured in kilograms (kg) per MWh. We scale the emissions by heat input to obtain our input emission rates $\mathrm{CO_2/H}$, $\mathrm{SO_2/H}$, and $\mathrm{NO_x/H}$, measured in kilograms per MMBtu. We also scale the heat input by the electricity produced to obtain the heat rate H/E, expressed in MMBtu per MWh (or equivalently, Btu/Wh). Because the emission rates and heat rate variables are highly skewed, we take the natural log of them in most of our analysis. One additional advantage of using the log rates is that it allows an additive decomposition of the output emission rate, as shown in Equation (2). We also use the raw emission and heat rates in some of our analysis, in which case the rates are winsorized at the 1st and 99th percentiles to mitigate the effect of outliers.

We sum the input, output and emissions across EGUs to obtain quantities at the plant level and calculate the plant-level ratios accordingly. We measure the plant age by

---

[9] One megawatthour is equal to 1,000 kilowatthours (kWh). According to the EIA, the average annual electricity consumption for a U.S. residential utility customer was 10,632 kWh in 2021. One British thermal unit is defined as the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit.

the number of years since the start of commercial operation (based on the earliest start date across all EGUs in the plant). We drop the first operation year of each plant, as it is generally not a full year. We do not drop the first operation year of EGUs subsequently added to an existing plant, as such additions represent a plant expansion.

Fuel costs reported in Form EIA-923 are expressed in cents per MMBtu of heat content. The number of plants reporting at least some transaction-level fuel cost data varies from over 700 in 2008 to over 500 in 2021. Many plants report the quantity of each fuel purchase but not the cost. To expand the sample coverage, we first estimate the average cost per MMBtu of each fuel type in each year using all transactions with non-missing cost data, weighted by heat contents obtained in each transaction. We then calculate the average fuel cost per MMBtu at the plant-year level, also weighted by heat content obtained in each transaction, using the imputed fuel cost per MMBtu when necessary.[10] We multiply the fuel cost per MMBtu by the heat rate to obtain fuel cost per MWh electricity generated.

Similarly, we normalize the annual O&M and capital expenditures related to pollution abatement by electricity generated. We set these expenditures to zero for plants that file Schedule 8 of Form EIA-923 but do not report such expenditures, and treat them as missing for plants that do not file this schedule in a given year. For plants with revenues from electricity sales in wholesale markets, we calculate the electricity price by dividing the revenues by the sale volume. All financial variables are expressed in dollars per MWh.

[Insert Table 1 About Here]

---

[10] Fuel is classified into 17 types in Form EIA-923. This granular classification allows us to impute missing fuel costs accurately. At the plant-year level, the correlation between average fuel costs calculated using imputed data and actual data, when both are available, is 0.90. About 43% of fuel cost observations at the plant-year level are imputed in our sample.

Table A.1 summarizes the variable definitions. Panels A and B of Table 1 show the summary statistics at the EGU and plant levels, respectively. The average plant in our sample produces 1,988 GWh of electricity annually, with the largest producing 25,400 GWh. The average plant is 27 years old, with the oldest one being 86 years old. 73% of EGUs use natural gas as the primary fuel, 21% use coal, and only 6% use oil.

IV. Empirical Methodology

Following Gormley and Matsa (2011), Fracassi, Previtero, and Sheen (2022), and Sheen, Wu, and Yuan (2025), we run stacked DiD regressions using matched samples to analyze the private equity buyout effect on emissions. Recent studies (e.g., Baker, Larcker, and Wang (2022)) show that this method can estimate the treatment effect efficiently while circumventing the problems introduced by staggered treatment timing and treatment effect heterogeneity. We acknowledge that our approach does not fully resolve selection concerns arising from unobservables.

A. Stacked DiD Regressions

We match each private equity-acquired plant to a control plant based on year, state, primary fuel type, and a Mahalanobis distance measure (explained below). Each pair of matched treated and control plants forms a cohort, and all cohorts are stacked together for the DiD regressions. The baseline specification for our EGU-level regressions is:

$$(3) \qquad y_{i,j,c,t} = \beta Buyout_{j,c} \times Post_{t,c} + \gamma Controls_{i,j,c,t} + \lambda_{j,c} + \sigma_{t,c} + \epsilon_{i,j,c,t},$$

where $y_{i,j,c,t}$ is the outcome variable for EGU i of plant j belonging to cohort c in year t; $Buyout_{j,c}$ and $Post_{t,c}$ are dummy variables indicating the acquired plants and post-buyout years (after the year 0), respectively; $\lambda_{j,c}$ and $\sigma_{t,c}$ are terms capturing plant and year fixed effects within each cohort, respectively. The plant-cohort fixed effects term $\lambda_{j,c}$ captures the difference in the outcome variables between the treated and control plants due to time-invariant plant characteristics within a cohort, while the year-cohort fixed effects term $\sigma_{t,c}$ captures the common variation within each year of a cohort. The main outcome variables of interest include the output and input emission rates and the heat rate. We cluster the standard errors by plant owner. If private equity buyout leads to a decline in an outcome variable, the coefficient on the interaction term $Buyout \times Post$, β, should be significantly negative. Note that the dummy variables *Buyout* and *Post* themselves are subsumed because we control for both plant-cohort and year-cohort fixed effects. Considering the typical holding period of the private equity firms, we adopt an 11-year buyout event window for our baseline analysis, from five years before to five years after the event year (i.e., year 0).

We run similar regressions using the plant-level data, with the observations weighted by the number of EGUs that a plant has.

B. Matching

The stacked DiD regressions identify the treatment effect only if the control group and the treatment group follow parallel trends. This assumption is more likely to hold if the two groups are observably similar. The purpose of the matching procedure is to construct a sample of control plants that are as close as possible to those that are acquired by private equity based on observables.

The pool of potential control plants includes all plants that have never been acquired by private equity. To avoid potential contaminating effects caused by other merger events, we also exclude plants that are acquired by non-private equity firms during our sample period from this pool. We require the control and treated plants to be located in the same state because emissions may be affected by state-specific emission and energy policies. We also require them to use the same type of primary fuel because technologies may progress at different paces for different fuel types. Among the plants that satisfy these conditions, we select (with replacement) for each acquired plant a control plant based on the shortest Mahalanobis distance. This distance measure accounts for covariance among the matching variables, and it is calculated using plant characteristics observed in the year before the buyout.

To determine the selection of variables used in the calculation of the distance measure, and to shed light on private equity firms' motives in acquiring power plants, we estimate several linear probability models to examine private equity's choice of buyout targets using annual plant-level data. The dependent variable equals one if a plant is bought out by private equity in a given year and zero otherwise. All explanatory variables are lagged by one year. Since we are interested in the first buyout deal of each target plant, we drop the observations after a plant is bought out by a private equity firm for the first time (i.e., we do not model the probability that an acquired plant is subsequently bought out by another private equity firm). We control for year fixed effects in all models and cluster the standard errors by plant owner.

[Insert Table 2 About Here]

Table 2 shows the estimation results for eight model specifications. In the first five specifications, we consider only explanatory variables available in the CAMD database, including the log output emission rates of CO_2, SO_2, and NO_x, log heat rate, log plant age and log nameplate capacity, capacity factor, and three primary fuel dummies (with Other being the base group). The results consistently show that the buyout probability is negatively related to log plant age and positively related to log capacity, suggesting that private equity is more interested in new and large plants. This does not support the idea that private equity extends the lifespan of old fossil plants by buying those plants from incumbents. None of the output emission rates are significantly related to the buyout probability, irrespective of whether they enter the model jointly (column 1) or separately (columns 2 to 5). Nor is the heat rate or the capacity factor.[11] These results suggest that private equity does not filter targets by emission intensities of environmentally harmful gases, nor does it target plants struggling with low efficiency.

Andonov and Rauh (2024) find that ownership changes are more frequent in deregulated than in regulated electricity markets. Their broadest measure of whether a market is deregulated is a dummy variable indicating whether it is operated by an Independent System Operator (ISO) serving as a balancing authority. Consistent with their finding, column 6 shows that the ISO dummy positively predicts private equity buyout.[12] In columns 7 and 8, we further examine whether financial variables, including fuel costs, O&M and capital expenditures related to pollution abatement, affect the buyout probability. Column 8 shows that buyout probability is negatively related to expenditures on pollution abatement. This result should be interpreted with caution, as the sample size decreases by almost two-thirds upon the inclusion of these variables.

The full-sample results in columns 1 to 5 of Table 2 suggest that the treatment and control groups in our DiD analysis should be matched on log plant age and log capacity. Columns 6 and 8 suggest that one may also consider matching on whether a

---

[11] We find similar results using input instead of output emission rates as the explanatory variables.

[12] We thank Aleksandar Andonov for generously sharing with us the data on this classification. The data are at the plant level on a monthly basis from 2005 to 2020. We use the annualized version based on observations in December of each year.

plant operates under the ISO regime and on pollution abatement expenditures; however, doing so would result in a smaller sample for our DiD analysis. Therefore, we do not include these variables in our baseline matching scheme.[13] To enhance the comparability, we also consider the capacity factor, the logarithm of the average heat rate and the average change in the log heat rate in the years (up to three) prior to the buyout in our distance measure. The heat rate not only measures a plant's thermal efficiency, but also indirectly captures a plant's emission intensity, as it is positively related to output emission rates of all gas types. We require both the treated and control firms to have data at least in the two years before the buyout and in the first year after the buyout. 105 acquired plants satisfy this requirement, and 102 of them are successfully matched.

[**Insert Table 3 About Here**]

Table 3 presents the comparison of the treatment and control groups in the year before the buyout for 102 acquired plants that are successfully matched based on our criteria, each on average with three EGUs. It shows that the two groups are comparable in all potentially relevant dimensions that are observable. None of the variables shows a statistically significant difference between the two samples. This provides the foundation for our match-based DiD analysis.

V. Private Equity Buyout Effect: Baseline Results

In this section, we present the baseline results on the effects of private equity buyouts on power plant gas emission rates and production efficiency.

---

[13] In Table 12, we show that our results are robust to various alternative matching criteria.

A. Baseline Stacked DiD Regression Results

Table 4 shows the results of the baseline stacked DiD regressions at the EGU level. In Panel A, we use the logarithms of output emission rates (columns 1 to 3), heat rate (column 4) and input emission rates (columns 5 to 7) as the dependent variables. In Panel B, we use the winsorized raw rates as the dependent variables. We include the log EGU age, which is unlikely to be affected by the buyout, as a control variable.

[Insert Table 4 About Here]

The first three columns of Panel A show that the log output emission rates of both CO_2 and NO_x decrease significantly after the private equity buyout. The DiD coefficient on the interaction term $Post \times Buyout$ is -0.042 (with a t-statistic of -3.44) in column 1, suggesting that buyouts on average lead to a decline of the CO_2 output emission rate by 4.2%.[14] Similarly, the estimate of the same coefficient in column 3 suggests that buyouts on average lead to a 9.0% decline in the NO_x output emission rate (with a t-statistic of -2.53). Given the large volumes of total emissions of these gases in the power sector, the economic magnitudes of these estimates are significant. The estimate of the DiD coefficient for the log output emission rate of SO_2 is statistically insignificant.

Instead of changes in percent, we can also assess the economic magnitudes of these effects in terms of the standard deviations. The standard deviations of $\ln(CO_2/E)$ and $\ln(NO_x/E)$ are 0.36 and 1.43, respectively, in the full sample. The coefficient estimates above suggest that the declines in $\ln(CO_2/E)$ and $\ln(NO_x/E)$ are equivalent to 0.12 and 0.06 standard deviations of these variables, respectively.

---

[14] More precisely, the decline is 4.1% ($=e^{-0.042}-1$). For simplicity, we interpret the effect in log points as percent change throughout the paper, as the differences are small for our coefficient estimates.

Equation (2) implies that the decline in the log output emission rate is the sum of the declines in the log heat rate and log input emission rate. Columns 4 to 7 show that private equity buyouts on average lead to a decline of the heat rate by 4.0% (with a t-statistic of 3.38), but they have no statistically significant effect on any of the input emission rates. The post-buyout decline in output-scaled CO_2 emissions is almost entirely due to lower heat input required for each unit of electricity output. While the decline in the input emission rate of NO_x also contributes to the reduced output emission rate of NO_x, this decline itself is statistically insignificant. Thus, the post-buyout improvements in environmental performance are mainly due to increased production efficiency instead of more effective emission control measures. This supports the hypothesis we propose in Section II, and it is consistent with the profit motive of private equity firms: Private equity buyouts improve the efficiency (profit-boosting) component of acquired plants' environmental performance, but they have no statistically significant effect on the non-efficiency (profit-draining) component.

Panel B of Table 4 shows similar results in terms of the raw emission rates and heat rate. The point estimates in columns 1 and 3 suggest that buyouts, on average, are followed by declines in CO_2 and NO_x emissions by 22.009kg and 0.079kg, respectively, for each MWh of electricity produced. Column 4 shows that buyouts are associated with a decline of the heat input by 0.358 MMBtu per MWh. These numbers are equivalent to 10%, 9%, and 16% of the standard deviations of the corresponding variables in the full sample, which further suggests that the buyout effect is economically large. The buyout effects on the raw input emission rates are more mixed: the coefficient estimates are insignificant for CO_2, positive with marginal significance for SO_2, and negative at the 5% significance level for NO_x.

B. Pre-trends and Treatment Effect Dynamics

The key identifying assumption for our DiD analysis is that the outcome variables for both the treated and control plants follow parallel trends in the absence of the buyout. To test whether this assumption holds for the pre-buyout years and to examine the dynamics of the buyout effect, we modify Equation (3) to allow the coefficient on the interaction term to vary across the event-time years. Specifically, we create a dummy variable for each event-time year in the 11-year window and replace the interaction term in (3) with the interactions of the Buyout dummy with all the event-time year dummies. That is, we estimate the following generalized DiD model:

$$y_{i,j,c,t} = \sum_{\tau} \beta_{\tau} Buyout_{j,c} \times T_{\tau,c} + \lambda ln(Age)_{i,j,c,t} + \delta_{t,c} + \theta_{i,c} + \varepsilon_{i,c,t}, \tag{4}$$

where $T_{\tau,c}$ is a dummy variable that equals 1 for observations in year τ relative to the buyout year and zero for all others, with $\tau \in \{-5, ..., 5\} \backslash \{-1\}$. We use the year $\tau = -1$ as the base year.

[Insert Figure 2 About Here]

We plot the coefficients on the interaction terms in Figure 2 for the models of the output emission rates and heat rate. All four panels in the figure show that the coefficients for the pre-buyout years are largely flat, supporting the parallel trend assumption and our empirical design. Panels A and D show significant declines in ln(CO_2/E) and ln(H/E) starting from the first year after the buyout. Panel B shows a temporary drop in ln(SO_2/E) in the first two post-buyout years, which was reversed subsequently. Panel C shows a steady decline in ln(NO_x/E) starting from the buyout year. These patterns are consistent with the results reported in Table 4.

C. Comparison with M&As and SBOs

To examine whether the effects we find in Table 4 are specific to private equity-backed buyouts, we compare them with the effects of M&A deals not backed by private equity. Applying the same method that we use to identify control plants for the private equity-acquired plants, we identify 77 pairs of treatment and control plants for the M&A deals. We combine the stacked buyout and M&A samples to run stacked DiD regressions jointly at the EGU level. We extend the model specification (3) to include an additional interaction term: $Post \times M\&A$, where $Post$ is a dummy that equals one for post-buyout or post-M&A years and zero for other years, and $M\&A$ is a dummy that equals one for target plants and zero for control plants.

[Insert Table 5 About Here]

Panel A in Table 5 shows the regression results. While the buyout effects are largely the same as our baseline estimates, both qualitatively and quantitatively, we find no significant M&A effect on any of the outcome variables. The coefficients on $Post \times M\&A$ are insignificant in all columns. This suggests that M&As not backed by private equity do not bring the same operational and environmental benefits as do private equity-backed buyout deals. The table also reports the F-statistics and p-values for the F-tests of the null hypothesis that the coefficients on $Post \times Buyout$ and $Post \times M\&A$ are equal. They suggest that the differences between PE buyout and M&A effects on the heat rate, NO_x output and input emission rate are statistically significant at the 5% level.

Our analysis so far focuses on the effect of the first private equity buyout of each target plant. To compare it with the effect of secondary private equity buyouts, we extend our analysis to include SBO deals. Applying the same matching procedure described in Subsection IV.B, we identify 29 pairs of SBO treatment and control plants. We add EGUs of those plants to the baseline DiD sample and run regressions similar to those in Panel A of Table 5. The results, presented in Panel B, show that SBOs have no significant effect on either the heat rate or emission rates. The F-tests show that, in terms of the effects on the heat rate and the CO_2 output emission rate, the difference between first buyouts and SBOs is statistically significant at the 1% level. This suggests that positive effects of private equity ownership are concentrated in first buyouts.

D. Stacked DiD Regressions at the Plant Level

While we focus primarily on the EGU-level data in our analysis, which provide more power due to the larger number of observations, we perform a similar analysis using the plant-level data. Because financial variables are observed at the plant level, we examine the effect of private equity buyouts on financial variables only at the plant level. To account for the higher importance of larger plants, we weight the observations by the number of EGUs that a plant has.

[Insert Table 6 About Here]

The results from the plant-level stacked DiD regressions are presented in Table 6. Panel A shows the estimates from the baseline model specification. Consistent with the EGU-level baseline results, there are statistically significant drops in both the CO_2 output emission rate and heat rate after the buyout. The magnitudes of these drops are very close to each other (3.6% and 3.4%, respectively), suggesting that the drop in the CO_2 output emission is almost fully due to the improvement in production efficiency. The effect on the NO_x output emission rate is also very similar to what we estimate using the EGU-level data, with a post-buyout drop of 8.7%.

Panel B shows the buyout effect on financial performance. Consistent with the post-buyout reduction in the heat rate, fuel costs per MWh drop significantly by 7.3%. This is about twice the reduction in the heat rate at the plant level. It suggests that private equity ownership reduces fuel costs not only through improvement in production efficiency, but also through cost savings in fuel procurement, potentially because of improved fuel sourcing decisions or stronger bargaining power against suppliers.[15]

Columns 2 to 4 show that private equity ownership does not significantly alter O&M and capital expenditures on pollution abatement per MWh. This is consistent with our baseline result that buyouts have no significant effect on input emission rates. While spending on emission control is environmentally beneficial, it is privately costly for the owners. Therefore, private equity firms in general do not have strong incentives to increase such spending. The last column shows that private equity buyouts do not have a significant effect on power plants' wholesale price of electricity, potentially because of the competitiveness of the wholesale markets. However, this result should be interpreted with caution due to the small sample size.

VI. Exploring the Mechanism

We now explore the mechanism underlying the private equity buyout effects documented in the last section. We first present a set of cross-sectional results and then examine the roles of within-EGU improvements versus changes in the EGU composition. We also examine the buyout effects on other aspects of plant operations that can potentially affect gas emission rates.

---

[15] When we run the same regression using only non-imputed fuel costs, the effect is even stronger: the fuel costs per MWh declines by 22.9% after the buyout, statistically significant at the 10% level (with a t-statistic of -2.02). However, the number of observations drops from 1144 to 136. Therefore, this estimate should be interpreted with caution.

A. The Role of Private Equity Firms' ESG Preferences

Given the active role played by private equity firms in the operations of their portfolio companies, we expect the post-buyout reductions in harmful gas emissions to be strongly influenced by the deal-backing private equity firms' attitudes toward ESG. One way to measure a firm's ESG attitude is to use its stated investment preferences. PitchBook records such preferences for each investor in its database in a variable called "other stated preferences," which includes contents such as "Prefers majority stake," "Will lead on a deal," "Seeks ESG investments," "Seeks Impact investments," etc. We use this information to determine whether a deal is backed by pro-ESG private equity.

Specifically, we classify a private equity investor as pro-ESG if its "other stated preferences" include "Seeks ESG investments" or "Seeks Impact investments."[16] About 30% of deals in our sample have more than one private equity investor. In such cases, if one of them is designated as the lead investor, we classify the deal based on the preferences of the lead investor; otherwise, we classify it as backed by pro-ESG private equity if more than 50% of private equity firms in the deal are pro-ESG. Based on this classification scheme, 34 of the 102 acquired plants used in the stacked DiD analysis are acquired by pro-ESG private equity. The rest are acquired by non-ESG private equity.[17] If private equity firms are truly committed to their stated preference for ESG, then we should expect plants acquired by pro-ESG private equity to exhibit more significant post-buyout emission reductions. In contrast, if private equity firms use the stated ESG preference just for greenwashing, then there will be no difference.

To test which scenario is supported by the data, we extend our baseline model

---

[16] We exclude a small number of investors that are neither a private equity firm nor a private equity-backed firm.

[17] Among the 34, 7 are acquired by investors with a stated preference for Impact investment.

by adding a triple interaction term $Post \times Buyout \times ESG$, with ESG being a cohort-level dummy variable indicating deals backed by pro-ESG private equity.[18] The results are reported in Panel A of Table 7. The coefficient estimates on $Post \times Buyout$ are significantly negative in columns 1 and 4. They show that buyouts backed by non-ESG private equity are followed by a decline in CO_2 output emission rate by 2.7%, which is almost entirely explained by the 2.6% decline in heat rate. Interestingly, the reductions are significantly stronger for deals backed by pro-ESG private equity. The significantly negative coefficient estimates on $Post \times Buyout \times ESG$ in columns 1 and 4, combined with those on $Post \times Buyout$, suggest that buyouts backed by pro-ESG private equity reduce the CO_2 output emission rate and the heat rate by 7.9% and 7.5%, respectively. This is consistent with our hypothesis that a pro-ESG preference brings further incentive to improve production efficiency beyond the profit motive.

[Insert Table 7 About Here]

More remarkably, while buyouts backed by non-ESG private equity have no significant relation with any input emission rate, those backed by pro-ESG private equity are followed by a significant decline of 16.6% in NO_x input emission rate. Combined with the decline in the heat rate, the NO_x output emission rate declines by 24.1% for plants bought out by pro-ESG private equity. This suggests that pro-ESG private equity firms generate more significant environmental benefits not only through more significant production efficiency increases, but also through improvements in emission control. Thus, the pro-ESG preference stated by private equity firms appears to be a credible commitment instead of a greenwashing tool.

---

[18] Like the variables *Post* and *Buyout*, the variables ESG, $ESG \times Post$, $ESG \times Buyout$ are subsumed in the triple DiD regressions.

In Panel B, we extend this analysis to SBO deals. Given the stronger effect of deals backed by pro-ESG private equity, a plant's performance may improve after it is acquired by a pro-ESG private equity firm from a non-ESG one. For each SBO deal, we create a dummy variable that equals one if it is backed by pro-ESG private equity and the prior acquirers of the target plant are non-ESG private equity firms. The results show that while SBOs backed by non-ESG private equity have no significant effect, those backed by pro-ESG private equity are associated with a significantly stronger improvement in CO_2 output emission rate, and the difference is statistically significant at the 5% level.[19] This further suggests that ESG preferences of private equity firms matter for the environmental performance of deals they back.

We also examine whether deals backed by pro-ESG and non-ESG private equity have different effects on financial variables. The results, reported in Table IA1 in the Online Appendix, do not show any significant difference.

One may wonder whether pro-ESG and non-ESG private equity firms choose different buyout targets. To shed light on this question, we estimate two multinomial logistic models in which the outcome variable is 1 (2) if a plant is bought out for the first time in a deal backed by non-ESG (pro-ESG) private equity in a given year, and 0 otherwise. The results are reported in Table IA2 in the Online Appendix. The more parsimonious model, which contains no financial variables, shows that non-ESG private equity firms target newer and larger power plants, while pro-ESG ones do not. As we show later in Panel A of Table 9, the buyout effect is stronger for larger plants. Therefore, the stronger effect of deals backed by pro-ESG private equity cannot be explained by this difference in the choice of target plants between pro-ESG and

---

[19] The sum of the coefficients on $Post \times SBO$ and $Post \times SBO \times ESG$ shows that the latter type of SBOs is associated with a decline in the CO_2 input emission rate by 0.6%, statistically significant at the 10% level.

non-ESG private equity. The extended model, which includes financial variables and is estimated on a significantly smaller sample, shows that pro-ESG private equity shows a preference for power plants operating at a higher capacity factor while non-ESG private equity does not.

Since pro-ESG private equity firms tend to be larger, one may wonder whether the difference reported above is due to differences between large/experienced and small/young private equity firms. To test this possibility, we split the sample into two based on the size/experience of the lead private equity investor relative to the median. We measure size/experience by the number of deals a firm has participated in by the year of each deal in our sample. The result does not support this conjecture. If anything, they show that improvements in environmental performance are less significant in deals led by large/experienced private equity firms.

B. The Role of Regulatory and Social Environments

Power plants in the U.S. operate in two distinct regulatory and market environments: ISO (Independent System Operator) and non-ISO regimes. These regimes represent different approaches to managing and operating electrical grids and electricity markets. In the ISO system, the transmission grid and the flow of electricity over the networks are controlled by entities separate from power generation (i.e., ISOs). In contrast, in the Non-ISO regime, the generation, transmission, and distribution of electricity are typically managed by vertically integrated utilities. ISOs were created following the adoption of the Energy Policy Act of 1992 and the issuance of Federal Energy Regulatory Commission Orders 888 and 889 in 1996, which opened wholesale electricity markets to competition. Markets are generally more competitive in the ISO regime than in the non-ISO regime (see Cicala (2022) for more detailed descriptions).

The coexistence of the two regimes allows us to examine the variation of the buyout effect across regulatory and market environments.

[Insert Table 8 About Here]

To explore this variation, we extend our baseline model (3) to include a triple interaction term $Post \times Buyout \times ISO$, with ISO being a cohort-level dummy variable that equals one if the acquired plant operates in an ISO regime in the year prior to the buyout.[20] We report this set of triple DiD results in Panel A of Table 8. Columns 1 and 4 show that the post-buyout decrease in CO_2 emission intensity and improvement in production efficiency are concentrated in plants operating in the ISO regime. This is consistent with the finding in the literature that private equity tends to have more positive effects in markets that are more competitive (Sorensen and Yasuda (2023)). Columns 5 and 7 show post-buyout declines in CO_2 and NO_x input emissions for non-ISO plants, but the effects are only statistically significant at the 10% level.

The buyout effect may also differ under different social environments. In a state with strong public support for environment protection and emission control, private equity firms may face more pressure to improve environmental performance. To test this conjecture, we use two survey results to gauge the strength of public support for government intervention and regulation on environment protection. The first is the 2020 Climate Insights survey conducted by researchers at Stanford University, Resources for the Future, and ReconMR (see Tyson, Funk, and Kennedy (2020)). The second is the 2014 Religious Landscape Survey conducted by the Pew Research Center (see Pew Research Center (2016)).[21] Both surveys break down the opinions of

---

[20] Based on the data generously shared with us by Aleksandar Andonov, 80 (20) acquired plants in our sample operated under the ISO (non-ISO) regime prior to the buyout, 2 have missing information.

[21] We thank an anonymous referee for recommending us to explore geographic variation in the buyout effects using these survey results.

respondents by state. The first survey includes a question directly related to our study, asking the respondents whether they believe the government should take action to lower power plant gas emissions. The second includes a question asking respondents whether they believe “stricter environmental laws and regulations are worth the cost.” We use the fraction of respondents providing an affirmative answer to these questions to measure public opinions in a state. We create a cohort-level dummy variable LowerEmi (StricterReg) that equals one if an acquired plant is located in a state where the fraction of respondents answering “yes” to the first (second) question is above the median across states. We extend the baseline model to include a three-way interaction term to capture the differential buyout effect under different social environments.

The results in Panel B of Table 8 show that in states where the public support for government action in lowering power plant emissions is stronger than the median, the post-buyout reductions in the heat rate and NO_x input emission rate are more significant, resulting in more significant improvement in output emission rates of CO_2 and NO_x. The results in Panel C show that the buyout effects on NO_x input and output emission rates also differ between states differing in public support for stricter environmental regulations, but the differences are only marginally significant at the 10% level. These results suggest that the environmentally beneficial effect of private equity buyouts is stronger in states in which the public shows strong interest in lowering power plant emissions. Public opinion on environmental regulations in general also matters, but to a lesser extent.

To verify whether the responses to the two survey questions indeed capture some underlying differences in social and regulatory environments, we run panel regressions to examine the power plant performance differences between states classified as above using the full sample of the plant-level data.[22] The results are reported in Table IA4 in the Online Appendix. While no significant difference in production efficiency is observed, input emission rates are lower in states with strong public support for government action in lowering power plant emissions or stricter environmental regulations. The differences are statistically significant for CO_2 and NO_x. The differences in SO_2 input emission rate are statistically insignificant, but the economic magnitudes of the coefficient estimates are even larger (-0.563 on the dummy variable LowerEmi and -0.641 on StricterReg). Obviously, one cannot draw causal claims from these results; however, they do suggest that the survey responses reflect some genuine differences across states.

C. Other Cross-sectional Patterns in the Buyout Effect

We next explore the heterogeneity in the buyout effect along other dimensions.

1. High vs. Low Plant Capacity

The post-buyout improvements in operational and environmental performance likely depend on private equity firms' attention and focus. With limited attention, private equity firms are more likely to focus on plants with large capacity, as they are more important drivers of their portfolio performance. Large plants are also likely to attract more public attention and regulatory scrutiny. We therefore expect the private equity buyout effect to be stronger among large plants. We test this conjecture by splitting the sample for the stacked DiD analysis into two groups based on whether the nameplate electricity generation capacity of the acquired plant is above the median of all acquired plants in the year prior to the buyout. The results from the triple DiD

---

[22] Some observations drop out due to missing survey data in several states.

regressions, reported in panel A of Table 9, are consistent with our conjecture. The buyout effects are concentrated in plants with above-median capacity. None of the coefficient estimates on *Post* × *Buyout* is significant, suggesting no buyout effect for plants with below-median capacity.

[**Insert Table 9 About Here**]

2. Corporate Divestiture Deals vs. Non-divestiture Deals

The buyout effects may also depend on the financial situation and objective of plant sellers. One example is plants acquired through corporate divestiture deals. A divestiture is the disposal of some assets or business units by a company. This often occurs when a business unit is no longer viewed as core competency or when a company is in financial distress. In either case, the company is unlikely to invest much in the unit before it is disposed. Therefore, we expect the private equity buyout effect to be greater for plants acquired by private equity through corporate divestiture deals. To test this hypothesis, we extend the baseline specification (3) by adding a three-way interaction term, *Post* × *Buyout* × *Divestiture*, where *Divestiture* is a dummy variable that equals one for cohorts with a plant acquired in a divestiture deal (47 of the 102 acquired plants fall into this category). The results from the triple DiD regressions are presented in Panel B of Table 8. The coefficient estimates on the three-way interaction term are significantly negative in columns 1, 4, and 5, suggesting a stronger buyout effect following a divestiture deal.

3. Long vs. Short Holding Periods

Investments in efficiency improvements and emission reductions are not only financially costly, but also take time. This suggests that post-buyout improvements in production efficiency and environmental performance may depend on how long a power plant is held by the acquiring private equity firm. To test this possibility, we examine the exit date of the acquiring private equity firm based on subsequent deals captured in the Pitchbook database. We calculate the duration of the holding period based on the exit date and the acquisition date, and we create a cohort-level dummy Long (Short) that equals one if the holding period is longer (shorter) than four years.[23] Consistent with the conjecture, the results in Panel C of Table 9 show that post-buyout improvements are concentrated in plants held by the acquiring private equity firm for more than four years.[24]

4. Difference in Exit Channels

Given the heterogeneity in the buyout effect, it would be interesting to see how the post-buyout changes in production efficiency and environmental performance are related to the exit outcome. Unfortunately, the financial information for power plant deals is limited and the transaction values are generally undisclosed. Nevertheless, we are able to classify the exit channel based on the subsequent deals covered by Pitchbook. The two most common exit channels are M&As and SBOs. To examine whether the buyout effects are different between these two exit channels, we create two cohort-level dummy variables, ExitM&A and ExitSBO, to indicate cohorts in which the

---

[23] Based on this classification, the holding period is long for 16 acquired plants and short for 18 plants.

[24] We thank an anonymous referee for suggesting this test.

private equity firm exits through an SBO and M&A, respectively.[25] To ensure that the post-buyout performance is not affected by the subsequent acquirers, if the exit occurs within the five-year post-buyout window, we include the observations only up to the year of the exit. Panel D of Table 9 shows that power plants exited via an M&A show a significant post-buyout reduction in the heat rate, potentially because the improvement in production efficiency makes the plant more attractive to other firms in the electricity industry. In contrast, plants exited via an SBO show no significant buyout effect on the heat rate and mixed effects on input emission rates: the CO_2 and NO_x input emission rate decline significantly while the SO_2 input emission rate increases significantly.

Given the concern about the lack of transparency in firms owned by private equity, we have also examined whether buyout effects are different between public-to-private deals and private-to-private deals. Among the 102 acquired plants, 22 are bought out through public-to-private deals. The rest are bought out through private-to-private deals. We do not find a significant difference in the buyout effect between these two deal types.

D. Within-EGU Improvements vs. EGU Composition Effect

The post-buyout reductions in the heat rate and CO_2 and NO_x output emission rates can be due to either improvements of existing EGUs or changes in the EGU composition (through the retirement of old EGUs and the installation of new EGUs). To examine which force is more important, we extend the baseline model specification (3) by controlling for EGU-cohort fixed effects, which subsume the less granular plant-cohort fixed effects. This allows us to identify the within-EGU effects of private equity buyouts. If private equity mainly improves the performance of existing EGUs

---

[25] The acquiring private equity firm exits 13 (20) plants through an M&A (SBO).

through, for example, software or equipment upgrades, more efficient planning/scheduling, or more efficient operating procedures, then the results should be largely the same irrespective of whether we control for plant-cohort or EGU-cohort fixed effects. In contrast, if private equity improves the output emission rates and production efficiency by replacing old and inefficient EGUs with new ones, the buyout effect should diminish after controlling for the EGU-cohort fixed effects.

[Insert Table 10 About Here]

Panel A of Table 10 shows the results from the extended model for the full sample. For the log heat rate, the coefficient on *Post* × *Buyout* drops in magnitude from -0.40 in Table 4 to -0.32 after controlling for EGU fixed effects, suggesting that within-EGU variation accounts for 80% of the post-buyout efficiency improvement estimated from our baseline regression. The DiD coefficient estimate for $\ln(\mathrm{CO_2/E})$ shrinks by 17% in magnitude, and the estimate for $\ln(\mathrm{NO_x/E})$ remains almost exactly the same. This suggests that, for the full sample, the large majority of the private equity buyout effects we uncover in the baseline model come from improvements of existing EGUs instead of changes in the EGU composition.

The importance of changes in the EGU composition is likely to be different for coal or oil-fired plants than for natural gas-fired plants. For the gas-fired plants, which tend to be newer, replacing an existing EGU is likely to be less important. However, for coal- or oil-fire plants, which are older and operate at lower fuel efficiency, replacements or switching to natural gas-fired EGUs can lead to substantial efficiency gain. To test this possibility, we separate coal- and oil-fired target plants from natural gas-fired one and examine the buyout effect on log heat rate separately for these two subsamples.

Among the 102 acquired plants in our sample for DiD analysis, there are only 8 plants fired by coal or oil, with a total of 21 EGUs. The results, reported in Panel B of Table 10, show striking differences between these plants and the natural gas-fired plants. The decrease in the heat rate is much greater for coal- or oil-fired plants than for natural gas-fired plant: 14.1% vs. 3.3%. Furthermore, while post-buyout efficiency improvement in natural gas-fired plants comes almost exclusively from within-EGU variation (the coefficients in columns 3 and 4 are almost identical), this variation accounts for only for 13% of the efficiency gain in coal- or oil-fired plants: the coefficient shrinks from -0.141 to -0.019 after controlling for the EGU fixed effects. This shows that EGU upgrades indeed play a much more important role in efficiency improvements for coal- or oil-fired plants than for natural gas-fired plants.

E. Production Scale and Other Operational Changes

The post-buyout decrease in output emission rate and heat rate may also be due to an increase in production scale. To examine this possibility, we extend the baseline model by controlling for log electricity output. The results reported in Table 11 show that output scale is indeed negatively related to the CO_2 and NO_x output emission rates and heat rate. But its ability to explain the buyout effect on CO_2 output emission rate and heat rate is rather minor. Compared to the baseline results in Panel A of Table 4, the DiD coefficient estimates remain almost identical, suggesting that changes in production scale play little role in explaining the post-buyout improvements in production efficiency and emission intensity.

[Insert Table 11 About Here]

In Panel B of Table 11, we examine the effect of private equity buyouts on various aspects of plant operations, including total output, input, operating time

(OPT), hourly output and input (E/OPT and H/OPT), capacity factor (CapFactor), and EGU retirement. The first four columns show that private equity buyouts are insignificantly related to the total output, total input, total operating hours, and hourly output at the EGU level. However, column 5 shows that they are associated with a significant decline in hourly heat input by 4.6%. This provides further evidence for the positive buyout effect on production efficiency. Columns 6 and 7 show that buyouts have no significant relation with EGU capacity factor or retirement. This suggests that private equity does not operate EGUs more intensively, or prolong their lifespan, consistent with the findings of Andonov and Rauh (2024).[26]

We conduct a similar analysis at the plant level and report the results in Table IA3 in the Online Appendix. As in the EGU-level regressions, controlling for log electricity output has almost no effect on the estimates of the DiD coefficients; moreover, private equity buyouts have no significant effect on aggregate capacity, electricity output, heat input, and emission volumes at the plant level, or the number of EGUs in each plant. This further suggests that the private equity buyout effect on production efficiency and emission intensity is not due to an expansion of production scale.

VII. Robustness Checks

We perform a series of robustness checks on our main results.

A. Variations of Match-based Stacked DiD Regressions

We first consider variations of our stacked DiD regressions, repeating our baseline analysis using an alternative event window, an alternative treatment-control ratio, and

---

[26] Since EGU retirement includes plant closure, which can only happen at the end of a plant's lifespan, we do not control for plant-cohort fixed effects in Column 7. As a result, the dummy variable Buyout is not subsumed. We identify whether an EGU is retired by checking whether it is included in the August 2022 version of the Power Sector Emission Data. If not, then we record the last year of an EGU's appearance as its retirement year.

three alternative sets of matching variables. The results from these tests, reported in Table 12, further show that private equity buyouts are associated with an improvement in the efficiency component of acquired plants' environmental performance, but their relation with the non-efficiency component is mostly insignificant.

[**Insert Table 12 About Here**]

In our baseline analysis, we use an 11-year event window, which implicitly assumes that private equity firms hold the acquired plants for five years. Some private equity firms may exit earlier. Therefore, our first robustness check is to use a shorter event window of seven years, from $t-3$ to $t+3$. The results, reported in Panel A of Table 12, are very similar to those in Table 4.

In our baseline analysis, we match each private equity-acquired plant to one control plant. This maximizes the comparability of the treated and control plants. As another robustness check, we match each treated plant to up to four control plants, using the same matching criteria. This increases the statistical power of our tests, at the expense of losing some comparability. Panel B of Table 12 shows the results. They are largely the same as those in Table 4, with the buyout effect on the heat rate being slightly larger (a decline of 4.5% instead of 4.0%).

In our baseline analysis, we match each acquired plant to a control plant based on year, state, primary fuel type, and the Mahalanobis distance calculated using log capacity, capacity factor, log plant age, and the level and slope of log heat rate. We consider three alternative matching criteria: (1) We extend the baseline matching criteria to require that treatment and control plants operate under the same regulatory and market regime (ISO vs. non-ISO); (2) We replace log capacity and capacity factor by log electricity output in the calculation of the Mahalanobis distance, keeping the other matching variables unchanged; (3) We compute the Mahalanobis distance based entirely on output emission rates: the logarithms of average CO_2/E, average SO_2/E, average NO_x/E, and the average changes of ln(CO_2/E), ln(SO_2/E), and ln(NO_x/E) in the years (up to three) prior to the buyout. The results based on these alternative matching criteria are presented in Panels C, D, and E of Table 12, respectively. They are all very similar to the baseline results reported in Table 4.

B. Panel DiD Regressions

Our match-based DiD analysis is well-suited for identifying the private equity buyout effect, as it mitigates potential biases due to staggered timing and treatment effect heterogeneity. However, its reliance on matching may still be a concern, despite the robustness checks described above. Next, we complement our previous analysis by running panel DiD regressions using the full sample of EGU-level observations. Instead of relying on matching, we control for a host of fixed effects. Specifically, we estimate the model:

$$y_{i,j,k,t} = \beta Post_{j,t} + \gamma Controls_{i,j,k,t} + \lambda_j + \sigma_k + \delta_{s,t} + \theta_{f,t} + \epsilon_{i,j,k,t}, \tag{5}$$

where $y_{i,j,k,t}$ is the year-t outcome variable for EGU i in plant j of owner k; $Post_{j,t}$ is a dummy variable that equals one for the post-buyout years of private equity-acquired plant j and zero for all other observations; λ_j, σ_k, $\delta_{s,t}$ and $\theta_{f,t}$ are plant fixed effects, owner fixed effects, year-by-state fixed effects, and year-by-fuel type fixed effects, respectively. Note that unlike in Equation (3), the dummy variable Post in Equation (5) can only be non-zero for plants that are bought out. Therefore, it is identical to $Buyout_j \times Post_{j,t}$ in Equation (3). We double-cluster the standard errors by plant owner and year. To focus on the years around the buyout event, we drop observations more than five years away (before or after) from the buyout year. Compared to our baseline approach, an advantage of this approach is that it does not rely on any specific matching method. The disadvantage is that it may produce biased results due to staggered timing and treatment effect heterogeneity (e.g., Sun and Abraham (2021)).

Table 13 presents the results. Panel A corresponds to the baseline model specified in Equation (5). The results are qualitatively similar to those from the stacked DiD regressions reported in Table 4, but quantitatively larger. The point estimates imply that private equity buyouts are associated with declines in CO_2 and NO_x output emission rates by 6.5% and 15.5%, respectively. They are also associated with a decline in the heat rate by 6.6% and a decline in the NO_x input emission rate by 8.8%. The slightly larger magnitudes of the buyout effect estimated from this alternative approach suggest that results from our baseline analysis are conservative.

[Insert Table 13 About Here]

In Panel B, we explore within-EGU variation by controlling for the EGU instead of the plant fixed effects, and the coefficient estimates show little change. Consistent with our findings in Table 10, the private equity buyout effect comes mainly from within-EGU variation. In Panel C, we add ln(Electricity) to the benchmark model as an additional control. The DiD coefficient estimates on *Post* drop in magnitude by 15%, 22%, and 14%, respectively, in the models of $\ln(CO_2/E)$, $\ln(NO_x/E)$, and $\ln(H/E)$, suggesting that changes in outputs scale explain only a small fraction of the private equity buyout effect.

VIII. Conclusion

Private equity firms' acquisitions of brown assets are viewed by many as a hidden environmental threat and an obstacle to the green transition. We study the effect of private equity ownership on firms' environmental performance using data from U.S. fossil fuel power plants. Exploiting the unique feature of electricity production, we decompose power plants' gas emission intensity into a component that reflects production efficiency (the heat rate) and a non-efficiency component that reflects the effectiveness of emission control (emissions per unit of heat input). We examine the private equity buyout effects on both components. Our results show that on average, private equity buyouts are associated with a significant improvement in the efficiency component (a 4% decline in the heat rate), but they generally have no significant effect on the non-efficiency component. Corroborating this result, we find that buyouts are followed by a decline in fuel costs per MWh by 7.3%, while having no significant relation with expenditures related to pollution abatement. Buyouts backed by private equity with a stated preference for ESG investments are followed not only by substantially larger efficiency improvements than buyouts backed by non-ESG firms (7.5% vs. 2.6%), but also by a significant decline of 16.6% in NO_x emissions per unit of heat input.

The efficiency gains following private equity buyouts are largely concentrated in plants operating in deregulated markets and in states with strong public support for government action in lowering power plant emissions. The improvement in environmental performance is also more significant in acquired plants with large capacity, plants acquired through corporate divestiture deals, and plants held by the acquiring private equity firm for more than four years. For natural gas-fired plants, the increase in production efficiency occurs almost entirely via improvements of existing

EGUs. However, for coal- and oil-fired plants, the efficiency gain comes mainly from changes in the EGU composition.

Our results suggest that private equity's acquisitions of fossil fuel power plants have positive effects, both financially and environmentally. Meanwhile, they also suggest that while private equity firms are effective at implementing environmentally beneficial operational changes that are profit-boosting, they have do not have strong incentives to undertaken environmentally beneficial changes that are privately costly, except for those with pro-ESG preferences. Thus, our findings highlight both the strengths and limitations of private equity as a potential force for sustainability. Since firms in the power sector are monitored closely by regulators, the extent to which our results can be extended to other industries is an interesting question for future research.

[**Insert Table A1 About Here**]

References

Akey, P., and I. Appel. "Environmental Externalities of Activism." (2019). Working paper available at SSRN.

Americans for Financial Reform Education Fund. "Private equity ownership of U.S. power plants: A hidden climate threat." (2022). `https://ourfinancialsecurity.org/wp-content/uploads/2022/09/Private-Equity-Hidden-Power-Plants-Threaten-Climate-5.16.22-official-2.pdf`.

Andonov, A., and J. D. Rauh. "The Shifting Finance of Electricity Generation." NBER Working Paper No. 32733 (2024).

Baker, A. C.; D. F. Larcker; and C. C. Wang. "How much should we trust staggered difference-in-differences estimates?" *Journal of Financial Economics*, 144 (2022), 370–395.

Bartram, S. M.; K. Hou; and S. Kim. "Real effects of climate policy: Financial constraints and spillovers." *Journal of Financial Economics*, 143 (2022), 668–696.

Bellon, A. “Does Private Equity Ownership Make Firms Cleaner? The Role of Environmental Liability Risks.” *Review of Financial Studies*, 38 (2025), 2517–2556.

Bolton, P., and M. Kacperczyk. “Do investors care about carbon risk?” *Journal of Financial Economics*, 142 (2021), 517–549.

Bolton, P., and M. T. Kacperczyk. “Global Pricing of Carbon-Transition Risk.” *Journal of Finance*, 78 (2023), 3677–3754.

Cicala, S. “Imperfect Markets versus Imperfect Regulation in US Electricity Generation.” *American Economic Review*, 112 (2022), 409–41.

Davis, S. J.; J. Haltiwanger; K. Handley; R. Jarmin; J. Lerner; and J. Miranda. “Private equity, jobs, and productivity.” *American Economic Review*, 104 (2014), 4184–4204.

Demirer, M., and Ö. Karaduman. “Do Mergers and Acquisitions Improve Efficiency? Evidence from Power Plants.” National Bureau of Economic Research (2024).

Dimson, E.; O. Karakaş; and X. Li. “Active Ownership.” *Review of Financial Studies*, 28 (2015), 3225–3268.

Duchin, R.; J. Gao; and Q. Xu. “Sustainability or Greenwashing: Evidence from the Asset Market for Industrial Pollution.” *Journal of Finance*, 80 (2025), 699–754.

Eaton, C.; S. T. Howell; and C. Yannelis. “When Investor Incentives and Consumer Interests Diverge: Private Equity in Higher Education.” *Review of Financial Studies*, 33 (2020), 4024–4060.

Eccles, R. G.; V. Shandal; D. Young; and B. Montgomery. “Private Equity Should Take the Lead in Sustainability.” *Harvard Business Review*, (July-August 2022).

Fernando, C. S.; M. P. Sharfman; and V. B. Uysal. “Corporate Environmental Policy and Shareholder Value: Following the Smart Money.” *Journal of Financial and Quantitative Analysis*, 52 (2017), 2023–2051.

Fracassi, C.; A. Previtero; and A. Sheen. “Barbarians at the Store? Private Equity, Products, and Consumers.” *Journal of Finance*, 77 (2022), 1439–1488.

Gao, J.; Y. Kim; and M. Sevilir. “Private equity in the hospital industry.” *Journal of Financial Economics*, 171 (2025), 104107.

Gormley, T. A., and D. A. Matsa. “Growing Out of Trouble? Corporate Responses to Liability Risk.” *Review of Financial Studies*, 24 (2011), 2781–2821.

Gupta, A.; S. T. Howell; C. Yannelis; and A. Gupta. “Does Private Equity Investment in Healthcare Benefit Patients? Evidence from Nursing Homes.” *Review of Financial Studies*, 37 (2024), 1029–1077.

Hartzmark, S. M., and K. Shue. “Counterproductive Sustainable Investing: The Impact Elasticity of Brown and Green Firms.” (2023). Working paper available at SSRN.

Heinkel, R.; A. Kraus; and J. Zechner. “The Effect of Green Investment on Corporate Behavior.” *Journal of Financial and Quantitative Analysis*, 36 (2001), 431–449.

Houston, J. F., and H. Shan. “Corporate ESG Profiles and Banking Relationships.” *Review of Financial Studies*, 35 (2021), 3373–3417.

Hsu, P.-H.; K. Li; and C.-Y. Tsou. “The Pollution Premium.” *Journal of Finance*, 78 (2023), 1343–1392.

Kumar, M. “Dirty Assets, Clean Opportunities: Private Equity Ownership of Fossil Fuels and the Energy Transition.” (2024). Working paper available at SSRN.

Li, Q.; H. Shan; Y. Tang; and V. Yao. “Corporate Climate Risk: Measurements and Responses.” *The Review of Financial Studies*, 37 (2024), 1778–1830.

Pástor, L.; R. F. Stambaugh; and L. A. Taylor. “Sustainable Investing in Equilibrium.” *Journal of Financial Economics*, 142 (2021), 550–571.

Pew Research Center. “2014 Religious Landscape Survey (RLS-II) Topline.” `https://assets.pewresearch.org/wp-content/uploads/sites/12/2016/02/topline-RLS-environment-regs-by-state-NUM-CHECKED-2-18-16.pdf` (2016).

Sautner, Z.; L. van Lent; G. Vilkov; and R. Zhang. “Firm-level Climate Change Exposure.” *Journal of Finance*, 78 (2023), 1449–1498.

Shapiro, J. S. "The Environmental Bias of Trade Policy." *Quarterly Journal of Economics*, 136 (2020), 831–886.

Sheen, A.; Y. Wu; and Y. Yuan. "Private Equity and Financial Adviser Misconduct." (2025). Working paper available at SSRN.

Shive, S. A., and M. M. Forster. "Corporate Governance and Pollution Externalities of Public and Private Firms." *Review of Financial Studies*, 33 (2020), 1296–1330. ISSN 14657368. doi:10.1093/rfs/hhz079.

Sorensen, M., and A. Yasuda. "Stakeholder Impact of Private Equity Investments." In *Private Equity and Entrepreneurial Finance*, Vol. 1 of *Handbook of the Economics of Corporate Finance*, B. E. Eckbo; G. M. Phillips; and M. Sorensen, eds. North-Holland (2023), 299–341.

Sun, L., and S. Abraham. "Estimating Dynamic Treatment Effects in Event Studies with Heterogeneous Treatment Effects." *Journal of Econometrics*, 225 (2021), 175–199.

Tyson, A.; C. Funk; and B. Kennedy. "Climate Insights 2020: Surveying American Public Opinion on Climate Change and the Environment." `https://www.rff.org/publications/reports/climateinsights2020-opinion-in-the-states/` (2020).

U.S. Energy Information Administration. "Electric Power Annual 2021." (2022). Https://www.eia.gov/electricity/annual/.

U.S. Environmental Protection Agency. "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020." (2022). EPA 430-R-22-003. `https://www.epa.gov/ghgemissions/draft-inventory-us-greenhouse-gas-emissions-and-sinks-1990-2020`.

Wu, Y. "Carbon Footprint of Private Equity." In *The Palgrave Encyclopedia of Private Equity*, D. Cumming; and B. Hammer, eds. Springer International Publishing, Cham (2023).

Xu, Q., and T. Kim. "Financial Constraints and Corporate Environmental Policies." *Review of Financial Studies*, 35 (2022), 576–635.

Table A.1: **Variable definitions**

This table summarizes the variable definitions. The ratios that are not log transformed are winsorized at the 1st and 99th percentiles.

Variable (unit)	Description
Buyout	In the linear probability model, Buyout is a dummy variable that equals 1 if a plant is bought out by private equity for the first time in a given year and 0 otherwise; in the stacked DiD regressions, it is a time-invariant dummy variable that equals 1 for plants first bought out by private equity and 0 for others.
M&A	A time-invariant dummy variable that equals 1 for plants acquired in an M&A deal not backed by private equity.
SBO	A time-invariant dummy variable that equals 1 for plants acquired in a secondary buyout deal backed by private equity.
Post	In the stacked DiD regressions, Post is a dummy variable indicating the post-deal years for both acquired plants and control plants; in the panel DiD regressions, it is a dummy variable indicating the post-buyout years for acquired plants.
Capacity (MW)	The maximum electrical power output that an EGU is capable of producing on a steady-state basis, in Megawatt.
CapFactor	A measure of an EGU's utilization relative to its full capacity, calculated as the ratio of annual electricity output to the product of capacity and annual operating hours. The plant-level capacity factor is the average EGU-level factor weighted by EGU capacity.
Electricity (GWh)	Gross electricity generated in a year, in gigawatt hours (GWh).
Age (year)	Plant or EGU age, measured by the number of years since a plant/EGU starts its commercial operation.
Heat Input (BBtu)	Quantity of heat input, equal to fuel quantity times fuel heat content, measured in billion British thermal unit (BBtu).
CO_2 *(metric ton)*	Emitted carbon dioxide mass in metric tons.
SO_2 *(metric ton)*	Emitted sulfur dioxide mass in metric tons.
NO_x *(metric ton)*	Emitted nitrogen oxides mass in metric tons.
H/E (MMBtu/MWh)	Heat input in million British thermal unit (MMBtu) per megawatt hour (MWh) electricity generated, an inverse measure of thermal efficiency.
CO_2/E *(kg/MWh)*	CO_2 emissions (in kilogram) per MWh electricity generated.
SO_2/E *(kg/MWh)*	SO_2 emissions (in kilogram) per MWh electricity generated.
NO_x/E *(kg/MWh)*	NO_x emissions (kilogram) per MWh electricity generated.
CO_2/H *(kg/MMBtu)*	CO_2 emissions (in kilogram) per MMBtu heat input.
SO_2/H *(kg/MMBtu)*	SO_2 emissions (in kilogram) per MMBtu heat input.
NO_x/H *(kg/MMBtu)*	NO_x emissions (in kilogram) per MMBtu heat input.
D(Gas)	At the EGU level, D(Gas) is a dummy variable that equals 1 if an EGU uses gas as the primary fuel; at the plant level, it is a dummy variable that equals 1 if over 80% of a plant's electricity output is generated by gas-fired EGUs. *D(Coal)* and *D(Oil)* are defined similarly. *D(Other)* equals one if the other three fuel type dummies are zero.

Table A.1 continued.

OPT (hour)	The total number of hours an EGU is operating in a year.
E/OPT (MWh/hour)	The average amount of electricity generated (in MWh) by an EGU per operating hour.
H/OPT (MMBtu/hour)	The average heat input used (in MMBTu) by an EGU per operating hour.
N_Unit	The number of electricity generating units (EGUs) a plant has.
Retirement	A dummy that equals 1 if an EGU ceases to operate and 0 otherwise.
ISO	A dummy variable indicating whether a plant operates in the independent system operator (ISO) regime.
FuelCost/E ($/MWh)	Fuel costs per MWh of electricity generated.
OM/E ($/MWh)	Operation and maintenance (O&M) expenditures related to collection and disposal of combustion by-products and related pollution abatement activities, in dollars per MWh electricity generated.
Capx/E ($/MWh)	Pollution abatement capital expenditures during the reporting year, in dollars per MWh electricity generated.
Price ($/MWh)	Price of electricity in dollars per MWh, calculated using revenues from and quantity of electricity sold for resales (i.e., wholesale sales).
ln(X)	The natural logarithm of any variable X.

Table 1: **Summary Statistics: Full Sample**

Panel A shows the summary statistics of our sample at the electricity generating unit (EGU) level, including the mean, standard deviation (sd), minimum (min), median (p50), maximum (max), and the number of observations for each variable. Panel B shows the summary statistics for selected variables at the plant level. The sample is constructed using the annual CAMD Power Sector Emissions Database from 2003-2021. The full sample consists of 4,181 EGUs at 1,340 electric power plants owned by 1,007 owners. Variable definitions are provided in Table A.1.

Panel A. Summary Statistics at the EGU Level

	mean	sd	min	p50	max	count
Capacity	237.73	209.91	21.20	163.20	1,425.60	56,567
CapFactor	0.59	0.21	0.15	0.60	1.02	56,567
Electricity	681.21	1,094.62	0.00	148.81	11,347.78	56,575
Heat Input	6,228.95	10,116.86	0.02	1,602.44	105,802.34	56,575
Age	23.19	18.03	0.00	17.00	75.00	56,575
$\mathrm{CO_2/E}$	676.16	219.79	342.41	626.16	1,339.03	56,575
$\mathrm{SO_2/E}$	0.88	2.25	0.00	0.00	12.59	56,575
$\mathrm{NO_x/E}$	0.67	0.92	0.02	0.32	5.06	56,575
H/E	10.65	2.30	6.38	10.61	18.48	56,575
$\mathrm{CO_2/H}$	63.47	16.32	53.09	53.92	96.66	56,575
$\mathrm{SO_2/H}$	0.08	0.22	0.00	0.00	1.22	56,575
$\mathrm{NO_x/H}$	0.06	0.07	0.00	0.03	0.35	56,575
OPT	3,287.29	3,072.91	0.25	1,971.94	8,784.00	56,575
E/OPT	136.06	139.15	0.00	90.45	1,359.41	56,575
H/OPT	1,307.60	1,263.11	11.20	977.87	13,088.80	56,575
$\ln(\mathrm{CO_2/E})$	6.47	0.36	0.94	6.44	19.28	56,575
$\ln(\mathrm{SO_2/E})$	-3.99	2.90	-9.71	-5.70	13.05	56,575
$\ln(\mathrm{NO_x/E})$	-1.25	1.43	-5.36	-1.15	13.01	56,575
ln(H/E)	2.34	0.26	-0.89	2.36	14.75	56,575
$\ln(\mathrm{CO_2/H})$	4.12	0.24	-1.63	3.99	6.34	56,575
$\ln(\mathrm{SO_2/H})$	-6.34	2.87	-11.61	-8.20	1.03	56,575
$\ln(\mathrm{NO_x/H})$	-3.59	1.31	-7.76	-3.50	-0.24	56,575
ln(OPT)	7.20	1.71	-1.39	7.59	9.08	56,575
ln(E/OPT)	4.48	0.97	-6.17	4.50	7.21	56,575
ln(H/OPT)	6.82	0.85	2.42	6.89	9.48	56,575
Retirement	0.01	0.09	0.00	0.00	1.00	56,575
D(Gas)	0.73	0.45	0.00	1.00	1.00	56,575
D(Coal)	0.21	0.41	0.00	0.00	1.00	56,575
D(Oil)	0.06	0.23	0.00	0.00	1.00	56,575
D(Other)	0.00	0.06	0.00	0.00	1.00	56,575

Panel B. Summary Statistics at the Plant Level

	mean	sd	min	p50	max	count
Capacity	693.69	726.75	26.50	471.20	7,425.00	19,386
CapFactor	0.61	0.20	0.15	0.62	1.02	19,386
Electricity	1,987.60	3,056.51	1.00	658.66	25,400.31	19,390
Heat Input	18,174.47	27,847.67	7.80	6,577.46	226,548.00	19,390
Age	27.43	19.75	1.00	20.00	86.00	19,390
CO_2	1,411,444.01	2,503,767.54	40.55	404,172.01	21,086,791.50	19,390
SO_2	3,064.36	10,326.60	0.00	3.79	187,283.80	19,390
NO_x	1,250.35	3,134.04	0.06	100.43	41,207.63	19,390
CO_2/E	674.85	227.88	345.82	618.15	1,334.76	19,390
SO_2/E	0.96	2.30	0.00	0.00	12.73	19,390
NO_x/E	0.61	0.75	0.02	0.32	3.88	19,390
H/E	10.32	2.12	6.44	10.37	17.22	19,390
CO_2/H	65.14	17.37	53.24	53.92	98.77	19,390
SO_2/H	0.09	0.23	0.00	0.00	1.28	19,390
NO_x/H	0.06	0.07	0.00	0.03	0.32	19,390
$\ln(CO_2/E)$	6.46	0.35	0.94	6.43	8.75	19,390
$\ln(SO_2/E)$	-3.79	3.01	-8.21	-5.70	3.89	19,390
$\ln(NO_x/E)$	-1.29	1.41	-5.00	-1.13	2.89	19,390
ln(H/E)	2.31	0.22	-0.77	2.34	4.32	19,390
$\ln(CO_2/H)$	4.14	0.26	-1.63	3.99	6.34	19,390
$\ln(SO_2/H)$	-6.10	2.97	-10.89	-8.20	0.99	19,390
$\ln(NO_x/H)$	-3.61	1.30	-7.29	-3.48	-0.24	19,390
D(Gas)	0.70	0.46	0.00	1.00	1.00	19,390
D(Coal)	0.25	0.43	0.00	0.00	1.00	19,390
D(Oil)	0.03	0.17	0.00	0.00	1.00	19,390
D(Other)	0.02	0.14	0.00	0.00	1.00	19,390
N_Unit	2.92	2.31	1.00	2.00	24.00	19,390
ISO	0.68	0.47	0.00	1.00	1.00	16,485
FuelCost/E	43.45	31.14	13.04	34.74	201.58	11,861
OM/E	1.09	2.71	0.00	0.01	18.69	7,441
Capx/E	1.09	2.71	0.00	0.00	18.69	7,441
Price	58.51	54.12	6.73	40.62	311.11	3,436

Table 2: **Determinants of Private Equity Buyout Probability**

This tables shows the results estimated from linear probability models on the determinants of private equity firms' choice of buyout targets. The dependent variable equals one if a plant is bought out for the first time by private equity in a given year and zero otherwise. All explanatory variables are lagged by one year and measured at the plant level. Observations for post-buyout years are dropped from the sample (i.e., only the first buyout deal of each target firm is considered). Variable definitions are provided in Table A.1. To simplify reporting, all regression coefficients are multiplied by 100. Standard errors are clustered by plant owner. We report t-statistics in parentheses, with statistical significance levels of 10%, 5%, and 1% indicated by *, **, and ***, respectively.

	1 Buyout	2 Buyout	3 Buyout	4 Buyout	5 Buyout	6 Buyout	7 Buyout	8 Buyout
ln(CO_2/E)	0.087		0.165			-0.038	0.187	0.244
	(0.27)		(0.51)			(-0.09)	(0.41)	(0.42)
ln(SO_2/E)	0.016			0.027		0.022	0.056	-0.013
	(0.28)			(0.50)		(0.31)	(0.61)	(-0.14)
ln(NO_x/E)	0.031				0.045	0.067	0.044	0.108
	(0.35)				(0.53)	(0.65)	(0.33)	(0.64)
ISO						0.455**		
						(2.31)		
ln(FuelCost/E)							-0.322	-0.470
							(-1.03)	(-1.16)
OM/E								-0.046***
								(-2.71)
Capx/E								-0.008**
								(-2.29)
ln(H/E)	-0.009	0.174				0.027		
	(-0.02)	(0.42)				(0.04)		
ln(Age)	-0.271**	-0.251**	-0.250**	-0.257**	-0.270**	-0.399***	-0.364**	-0.286
	(-2.40)	(-2.31)	(-2.30)	(-2.30)	(-2.43)	(-3.40)	(-2.42)	(-1.64)
ln(Capacity)	0.164**	0.159**	0.159**	0.147**	0.161**	0.171*	0.025	-0.066
	(2.01)	(2.03)	(2.09)	(2.08)	(2.06)	(1.95)	(0.25)	(-0.61)
CapFactor	-0.348	-0.346	-0.350	-0.394	-0.370	-0.464	-0.882*	-1.639**
	(-0.89)	(-0.88)	(-0.93)	(-1.12)	(-1.02)	(-1.07)	(-1.73)	(-2.12)
D(Coal)	0.024	0.077	0.042	0.031	0.057	-0.053	-0.446	-0.330
	(0.10)	(0.30)	(0.16)	(0.12)	(0.22)	(-0.19)	(-1.00)	(-0.69)
D(Gas)	0.593	0.469	0.523	0.565	0.500	0.459	0.566	0.193
	(1.37)	(1.48)	(1.41)	(1.39)	(1.46)	(0.98)	(0.90)	(0.28)
D(Oil)	0.435	0.422	0.441	0.426	0.428	0.205	-0.044	0.142
	(0.95)	(0.97)	(1.01)	(0.98)	(0.98)	(0.41)	(-0.06)	(0.15)
Constant	-0.169	-0.091	-0.777	0.481	0.416	0.891	2.206	3.197
	(-0.08)	(-0.06)	(-0.30)	(0.59)	(0.50)	(0.38)	(0.69)	(0.86)
Observations	18181	18181	18181	18181	18181	15414	10929	6805
R^2	0.007	0.007	0.007	0.007	0.007	0.008	0.007	0.011
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3: **Comparison Between the Acquired and Control Plants**

The first column shows the mean values for the private equity-acquired plants in the year prior to the buyout. The second column shows the mean values for the one-to-one matched control plants. The third column shows the mean difference between the two groups. The last column shows the t-statistics for the t-tests of equal group means. For each acquired plant, we find a control plant matched by year, state, primary fuel type, and a Mahalanobis distance measure calculated using log plant age, log plant capacity, and capacity factor in the pre-buyout year, the logarithm of the average heat rate and the average change in the log heat rate in up to three pre-buyout years. Variable definitions are provided in Table A.1.

	mean(Treatment)	mean(Control)	Difference	t-stat
Capacity	674.249	595.006	79.243	1.05
Electricity	1391.702	1222.775	168.927	0.68
Age	17.824	16.814	1.010	0.44
CO_2/E	584.425	597.426	-13.000	-0.50
SO_2/E	0.203	0.336	-0.133	-0.78
NO_x/E	0.370	0.281	0.089	1.28
H/E	10.086	10.318	-0.232	-0.82
CO_2/H	57.012	57.192	-0.180	-0.13
SO_2/H	0.019	0.032	-0.013	-0.77
NO_x/H	0.033	0.025	0.008	1.44
ISO	0.804	0.802	0.002	0.03
CapFactor	0.576	0.585	-0.009	-0.37
D(Gas)	0.922	0.922	0.000	0.00
D(Coal)	0.069	0.069	0.000	0.00
D(Oil)	0.010	0.010	0.000	0.00
D(Other)	0.000	0.000	0.000	.
N_Unit	2.971	3.196	-0.225	-0.80
FuelCost/E	48.042	54.375	-6.332	-1.42
OM/E	0.074	0.758	-0.684	-1.05
Capx/E	0.052	0.193	-0.141	-1.01
Price	57.914	55.550	2.365	0.20
Observations	102	102		

Table 4: **Private Equity Buyout Effect: Baseline Stacked DiD Regressions**

This table shows the EGU-level stacked DiD regression results using matched samples of acquired and control plants. The dependent variables are the natural logarithms of output emission rates (CO_2/E, SO_2/E, NO_x/E), heat rate (H/E), and input emission rates (CO_2/H, SO_2/H, NO_x/H) in Panel A, and the winsorized rates in Panel B. Each acquired plant is matched to a control plant based on year, state, primary fuel type, and a Mahalanobis distance measure. The event window is up to 11 years, from t-5 to t+5, with t=0 being the buyout year. Post is a dummy variable equal to one for the post-buyout years and zero for other years. Buyout is a dummy variable equal to one for acquired plants and zero for control plants. Regression constants are not reported. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Log Emission Rates and Heat Rate

	1	2	3	4	5	6	7
	$\ln(CO_2/E)$	$\ln(SO_2/E)$	$\ln(NO_x/E)$	ln(H/E)	$\ln(CO_2/H)$	$\ln(SO_2/H)$	$\ln(NO_x/H)$
Post × Buyout	-0.042***	0.029	-0.090**	-0.040***	-0.002	0.069	-0.050
	(-3.44)	(0.49)	(-2.53)	(-3.38)	(-0.66)	(1.23)	(-1.62)
ln(Age)	0.054*	0.123	0.659***	0.033	0.021	0.090	0.626***
	(1.93)	(1.02)	(4.49)	(1.30)	(1.04)	(0.75)	(4.60)
Observations	6076	6076	6076	6076	6076	6076	6076
R^2	0.868	0.925	0.930	0.816	0.896	0.922	0.933
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Winsorized Raw Emission Rates and Heat Rate

	1	2	3	4	5	6	7
	CO_2/E	SO_2/E	NO_x/E	H/E	CO_2/H	SO_2/H	NO_x/H
Post × Buyout	-22.009***	0.062	-0.079***	-0.358***	0.037	0.009*	-0.005**
	(-3.56)	(1.29)	(-3.02)	(-3.33)	(0.26)	(1.71)	(-2.46)
ln(Age)	28.501	0.098	0.188***	0.279	1.573	0.012	0.017***
	(1.59)	(0.83)	(4.77)	(1.02)	(1.05)	(0.88)	(4.63)
Observations	6076	6076	6076	6076	6076	6076	6076
R^2	0.906	0.857	0.825	0.855	0.894	0.869	0.847
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5: **Comparison with M&As and Secondary Buyouts**

This table shows the comparison between the effect of first private equity buyouts, which are the main focus of our study, with the effects of M&As (in Panel A) and secondary private equity buyouts (SBOs, in Panel B). The results are based on EGU-level stacked DiD regressions using matched samples of treated and control plants. The dependent variables are the natural logarithms of output emission rates (CO_2/E, SO_2/E, NO_x/E), heat rate (H/E), and input emission rates (CO_2/H, SO_2/H, NO_x/H). Each acquired plant is matched to a control plant based on year, state, primary fuel type, and a Mahalanobis distance measure. The event window is up to 11 years, from t-5 to t+5, with t=0 being the buyout year. Buyout, M&A, and SBO are dummy variables indicating plants acquired in first private equity buyout, M&A, and SBO deals, respectively. Post is a dummy variable indicating the post-deal years. Regression constants are not reported. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively. We also report the F-statistics and p-values for the F-tests of the null hypothesis that the coefficients on *Post* × *Buyout* and *Post* × *M&A* (or *Post* × *SBO*) are equal.

Panel A. Comparison with M&As

	1	2	3	4	5	6	7
	ln(CO_2/E)	ln(SO_2/E)	ln(NO_x/E)	ln(H/E)	ln(CO_2/H)	ln(SO_2/H)	ln(NO_x/H)
Post × Buyout	-0.040***	0.048	-0.089**	-0.040***	-0.000	0.088	-0.049
	(-3.13)	(0.70)	(-2.47)	(-3.32)	(-0.05)	(1.32)	(-1.57)
Post × M&A	-0.004	0.019	0.076	-0.001	-0.002	0.021	0.078
	(-0.29)	(0.20)	(1.28)	(-0.11)	(-0.39)	(0.22)	(1.51)
ln(Age)	0.150***	1.056***	0.746***	0.062***	0.088***	0.994***	0.685***
	(4.66)	(3.78)	(7.06)	(3.05)	(3.39)	(3.61)	(7.00)
Observations	11288	11288	11288	11288	11288	11288	11288
R^2	0.840	0.921	0.925	0.774	0.917	0.921	0.929
F-statistic	3.688	0.069	5.576	4.336	0.113	0.394	4.436
p-value (F-test)	0.056	0.793	0.019	0.038	0.737	0.531	0.036
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Comparison with SBOs

	1	2	3	4	5	6	7
	ln(CO_2/E)	ln(SO_2/E)	ln(NO_x/E)	ln(H/E)	ln(CO_2/H)	ln(SO_2/H)	ln(NO_x/H)
Post × Buyout	-0.042***	0.030	-0.087**	-0.040***	-0.002	0.070	-0.047
	(-3.43)	(0.51)	(-2.45)	(-3.37)	(-0.67)	(1.25)	(-1.53)
Post × SBO	0.019	0.032	-0.019	0.020	-0.001	0.013	-0.039
	(1.33)	(0.24)	(-0.31)	(1.42)	(-0.28)	(0.10)	(-0.71)
ln(Age)	0.054*	0.156	0.663***	0.034	0.021	0.122	0.629***
	(1.83)	(1.13)	(3.60)	(1.27)	(1.15)	(0.95)	(3.76)
Observations	8330	8330	8330	8330	8330	8330	8330
R^2	0.874	0.912	0.938	0.835	0.895	0.906	0.942
F-statistic	10.609	0.000	0.924	10.640	0.069	0.161	0.017
p-value (F-test)	0.001	0.986	0.337	0.001	0.793	0.689	0.895
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: **Stacked DiD Regressions at the Plant Level**

This table shows the private equity buyout effect estimated from plant-level stacked DiD regressions. Panel A shows the buyout effects on the emission rates and the heat rate. Panel B shows the buyout effects on financial variables, including the logarithms of fuel costs and sale price per MWh electricity generated, operation/maintenance (O&M) and capital expenditures related to pollution abatement (also normalized by electricity generated). Each acquired plant is matched to a control plant based on year, state, primary fuel type, and a Mahalanobis distance measure. The event window is up to 11 years, from t-5 to t+5, with t=0 being the buyout year. Observations are weighted by the number of EGUs of a plant. Post is a dummy variable equal to one for the post-buyout years and zero for other years. Buyout is a dummy variable equal to one for acquired plants and zero for control plants. Regression constants are not reported. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Environmental Performance

	1	2	3	4	5	6	7
	$\ln(\mathrm{CO_2}/E)$	$\ln(\mathrm{SO_2}/E)$	$\ln(\mathrm{NO_x}/E)$	$\ln(H/E)$	$\ln(\mathrm{CO_2}/H)$	$\ln(\mathrm{SO_2}/H)$	$\ln(\mathrm{NO_x}/H)$
Post × Buyout	-0.036**	0.035	-0.087*	-0.034**	-0.002	0.069	-0.053
	(-2.04)	(0.39)	(-1.77)	(-1.98)	(-0.54)	(0.81)	(-1.26)
ln(Age)	-0.028	-0.308*	0.048	-0.026	-0.003	-0.282	0.073
	(-0.60)	(-1.71)	(0.28)	(-0.54)	(-0.36)	(-1.57)	(0.49)
Observations	1894	1894	1894	1894	1894	1894	1894
R^2	0.962	0.973	0.979	0.948	0.990	0.973	0.979
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Financial Variables

	1	2	3	4
	ln(FuelCost/E)	OM/E	Capx/E	ln(Price)
Post × Buyout	-0.073**	-0.091	2.732	-0.202
	(-2.16)	(-0.64)	(1.24)	(-1.35)
ln(Age)	0.433	0.649	21.050	0.942
	(1.39)	(0.58)	(1.17)	(0.75)
Observations	1144	344	344	292
R^2	0.942	0.905	0.684	0.896
Year-Cohort FE	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes

Table 7: **Private Equity Buyout Effects: The Role of Private Equity ESG Preferences**

This table shows the difference in the buyout effect between deals backed by pro-ESG and non-ESG private equity firms. In Panel A, we conduct stacked DiD analysis only for first buyout deals; in Panel B, we consider both first and secondary buyout deals. ESG is a cohort-level dummy equal to one for both the acquired and the matched control plants if the deal is backed by pro-ESG private equity firms and zero otherwise (for SBO deals, we further require that prior buyout deals be backed by non-ESG private equity firms for this dummy to be equal to one). Buyout and SBO are dummy variables indicating plants acquired in first and secondary private equity buyout deals, respectively. Post is a dummy variable indicating the post-deal years. The event window is up to 11 years, from t-5 to t+5, with t=0 being the buyout year. Regression constants are not reported. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Pro-ESG vs. Non-ESG Private Equity: First Buyouts

	1	2	3	4	5	6	7
	$\ln(CO_2/E)$	$\ln(SO_2/E)$	$\ln(NO_x/E)$	$\ln(H/E)$	$\ln(CO_2/H)$	$\ln(SO_2/H)$	$\ln(NO_x/H)$
Post × Buyout	-0.027**	0.059	-0.029	-0.026**	-0.001	0.085	-0.003
	(-2.07)	(0.86)	(-0.76)	(-2.06)	(-0.31)	(1.25)	(-0.09)
Post × Buyout × ESG	-0.052*	-0.104	-0.212***	-0.049*	-0.002	-0.054	-0.163**
	(-1.75)	(-0.83)	(-2.66)	(-1.68)	(-0.52)	(-0.47)	(-2.46)
ln(Age)	0.054*	0.123	0.659***	0.033	0.021	0.090	0.626***
	(1.94)	(1.02)	(4.50)	(1.30)	(1.04)	(0.75)	(4.61)
Observations	6076	6076	6076	6076	6076	6076	6076
R^2	0.869	0.925	0.930	0.817	0.896	0.922	0.933
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Pro-ESG vs. Non-ESG Private Equity: First and Secondary Buyouts

	1	2	3	4	5	6	7
	$\ln(CO_2/E)$	$\ln(SO_2/E)$	$\ln(NO_x/E)$	$\ln(H/E)$	$\ln(CO_2/H)$	$\ln(SO_2/H)$	$\ln(NO_x/H)$
Post × Buyout	-0.027**	0.059	-0.029	-0.026**	-0.001	0.086	-0.003
	(-2.09)	(0.87)	(-0.76)	(-2.07)	(-0.31)	(1.26)	(-0.09)
Post × Buyout × ESG	-0.051*	-0.103	-0.203**	-0.049*	-0.002	-0.054	-0.154**
	(-1.75)	(-0.82)	(-2.54)	(-1.67)	(-0.52)	(-0.47)	(-2.32)
Post × SBO	0.023	0.057	-0.063	0.020	0.003	0.038	-0.083
	(1.61)	(1.23)	(-1.06)	(1.34)	(1.49)	(0.87)	(-1.56)
Post × SBO × ESG	-0.009	-0.054	0.094	-0.000	-0.009**	-0.054	0.094
	(-0.30)	(-0.19)	(0.70)	(-0.01)	(-2.53)	(-0.19)	(0.80)
ln(Age)	0.054*	0.156	0.662***	0.034	0.021	0.122	0.628***
	(1.83)	(1.14)	(3.60)	(1.27)	(1.16)	(0.95)	(3.76)
Observations	8330	8330	8330	8330	8330	8330	8330
R^2	0.874	0.912	0.939	0.835	0.895	0.906	0.942
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: **Private Equity Buyout Effect: The Role of Regulatory and Social Environments**

This table shows the difference in the private equity buyout effect under different regulatory and social environments. ISO is a cohort-level dummy equal to one for both the acquired and the matched control plants if the acquired plant operates in the independent system operator (ISO) regime. LowerEmi is a cohort-level dummy equal to one if the acquired plant is located in a state in which the fraction of survey respondents believing that the government should take action to lower power plant emissions is above the median. StricterReg is a cohort-level dummy equal to one if the acquired plant is located in a state in which the fraction of survey respondents believing stricter environmental laws and regulations are worth the cost is above the median. Post and Buyout are dummy variables indicating the post-buyout years and the acquired plants, respectively. The event window is up to 11 years, from t-5 to t+5, with t=0 being the buyout year. Regression constants are not reported. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	1	2	3	4	5	6	7
	$\ln(CO_2/E)$	$\ln(SO_2/E)$	$\ln(NO_x/E)$	ln(H/E)	$\ln(CO_2/H)$	$\ln(SO_2/H)$	$\ln(NO_x/H)$
A. Regulatory environment: ISO vs. non-ISO							
Post × Buyout	0.002	0.221	-0.066*	0.013	-0.011*	0.208	-0.078*
	(0.08)	(1.49)	(-1.80)	(0.63)	(-1.76)	(1.41)	(-1.79)
Post × Buyout × ISO	-0.056**	-0.246	-0.031	-0.069***	0.012*	-0.178	0.038
	(-2.26)	(-1.59)	(-0.53)	(-2.80)	(1.94)	(-1.15)	(0.65)
Observations	6014	6014	6014	6014	6014	6014	6014
R^2	0.868	0.926	0.930	0.816	0.896	0.922	0.933
B. Public support for lowering power plant emissions: Strong vs. weak							
Post × Buyout	-0.014*	0.143	0.045	-0.014*	0.000	0.158	0.059
	(-1.77)	(1.32)	(1.03)	(-1.93)	(0.02)	(1.45)	(1.40)
Post × Buyout × LowerEmi	-0.043**	-0.178	-0.210***	-0.041**	-0.003	-0.137	-0.169***
	(-2.28)	(-1.42)	(-3.27)	(-2.15)	(-0.54)	(-1.11)	(-2.89)
Observations	6076	6076	6076	6076	6076	6076	6076
R^2	0.869	0.926	0.930	0.817	0.896	0.922	0.933
C. Public support for stricter environmental regulations: Strong vs. weak							
Post × Buyout	-0.032**	0.050	-0.001	-0.028***	-0.004	0.078	0.027
	(-2.51)	(0.39)	(-0.01)	(-2.77)	(-0.80)	(0.61)	(0.57)
Post × Buyout × StricterReg	-0.015	-0.032	-0.134*	-0.019	0.004	-0.013	-0.115*
	(-0.73)	(-0.22)	(-1.93)	(-0.96)	(0.67)	(-0.09)	(-1.86)
Observations	6076	6076	6076	6076	6076	6076	6076
R^2	0.868	0.925	0.930	0.816	0.896	0.922	0.933
All models							
Control for ln(Age)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 9: **Private Equity Buyout Effect: Other Cross-Sectional Differences**

This table shows additional cross-sectional patterns in the private equity buyout effect, indicated by different cohort dummies based on deal characteristics. HighCap is a dummy variable indicating cohorts in which the acquired plant's generation capacity is above the median of all acquired plants. Divestiture is a dummy variable indicating cohorts with a divestiture deal. Long (Short) is a dummy variable indicating cohorts in which the acquirer holds the acquired plant for more (less) than four years before exiting. ExitSBO (ExitM&A) is a dummy variable indicating cohorts in which the acquirer exits through an SBO (M&A) deal. Post and Buyout are dummy variables indicating the post-buyout years and the acquired plants, respectively. The event window is up to 11 years, from t-5 to t+5, with t=0 being the buyout year (in Panel D, if the exit occurs within the five-year post-buyout window, we include the observations only up to the year of the exit). Regression constants are not reported. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	1	2	3	4	5	6	7
	$\ln(CO_2/E)$	$\ln(SO_2/E)$	$\ln(NO_x/E)$	$\ln(H/E)$	$\ln(CO_2/H)$	$\ln(SO_2/H)$	$\ln(NO_x/H)$
A. Plant Capacity: High vs. Low							
Post × Buyout	0.003	-0.009	0.066	0.007	-0.004	-0.016	0.059
	(0.19)	(-0.08)	(1.32)	(0.50)	(-1.11)	(-0.15)	(1.20)
Post × Buyout × HighCap	-0.071***	0.060	-0.249***	-0.076***	0.005	0.136	-0.173***
	(-3.32)	(0.51)	(-3.61)	(-3.51)	(1.03)	(1.19)	(-2.76)
Observations	6076	6076	6076	6076	6076	6076	6076
R^2	0.869	0.925	0.930	0.818	0.896	0.922	0.933
B. Deal type: Divestiture vs. Non-divestiture							
Post × Buyout	-0.014	0.056	-0.097**	-0.017	0.003	0.073	-0.080*
	(-0.83)	(1.04)	(-2.11)	(-0.98)	(1.07)	(1.42)	(-1.86)
Post × Buyout × Divestiture	-0.049**	-0.047	0.011	-0.041*	-0.008*	-0.007	0.052
	(-2.03)	(-0.47)	(0.16)	(-1.71)	(-1.75)	(-0.07)	(0.86)
Observations	6076	6076	6076	6076	6076	6076	6076
R^2	0.869	0.925	0.930	0.817	0.896	0.922	0.933
C. Holding Period: Long vs. Short							
Post × Buyout × Long	-0.075*	0.050	-0.262***	-0.063*	-0.012**	0.113	-0.199***
	(-1.95)	(0.43)	(-3.23)	(-1.68)	(-2.30)	(1.05)	(-3.01)
Post × Buyout × Short	-0.045	0.152	-0.091	-0.041	-0.004	0.193	-0.051
	(-1.19)	(1.04)	(-1.02)	(-1.06)	(-1.00)	(1.43)	(-0.82)
Observations	2118	2118	2118	2118	2118	2118	2118
R^2	0.889	0.923	0.918	0.874	0.936	0.922	0.918
D. Exit Channel: SBO vs. M&A							
Post × Buyout × ExitSBO	-0.017	0.290**	-0.208***	-0.004	-0.013**	0.294**	-0.204***
	(-0.55)	(2.10)	(-3.62)	(-0.13)	(-2.53)	(2.16)	(-4.22)
Post × Buyout × ExitM&A	-0.131***	-0.183	-0.159	-0.123***	-0.009*	-0.060	-0.037
	(-3.81)	(-1.49)	(-1.43)	(-3.57)	(-1.75)	(-0.52)	(-0.45)
Observations	1689	1689	1689	1689	1689	1689	1689
R^2	0.918	0.930	0.933	0.904	0.945	0.928	0.929
All models							
Control for ln(Age)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 10: **Within-EGU Improvements vs. EGU Composition Effect**

In Panel A, we explore within-EGU variation by controlling for EGU-cohort fixed effects, which subsume the plant-cohort fixed effects in the baseline model. In Panel B, we show the effects on buyouts on log heat rate separately for coal- or oil-fired plants and natural gas-fired plants, both with and without controlling for EGU-cohort fixed effects. Each acquired plant is matched to a control plant based on year, state, primary fuel type, and a Mahalanobis distance measure. The event window is up to 11 years, from t-5 to t+5, with t=0 being the buyout year. Post is a dummy variable equal to one for the post-buyout years and zero for other years. Buyout is a dummy variable equal to one for acquired plants and zero for control plants. Regression constants are not reported. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Controlling for EGU-cohort Fixed Effects

	1	2	3	4	5	6	7
	ln(CO_2/E)	ln(SO_2/E)	ln(NO_x/E)	ln(H/E)	ln(CO_2/H)	ln(SO_2/H)	ln(NO_x/H)
Post × Buyout	-0.035***	0.027	-0.092**	-0.032***	-0.003	0.059	-0.060*
	(-2.99)	(0.47)	(-2.54)	(-2.84)	(-1.37)	(1.07)	(-1.91)
ln(Age)	-0.016	-0.205**	-0.033	-0.014	-0.002	-0.191*	-0.019
	(-0.38)	(-2.02)	(-0.30)	(-0.31)	(-0.42)	(-1.79)	(-0.24)
Observations	6074	6074	6074	6074	6074	6074	6074
R^2	0.913	0.949	0.972	0.887	0.976	0.947	0.973
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EGU-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Coal- or Oil-fired Plants vs. Gas-fired Plants

	Coal- or oil-fired plants		Gas-fired plants	
	1	2	3	4
	ln(H/E)	ln(H/E)	ln(H/E)	ln(H/E)
Post × Buyout	-0.141**	-0.019	-0.033***	-0.032***
	(-2.40)	(-1.51)	(-2.72)	(-2.69)
ln(Age)	-0.094	0.593**	0.039	-0.018
	(-1.45)	(2.82)	(1.55)	(-0.39)
Observations	464	464	5612	5610
R^2	0.396	0.857	0.848	0.889
Year-Cohort FE	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Subsumed	Yes	Subsumed
EGU-Cohort FE	No	Yes	No	Yes

Table 11: **Production Scale and Other Operational Changes**

In Panel A, we extend the baseline stacked DiD regressions to control for production scale measured by log electricity output. In Panel B, we examine the effect of private equity buyouts on other aspects of plant operations, including total electricity output, heat input, operating time (OPT), hourly output and input (E/OPT and H/OPT), capacity factor (CapFactor), and EGU retirement. Each acquired plant is matched to a control plant based on year, state, primary fuel type, and a Mahalanobis distance measure. The event window is up to 11 years, from t-5 to t+5, with t=0 being the buyout year. Post is a dummy variable equal to one for the post-buyout years and zero for other years. Buyout is a dummy variable equal to one for acquired plants and zero for control plants. Regression constants are not reported. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Controlling for Output Scale

	1 ln(CO$_2$/E)	2 ln(SO$_2$/E)	3 ln(NO$_x$/E)	4 ln(H/E)	5 ln(CO$_2$/H)	6 ln(SO$_2$/H)	7 ln(NO$_x$/H)
Post × Buyout	-0.040***	0.032	-0.081**	-0.038***	-0.002	0.069	-0.043
	(-3.32)	(0.55)	(-2.45)	(-3.16)	(-0.84)	(1.23)	(-1.51)
ln(Age)	0.054**	0.123	0.658***	0.033*	0.021	0.090	0.625***
	(2.23)	(1.03)	(5.15)	(1.83)	(1.06)	(0.75)	(5.00)
ln(Electricity)	-0.053***	-0.071	-0.249***	-0.070***	0.017*	-0.001	-0.180***
	(-3.56)	(-1.31)	(-5.26)	(-6.08)	(1.78)	(-0.02)	(-3.76)
Observations	6076	6076	6076	6076	6076	6076	6076
R^2	0.887	0.926	0.951	0.859	0.905	0.922	0.947
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Other Operational Changes

	1 ln(Electricity)	2 ln(HeatInput)	3 ln(OPT)	4 ln(E/OPT)	5 ln(H/OPT)	6 CapFactor	7 Retirement
Post × Buyout	0.039	-0.002	0.044	-0.005	-0.046**	0.004	-0.005
	(0.58)	(-0.03)	(0.67)	(-0.28)	(-2.52)	(0.59)	(-1.28)
Buyout							-0.000
							(-1.18)
ln(Age)	-0.005	0.028	0.235	-0.241**	-0.208**	-0.037	0.004**
	(-0.01)	(0.08)	(0.84)	(-2.08)	(-2.00)	(-0.96)	(2.14)
Observations	6076	6076	6076	6076	6076	6076	6076
R^2	0.899	0.899	0.892	0.907	0.916	0.880	0.667
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	No

Table 12: **Private Equity Buyout Effect: Robustness Checks**

This table shows the robustness of our baseline results. In Panel A, we use an event window 7 years (from *t*-3 to *t*+3 instead *t*-5 to *t*+5). In Panel B, we match each treated plant to up to four control plants (instead of one). In Panel C, we extend the baseline matching criteria to require that treatment and control plants operate under the same regulatory and market regime (ISO vs. non-ISO). In Panel D, we replace log capacity and capacity factor by log electricity output in our calculation of the Mahalanobis distance. In Panel E, we compute the Mahalanobis distance measure using the following alternative variables: the logarithms of the average CO_2/E, SO_2/E, NO_x/E in up to three pre-buyout years, and the average changes of ln(CO_2/E), ln(SO_2/E), and ln(NO_x/E) in those years. The model specifications are the same as those in Table 4. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	1 ln(CO_2/E)	2 ln(SO_2/E)	3 ln(NO_x/E)	4 ln(H/E)	5 ln(CO_2/H)	6 ln(SO_2/H)	7 ln(NO_x/H)
A. A 7-year Event Window							
Post × Buyout	-0.042***	-0.033	-0.079**	-0.037***	-0.004	0.005	-0.041
	(-3.55)	(-0.53)	(-2.37)	(-3.23)	(-1.65)	(0.08)	(-1.42)
Observations	4223	4223	4223	4223	4223	4223	4223
R^2	0.859	0.927	0.933	0.807	0.902	0.925	0.937
B. A 1-to-4 Treatment-control Ratio							
Post × Buyout	-0.045***	-0.001	-0.098**	-0.045***	-0.000	0.044	-0.053
	(-3.93)	(-0.02)	(-2.36)	(-4.02)	(-0.02)	(0.86)	(-1.46)
Observations	14438	14438	14438	14438	14438	14438	14438
R^2	0.841	0.881	0.893	0.791	0.874	0.878	0.891
C. Alternative Matching Variables: Baseline + ISO							
Post × Buyout	-0.046***	0.043	-0.091**	-0.043***	-0.003	0.086	-0.048
	(-3.72)	(0.73)	(-2.46)	(-3.52)	(-1.10)	(1.53)	(-1.48)
Observations	5779	5779	5779	5779	5779	5779	5779
R^2	0.872	0.928	0.932	0.820	0.899	0.924	0.935
D. Alternative Matching Variables: Output Instead of Capacity and Capacity Factor							
Post × Buyout	-0.048***	-0.001	-0.061	-0.047***	-0.001	0.046	-0.014
	(-3.99)	(-0.02)	(-1.52)	(-4.03)	(-0.35)	(0.98)	(-0.40)
Observations	6044	6044	6044	6044	6044	6044	6044
R^2	0.865	0.914	0.906	0.807	0.879	0.911	0.909
E. Alternative Matching Variables: Output Emission Rates							
Post × Buyout	-0.046***	-0.086*	-0.109***	-0.042***	-0.004*	-0.045	-0.067**
	(-3.63)	(-1.77)	(-3.00)	(-3.53)	(-1.95)	(-1.00)	(-2.06)
Observations	5678	5678	5678	5678	5678	5678	5678
R^2	0.872	0.936	0.924	0.820	0.901	0.932	0.924
All models							
Control for ln(Age)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 13: **Private Equity Buyout Effect: Results from Panel DiD Regressions**

This table shows the private equity effects on the EGU-level emission rates and heat rate estimated from the panel DiD regressions using the full sample. Panel A presents the results from the baseline specification, controlling for plant, owner, and year-by-state, and year-by-fuel type fixed effects. In Panel B, we further control for EGU fixed effects, which subsume plant-fixed effects. In Panel C, we extend the baseline specification by controlling for output scale. Regression constants are not reported. Standard errors are clustered by plant owner and year, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Baseline Specification

	1	2	3	4	5	6	7
	ln(CO_2/E)	ln(SO_2/E)	ln(NO_x/E)	ln(H/E)	ln(CO_2/H)	ln(SO_2/H)	ln(NO_x/H)
Post	-0.065***	0.016	-0.155**	-0.066***	0.001	0.082	-0.088*
	(-3.34)	(0.25)	(-2.62)	(-3.43)	(0.72)	(1.42)	(-1.87)
ln(Age)	0.068***	0.399***	0.534***	0.057***	0.010**	0.342***	0.476***
	(5.71)	(4.13)	(8.05)	(5.21)	(2.57)	(3.63)	(7.76)
Observations	52882	52882	52882	52882	52882	52882	52882
R^2	0.788	0.926	0.882	0.652	0.934	0.928	0.887
Year-State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Fuel Type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Owner FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Controlling for EGU Fixed Effects

	1	2	3	4	5	6	7
	ln(CO_2/E)	ln(SO_2/E)	ln(NO_x/E)	ln(H/E)	ln(CO_2/H)	ln(SO_2/H)	ln(NO_x/H)
Post	-0.051***	0.039	-0.105**	-0.054***	0.002	0.093	-0.051
	(-3.16)	(0.67)	(-2.31)	(-3.26)	(1.23)	(1.61)	(-1.41)
ln(Age)	-0.024**	0.138***	-0.064**	-0.032***	0.008**	0.170***	-0.033
	(-2.83)	(3.01)	(-2.78)	(-3.57)	(2.87)	(3.46)	(-1.49)
Observations	52774	52774	52774	52774	52774	52774	52774
R^2	0.865	0.953	0.953	0.767	0.962	0.953	0.955
Year-State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Fuel Type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Owner FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant FE	Subsumed	Subsumed	Subsumed	Subsumed	Subsumed	Subsumed	Subsumed
EGU FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel C. Controlling for Output Scale

	1	2	3	4	5	6	7
	ln(CO_2/E)	ln(SO_2/E)	ln(NO_x/E)	ln(H/E)	ln(CO_2/H)	ln(SO_2/H)	ln(NO_x/H)
Post	-0.055***	0.037	-0.121**	-0.057***	0.002	0.094	-0.064
	(-3.04)	(0.61)	(-2.32)	(-3.15)	(0.91)	(1.64)	(-1.52)
ln(Age)	0.050***	0.360***	0.473***	0.040***	0.010**	0.320***	0.433***
	(5.48)	(4.02)	(8.38)	(4.90)	(2.44)	(3.61)	(7.79)
ln(Electricity)	-0.068***	-0.148***	-0.229***	-0.066***	-0.003*	-0.083**	-0.163***
	(-9.87)	(-4.13)	(-12.02)	(-9.44)	(-2.02)	(-2.32)	(-8.45)
Observations	52882	52882	52882	52882	52882	52882	52882
R^2	0.822	0.928	0.905	0.711	0.934	0.929	0.901
Year-State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Fuel Type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Owner FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

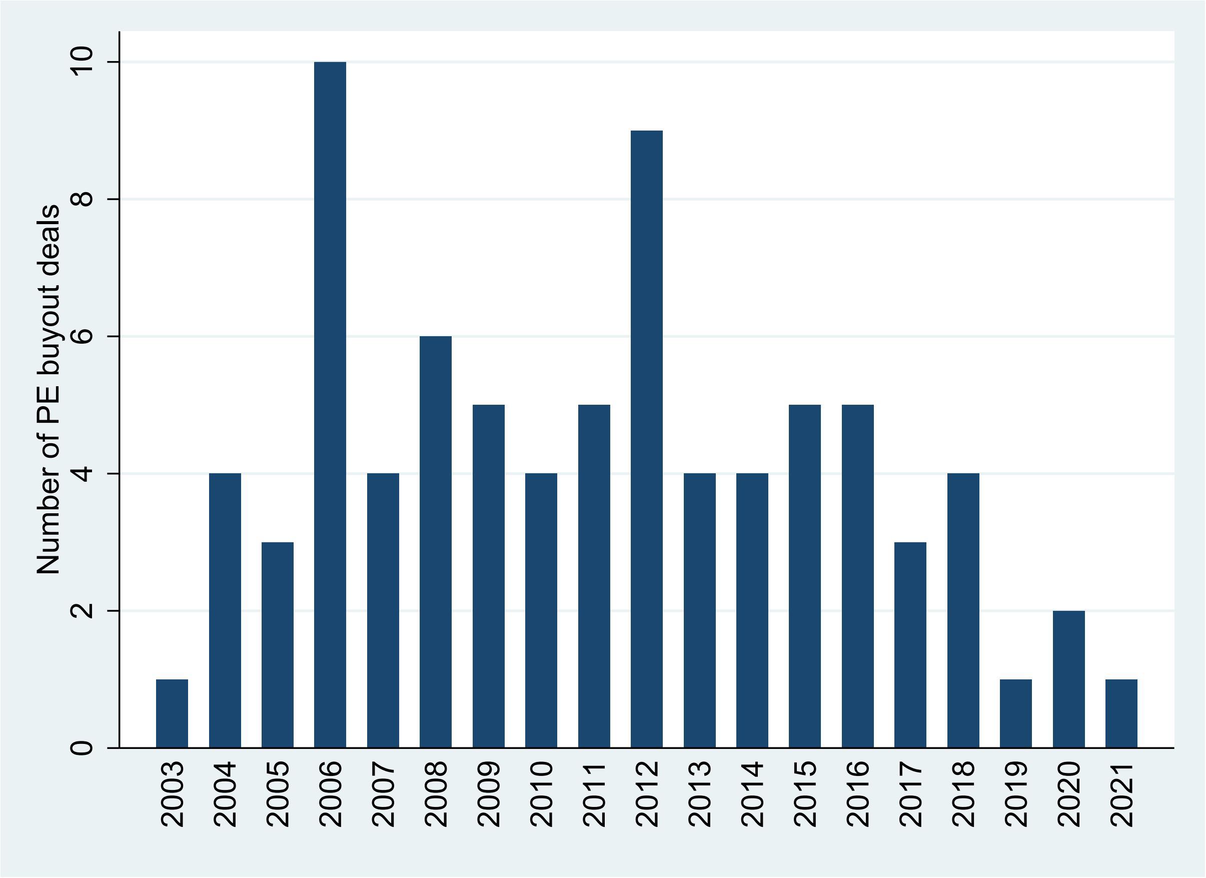
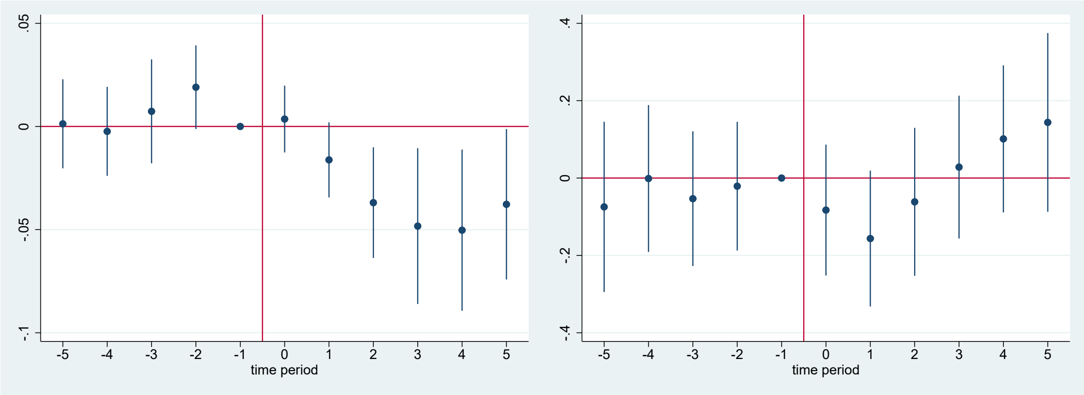
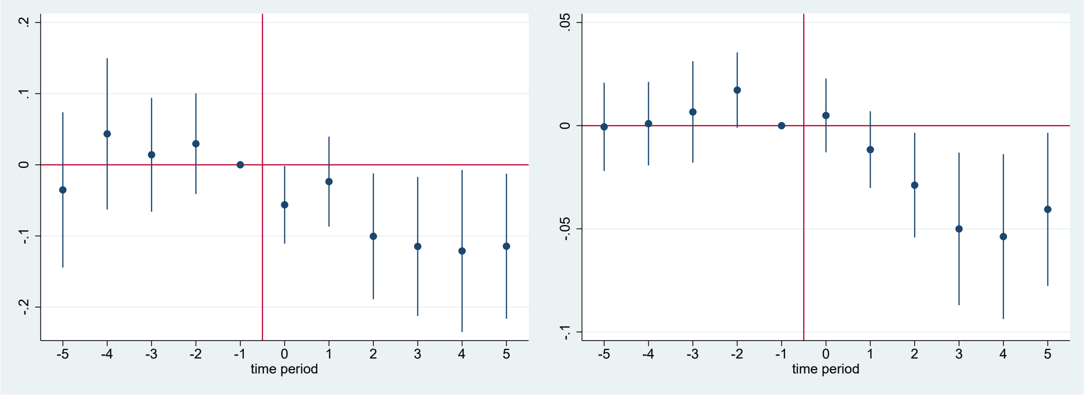


Figure 1: **The Number of Private Equity Buyout Deals in the Power Sector**. This figure shows, year by year, the number of completed private equity buyout deals in which the target firm is an owner of an electric power plant in our emissions data set. If a firm is acquired by private equity in multiple deals, we only count the first deal.



(A) Dependent Variable: $\ln(CO_2/E)$

(B) Dependent Variable: ln(SO2/E)



(C) Dependent Variable: $\ln(NOX_2/E)$

(D) Dependent Variable: ln(H/E)

Figure 2: **Coefficient Plot for Stacked DiD Regressions**. This figure shows the point estimates and 95% confidence intervals of the coefficients β_τ in Equation (4), where τ is the year relative to the buyout year (year 0) and $\tau = -1$ represents the base year. The dependent variables are the logarithms of the CO_2, SO_2, NO_2 output emission rates and the heat rate, respectively, in panels A to D.

A. Internet Appendix

This Internet Appendix contains supplementary tables of the paper by Xuanyu Bai and Youchang Wu titled "Private Equity and Gas Emissions: Evidence from Electric Power Plants."

Table IA1: **Financial Effects of Buyouts: Pro-ESG vs. Non-ESG Private Equity**

This table shows the private equity buyout effects on plant-level financial variables, allowing for potential difference between deals backed by pro-ESG and non-ESG private equity firms. The results are estimated using plant-level stacked DiD regressions. The outcome variables are the logarithms of fuel costs and wholesale price per MWh electricity generated, and operation & maintenance (O&M) and capital expenditures related to pollution abatement (also normalized by electricity generated). Each acquired plant is matched to a control plant based on year, state, primary fuel type, and a Mahalanobis distance measure. The event window is up to 11 years, from t-5 to t+5, with t=0 being the buyout year. Observations are weighted by the number of EGUs of a plant. Post is a dummy variable equal to one for the post-buyout years and zero for other years. Buyout is a dummy variable equal to one for acquired plants and zero for control plants. ESG is a cohort-level dummy equal to one for both the acquired and the matched control plants if the deal is backed by pro-ESG private equity firms and zero otherwise. Regression constants are not reported. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	1	2	3	4
	ln(FuelCost/E)	OM/E	Capx/E	ln(Price)
Post × Buyout	-0.065	-0.199	4.492	-0.058
	(-1.62)	(-1.01)	(1.47)	(-0.40)
Post × Buyout × ESG	-0.027	0.311	-5.082	-0.536
	(-0.37)	(1.44)	(-1.65)	(-1.57)
ln(Age)	0.430	0.517	23.200	0.197
	(1.37)	(0.45)	(1.37)	(0.20)
Observations	1144	344	344	292
R^2	0.942	0.907	0.694	0.901
Year-Cohort FE	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes

Table IA2: **Determinants of the Buyout Probability: Pro-ESG vs. Non-ESG private equity**

This table shows the results on the choice of buyout targets by pro-ESG and non-ESG private equity firms estimated using multinomial logistic models. The outcome variable is equal to 1 (2) if a plant is bought out for the first time in a deal backed by non-ESG (pro-ESG) private equity in a given year, and zero otherwise. All explanatory variables are lagged by one year and measured at the plant level. Observations for post-buyout years are dropped from the sample (i.e., only the first buyout deal of each target firm is considered). Variable definitions are provided in Table A.1. Standard errors are clustered by plant owner. We report z-statistics in parentheses, with statistical significance levels of 10%, 5%, and 1% indicated by *, **, and ***, respectively.

	1		2	
	Outcome		Outcome	
	1	2	1	2
$\ln(CO_2/E)$	-0.480	-0.527*	0.712	-1.876
	(-1.50)	(-1.78)	(0.92)	(-1.64)
$\ln(SO_2/E)$	-0.065	-0.113	-0.193	0.305
	(-0.81)	(-0.83)	(-1.51)	(1.40)
$\ln(NO_x/E)$	0.151	-0.155	0.224	0.103
	(0.94)	(-0.94)	(0.85)	(0.26)
ln(H/E)	0.606	1.002		
	(0.82)	(0.81)		
ln(Age)	-0.493***	0.046	-0.537*	-0.085
	(-3.93)	(0.29)	(-1.78)	(-0.30)
ln(Capacity)	0.307**	0.031	-0.026	-0.338
	(2.26)	(0.13)	(-0.10)	(-1.18)
CapFactor	-0.351	-0.827	-0.859	-4.427***
	(-0.57)	(-0.87)	(-0.35)	(-2.79)
ISO			0.151	0.398
			(0.19)	(0.41)
ln(FuelCost/E)			0.473	-1.546
			(0.86)	(-1.60)
OM/E			-0.482	-170.953
			(-0.97)	(-1.38)
Capx/E			-0.068*	-1.812
			(-1.77)	(-0.87)
Constant	-4.085*	-5.739	-9.704	17.862**
	(-1.75)	(-1.30)	(-1.49)	(2.14)
Observations	18181		6314	
Pseudo R^2	0.031		0.103	

Table IA3: **Stacked DiD Regressions at the Plant Level: Additional Results**

This table shows additional results from plant-level stacked DiD regressions. Panel A shows the private equity buyout effect on private equity buyout effect on the emission rates and the heat rate after controlling production scale. Panel B shows the effect of private equity buyout on the aggregate capacity, output, input, emissions, and the number of EGUs (N_Unit) at the plant level. Each acquired plant is matched to a control plant based on year, state, primary fuel type, and a Mahalanobis distance measure. The event window is up to 11 years, from t-5 to t+5, with t=0 being the buyout year. Observations are weighted by the number of EGUs of a plant. Post is a dummy variable equal to one for the post-buyout years and zero for other years. Buyout is a dummy variable equal to one for acquired plants and zero for control plants. Regression constants are not reported. Standard errors are clustered by plant owner, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Controlling for Output Scale

	1 ln(CO_2/E)	2 ln(SO_2/E)	3 ln(NO_x/E)	4 ln(H/E)	5 ln(CO_2/H)	6 ln(SO_2/H)	7 ln(NO_x/H)
Post × Buyout	-0.035**	0.040	-0.083*	-0.034**	-0.002	0.074	-0.050
	(-2.05)	(0.48)	(-1.85)	(-1.99)	(-0.50)	(0.91)	(-1.28)
ln(Age)	-0.015	-0.213	0.119	-0.015	-0.000	-0.198	0.134
	(-0.31)	(-1.14)	(0.75)	(-0.30)	(-0.03)	(-1.08)	(0.95)
ln(Electricity)	-0.032***	-0.232***	-0.173***	-0.026**	-0.006*	-0.206***	-0.147***
	(-2.77)	(-2.97)	(-5.29)	(-2.40)	(-1.68)	(-2.65)	(-5.63)
Observations	1894	1894	1894	1894	1894	1894	1894
R^2	0.964	0.975	0.982	0.949	0.990	0.975	0.981
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Aggregate Production Scale and Emissions

	1 ln(Capacity)	2 ln(Electricity)	3 ln(HeatInput)	4 N_Unit	5 ln(CO_2)	6 ln(SO_2)	7 ln(NO_x)
Post × Buyout	-0.007	0.024	-0.011	0.007	-0.012	0.058	-0.064
	(-0.30)	(0.25)	(-0.12)	(0.11)	(-0.14)	(0.55)	(-0.74)
ln(Age)	0.089	0.411*	0.385*	0.169	0.383*	0.103	0.459**
	(0.98)	(1.91)	(1.74)	(0.90)	(1.74)	(0.40)	(2.07)
Observations	1894	1894	1894	1894	1894	1894	1894
R^2	0.995	0.974	0.972	0.993	0.973	0.981	0.970
Year-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table IA4: **Public Opinions and Gas Emissions**

This table shows the differences in power plant environmental performance between states classified by survey-based public opinion. LowerEmi is a dummy equal to one if a plant is located in a state in which the fraction of respondents believing that the government should take action to lower power plant gas emissions is above the median value across the states. StricterReg is a dummy variable equal to one if a plant is located in a state in which the fraction of respondents believing that stricter environmental laws and regulations are worth the cost is above the median across the states. The regressions use annual observations at the plant level, weighted by the number of EGUs of each plant. Standard errors are clustered by state, t-statistics are in parentheses, and statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Strong vs. Weak Support for Lower Emissions

	1 $\ln(CO_2/E)$	2 $\ln(SO_2/E)$	3 $\ln(NO_x/E)$	4 ln(H/E)	5 $\ln(CO_2/H)$	6 $\ln(SO_2/H)$	7 $\ln(NO_x/H)$
LowerEmi	-0.056	-0.561	-0.387*	0.002	-0.058*	-0.563	-0.389*
	(-1.28)	(-1.31)	(-1.69)	(0.11)	(-1.83)	(-1.35)	(-1.79)
Constant	6.486***	-3.489***	-1.059***	2.318***	4.167***	-5.808***	-3.378***
	(228.59)	(-12.72)	(-11.24)	(198.15)	(182.72)	(-21.44)	(-38.41)
Observations	17645	17645	17645	17645	17645	17645	17645
R^2	0.050	0.077	0.084	0.016	0.044	0.074	0.087
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Strong vs. Weak Support for Stricter Environmental Regulations

	1 $\ln(CO_2/E)$	2 $\ln(SO_2/E)$	3 $\ln(NO_x/E)$	4 ln(H/E)	5 $\ln(CO_2/H)$	6 $\ln(SO_2/H)$	7 $\ln(NO_x/H)$
StricterReg	-0.073*	-0.643	-0.468**	-0.002	-0.070**	-0.641	-0.466**
	(-1.69)	(-1.52)	(-2.15)	(-0.13)	(-2.25)	(-1.55)	(-2.27)
Constant	6.499***	-3.412***	-0.997***	2.321***	4.178***	-5.733***	-3.319***
	(210.02)	(-11.61)	(-10.21)	(181.58)	(172.88)	(-19.80)	(-36.76)
Observations	17820	17820	17820	17820	17820	17820	17820
R^2	0.054	0.080	0.093	0.016	0.050	0.076	0.097
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes