The Shifting Finance of Electricity Generation*

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Abstract

While large regulated incumbents in the energy industry face positive incentives to create new energy-generating assets, we find that market deregulation and capital from the private equity industry and from foreign investors have played an outsize role in the adoption of new technologies. Over the 2005–2020 period, domestic publicly listed corporations reduced their ownership of U.S. electric power from 71% to 54% of total generation. Private equity, institutional investors, and foreign publicly listed corporations increased their ownership from 6% to 24%, and as of 2020 owned 60% of wind, 45% of solar, and 28% of natural gas generation capacity. Deregulated electricity markets attract more capital from new entrants to create new plants and acquire existing ones as well as accelerate the decommissioning of coal plants. We find only limited support for the leakage hypothesis that new entrants acquire older fossil-fuel power plants from incumbent domestic listed corporations and keep operating these plants. The changing ownership structure has implications for electricity markets as private equity operates power plants more efficiently at lower heat rates and sells electricity for a $2.04 higher average price per MWh. Within markets of a given regulatory structure, time, and technology, private equity owners sell electricity under contracts with shorter duration, shorter increment pricing, and more peak-term periods, especially when selling electricity generated from fossil fuels.

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1 Introduction

The impacts of both competition and financing on promoting innovation have been a significant topic of research for most of the past century. Schumpeter (1942) argued that the canonical firm in an environment of perfect competition has fewer incentives and lesser scope to adopt new technologies compared to larger firms in oligopolistic markets. Implementing innovation also requires investors willing to put capital at risk, so if smaller firms are to disrupt larger ones with new technologies, the smaller firms require significant financing. Arrow (1962) in contrast argued that market power stifles innovation, as firms wish to protect their rents and avoid cannibalization of existing assets. The destruction process is also costly as incumbents face legal or regulatory risks associated with legacy technologies and will question whether they should retain "stranded" assets or transfer them to specialized firms.[1] Whether the implementation of new technologies comes more from dominant incumbents or smaller new entrants depends on the competitive and regulatory environment, as well as the availability of capital whose owners are willing to bear risk (Shapiro, 2011).

In the electric power industry, regulated investor-owned utilities that serve as incumbents generally receive compensation for the fixed costs of building new assets via the regulatory process (Averch and Johnson, 1962; Joskow and Schmalensee, 1986; Joskow, Rose, and Wolfram, 1996),[2] and have other advantages including size, access to the electrical grid, synergies with existing operations, and the ability to influence government policy.[3] However, incumbents may prefer to delay the implementation of new technology when they are protected by limited competition and a lack of market discipline, as in Arrow (1962).[4] In this paper, we find that in the electricity generation

[1] The term "stranded assets" refers to legacy assets whose values unexpectedly and prematurely decline and expose incumbents to economic losses and risks. In the energy industry, the term refers to older assets using fossil fuels whose value may decline due to technology shifts or regulations promoting green energy.

[2] Public Utility Commissions (PUCs) will increase a utility's rate base for new construction, and in some cases include credits for Construction Work in Progress (CWIP).

[3] Much of the recent literature on increasing concentration and rise of large firms has emphasized these advantages of large incumbents more generally (e.g., Chandler, 1994; Autor et al., 2020; Kwon, Ma, and Zimmermann, 2023).

[4] The empirical literature that has found evidence of this channel includes Bertrand and Mullainathan (2003), Gutiérrez and Philippon (2017), and Cunningham et al. (2021). The incentives to promote innovation may also depend

industry, despite the advantages of regulated incumbents, it is deregulation that has driven the creation and destruction of new assets, in that it has facilitated the creation and destruction of assets by new owners: private equity and foreign corporations.

The electricity generation industry is well-suited to examine the role of competition and adoption of new technology for three reasons. First, power plants are infrastructure assets that can stimulate economic growth through spillovers to other sectors and provision of vital services to the population (Glaeser and Poterba, 2020). Blackouts and volatility in electricity pricing can have a profound influence on industrial production, quality of life, and poverty. War conflicts and other global events have also heightened demands for energy independence across countries, a goal that requires substantial new investments. Second, energy is a capital-intensive sector that has experienced a great deal of innovation, including new renewable technologies using solar and wind energy as well as the shale gas boom (e.g., Gilje, Loutskina, and Strahan, 2016). Adopting these technologies requires large amounts of capital. Third, electricity generation is at the center of government environmental policy and demands for reduced carbon emissions.[5] The electricity generation industry requires substantial investments if its carbon footprint is to be further reduced.

We collect data on the ownership of U.S. power plants and document that, over the 2005–2020 period, the ownership share of domestic listed corporations (DLCs) has declined from 71% to 54%, while the total U.S. electricity generation has remained roughly constant at around 4.1 trillion kWh per year. Private equity (PE), institutional investors, and foreign listed corporations have gradually replaced DLCs in the ownership of both renewable and fossil fuel power plants. As of 2020, PE, institutional investors, and foreign listed corporations together owned 60% of wind, 45% of solar, 28% of natural gas, and 11% of coal electricity generating capacity.

on the firm's ownership structure (Aghion, Van Reenen, and Zingales, 2013; Antón, Ederer, Giné, and Schmalz, 2023).

[5]The International Energy Association (2021) calculated that energy investments must rise to $5 trillion per year by 2030 to achieve net zero emissions by 2050. At the 26th Glasgow Conference of the Parties, 450 financial institutions that manage $130 trillion of assets pledged to use their funds towards that goal (Council on Foreign Relations, 2021).

We analyze the relative importance of three mechanisms that could drive these ownership changes — creation of new power plants, acquisitions of existing power plants, and decommissioning (shutdown) of power plants — as well as the economic conditions that facilitate ownership transitions. To do this, we compare the role of incumbent owners, which are primarily DLCs, and new owners which include PE, institutional investors, and foreign corporations, in each of the three mechanisms, as a function of the extent of local electricity market deregulation.

Our primary measure of deregulated markets captures whether the wholesale electricity market is administered by an independent balancing authority rather than a traditional vertically integrated utility.[6] The staggered introduction of market dispatch mechanism and independent system operators (ISOs) as balancing authorities represents an important source of regional-level variation in market competition (Borenstein and Bushnell, 2015; Cicala, 2022). The ISO-operated wholesale markets were established almost exclusively before our sample period, and before new technologies became competitive, which reduces concerns regarding reverse causality. We also consider other more restrictive measures of deregulation at the wholesale and retail levels.

The first mechanism driving ownership changes focuses on differences in the creation of new power plants. Deregulated electricity markets exhibit a higher degree of creation of new greenfield power plants. Consistent with a strong role for new entrants in creating greenfield assets, we find that PE and foreign-listed corporations are disproportionally more likely to finance the creation of new assets. PE and foreign corporations create more new renewable solar and wind plants as well as natural gas plants.[7] For instance, conditional on power plant fuel type (i.e., solar, wind, natural gas, coal, and other production technologies) and plant state, PE is 1.32 percentage points more

[6]The introduction of ISO balancing authorities occurred during the wave of state-level restructurings in the 1990s and early 2000s, before the expansion of renewable technologies and shale gas. The restructuring reform allowed independent power producers to sell electricity to utilities, and new retail service providers to displace utilities' role in procuring energy and billing customers. The wholesale market restructurings are generally associated with production cost reductions (Fabrizio, Rose, and Wolfram, 2007; Davis and Wolfram, 2012; Cicala, 2015).

[7]This is somewhat in contrast to the focus of the PE literature on PE funds that acquire and improve portfolio companies (Gompers, Kaplan, and Mukharlyamov, 2016).

likely to own a given power plant in the greenfield stage than DLCs, representing an increase of 82% relative to the baseline greenfield share of 1.63%. Institutional investors are considerably less likely to directly own a greenfield plant, as they seek more mature operating assets with stable cash flows. Our results do not merely reflect differences in creation probabilities between regulated utilities and independent power producers (IPPs), as IPPs owned by DLCs are significantly less likely to own greenfield plants. However, the difference in new power plant creation between DLCs versus PE and foreign corporations is significant only in deregulated markets, which explains how these markets finance a higher proportion of greenfield assets.[8]

The creation of new plants and the entrance of new ownership types have implications for the existing power plants. Some research has raised concern that sales of existing plants by incumbent DLCs to PE, institutional investors, and foreign corporations could lead to leakage (reallocation) of older fossil fuel power plants by delaying their decommissioning and extending their operation (Fowlie, Reguant, and Ryan, 2016; Copeland, Shapiro, and Taylor, 2021). Stricter disclosure requirements apply to DLCs, and they are also more likely to be affected by public pressure (Benthem et al., 2022; Bolton and Kacperczyk, 2022).[9] DLCs might therefore sell their older power plants to owners who are subject to more lenient regulatory and disclosure requirements such as PE (see Bernstein (2022) for a review) and foreign corporations.[10]

Using a competing risk model for power plants owned by DLCs, we analyze their decisions to sell or decommission power plants. The second mechanism, sales of existing operational power plants, is

[8]Our results therefore do not support the Averch and Johnson (1962) argument that regulated utilities engage in more capital investments because they receive an artificially high rate of return on capital. Traditional electricity markets exhibit a lower level of asset creation, potentially because state utility commissions adhere to the "used and useful principle" when permitting new investments. Under this principle, electric utilities need to show that a power plant will be used and useful to current ratepayers to get the regulator's approval to include a corporate investment in the cost of service.

[9]One example of the increased public scrutiny is the 2021 action by activist investor Engine No. 1 in collaboration with several large asset managers to win board seats at Exxon Mobil Corporation. The activist investors then voted to cut oil production at Exxon, and Exxon reportedly sold some oil fields to PetroChina (Rubenfeld and Barr, 2022).

[10]The leakage hypothesis relates to the concerns about outsourcing pollution in international trade (e.g., Antweiler, Copeland, and Taylor, 2001; Cherniwchan, Copeland, and Taylor, 2017; Shapiro and Walker, 2018; Shapiro, 2021).

important for the reallocation of electricity-generating assets from DLCs to new entrants and these transactions are twice more likely to occur in deregulated markets. However, there is little evidence that these sales support the leakage hypothesis. First, the older the plant, the more likely the plant is to be retired by the DLC and the less likely it is to be sold and still operating. Second, DLCs are less likely to sell and more likely to decommission coal plants, which use the most polluting fuel type of the six main fuels.

The decommissioning of power plants is the third mechanism and deregulated electricity markets amplify also this mechanism as there are more plant shutdowns in these markets. We examine the differences in the probability of decommissioning plants across ownership types using Cox hazard models. Differences in the probability of decommissioning plants could lead to leakage if the new owners are more likely to continue operating plants for a longer period than DLCs. We find some evidence supporting the leakage hypothesis as DLCs are more likely to retire power plants than foreign corporations, but the differences with PE are economically smaller and insignificant. The incumbent DLCs and new entrants do not consistently display different sensitivity to market regulation for all fossil fuel type. Deregulated electricity markets therefore do not exhibit more leakage but rather induce all owners jointly to decommission more plants.[11]

Overall, deregulated electricity markets amplify all three mechanisms of ownership changes as they exhibit more creation of new assets, transactions of operational plants, and shutdowns of plants. Deregulated markets attract more capital from PE, institutional investors, and foreign corporations so these new entrants provide 32% of the electricity in these markets in 2020 as compared to only 12% in traditional markets with vertically integrated utilities. In terms of economic factors, the effect of market deregulation on heterogeneity in ownership structures is robust to controlling for

[11]When investing directly in power plants, institutional investors seem to reduce their exposure to the creation of new assets as well as shut down of old assets, as these activities are associated with higher liability and litigation risks (e.g., Bellon, 2022; Lam, 2022). Consequently, we find that institutional investors do not hold almost any plants in the decommissioning stage but have also very limited overall exposure to coal power plants.

climate concerns among the state population, and policy incentives for renewable energy.

The ownership changes have implications for the operational performance of power plants, contracting of electricity transactions, and pricing in electricity markets. Based on the ratio of fuel consumption relative to electricity generation (heat rate), fossil fuel power plants owned by PE, institutional investors, and foreign corporations operate more efficiently than power plants owned by DLCs and consume around 5% less fuel per unit of electricity. The lower heat rate automatically implies reduced carbon emissions and pollution. The efficiency improvements by new entrants relative to DLCs are also concentrated in deregulated markets with more competitive pressure. We also reject an alternative version of the leakage hypothesis, namely that the new owners might operate the older fossil fuel assets more intensively or less efficiently. If anything, DLCs operate fossil fuel plants at a higher intensity (capacity factor), particularly in traditional markets.

Using the Federal Energy Regulatory Commission (FERC) data on wholesale electricity transactions, we find that PE implements substantially different electricity contracts, though primarily in the non-renewables space. PE-owned power plants sell electricity for $2.04 higher average price per MWh relative to other producers of the same fuel type in the same state and month. PE owners enter into contracts with more short-term duration, lower length pricing increments, and more peak-period sales, all conditional on fuel type, location, and time. Direct ownership by institutional investors is associated with longer-term contracts and contracts with longer increment lengths, in line with their objective to obtain stable long-term cash flows from infrastructure investments (Andonov, Kräussl, and Rauh, 2021). The results overall indicate that the pricing by PE is at higher levels and of shorter duration than pricing by DLCs.

In addition to the literature on the role of new entrants as adopters of technology (e.g., Shapiro, 2011), our findings also relate to research on the role of regulation and market power in the environmental space (Porter, 1996; Jaffe and Palmer, 1997) as we observe that owners with a monopoly on customers, such as incumbent domestic corporations, industrial firms, cooperatives, and government, are the last to adopt new technology (Aghion, Bergeaud, and Van Reenen, 2021). Our results contribute also to the literature on climate finance (e.g., Hong, Karolyi, and Scheinkman, 2020; Giglio, Kelly, and Stroebel, 2021), as we highlight the role of capital expenditures and greenfield investments from new entrants and competitive markets in accelerating the energy transition away from legacy electricity generation technologies. Our results on the limited acquisitions of older fossil fuel power plants by new entrants complement findings that banks also reduce financing of these plants (Green and Vallee, 2022). We show that these reduced financing sources force DLCs to retire older fossil fuel assets, especially in competitive markets.

Our paper relates to the energy economics literature that studies the deregulation of wholesale electricity markets, or more specifically the ceasing of regulating vertically-integrated utilities based on cost-of-service and the impact on market power in deregulated markets (e.g., Borenstein, Bushnell, and Wolak, 2002; Borenstein, 2002) and efficiency gains from markets (e.g., Fabrizio, Rose, and Wolfram, 2007; Cicala, 2015, 2022). Demirer and Karaduman (2023) find that acquired power plants experience efficiency increases. Our contribution is to show that as the regulatory status changes, ownership structure also changes, and new participants, such as PE and foreign corporations, potentially drive efficiency improvements in the deregulated electricity markets.

Finally, our paper relates to the literature on the impact of PE on efficiency and productivity.[12] We study the creation of new assets and retirement of existing assets, rather than focusing only on changes in ownership through acquisitions. PE plays a major role in adopting new technologies and shutting down stranded assets, but this is not necessarily attributable to PE's business model and high-powered incentives, since foreign corporations also adopt innovative technologies. The

[12]Prior research has examined the impact of PE ownership on operational performance, productivity, employment, and profitability (e.g., Davis et al., 2014; Bernstein and Sheen, 2016; Antoni et al., 2019; Davis et al., 2021; Howell et al., 2022); workplace safety, employees health, and employee satisfaction (e.g., Cohn et al., 2021; Lambert et al., 2021); environment and pollution (e.g., Shive and Forster, 2020; Bellon, 2022; Bai and Wu, 2023); customers in regulated industries such as education and healthcare (e.g., Eaton, Howell, and Yannelis, 2020; Liu, 2022).

creation and destruction seem to be primarily affected by market competition, incumbency status, and pressures specific to U.S. listed corporations versus their foreign and private counterparts.

2 Power Plants and Electricity Markets

2.1 Power Plant Characteristics and Ownership

Our sample covers all U.S. power plants reporting to the Energy Information Administration (EIA) over the 2005–2020 period. We use EIA Form 923 to collect data on monthly electricity generation at the level of a power plant by technology by month, which we call the "power-plant-prime-mover" level. That is, if a power plant uses multiple technologies (prime movers) for generating electricity (e.g., a natural gas plant using a steam turbine, combustion turbine, and combined-cycle combustion turbine), it will have multiple observations. EIA Form 860 provides information on all U.S. power plants with at least 1MW of nameplate capacity.[13] We aggregate the information from EIA Form 860 for power-plant generators that use the same prime-mover technology and merge both datasets on a power-plant-prime-mover level. Table 1 shows that our sample contains 11,590 unique power plants, 13,278 unique power-plant-prime-mover units, and 1,509,336 monthly observations. Fossil fuel power plants often use multiple prime-mover technologies, while nuclear, hydro, wind, and solar power plants rely only on one prime-mover technology. When we use the term power plant in this paper, we refer to power-plant-prime-mover observations.

Table 1 reports summary statistics on the average power plant characteristics. In our analysis, all values are weighted by power plant nameplate capacity. We present weighted statistics and regression estimates, as the sample contains many small power plants that contribute very little to overall net generation. For instance, there are 3,941 solar power plants in the sample, but they

[13] For example, if a 1MW plant runs at its maximum strength for an hour it would produce 1MWh of electricity. The average US residential customer consumed around 10MWh of electricity in a year: [Link]

account for less than 3% of electricity generation in 2020. The average power plant (weighted by capacity) has a nameplate capacity of 0.98GW (980MW) and is 30.9 years old.

We construct two measures of power plants' operating performance. First, the capacity factor captures operating intensity and is defined as the ratio of net electricity generation to monthly capacity (the maximum potential output). Power plants differ in the average capacity factor based on the fuel type. Nuclear plants operate almost continuously and have the highest capacity factor of 0.86, while solar plants depend on the weather and have the lowest capacity factor of 0.24.[14] Second, the heat rate captures operating efficiency and is defined as the ratio of fuel consumption in millions of Btu to electricity generation in MWh. We observe the heat rate for fossil fuel and nuclear plants, and lower values imply lower fuel consumption and higher efficiency.

During our sample period, the electricity industry exhibited substantial construction of new greenfield plants and decommissioning of old plants. Out of 13,278 unique plants, 6,111 are new greenfield plants, and their first 12 months of operation account for 1.63% of the sample on a capacity-weighted basis. Greenfield plants use either renewable solar and wind technologies or natural gas fuel, following the shale gas boom. The decommissioned indicator is equal to one for the last 12 months of operation before a plant is shut down. During our sample period, 2,011 power plants were shut down, and their last 12 months of operation account for 1.05% of the sample. Decommissioned plants are concentrated in fossil fuels, such as coal and natural gas.

We manually collect ownership data of all power plants based on regulatory announcements, Preqin infrastructure dataset, S&P Global, and newswire articles, and classify the owners into eight categories.[15] The largest category based on ownership stakes is *domestic publicly listed corporations*,

[14]One limitation of the nameplate-capacity-weighting is that power plants that use fuels with lower capacity factors receive disproportionately higher weights than power plants that use fuels with higher capacity factors. In our analysis, we rely primarily on capacity weights within a fuel type, but we also estimate tests without weighting. In these tests, we limit attention to the subsample of power plants with a capacity of at least 20MW. Online Appendix Table A.1 reports summary statistics without weighting the power plants and focuses only on the subsample of power plants with a capacity of at least 20MW.

[15]We do not classify tax equity investors as owners because tax equity investors do not have decision-making power and acquire different share classes (Shive, 2022).

or DLCs, which includes both traditional utilities and listed independent power producers (e.g., Duke Energy, Exelon, PG&E, Southern Company, etc.). DLCs are the incumbent owners of power plants as the vast majority originated from vertically-integrated electric utilities.[16]

The other traditional owners of power plants are industry firms, government, and cooperatives. The *industry* category includes power plants owned by industrial companies engaged in producing paper, steel, aluminum, and other energy-intensive manufacturing (e.g., International Paper Co, Dow Chemical Co, Alcoa Corporation, etc.). These industrial firms consume most of the produced energy for their own factories. The *government* category includes power plants owned by federal, state, and local governmental entities (e.g., Tennessee Valley Authority, U.S. Bureau of Reclamation, etc.). The electric *cooperatives* category covers power plants that are built and owned by the communities they serve (e.g., Basin Electric Power Coop, Associated Electric Coop, etc.).

The new rising owners of power plants are private equity, institutional investors, and foreign corporations. The *private equity* category includes investments made by private equity buyout and infrastructure funds as well as other investment vehicles (e.g., ArcLight, KKR, LS Power, Macquarie, etc.). In this category, we also incorporate a small number of power plants owned by private firms (e.g., Caithness Energy, Koch Industries, Tenaska, etc.). The *institutional investors* category covers direct investments of pension funds, insurance companies, and sovereign wealth funds in power plants. Almost all direct investments come from foreign institutional investors, such as Canadian and Dutch pension funds (e.g., CPPIB, OMERS, APG, etc.). The *foreign publicly listed corporations* category covers power plants owned by European, Canadian, and Asian energy companies (e.g., EDP Group, Engie, Iberdrola, ITOCHU, Osaka Gas, etc.). The final category includes *other* small power plants, which we have not classified yet in one of the other categories.

Table 1 and Figure 1 show that we categorize 99% of electricity generation in any month over

[16]The domestic publicly listed corporations category includes also YieldCo companies, such as NRG Yield and NextEra Energy, established by U.S. corporations to sell minority stakes and raise capital.

2005–2020 period into one of the seven ownership categories. If a power plant is owned by multiple ownership types, we divide the ownership and generation equally across the ownership types (i.e., if a private equity and institutional investor jointly own a power plant, we assume that each ownership type owns 50% of the plant). This adjustment does not matter for most ownership types, as they typically act as sole investors and acquire 100% stake in the power plants, except for institutional investors. Institutional investors often co-invest with other investors and share ownership in 87% of their observations.[17] Thus, institutional investors do not lead energy investments but provide deep pockets for larger transactions or partial exit to other investors (Fang, Ivashina, and Lerner, 2015; Andonov, Kräussl, and Rauh, 2021; Lerner, Mao, Schoar, and Zhang, 2022).

Figure 1 shows that the percentage of electricity generated by power plants owned by DLCs declines from 70% in 2005 to 54% in 2020. Private equity, institutional investors, and foreign corporations replace DLCs as their share jointly increases from 7% in 2005 to 24% in 2020. The generation share of governments, cooperatives, and industry firms remains constant. The ownership changes while the total output remains constant. Online Appendix Figure A.1 Panel A shows that the U.S. produced around 4.1 trillion kWh of electricity in 2005 and the total output has remained constant over our sample period. Panel B plots the total imports and exports of electricity, which also remain stable and account for less than 1.5% of the U.S. electricity market.

The ownership structure of power plants differs across fuel types. Figure 2 depicts ownership for the six main fuel types: natural gas, coal, nuclear, hydro, wind, and solar.[18] Renewable fuels have a smaller contribution to overall electricity generation, so we scale the y-axis for their plots to 35TWh, while nuclear and fossil fuels account for the majority of generation and we scale the

[17]For instance, Canada Pension Plan Investment Board co-invested with Energy Capital Partners fund in the buyout of Calpine Corporation in 2018. Alberta Investment Management Corporation established a joint venture with AES Corporation to acquire Sustainable Power Group LLC in 2017.

[18]The hydro category includes only power plants using hydraulic turbines and excludes plants with pumped storage. The solar category includes only power plants with a photovoltaic prime mover and excludes plants with steam turbines that can use a solar stream. The EIA data covers only utility-scale solar and does not include information on distributed small-scale solar. The capacity of the small-scale solar installations is 33GW in 2021, or 50% of the capacity of utility-scale solar, so the EIA data underestimates the importance of solar energy (EIA Table 4.3).

y-axis for their plots to 200TWh. Over the 2005–2020 period, natural gas became the main fuel for electricity generation and replaced declining coal generation. Wind and solar energy are increasing and account for the majority of newly created plants. The amount of electricity generation from hydro and nuclear power plants stays relatively stable and the ownership of these assets also does not exhibit significant shifts. The new types of owners (private equity, institutional investors, and foreign corporations) controlled 34% of the natural gas, 58% of the wind, and 47% of the solar electricity generation as of 2020. DLCs own a large part of the generation in all fuel types, but they are especially negatively affected by the declining coal generation.

2.2 Regulation of Electricity Markets

ISO Balancing is our main measure of market deregulation, and it is an indicator for power plants that operate in a wholesale market administered by an Independent System Operator (ISO) as a balancing authority. The ISOs were formed after the adoption of the Energy Policy Act of 1992 and Federal Energy Regulatory Commission orders 888 and 889 to provide nondiscriminatory grid access.[19] In the areas that are not serviced by an ISO, vertically integrated local electric utilities own power plants generating electricity as well as the transmission system and delivery network. These utilities do not adopt a market dispatch mechanism and could potentially exclude independent producers from the market by denying transmission access (Borenstein and Bushnell, 2015; Cicala, 2022). The vertically integrated utilities are typically owned by the government or DLCs. Importantly for our analysis, the ISO-operated wholesale markets were established before our sample period, mostly around 2000, and before the wind and solar technologies became competitive as well as before the shale gas revolution, which reduces concerns regarding reverse causality that ISOs were created to stimulate the adoption of new technologies.

[19] Our definition classifies the following balancing authorities as ISO: California Independent System Operator, Electric Reliability Council of Texas, Midcontinent Independent System Operator, ISO New England, New York Independent System Operator, PJM Interconnection, and Southwest Power Pool.

ISO Restructured is a more restrictive definition of market deregulation than *ISO Balancing* and captures power plants that participate in a wholesale market administered by an ISO balancing authority and are located in areas with restructured electric utilities. States that have an ISO balancing authority and restructured electric utilities required vertically integrated utilities to break up through asset sales. In these cases of forced divestiture, the utilities sold off their power plants or transferred them to unregulated affiliates (Fabrizio, Rose, and Wolfram, 2007; Cicala, 2015). The forced divestitures were completed by 2002, so they did not drive the ownership changes in our sample period, but these measures created relatively more competitive markets. Based on Table 1 Panel D, 61% of the power plants participate in a wholesale market that is administered by an ISO balancing authority, while only 37% participate in a wholesale market administered by an ISO balancing authority and are located in areas with restructured electric utilities.[20]

An alternative measure of the regulatory environment captures states that have restructured their retail electricity markets, i.e. marketing and resale of wholesale power to end-use customers (Borenstein and Bushnell, 2015). The *Retail Choice* measure is equal to one for power plants located in an area (typically state level) where residential or business customers have some level of choice of who provides their electricity.[21] These state restructuring initiatives stopped after the California electricity crisis in 2000–2001, and there were no changes after 2003.

Online Appendix Table A.2 shows how many power plants in each state operate under a deregulated wholesale and retail market. The *ISO Balancing* measure is broader and covers also states that did not restructure their utilities but agreed to operate in a competitive wholesale market. On the other hand, the vast majority of power plants located in an area that offers a *Retail Choice*

[20] *ISO Restructured* classifies mainly the following balancing authorities as restructured markets: Electric Reliability Council of Texas, ISO New England, New York Independent System Operator, and PJM Interconnection.

[21] *Retail Choice* equals one for states that offer full choice (e.g., Illinois and Pennsylvania) as well as limited choice (e.g., California and Michigan). We construct this indicator based on the EIA classification of restructurings as of 2003 (EIA summary: link) and verify the retail market status using regulatory documents and industry reports, such as National Renewable Energy Laboratory, ElectricChoice, and American Coalition of Competitive Energy Suppliers.

participate in an *ISO Restructured* wholesale market. While there is significant overlap between ISO Restructured and Retail Choice, several states such as California, Nevada, and Oregon retain the structure of vertically integrated utilities while offering at least limited retail choice.

In addition to the market regulation, we also control for climate concerns and renewable energy policy incentives on a state level. The climate concern measure is based on the Yale Climate Opinion Survey (Howe, Mildenberger, Marlon, and Leiserowitz, 2015) which was created in 2014 and then rerun in 2016, 2018, and 2021.[22] The comparison of responses within a state over time is limited by changes in the survey design, but we use it to control for cross-sectional differences across states in the same year. Our *Climate Concern* variable is based on the percentage of the state population who think that global warming is happening and is defined as the percentile ranking of the state where the plant is located. The percentile rankings of states based on climate concern over time are very stable and, therefore, we merge the survey ranking in 2014 with our data on power plants over the 2005–2014 period. We make similar adjustments with the later survey waves.

We use the Database of State Incentives for Renewables & Efficiency from the N.C. Clean Energy Technology Center to collect information on the policy incentives introduced by different states to stimulate the transition to renewable energy. We split the policy initiatives into three types of tax incentives: Renewables Corporate Tax, Renewables Property Tax, and Renewables Sales Tax; and two types of production incentives: Renewables Production and Renewables Tariffs.[23] Our analysis includes a *Renewables Incentives* index, which aggregates the three tax indicators and the two production indicators. Online Appendix Table A.3 presents the average value of the five indicators and aggregate renewables incentives index by state over the 2005–2020 period. The index varies

[22]The Yale Climate Opinion Maps data has been used by Bernstein, Gustafson, and Lewis (2019) and Baldauf, Garlappi, and Yannelis (2020) to examine the relation between climate change beliefs and real estate prices.

[23]Renewables Corporate Tax Incentives capture programs that provide a corporate tax credit, corporate tax deduction, and corporate depreciation. Property tax incentives capture programs offering property tax exemption or reduction. Sales tax incentives offer an exemption or reduction from sales and use tax for equipment, generation, etc. Renewables Production Incentives offer monetary compensation per KWh that can differ by fuel type and plant capacity. Renewable Tariffs capture primarily feed-in tariffs, which offer long-term contracts with an above-market price to renewable energy producers.

from 0.00 in Arkansas to 3.91 incentive types in Vermont.

2.3 Pricing and Contractual Terms of Electricity Sales

We merge the EIA power plant data with information on pricing and contracting of electricity sales from the Federal Energy Regulatory Commission (FERC) Electric Quarterly Reports (EQR). The FERC EQR data is available from July 2013 to December 2020, and we convert the quarterly reports into monthly data.[24] The FERC regulatory requirements affect (larger) power plants located in states that are interconnected with other states. This requirement implies that power plants located in the Electric Reliability Council of Texas, Alaska, and Hawaii are not required to report to FERC as they are not interconnected with power plants in other states.[25]

The two main products that power plants sell are capacity and electricity. The capacity sales are used in some wholesale electricity markets to pay power plants for being available to meet predicted electricity demand in the future. The objective of capacity markets is to cover the fixed costs of building and maintaining power plants and ensure having sufficient capacity in the future. However, capacity sales do not represent a commitment to produce electricity. Power plants sell electricity to meet consumers' demands using separate spot-market or long-term contracts.

Overall, we merge 305,225 monthly observations of plants owned by DLCs, private equity, institutional investors, and foreign corporations with FERC data on contractual terms and pricing. We do not analyze electricity transactions of power plants owned by government, cooperatives, and industrial firms as they typically do not transact on the wholesale market, but rather use their electricity generation for their own consumption within an area that they exclusively serve.[26] Panel

[24] If an electricity transaction in the FERC dataset continues over multiple months, we split the quantity and transaction charges across the months based on the number of days contracted in each month.

[25] The FERC EQR data has been used by Lin, Schmid, and Weisbach (2021) to study pricing and liquidity management.

[26] Sections 205(c) and 201(f) of the Federal Power Act define who must submit EQRs to FERC. The reporting provisions do not apply to the United States, a state, or any political subdivision, as well as electric cooperatives. The reporting requirements also do not apply to utilities that make less than 4,000,000 MWh of annual wholesale sales.

A of Table 2 shows that the average electricity price is \$33.67 per MWh, while the median price is \$31.13 per MWh.

We classify electricity transactions based on contractual terms in three ways. First, we distinguish between short and long-term contracts. Electricity sales transactions with contract durations of one year or greater are classified as long-term, while transactions with shorter contract durations are classified as short-term. Second, we split the transactions into short, medium, and long based on the increment pricing terms. Transactions with short increments use 5-minute, 15-minute, or hourly increments (up to 6 hours) to determine the price. Medium transactions have daily increments (6 to 168 hours). Long transactions use monthly or yearly increments (longer than 168 hours). Third, we classify transactions into full-period, peak, and off-peak based on the peaking terms. Full-period transactions cover both peak and off-peak periods.

Panel A of Table 2 reports the average percentage of transaction charges for electricity sales by different contractual terms, while Online Appendix Table A.4 presents the average percentage of the quantity of electricity sold by different contractual terms. Around 58% of the electricity charges are for sales under contracts with short durations and 50% of the transactions use short increments to determine the price. Transactions covering the full period account for 38% of the charges. Peak period sales are more expensive as they account for 31% of the quantity and 35% of the charges, while off-peak sales are smaller and cheaper. Power plants using fossil fuels, such as coal and natural gas, are more flexible to adjust operating hours so they rely relatively more on short-term contracts, short increment pricing, and peak-term production for electricity sales. Solar and wind power plants have limited flexibility in operating hours, so they use relatively more long-term contracts, long increment pricing, and full-period contractual terms for electricity sales.

Panel B of Table 2 presents summary statistics on capacity sales. The number of power plants that receive compensation for maintaining available capacity in the future is smaller than the number of power plants selling electricity, as not all wholesale markets have a capacity market and power plants must submit bids on competitive auctions to receive compensation for maintaining capacity. Power plants using renewable technologies, such as solar and wind, are significantly less likely to make capacity sales. Around 85% of the capacity sales are made under long-term contracts with a duration of longer than 1 year. There is very limited variation in the increment and peaking period terms as almost all capacity sales use long-term increments and cover the full period.

3 Market Regulation and the Mechanisms of Ownership Changes

The main trend that we document is the declining ownership share of DLCs from 70% in 2005 to 54% in 2020. Private equity, institutional investors, and foreign corporations have gradually replaced DLCs as new owners of renewable and fossil fuel power plants. These ownership changes can occur through three mechanisms: creation of new power plants, sales of existing plants, and decommissioning of plants. In this section, we examine the relative importance of the three mechanisms as well as the role of electricity market deregulation in stimulating ownership changes.

3.1 Creation of New Greenfield Power Plants

The first mechanism examines differences in the probability of creating new power plants. Energy markets experienced substantial innovation over our sample period, and we analyze which owners are more likely to implement innovative technologies as well as whether the ownership types display different sensitivity to the economic conditions. Our dataset does not provide information on all potential entries, so we do not estimate the probability of completing a proposed power plant. We estimate the differences in capacity-weighted conditional means to own a newly created greenfield plant across ownership types relative to their baseline ownership stakes while controlling for fuel types, location, and market regulation.

Creating and owning new power plants is risky as it exposes the owners to risks related to connecting the plant to the electric grid and establishing sales contracts with customers. One potential hypothesis is that DLCs, which are the traditional incumbent asset owners in our setting, may have competitive advantages for creating new assets. Their advantages are size, established access to the transmission network, synergies with existing operations, and ability to impact government policy. However, an alternative hypothesis is DLCs may instead prefer to delay the implementation of new technology (Arrow, 1962), especially under the protection of market power (Bertrand and Mullainathan, 2003; Cunningham, Ederer, and Ma, 2021).

In terms of economic factors, our focus is on the role of market regulation as it affects the ability of a power plant to operate and sell electricity. Deregulated electricity markets may attract relatively more capital from investors as the transmission is not operated by a monopolist utility that is also involved in electricity generation. We use the indicator for power plants participating in a wholesale market administered by an ISO balancing authority as our main indicator for deregulated electricity markets. Figure 3 Panel A shows that deregulated markets with an ISO balancing authority attract more capital to adopt new technologies and create greenfield power plants. In 2020, greenfield power plants created during our sample period represent 28% of the total installed capacity in markets with an ISO balancing authority and 22% of the total installed capacity in markets with a traditional balancing authority. Panel B shows that this difference is concentrated in renewable power plants as newly created solar and wind plants represent 15% of the installed capacity in ISO balancing markets and only 9% in traditional markets, and the difference increases over time.

These figures suggest that electricity market deregulation is an important economic factor that attracts investments in new power plants. We examine which ownership types drive these differences. We compare the probability of creating greenfield power plants across ownership types and their sensitivity to market regulation. This analysis enables us to disentangle how much different ownership structures create new assets from what may be a general preference to invest in certain fuel types (e.g., preference for renewable energy). In Table 3, we estimate pooled OLS regressions where the unit of observation is at the plant-prime-mover-month level. The dependent variable is binary and captures whether a plant is a greenfield plant or not; it is set at one for the first 12 months of plant operation. In the pooled OLS regressions, we weigh the power plants by nameplate capacity which assigns a higher weight to larger power plants. The OLS regressions are more suitable for our setting than nonlinear logit regressions as our focus is on the marginal effects rather than the latent index variable (Angrist and Pischke, 2009; Bertrand et al., 2007). Online Appendix Table A.5 shows that our results are robust to using logit specifications instead of pooled OLS, and without weighting the observations by nameplate capacity. However, we rely more on the OLS specification as the weighted coefficients are economically more relevant and include a more saturated set of fixed effects.

To distinguish willingness to create new assets from preferences to invest in certain technologies, we interact several fixed effects. The fuel type fixed effects capture the baseline level that a solar or natural gas power plant is greenfield, while state fixed effects capture differences in weather conditions or available natural resources affecting plant location. In our analysis, we saturate the specifications by including fully interacted fuel-type, state, and year-month fixed effects. When including this saturated set of interacted fixed effects, the estimates rely only on variation in ownership and probability of creating greenfield assets across power plants using the same fuel, located in the same state, and at the same moment of time.

The unconditional probability equals 1.63% which captures the proportion of power plants that are in their first greenfield level in any given month. We find that DLCs are significantly less likely to own a given greenfield power plant relative to their baseline probability of owning any power plant. Based on Column (1), DLCs have a 1.00 percentage point lower probability of owning a greenfield plant than the omitted ownership types, which are PE, institutional investors, and foreign corporations. This coefficient corresponds approximately to a 61% decrease relative to the baseline unconditional probability. The probability that DLCs create fewer power plants is not equally distributed across all states. The interaction term of DLC and ISO balancing authority in Column (3) of Table 3 shows that DLCs are especially less likely to create new power plants in states with deregulated wholesale electricity markets. The baseline coefficient on DLCs in Column (3) is insignificant which implies that DLCs are equally likely to create a given greenfield power plant in states with traditional markets as PE and foreign listed corporations. The interaction term of DLCs and ISO balancing authority implies that DLCs are around 1.12 percentage points less likely to own a given greenfield plant in states with deregulated markets than in states with traditional markets.

Column (4) considers an interaction term between DLC and our alternative more restrictive measure of wholesale market deregulation, *ISO Restructured*. Here the results are even stronger, with DLCs 1.46 percentage points less likely to own a given greenfield plant in states with an ISO balancing authority and restructured electric utilities. Column (5) includes an interaction term of DLCs and with *Retail Choice* variable. This can also be seen as a restriction on the ISO balancing measure, as only some areas that are administered by an ISO balancing authority offer electricity supplier choice to residential and business customers. This interaction term is economically even more significant and suggests that DLCs are 2.65 (=0.85+1.80) percentage points less likely than the alternative new owners (PE, institutional investors, and foreign corporations) to own a given greenfield plant in states that offer a competitive retail choice to customers. These results suggest that the existence of a deregulated electricity market is the main economic condition that attracts investments by new ownership types in greenfield power plants.

Figure 4 Panel A reports the coefficients of a subsample analysis instead of including interaction terms in the specifications. This figure shows that private equity and foreign listed corporations have a disproportionally higher probability of owning a greenfield power plant and this difference is concentrated almost entirely in deregulated electricity markets. Based on Panel A, private equity and foreign corporations have a 1.90 and 1.12 percentage points higher probability of owning a greenfield power plant in wholesale markets administered by an ISO balancing authority, respectively.

In Panels B and C of Figure 4, we consider heterogeneity by fuel type in the greenfield ownership results.[27] The specifications focus on greenfield plants using solar, wind, and natural gas fuels as they account for the vast majority of newly created power plants. The baseline probability for greenfield solar and wind plants is 13.66%, which is relatively high as these new technologies were not adopted before our sample period and almost all solar and wind plants have 12 months of greenfield stage. The baseline probability for greenfield natural gas plants is 1.47% which is lower as they are added to an already existing capacity of natural gas plants. However, in terms of capacity, the newly installed solar & wind and natural gas plants are equally important as the natural gas plants are larger. DLCs are significantly less likely to own new renewable as well as new fossil fuel plants.

Panel B shows that private equity and foreign corporations have a 6.49 and 3.66 percentage points higher probability of owning greenfield solar and wind power plants, respectively. The heterogeneity in ownership of new wind and solar farms is economically stronger in competitive electricity markets but does not seem to be entirely concentrated in these markets. States with traditional markets also attract more capital from private equity and foreign corporations to finance new renewable power plants relative to DLCs.

Within the subsample of natural gas power plants, we observe that only private equity is more likely to create new natural gas plants. The coefficient on foreign corporations is statistically not different from DLCs. The difference in the probability of creating new natural gas power plants between DLCs and private equity is entirely concentrated in deregulated electricity markets. For instance, in ISO Restructured markets, private equity firms are 1.92 percentage points more likely to

[27] Online Appendix Table A.7 presents a robustness test that reports the coefficients for DLCs from specifications of greenfield power plants by fuel type that use interaction terms instead of subsamples.

create a new natural gas plant, while in traditional markets the coefficient is -0.51 and statistically insignificant.

When analyzing the other ownership types, we find that institutional investors have a lower probability of owning greenfield power plants after controlling for interacted fixed effects, even though Figure 2 shows that they own a substantial share of the wind and solar power plants. Thus, institutional investors seem to prefer to co-invest in established operational renewable energy assets, but are less willing to create these new power plants. In the analysis, we control but do not report the coefficients on government, cooperatives, and industrial firms. These ownership structures are also less likely to create new power plants.

In the OLS specifications, power plants that have been created earlier in the sample period are considered greenfield only in the first 12 months and later have multiple observations that are not classified as new entries, so creating power plants at the end of the sample period can appear as relatively more greenfield and bias some of the estimates. To address this limitation, we estimate a robustness test by limiting attention only to the subsample of greenfield power plants so plants created at any time during the sample period are equally important. In Table 4, the dependent variables are the ownership stakes of DLCs, private equity, and foreign corporations, and we examine the relation with market regulation.

These specifications confirm that electricity market competition significantly affects the types of corporate ownership that create new power plants. Within the subsample of greenfield observations, we find that private equity and foreign corporations are more likely to create new plants in deregulated markets. Based on Panel A, DLCs have a 23.1 percentage point lower probability of owning greenfield plants in markets with retail choice, while private equity and foreign corporations have a 19.3 and 4.7 percentage points higher probability of owning greenfield plants in markets with retail choice. Market deregulation attracts financing from private equity and foreign corporations to create and own new renewable as well as natural gas power plants.

Another potential concern is that the differences in the probability of owning newly created power plants between DLCs and new entrants may just reflect the differences in the probability of creating new power plants between regulated electric utilities and independent power producers (IPPs). DLCs operate both as regulated electric utilities as well as IPPs, while the new entrants operate predominantly as IPPs. This alternative hypothesis would predict that traditional regulated electric utilities should be less likely to own greenfield power plants because they need approval from the state public utility commissions to make new investments and to adjust their rate base. Under this alternative hypothesis, we would expect that the baseline coefficient on IPPs in Table 3 Column (6) should be positive and significant, while the interaction term of DLC $\times$ IPP should not be significant, as this would suggest that IPPs create more power plants and the ownership of IPPs does not matter. However, we document that the baseline coefficient on IPPs is not economically and statistically different from zero, while the interaction term DLC $\times$ IPP is negative and significant. This interaction term suggests that ownership structure matters as within the universe of IPPs domestic corporations are 1.93 percentage points less likely to own a greenfield power plant.

In Online Appendix Table A.6, we estimate a robustness test where we do not weigh the observations by power plant capacity and examine whether the results are driven by a few large newly created plants. In this test, we analyze the subsample of power plants with a nameplate capacity above 20MW as we also want to avoid that small solar plants drive the results. The unconditional baseline probability in this unweighted subsample equals 2.75% as compared to 1.63% in the weighted broad sample, which shows that the newly created power plants tend to be on average smaller than the existing power plants. The results confirm that DLCs are less likely to create new power plants than private equity and foreign corporations. The difference in the probability of creating new electricity generating assets is concentrated in deregulated wholesale and retail electricity markets.

Overall, PE and foreign listed corporations are significantly more likely to create new power plants and their willingness to finance the capital expenditures to adopt new innovative technologies contributes significantly to the changing ownership structure. The market organization driven by restructurings affects the extent to which PE and foreign corporations finance new fossil fuel and renewable power plants as compared to DLCs, which have traditionally dominated electricity markets. We can conclude that the higher degree of creation in deregulated markets is driven by the ability of these markets to attract additional capital flows from private equity and foreign corporations into new greenfield assets.

3.2 Sales and Decommissioning of Power Plants

In this section, we jointly consider the second and third mechanisms of ownership transition: sales and decommissioning of power plants. The sale of existing power plants by incumbent DLCs to new ownership structures, such as PE, institutional investors, and foreign corporations has received significant attention in prior research on cross-border mergers and acquisitions (see Erel, Jang, and Weisbach (2022) for a review), and private equity leveraged buyouts (see Bernstein (2022) for a review).

To assess the relative importance of the sale-and-acquisition mechanism we start by focusing on all power plants that were owned by DLCs at the beginning of our sample in January 2005, when DLCs accounted for 70% of the electricity generation and before their share declined to 54%. We classify all power plants that were owned by DLCs into four potential outcomes based on the latest observation in our dataset. The latest observation is either the shutdown date or December 2020 for plants that are not decommissioned. These are the four potential outcomes: *Still Own & Operating* covers plants that did not change ownership and are still operated by domestic corporations; *Owned*

& Retired captures plants that did not change ownership, but were retired by domestic corporations during the sample period; *Sold & Operating* captures plants that were sold to other ownership type and are still operated by these new owners; and *Sold & Retired* covers power plants that were sold to other ownership types and were retired by these new owners during the sample period.

The top panel of Table 5 presents the probabilities for all these four outcomes weighted by nameplate capacity. We observe that DLCs retain ownership and continue operating 1,083 out of 2,194 power plants or 62% of their initial capacity. The sales mechanism is economically similar to the decommissioning mechanism. DLCs retired 16.6% and sold 21.2% (= 19.2% + 2.0%) of their initial capacity. However, the importance of these two mechanisms differs across the two main fossil fuel types. In the subsample of coal and petroleum plants, DLCs retired 26.4% of the initial capacity, while only 11.7% of the initial capacity is sold and still operated by the new owners. In the subsample of natural gas plants, DLCs retired only 9.8%, while selling more than 35% of the initial capacity. These statistics highlight that the decommissioning of coal power plants by DLCs is a highly relevant mechanism for the energy transition.

The main concern frequently raised in the financial press and industry reports regarding the sales mechanism is that DLCs transfer older polluting power plants to other owners.[28] Based on this leakage hypothesis, DLCs face a higher degree of regulatory pressure and public scrutiny (Benthem et al., 2022; Bolton and Kacperczyk, 2022). PE and foreign corporations are subject to more lenient regulation and weaker reporting requirements so they may be willing to own and operate older power plants for longer. Thus, the leakage hypothesis would predict that private equity and foreign corporations should be more likely to continue operating older fossil fuel plants and postpone their decommissioning.

In Table 5, we report the hazard ratios of competing risk models and compare the characteristics

[28]See for example the Private Equity Stakeholder Project report "Private Equity Propels the Climate Crisis: The Risks of a Shadowy Industry's Massive Exposure to Oil, Gas and Coal" and the New York Times article "Private Equity Funds, Sensing Profit in Tumult, Are Propping Up Oil."

of power plants that are sold and retired by DLCs. In columns (1) to (3), the main event is a power plant sale, while the competing event is a plant decommissioning. In columns (4) to (6), the main event is plant decommissioning, while the competing event is a power plant sale. The results provide very mixed evidence on the leakage hypothesis.

Consistent with the leakage hypothesis, DLCs are more likely to sell power plants operating in deregulated markets, controlling for the competing risk of decommissioning them. Based on column (2), for example, DLCs are twice more likely to sell a plant in an ISO restructured market after controlling for fuel type, plant size, and age. DLCs are also less likely to retire power plants in an ISO restructured market as shown in column (5), but the hazard ratios are not significantly different in ISO balancing or retail choice markets. In addition, the coefficients on plant age that are greater than one in columns (1)-(3) suggest that older plants are slightly more likely to be sold, and DLCs are also more likely to sell power plants in states where the population displays high climate concerns.

These results contrast however, with two other results that push against the leakage hypothesis. First, focusing on the coal coefficient, DLCs are less likely to sell (columns (1)-(3)) and more likely to decommission coal power plants, which of course are the most polluting fuel type of the six main fuels.[29] Second, DLCs are much more likely to decommission an older power plant than a younger one, by a factor of four to one for every unit increase in log age.

The competing risk model has the advantage of including all power plants ever owned by DLCs, as well as taking into account the timing of sales and decommissioning events (earlier or later in the sample period). A simpler model for interpretation is a multinomial logit, which we can use to provide a snapshot of outcomes for plants that were owned by DLCs in January 2005. The advantage of the multinomial logit model is that we can classify separately more potential outcomes and also

[29] In the specifications, we control for all 19 fuel types that are part of the EIA classifications but display the coefficients only for coal, nuclear, hydro, wind, and solar power plants (the omitted category is natural gas plants).

study the probability that DLCs sell a power plant and the new owner decommissions this plant before the end of the sample period. We show this robustness in Online Appendix Table A.8 and most of the results are generally similar. One new result is that, in deregulated markets, the new owners are also more likely to retire the acquired power plants. If a plant is located in an ISO balancing market, it has a 4.4 percentage points higher probability of being acquired and decommissioned by the new owners, which is a substantial increase relative to the baseline probability of 3.7% for this outcome. This additional result provides further evidence against the leakage hypothesis. In the multinomial logit specification we see that while DLCs are indeed more likely to retire older power plants, they are also less likely to sell older power plants than younger ones.

Overall, the sales mechanism is highly relevant but explains only one-third of the ownership transitions and does not have a substantial effect on plants using new renewable technologies or coal plants using older technologies. While in other industries transactions account for the vast majority of ownership changes and privatization reforms (e.g., La Porta and López-de Silanes, 1999; Dinc and Gupta, 2011; Howell, Jang, Kim, and Weisbach, 2022), creation of new power plants as well as decommissioning of older plants are highly relevant in the energy sector. The power plant transactions are also concentrated in deregulated markets which confirms that the electricity market organization influences the capital flows from new ownership types.

In terms of the economic conditions that drive decommissioning, our focus is again on the role of energy market regulation. Figure 3 shows that the decisions to commission new greenfield plants and decommission old plants closely follow each other, as the figures display correlated trends over time. In line with the trend of plant creation, Panel C shows that owners shut down more power plants in deregulated markets with an independent balancing authority. The cumulative hazard rate implies a decommissioning rate in deregulated markets that is around 49% higher than in regulated markets, as reflected by a decommissioning rate of 16% in markets with an independent balancing authority versus 11% in traditionally regulated markets. Panel D shows that this effect is driven by differences in fossil fuel plant retirements. This is in contrast to the asset creation differential between regulated and deregulated markets, which is driven by differences in the creation of solar and wind power. Overall, the figure shows that deregulated markets stimulate both faster retirement of older plants and more creation of newer plants, while in the previous section we showed that there were also more transactions in deregulated markets.

In Table 6, we estimate the differences in decommissioning power plants across ownership types and market regulation settings using a Cox proportional hazard model, where the unit of observation is the plant-prime-mover-month. The hazard rate of decommissioning a power plant is defined as the probability that a decommissioning will be completed in month t conditional on it not becoming complete prior to month t. The hazard event is the complete decommissioning of a power plant, not for example a partial retirement of one generator. The Cox proportional hazard model is robust to time-specific common factors, which is analogous to controlling for time fixed effects (Dinc and Gupta, 2011).

To exclude the effects of a large number of smaller plants on the results, we estimate this specification only on power plants with a nameplate capacity of at least 20MW, although as robustness in Table **??** we conduct an OLS analysis on the full sample with observations weighted by power plant nameplate capacity. We also control for plant capacity as larger power plants have greater strategic importance for network stability and security of electricity supply. One limitation of the hazard models is that we cannot include interacted fixed effects, but we still control for fuel and state fixed effects. We also control for plant age which in combination with fuel-type fixed effects captures the profitability and efficiency of a power plant. In these specifications with a saturated set of interacted fixed effects and plant age, the ownership coefficients can be interpreted as differences in the hazard rate of decommissioning a power plant controlling for differences in profitability of different fuel sources and technologies, with coefficients greater than one reflecting an increased hazard relative to the baseline.

Column (1) suggests that DLCs are more likely to retire power plants than are other ownership types, which on its face could be consistent with leakage, although we will see below this result is not robust. Column (2) shows DLCs are more likely to retire power plants relative to institutional investors (who do almost no retiring) and foreign corporations. The difference with private equity is economically smaller and statistically insignificant. Institutional investors appear not to want to own plants during the decommissioning stage. Consistent with our findings on greenfield assets, institutional investors appear to seek stable operating assets. Columns (3) to (6) show that the differences in decommissioning hazard ratios seem to be concentrated in deregulated markets, but they are not statistically significantly different from traditional markets.

In Columns (3) through (6) of Table 6, we also examine whether the role of market deregulation in explaining the heterogeneity in ownership structure across decommissioned power plants is robust to two other economic factors. First, states where the population displays higher climate concerns may pressure relatively more the incumbent DLCs to retire power plants relatively faster after controlling for age and fuel technology. For instance, the higher climate concern among the population could incentivize politicians in these states to adopt stricter regulations and licensing of old power plants. Second, states implement various tax and production-based incentives to stimulate the transition to renewable energy and different ownership types may display different sensitivity to these incentives when deciding whether to retire an existing power plant. However, we do not find robust evidence of these effects on decommissioning, and the differences in ownership of decommissioned plants do not merely reflect differences in the sensitivity of DLCs, PE, and foreign corporations to climate concern or renewable energy policy incentives.

In Online Appendix Table A.9, we provide robustness analysis using OLS, defining a dependent variable that equals one for the last 12 months of the plant's operation. These specifications allow for weighting by power plant capacity and include fully interacted fuel-type, state, and year-month fixed effects. The unconditional probability equals 1.05% which represents the proportion of power plants that are in this decommissioning stage in any given month. Based on Column (1), DLCs have no higher probability of owning a decommissioned plant as compared to the omitted ownership types, which are PE, institutional investors, and foreign corporations, when analyzing power plants using the same fuel, located in the same state, and at the same moment of time. Similar to the Cox hazard results, column (2) shows that private equity has a similar probability to own retired power plants as DLCs, while institutional investors and foreign listed corporations have a 1.06 and 0.73 percentage points lower probability of owning a decommissioned power plant.

In terms of economic significance, Figure 2 shows that institutional investors and foreign corporations have very limited exposure to legacy power plants using coal, which is the main fuel type subject to shutdowns, and this may explain the lack of a statistically significant coefficient on DLCs. We also observe that smaller power plants, as proxied by nameplate capacity, and older power plants have significantly higher decommissioning rates. The estimated effects on these controls confirm that decommissioning decisions are affected by the strategic importance and profitability of technology over time.

In contrast to the Cox hazard regressions, in the OLS specifications the probability that DLCs shut down power plants does appear to vary by the regulatory environment in some statistically significant ways. Based on the interaction term with ISO balancing authority in Column (3) of Appendix Table A.9, DLCs are 0.77 percentage points less likely to shut down power plants in regulated electricity markets, but a largely offsetting coefficient on the interaction term with ISO Balancing eliminates this difference in states with deregulated wholesale electricity markets. We also find that the interaction term of DLCs and climate concern percentile ranking of the state is positive and statistically significant, suggesting that the differences in the probability to shut down existing power plants may be related to the stronger sensitivity of DLCs to climate concerns among the population. Other results largely parallel those in Table 6.

So far the results suggest that DLCs may be marginally more likely to shut down power plants than other ownership types, which provides some evidence supporting the leakage hypothesis. However, the effect is not robust and PE is the second most likely ownership type to decommission power plants. What is clear is that there is overall more decommissioning of older plants in deregulated markets.

Next, in Figure 5, we examine how the differential decommissioning results across ownership types (DLCs vs PE and foreign corporations) might vary by fuel type across fossil fuel technologies (coal vs natural gas).[30] Panel A confirms that on average private equity has similar decommissioning rates as DLCs; foreign corporations have lower decommissioning rates, and the difference is statistically significant in ISO balancing markets. The effects of private equity relative to DLCs differs across fuel types: PE seems to be less likely to retire coal and petroleum power plants particularly in restructured electricity markets, but seems to be more likely to retire natural gas plants. However, most coefficients are statistically insignificant so the evidence is not as clear as in the greenfield analysis. Online Appendix Table A.10 confirms this analysis by showing that DLCs seem to have a slightly higher probability of retiring coal and petroleum power plants.

Overall, we observe that the higher level of power plant shutdowns in deregulated markets, presented in Figure 3 Panel C, reflects a higher decommissioning rate of coal and petroleum power plants by DLCs. These differences in the retirement of these fossil fuel plants might at first glance appear to provide supporting evidence of the leakage hypothesis. However, a more consistent interpretation is that competitive electricity markets with an independent balancing authority and

[30] If a power plant is designed to use both coal and natural gas as a fuel, we classify this plant in the sample of coal and petroleum power plants. Some natural gas power plants use also biogenic municipal solid waste, landfill gas, wood waste, or other gases as alternative fuels, so we can still include fuel-state-time fixed effects in the specifications.

retail choice stimulate a faster transition away from fossil fuels since DLCs are retiring more fossil fuel plants in deregulated markets and, critically, new ownership types are not acquiring these plants. This interpretation is also in line with the results of Green and Vallee (2022) that banks reduce financing of coal power plants, which implies that DLCs cannot sell the power plants to new entrants and issue debt to finance these assets.

3.3 Implications of Market Deregulation for Power Plant Ownership

We document that all three mechanisms for ownership changes, the creation of new power plants, sales of existing plants, and decommissioning of plants, are stronger in deregulated electricity markets. The creation of greenfield plants has a substantial contribution to the ownership changes as new entrants, such as PE and foreign corporations, are significantly more likely than DLCs to create new renewable and fossil fuel plants in deregulated markets. The sales mechanism also results in a substantial transfer of plant ownership from DLCs to new entrants in deregulated markets. DLCs and new entrants do not have a significantly different probability of retiring power plants but the decommissioning mechanism is also stronger in deregulated markets across all ownership types.

Figure 6 summarizes the implications of electricity market deregulation on the ownership structures. Panel A shows that new entrants generated 32% of the electricity in 2020 in ISO balancing markets, and private equity alone contributes 21% to the electricity generation in these markets. In traditional markets, the ownership share of new entrants remains almost constant over time and they account for only 12% of the electricity generation in 2020.

These trends are substantial and changed the dominant ownership type of electricity generators across some deregulated states. For example, Panels C to F show that, over the 2005–2020 period, DLCs reduced their ownership share in Pennsylvania (PJM balancing authority) by 62%, so private equity has become the main corporate form of ownership of power plants in this state. New entrants also account for a larger share of the electricity generation than DLCs in Texas (ERCOT balancing authority), New York (NYISO balancing authority), and Massachusetts (ISO New England balancing authority) in 2020.

3.4 Comparing the Role of Market Regulation with Other Economic Factors

The role of market deregulation in explaining the heterogeneity in ownership structure across greenfield power plants, sales of existing power plants, and decommissioning decisions is robust to two other economic factors. First, states, where the population displays higher climate concerns, may attract more investors through increased demand for new renewable or efficient power plants. The higher climate concern among the population could also incentivize relatively more new investors to commit capital to greenfield projects as they could expect politicians in these states to adopt stricter regulation and licensing of old power plants. Second, states implement various tax and production-based incentives to stimulate the transition to renewable energy and different owner types may respond to different incentives. We find that the interaction term of DLCs and the climate concern percentile ranking is mostly insignificant suggesting that the differences in probability to finance new power plants are not driven by stronger sensitivity of private equity and foreign publicly listed corporations to climate concerns among the population. The differences in ownership of greenfield plants are also not captured by differences in the sensitivity of DLCs, PE, and foreign corporations to renewable energy policy incentives.

In Table 3, we report the coefficients on interaction terms of DLC with *Renewable Incentives* index, which aggregates five separate renewable policy indicators. One potential concern is that the aggregate index is broad and only some specific policy measures explain the heterogeneity across ownership types to own greenfield power plants. In Figure A.2 Panel A, we present the coefficients of specifications that include separate interaction terms of DLC with the three indicators if a state has corporate tax, property tax, and sales tax incentives for renewable energy as well as separate interaction terms of DLC with the two indicators if a state has production or feed-in tariffs incentives for renewable energy. These specifications confirm that DLCs are significantly less likely to own greenfield power plants in areas with deregulated electricity markets and these results are robust to controlling for climate concerns among the population and renewable policy incentives. Market competition seems to be the key economic factor in explaining the heterogeneity in the ownership structure of new power plants. Panel B presents a similar robustness test for decommissioning of power plants. Our baseline specifications do not find significant heterogeneity across ownership structures in their sensitivity to market regulation and decommissioning decisions. The robustness test with five separate indicators for renewable policy measures documents similar results.

In Online Appendix Figure A.3 and Online Appendix Figure A.4, we consider whether our results on plant creation and decommissioning could be driven by other factors, specifically credit ratings and ESG ratings. An alternative hypothesis is that electricity market regulation correlates with DLC characteristics so these corporate characteristics explain the ownership changes rather than market competitiveness. Under this hypothesis, firms with weaker credit ratings are more likely to be credit-constrained and thus might engage in less plant creation or more plant destruction. Firms with higher ESG ratings may favor the creation of solar and wind electricity generating assets and the decommissioning of fossil fuel assets. This hypothesis would predict that only low ESG or low credit rating DCLs would be less likely to create new greenfield power plants and the differences should be insignificant for high-ranked DLCs regardless of market regulation.

Online Appendix Figure A.3 shows that across all ESG categories and all Fitch credit rating categories, DLCs engage in less greenfield asset creation, while the interaction effects with the regulatory variables remain robust and statistically significant in almost all ESG rating and credit rating categories. DLCs of all credit rating classes and ESG rating classes are less likely to create new solar and wind plants. Panels B and D provide some evidence that DLCs lack of creation of new natural gas plants is more concentrated in firms with lower ESG ratings (counterintuitively) and lower credit ratings. Online Appendix Figure A.4 finds essentially no variation of interest across the ESG and credit rating categories. To the extent that DLCs are more likely to decommission, there is no specific ESG rating or credit rating type that is more likely to do it in a statistically robust fashion.

4 Power Plant Operating Performance

Based on the previous analysis, DLCs have lost ownership share primarily by creating fewer new greenfield power plants and retiring more power plants. We find only limited support for the leakage of older fossil fuel plants from DLCs to PE, institutional investors, and foreign publicly listed corporations. However, the previous analysis examines only ownership of power plants and does not study the fuel consumption and intensity of power plant operation. An alternative hypothesis is that the new ownership types operate their power plants with a higher capacity factor or lower heat rate. The increased operating intensity or lower fuel consumption efficiency could represent an alternative form of leakage.

In this section, we analyze power plant operating performance. In Columns (1) to (4) of Table 7, we focus on the power plant's capacity factor, which measures the operating intensity and equals the ratio of net electricity generation in MWh to nameplate capacity. We winsorize the capacity factor at 0.5% and 99.5%. In Columns (5) to (8), the dependent variable is the power plant's heat rate, which measures operating efficiency and is defined as the ratio of monthly fuel consumption in millions Btu to net electricity generation in MWh. The specifications in Table 7 include interacted fuel-state-year-month fixed effects and effectively limit the analysis to comparing the operating performance of power plants using the same fuel type, located in the same state, and in the same moment of time. This saturated set of fixed effects addresses to a large extent differences in the prices of resources (e.g., coal and natural gas prices) as well as weather differences (e.g., the number of sunshine hours in different months).

In the specifications, we also control for the greenfield and decommissioning stage. *Greenfield 1m* is an indicator for the first month when a plant starts operating, and *Greenfield 12m* is an indicator for the first 12 months when a plant starts operating. *Decommissioned 1m* is an indicator for the last month when a plant is still operating, and *Decommissioned 12m* is an indicator for the last 12 months when a plant is still operating. We find that creating new power plants and retiring old power plants is costly for the owners as power plants in these periods operate under significantly lower capacity factors as well as higher heat rates. Based on Column (1) of Table 7, power plants have a 0.14 lower capacity factor in the first 12 months after starting operation and a 0.12 lower capacity factor in the last 12 months of their operation. These coefficients are economically and statistically significant as the average capacity factor of all power plants is 0.40. Based on Column (5), power plants have a 1.75 higher heat rate in the first 12 months of operation and 0.50 in the last 12 months of their operation, which are economically significantly lower operating efficiencies relative to the average heat rate of 11.32.[31]

Regarding the lifecycle of power plant operating performance, the coefficients on *Greenfield 12m* and *Decommissioned 12m* should be also interpreted jointly with the coefficient on plant age. The negative and significant coefficient on plant age suggests that newer assets are more efficient than older assets and operate with higher capacity factors and lower heat rates. Implementing new technologies leads to higher marginal efficiency of electricity generation. However, the indicators for

[31]The operating performance seems to be even lower in the first and last month as the coefficients on *Greenfield 1m* and *Decommissioned 1m* indicator variables are negative and significant. However, these coefficients should not be added to the effect estimated for the 12-month indicator variables. A large part of the negative coefficient for the first and last month is probably mechanical as power plants do not always operate for the entire month and could be started or decommissioned in the middle of the month. We include separate indicators for the first and last month to isolate this mechanical effect so we can interpret the indicators for the first 12 and last 12 months as differences in operating performance during the greenfield and decommissioning stage.

the greenfield and decommissioning stage show that the creation and destruction processes in the electricity sector are costly for the owners as power plants in these stages stand idle for a longer period and generate less electricity as well as consume more fuel to generate electricity. For greenfield plants, we interpret these results as evidence that it takes time to gain market share, establish contracts with customers, and increase the capacity factor as well as to gain experience in how to operate the power plant efficiently with a lower heat rate.

Table 7 shows that power plant owner types differ in operating performance across owner types. Based on Column (2), PE owners have a 0.03 lower capacity factor on their power plants than DLCs. However, power plants owned by institutional investors seem to have the highest operating performance and their capacity factor is 0.09 higher than the capacity factor of plants owned by DLCs. The difference in operating intensity between DLCs and PE is concentrated in states with traditional wholesale electricity markets. In these markets, PE power plants depend on the local electric utility serving also as a balancing authority when deciding how much electricity to produce. Based on Column (3), a power plant owned by domestic corporations in areas that are not covered by an ISO balancing authority has a 0.05 higher capacity factor than plants owned by PE, institutional investors, and foreign corporations. The interaction term of DLCs and ISO balancing authority is significantly negative and outweighs the baseline coefficient on DLCs, which suggests that the differences in operating intensity across ownership categories are not significant in areas covered by an ISO balancing authority.

We also observe differences in power plant operating efficiency across ownership types. Based on Column (5), power plants owned by DLCs have a 0.61 higher heat rate than power plants owned by the new entrants. This coefficient implies that power plants owned by domestic listed corporations use around 5% (= 0.611 / 11.323) more fuel to produce one unit of electricity when we compare plants using the same fuel, located in the same state and in the same moment of time. Power plants owned by PE, institutional investors, and foreign listed corporations consume less fuel and operate more efficiently. The differences in operating efficiency between DLCs and new entrants are relatively larger in deregulated markets. Based on Column (8), DLCs have a 0.30 higher heat rate in states that offer a competitive retail choice to customers than in states without a retail choice. These interaction terms suggest that market competition attracts new entrants that potentially compete based on operating efficiency.

Table 8 examines separately the operating performance of wind and solar plants, natural gas plants, and coal and petroleum plants. Panel A shows that the difference in utilization rate between DLCs and new ownership structures is driven primarily by fossil fuel plants. Based on Column (1), DLCs operate their natural gas power plants with a 0.030 higher capacity factor, which is economically substantial as the average capacity factor of natural gas power plants is 0.276. Based on Column (2), the differences in the capacity factor of natural plants between DLCs and new ownership types are significant only in traditional markets. The interaction term of DLCs and ISO balancing authority is negative and outweighs the baseline coefficient on DLCs. The results for coal and petroleum present a similar trend in terms of differences between deregulated and traditional markets as natural gas power plants, but they are less significant because the new entrants own a very small proportion of the coal and petroleum power plants. For renewable power plants, the differences in operating performance are economically and statistically smaller.

Panel B of Table 8 shows that the difference in heat rate between DLCs and new ownership structures is also driven primarily by natural gas plants. DLCs operate their natural gas power plants with a 0.852 higher heat rate, which is economically substantial as the average heat rate of natural gas power plants is 11.816. There are no differences in the operating efficiency of coal and petroleum plants across ownership categories, which is in line with the observation that the new entrants do not hold a substantial share of these plants and the main action has been decommissioning of plants rather than improving operational performance.

Our results that new owners operate power plants more efficiently are in line with research that studies only power plants that experience changes in ownership and finds that acquisitions reduce the heat rate of acquired power plants. Similar to our findings that all new owners, PE, institutional investors, and foreign corporations, operate power plants more efficiently, Demirer and Karaduman (2023) document that high-productivity firms acquire plants and increase their efficiency by 4% five to eight months after acquisition. Bai and Wu (2023) focus on a smaller sample of private equity acquirers and also document that acquired plants operate with a lower heat rate, which translates into reduced fuel consumption and reduced output-scaled emissions.

Overall, we do not find evidence that new ownership types, which are subject to less strict disclosure requirements and public scrutiny operate fossil fuel power plants with a higher capacity factor. If anything, our results suggest that DLCs operating more intensely fossil fuel power plants in traditional markets where they face relatively more limited competition from new entrants. In addition, we observe that new entrants, such as PE and institutional investors, operate power plants more efficiently and consume less fossil fuel to produce one unit of electricity. This result suggests that the ownership changes are accompanied by operational improvements.

5 Electricity Pricing and Contractual Terms

In this section, we examine the implications of the emergence of PE, institutional investors, and foreign listed corporations as major electricity producers. The two main products that power plants sell are electricity and capacity. First, we study differences in contractual terms across ownership types. Second, we examine whether different ownership structures are associated with differences in electricity pricing. The new types of power plant owners enter electricity markets typically as independent power producers and have significant flexibility to adjust contractual sales terms in line with their objectives and incentives.

The contracting and pricing analysis is limited to the subsample of larger power plants matched with the FERC EQR data over the 2013–2020 period. We focus on power plants owned by DLCs, PE, institutional investors, and foreign publicly listed corporations, as the other ownership categories (e.g. industry and cooperatives) use a large part of their generated electricity for their own consumption and are not required to report all transactions to FERC.

In Table 9, we examine the contractual terms of electricity transactions. The dependent variables are the percentage of the transaction charges for electricity sales under different contractual terms. Columns (1) and (2) analyze contract duration and distinguish between short contracts with a duration of less than one year and long-term contracts. Columns (3) to (5) split the transactions into short, medium, and long based on increment terms used to determine the price. Columns (6) to (8) classify transactions into full-period, peak, and off-peak based on the peaking terms. The specifications include interacted fuel-state-year-month fixed effects which absorb variation in contracting terms across power plant technologies, location, and time. Online Appendix Table A.11 shows that our results are robust to defining all contractual-term dependent variables as a percentage of the quantity sold instead of the transaction charges.

PE seems to prefer selling electricity under contracts with shorter duration and during peak term periods. Column (1) shows that power plants owned by private equity sell 9.3 percentage points more electricity under short-term instead of long-term contracts. PE general partners also use more shorter increment pricing periods as they contract 13.2 percentage points more for electricity sales based on increment terms of less than six hours instead of long-term monthly or yearly increment terms.

Institutional investors differ significantly from PE and DLCs as they rely less on short increments to determine the price and establish contracts that cover the full period instead of targeting peak-period sales. Based on Column (6) of Table 9, institutional investors sell 23.6 percentage points more electricity under contracts that cover the full period instead of separate peak-period and off-peak-period contracts. This result is in line with the objective of institutional investors to obtain stable long-term cash flows from their direct investments in infrastructure assets (Andonov, Kräussl, and Rauh, 2021). The differences in contracting terms between institutional investors and PE are highly relevant as institutional investors supply the vast majority of commitments to PE funds. These differences indicate potential agency conflicts and misalignment of objectives between institutional investors and PE funds acting as intermediaries (Binsbergen, Brandt, and Koijen, 2008). For foreign listed corporations, we observe that they display some preferences against sales under longer increments and during off-peak hours. Their contractual terms have similarities with the contracts of PE as well as with the contracts of DLCs.

Online Appendix Table A.12 shows that the differences in contractual terms of electricity sales between new entrants and incumbent DLCs are entirely driven by fossil fuel power plants. When selling electricity from natural gas and coal power plants PE firms use contracts with a shorter duration and shorter pricing increments, and target peak-period sales. The contractual terms of fossil fuel power plants dominate the aggregate results because we weigh the observations by nameplate capacity and fossil fuel power plants are economically substantially more significant than renewable power plants. Panel C shows that wind and solar power plants owned by PE seem to be selling more electricity actually under long-term contracts and increments.

In Table 10, we analyze the capacity sales, which represent the second product sold by most power plants. We start the analysis by examining the probability that a power plant receives compensation for selling capacity and the sample covers all power plants reporting electricity sales in the FERC dataset. The dependent variable equals 0.836, which suggests that, on a nameplate-capacity-weighted basis, almost all large power plants receive compensation for maintaining available generation resources in the future. The probability of receiving compensation for selling capacity differs within the universe of new ownership types. The difference in the probability of establishing capacity sales contracts between DLCs and PE owners is not significant. Foreign corporations are the only new ownership category that is significantly less likely to participate in capacity markets.

Conditional on participating in capacity markets, the ownership types differ in the contract duration. We focus only on the contract duration as the capacity sales do not differ in the other dimensions and almost all of them are based on long-term increments and full-period coverage. Column (3) shows that DLCs sell more capacity under long-term contracts. Foreign corporations and PE owners are again more likely to establish short-term contracts for capacity sales. Based on Column (4), PE and foreign corporations sell 9.5 and 14.6 more capacity under contracts with a duration of less than one year. Institutional investors enter almost exclusively long-term contracts for capacity sales. Power plants owned by institutional investors have a 25.5 percentage points higher exposure to long-term capacity contracts which confirms our conclusion that institutional investors look for stable cash flows and capacity sales to ensure a long stream of payments in the future.

Overall, we document substantial heterogeneity in the contractual preferences of different ownership types. Private equity owners establish more short-term contracts that can respond more to short-term signals in the electricity market and have more flexibility to adjust their electricity production. Institutional investors seem to prefer long-term contracts that can deliver less volatile output and more predictable cash flows. Domestic and foreign publicly listed corporations seem to establish contracts between these two extremes.

In Table 11, we examine the pricing of electricity sales and the dependent variables are the mean and median of monthly electricity price per MWh, and we winsorize these pricing variables at 0.5% and 99.5%. The observations are weighted by the quantity of sold electricity and the specifications include either fuel-type and state-year-month fixed effects or fully interacted fuel-state-year-month fixed effects. We find that PE sells electricity for higher prices than domestic corporations. Based on Columns (1) and (3), private equity obtains a \$4.63 higher average price per MWh and \$4.52 higher median price per MWh of electricity sales. The interacted state-year-month fixed effects in this specification absorb variation in electricity prices across states and over time, but they do not absorb variation from power plants using different fuels and selling electricity in the same state and at the same moment in time.

In Columns (2) and (4), we introduce a more saturated set of fixed effects on a fuel-state-year-month level. In these specifications, the difference between PE and DLCs shrinks to \$2.04 average price per MWh and \$2.09 median price per MWh. This reduction in the coefficients suggests the higher prices obtained by PE may partly reflect the greater flexibility of PE-owned plants to scale up or down their production using different fuels in certain state-months.

We interpret the pricing differences between PE and DLCs jointly with our results on contractual differences. We observe that power plants owned by PE have more flexible contractual terms, so they can adjust both output and pricing according to demand. PE owners seem to obtain higher electricity prices on the wholesale market through flexible output that responds to signals in the spot electricity market. For instance, PE could reduce electricity production in periods of low prices, which could result in higher average prices. PE could establish different sales contracts that result in higher average prices, such as short-term contracts that target peak-period sales. For institutional investors and foreign listed corporations, we do not observe significant differences in mean or median electricity prices. Even though these ownership types display some differences in the contractual terms, we do not see that these differences translate into different prices.

Reflecting on the challenges of adopting new technologies in the electricity sector, we find that greenfield power plants obtain significantly lower mean and median prices. This result can be interpreted in two ways. First, newer power plants are competitive and can potentially reduce the average prices on wholesale markets, by undercutting incumbents and increasing market competition. Second, new power plants seem to have lower operating performance (see Table 7) as well as lower average prices, which suggests that new owners adopting innovation need time to gain market share and establish contracts with customers as well as to gain experience with how to operate the power plant efficiently.

Overall, we document that the new ownership types offer different contractual terms and electricity pricing compared to domestic listed corporations. Private equity firms sell electricity for a higher price per MWh, and they sell electricity under contracts with shorter duration, shorter increment pricing, and peak term periods. Institutional investors establish fewer volatile contracts for the power plants that they own directly, thus reducing the volatility of the electricity sales by their power plants.

6 Conclusion

Regardless of the exact policy direction, stated national commitments to reduce greenhouse gas emissions and achieve greater energy independence will require substantial capital investments to change the mix of capital assets that produce electricity. Using data on U.S. power plants accounting for 99% of the electricity generation over 2005–2020 period, we find that incumbent domestic publicly listed corporations have reduced their ownership from 71% to 54%, while new entrants, such as private equity, institutional investors, and foreign corporations, have increased their ownership stakes from 6% to 24%.

Private equity and foreign publicly listed corporations have increased their ownership share largely through the creation of new solar, wind, and natural gas power plants in states with deregulated electricity markets, where the wholesale market is administered by an independent balancing authority and retail customers can choose electricity suppliers. We find limited support for the leakage hypothesis that incumbent domestic listed corporations, which are subject to higher disclosure requirements and public scrutiny, are more likely to sell older fossil fuel power plants to the new ownership types. Domestic listed corporations have the highest probability of decommissioning a power plant conditional on plant age and capacity, but private equity is the second most likely ownership structure to shut down power plants. Institutional investors and foreign corporations maintain very low exposure to plants subject to decommissioning.

Domestic corporations operate electricity generating assets with higher intensity in traditional markets with limited competition, but they are less efficient. The new entrants, such as private equity and institutional invetsors, operate power plants more efficiently at lower heat rates

Private equity owners also show differences in contractual terms and electricity pricing compared to the incumbent domestic listed corporations. For instance, private equity sells electricity for \$2.04 higher average price per MWh. Private equity firms, and to some extent foreign corporations, sell electricity under contracts with shorter duration, shorter increment pricing, and more peak-term periods, especially when selling electricity generated from fossil fuels. Overall, private equity owners appear to obtain higher electricity prices on the wholesale market through flexibility in output that responds to signals in the spot electricity market. Therefore, variation in market competition affects not only the financier of capital expenditures and ownership of assets but also pricing in the product market. The results highlight an important tradeoff in bringing more private equity financing to the electricity sector. Private equity has played an important role in creating new and more efficient power plants but their electricity also on average tends to be sold more through short-term contracts and at higher prices.

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Figure 1: Ownership and Electricity Generation

This figure presents the aggregate ownership by the eight categories of owners as a percentage of monthly electricity generation over the 2005–2020 period. Electricity generation is measured as the total electrical output net of the power plant service. If a power plant is owned by multiple ownership types, we divide the ownership and generation equally across the ownership types (i.e., if a private equity and domestic corporation jointly own a power plant, we assume that each ownership type owns 50% of the power plant and accounts for 50% of the electricity output).

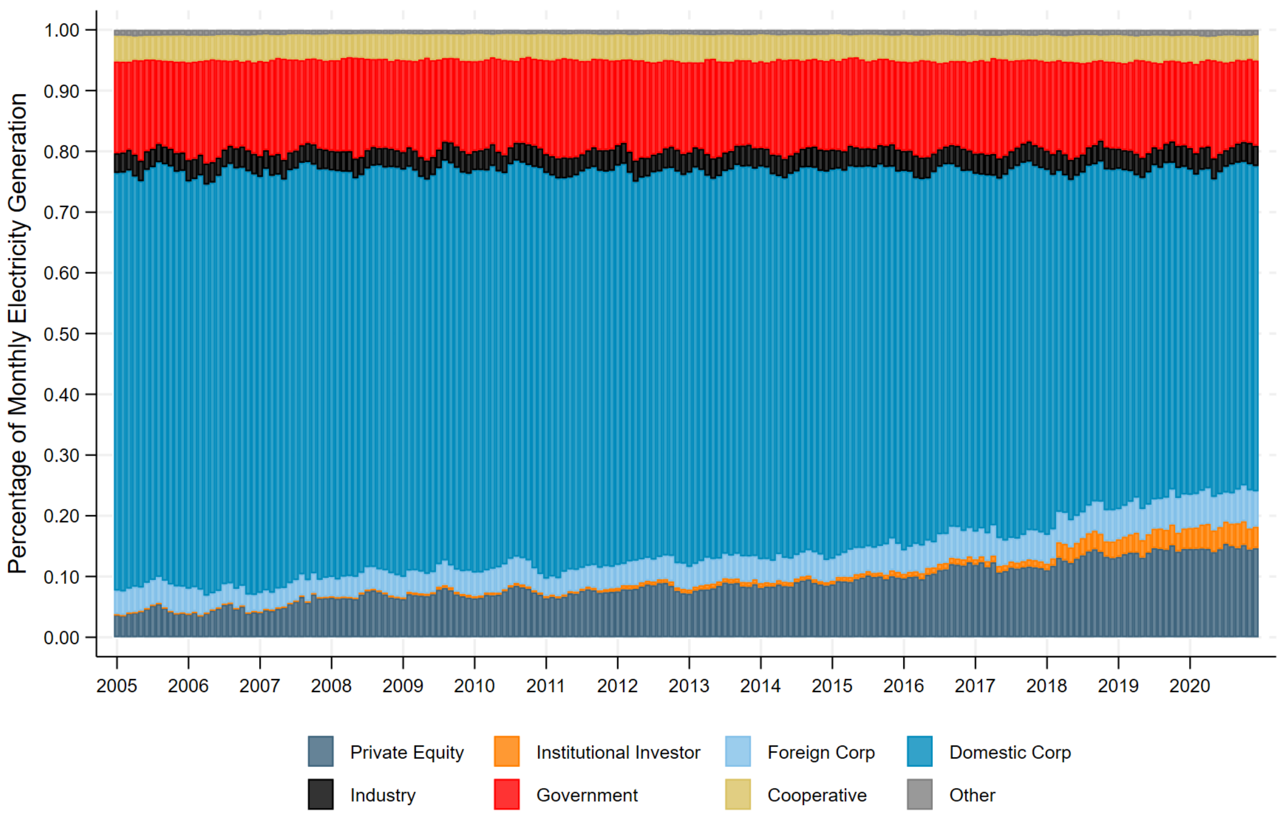


Figure 2: Ownership and Electricity Generation by Fuel Type

This figure presents the ownership by the eight categories of owners by fuel type based on the monthly electricity generation. For natural gas, coal, and nuclear, the y-axis is scaled to 200 TWh, while for hydro, wind, and solar the y-axis is scaled to 35 TWh.

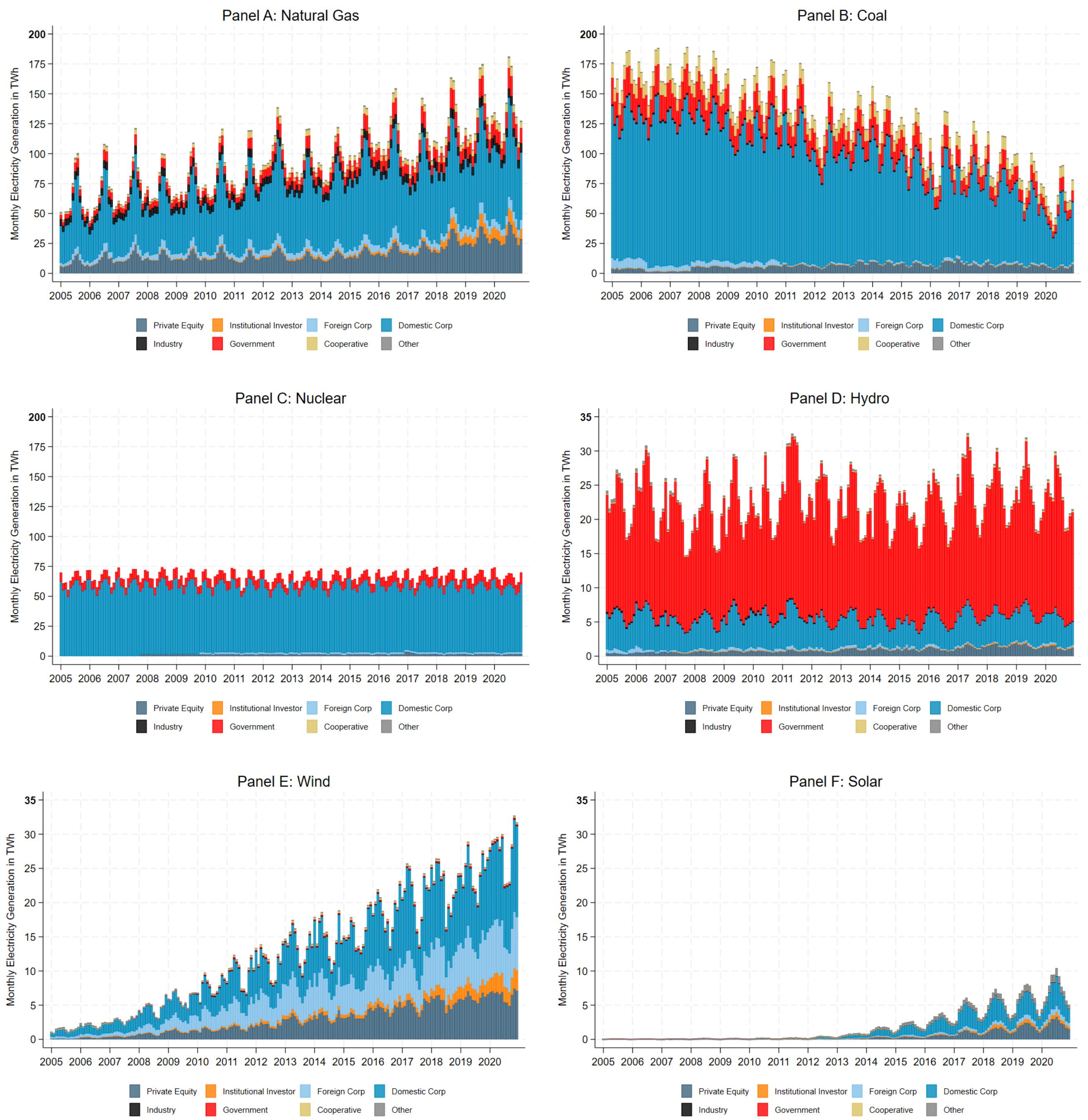


Figure 3: Market Regulation and Greenfield or Decommissioned Power Plants

Panel A presents the cumulative capacity of greenfield power plants installed during our sample period as a percentage of the total generating capacity, while Panel B shows the cumulative capacity of solar and wind greenfield power plants installed during our sample period as a percentage of the total capacity. Panel C presents the cumulative hazard rate of decommissioned power plants, while Panel D shows the cumulative hazard rate of fossil fuel decommissioned power plants. In the hazard figures, observations are weighted by nameplate capacity. *ISO Balancing* is an indicator for power plants that participate in a wholesale market administered by an Independent System Operator (ISO) as a balancing authority and electric power transmission system operator.

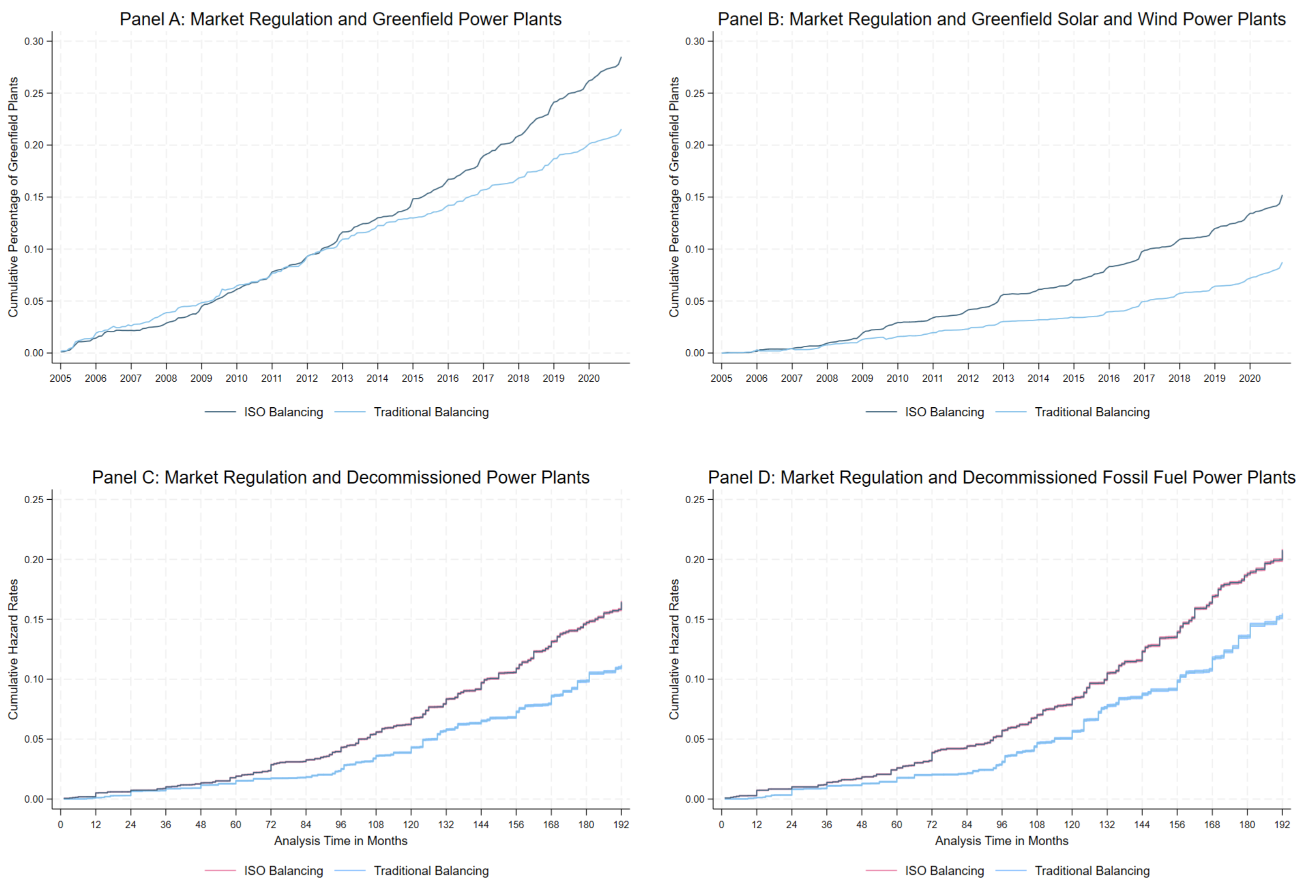


Figure 4: Ownership of Greenfield Power Plants by Fuel Type

In Panel A, the dependent variable captures all greenfield power plants. In Panels B and C, we decompose it to capture solar & wind and natural gas greenfield plants. The figures present coefficient estimates for private equity and foreign corporations. Observations are at the plant-prime-mover-month level and weighted by nameplate capacity. The omitted category in all specifications is DLCs, and we also control for the ownership by institutional investors, industry firms, government, cooperatives, and others. The baseline coefficients correspond to the estimations in Table 3 Column (2). We estimate separately the role of ownership categories for power plants located in areas with ISO balancing authority, ISO restructured market, and retail choice. The specifications include interacted fuel-type, state, and year-month fixed effects. We double-cluster the standard errors by plant-prime-mover and year-month.

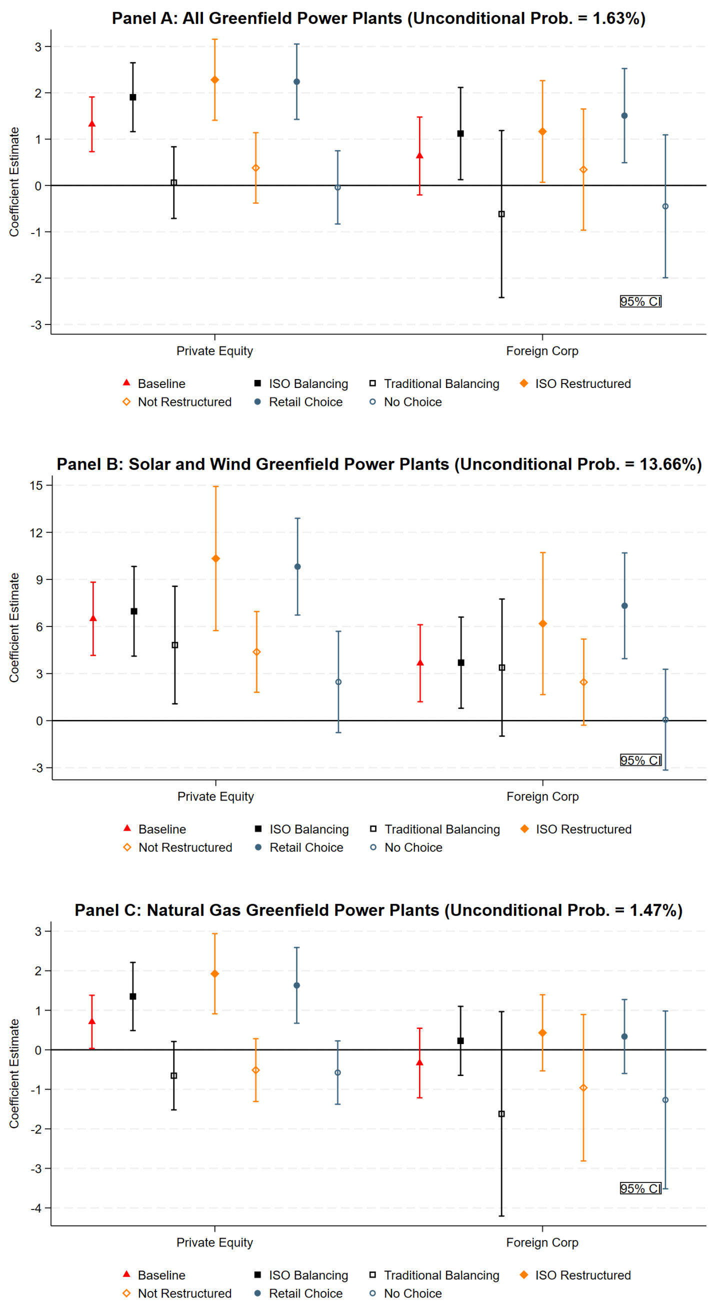


Figure 5: Ownership of Decommissioned Power Plants by Fuel Type

In Panel A, the dependent variable captures all decommissioned power plants. In Panels B and C, we decompose it to capture coal & petroleum and natural gas decommissioned plants. The figures present coefficients for private equity and foreign corporations in the Cox hazard specifications. Observations are at the plant-prime-mover-month level and the sample includes power plants with a nameplate capacity of at least 20MW. The omitted category in all specifications is DLCs, and we also control for the ownership by institutional investors, industry firms, government, cooperatives, and others. The baseline coefficients correspond to the estimations in Table 6 Column (2). We estimate separately the role of ownership categories for power plants located in ISO balancing, ISO restructured, and retail choice markets. The specifications include fuel-type and state fixed effects. We cluster the standard errors by plant-prime-mover.

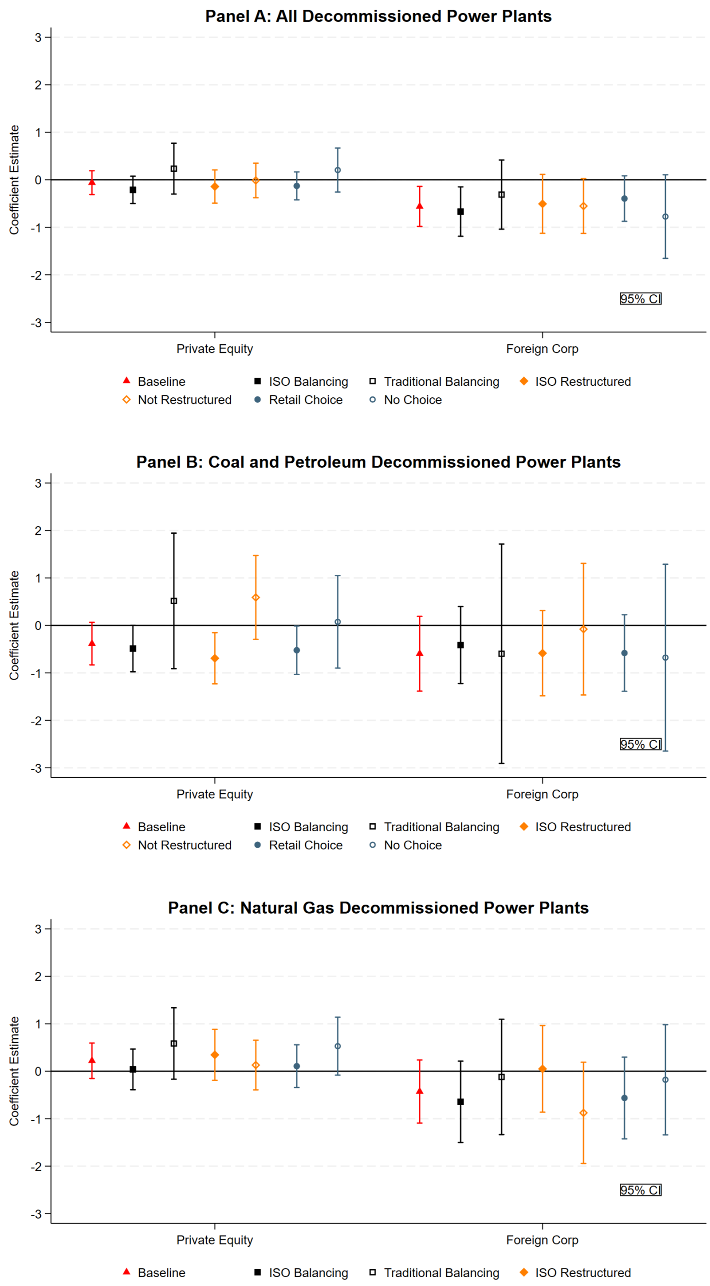


Figure 6: Ownership and Electricity Generation by Market Regulation and State

Panels A and B present the aggregate ownership by private equity, institutional investors, and foreign listed corporations as a percentage of monthly electricity generation over 2005–2020 period. Panel A shows the ownership stakes in wholesale markets administered by an ISO balancing authority. Panel B shows the ownership stakes in wholesale markets administered by a traditional balancing authority. Panels C to F display the changes in the ownership stakes of domestic listed corporations, private equity, institutional investors, and foreign listed corporations by state between 2005 and 2020. The changes are measured in percentage points of the state's electricity generation.

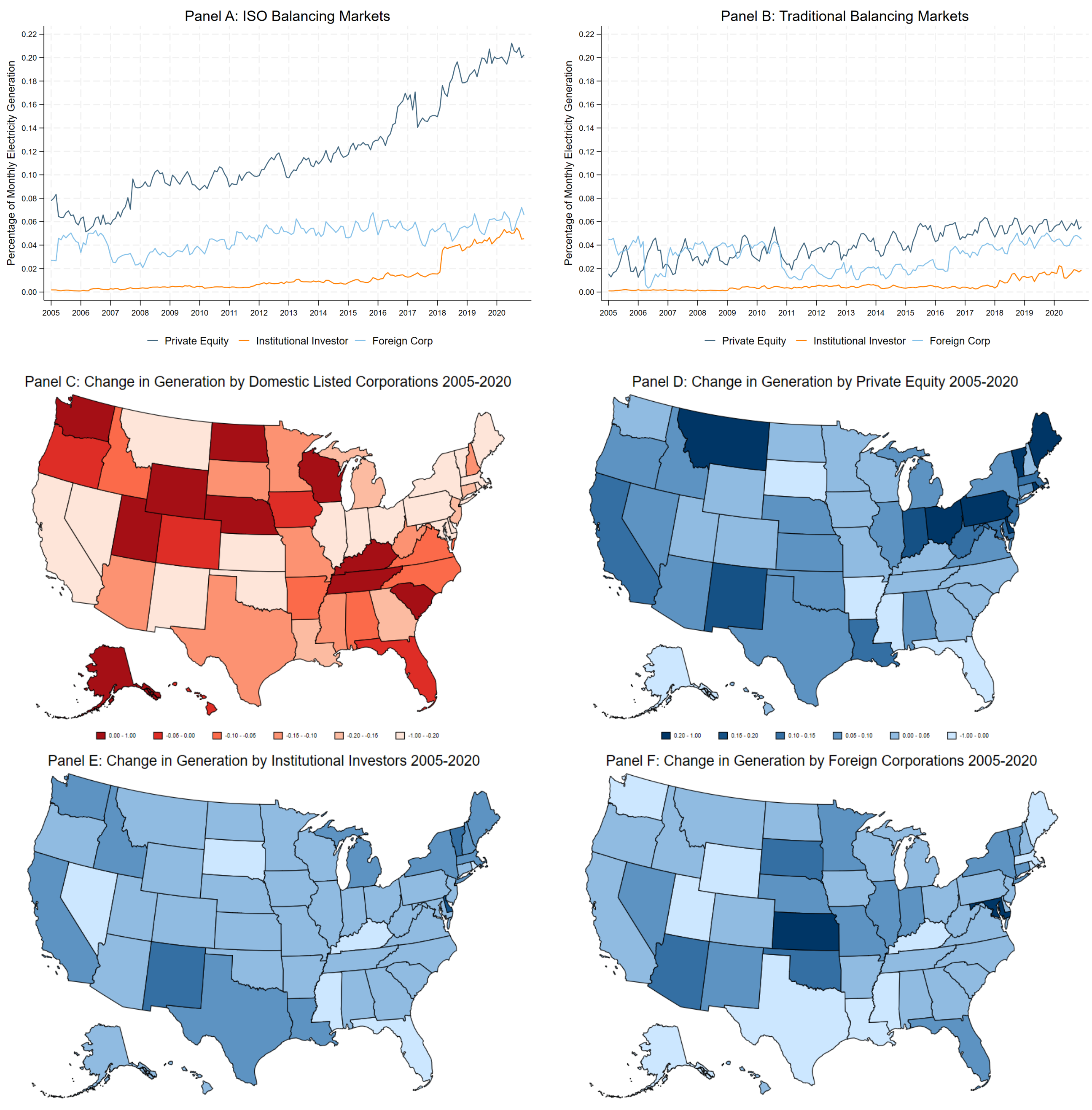


Table 1: EIA Power Plants

The table presents summary statistics on a plant-prime-mover-month level for all power plants and separately for the main fuel types: natural gas, coal, nuclear, hydro, wind, and solar. All statistics are the weighted means by power plant nameplate capacity. Panel B reports statistics for the power plant characteristics. *Capacity* is the nameplate capacity in GWh. *Capacity Factor* is the ratio of monthly net generation to capacity. *Heat Rate* is the ratio of fuel consumption in millions of Btu to electricity generation in MWh. *Age* presents the plant age in years. *Independent Power Producer* is an indicator for an entity that owns and operates power plants but is not regulated as a traditional electric utility. *Greenfield 12m* is an indicator for the first 12 months when a plant starts operating. *Decommissioned 12m* is an indicator for the last 12 months when a plant is still operating. Panel C reports the average ownership by the eight categories in percent. If a power plant is owned by multiple ownership types, we divide the ownership and generation equally across the ownership types. Panel D presents statistics on electricity markets. *ISO Balancing* is an indicator for power plants that participate in a wholesale market administered by an Independent System Operator. *ISO Restructured* is an indicator for power plants that participate in a wholesale market administered by an ISO balancing authority and are located in areas with restructured electric utilities. *Retail Choice* is an indicator for power plants located in an area where residential or business customers can choose an electricity provider. *Climate Concern* is the percentile ranking of the state where the plant is located based on the percentage of the state population who think that global warming is happening. *Renewables Incentives* is an aggregate index of three indicators if a state has corporate tax, property tax, and sales tax incentives for renewable energy as well as two indicators if a state has production or feed-in tariffs incentives for renewable energy.

	All	**NatGas**	**Coal**	**Nuclear**	**Hydro**	**Wind**	**Solar**
Panel A: Power Plants Sample							
# Unique Plants	11,590	3,024	751	66	1,498	1,294	3,941
# Unique Plants-Prime-Mover	13,278	4,148	868	66	1,498	1,294	3,941
# Unique Greenfield	6,111	767	38	0	54	1,035	3,631
# Unique Decommissioned	2,011	971	314	10	101	98	44
Observations	1,509,336	572,743	115,450	12,215	270,290	135,709	188,066
Panel B: Power Plant Characteristics							
Capacity (GWh)	0.980	0.584	1.426	2.037	1.090	0.176	0.100
Capacity Factor	0.403	0.264	0.533	0.855	0.399	0.328	0.241
Heat Rate		11.892	10.686	10.457			
Age (Years)	30.908	21.656	41.944	33.091	58.883	6.161	2.912
Independent Power Producer	0.429	0.531	0.277	0.445	0.079	0.845	0.900
Greenfield 12m	0.016	0.017	0.003	0.000	0.000	0.116	0.244
Decommissioned 12m	0.010	0.010	0.017	0.005	0.000	0.002	0.001
Panel C: Power Plant Ownership							
Domestic Listed Corp (DLC)	0.591	0.547	0.706	0.843	0.209	0.421	0.471
Private Equity	0.110	0.167	0.053	0.019	0.035	0.222	0.249
Institutional Investor	0.011	0.017	0.002	0.000	0.003	0.049	0.046
Foreign Corp	0.048	0.054	0.021	0.014	0.014	0.271	0.066
Industry	0.025	0.040	0.020	0.000	0.006	0.001	0.006
Government	0.159	0.112	0.132	0.124	0.716	0.015	0.007
Cooperative	0.047	0.056	0.064	0.000	0.007	0.010	0.006
Other	0.009	0.008	0.002	0.000	0.010	0.013	0.149
Panel D: Wholesale and Retail Electricity Markets							
ISO Balancing	0.607	0.634	0.607	0.630	0.267	0.788	0.611
ISO Restructured	0.368	0.400	0.335	0.486	0.122	0.369	0.158
Retail Choice	0.448	0.492	0.339	0.515	0.399	0.488	0.597
Climate Concern	0.529	0.568	0.410	0.558	0.650	0.529	0.737
Renewables Incentives	2.179	2.228	2.066	2.065	2.198	2.705	2.598

Table 2: FERC Electricity Pricing and Contracting

Observations are on a plant-prime-mover-month level weighted by nameplate capacity. The sample includes power plants owned by domestic listed corporations (DLC), private equity, institutional investors, and foreign corporations. Panel A presents summary statistics on electricity prices and reports the average of the mean and median monthly price per MWh. This panel also reports the average percentage of transaction charges for electricity sales by different contractual terms. We split the electricity sales based on three contractual terms. First, we analyze contract duration and distinguish between short contracts with a duration of less than one year and long-term contract duration. Second, we split the transactions into short, medium, and long based on the increment terms. Short transactions use 5-minute, 15-minute, or hourly increments (up to 6 hours). Medium transactions have daily or weekly increments (from 6 hours to 168 hours). Long transactions use monthly or yearly increments (longer than 168 hours). Third, we classify transactions into full-period, peak, and off-peak based on the peaking terms. Panel B presents the average percentage of transaction charges for capacity sales by different contractual terms. We split the capacity sales also based on three contractual terms: contract duration, increment terms, and peak period terms.

	All	**NatGas**	**Coal**	**Nuclear**	**Hydro**	**Wind**	**Solar**
Panel A: Electricity Sales							
#Unique Plants	5,540	1,466	373	56	670	868	1,726
Observations	305,225	98,480	23,781	4,523	52,019	52,578	54,174
Mean Price MWh	33.665	34.356	29.904	29.661	29.756	40.282	71.063
Median Price MWh	31.132	30.964	28.103	27.351	28.007	39.324	67.207
Contract Duration - Short	0.581	0.645	0.594	0.480	0.675	0.371	0.263
Contract Duration - Long	0.417	0.351	0.405	0.520	0.325	0.623	0.737
Increment Terms - Short	0.505	0.546	0.564	0.383	0.387	0.334	0.197
Increment Terms - Medium	0.044	0.061	0.032	0.043	0.084	0.014	0.031
Increment Terms - Long	0.425	0.378	0.389	0.531	0.398	0.606	0.724
Peaking Terms - Full Period	0.384	0.346	0.348	0.479	0.360	0.560	0.584
Peaking Terms - Peak	0.354	0.393	0.376	0.284	0.296	0.206	0.208
Peaking Terms - Off-Peak	0.192	0.195	0.215	0.179	0.180	0.141	0.080
Panel B: Capacity Sales							
#Unique Plants	4,421	1,421	353	53	629	432	1,203
Observations	202,845	90,390	20,702	3,973	43,346	14,302	18,289
Contract Duration - Short	0.153	0.166	0.121	0.147	0.282	0.160	0.111
Contract Duration - Long	0.846	0.833	0.877	0.853	0.718	0.840	0.889
Increment Terms - Short	0.010	0.013	0.007	0.003	0.017	0.008	0.010
Increment Terms - Medium	0.034	0.025	0.055	0.015	0.049	0.056	0.012
Increment Terms - Long	0.945	0.953	0.932	0.961	0.879	0.929	0.958
Peaking Terms - Full Period	0.926	0.925	0.940	0.940	0.817	0.882	0.810
Peaking Terms - Peak	0.015	0.017	0.012	0.003	0.036	0.049	0.055
Peaking Terms - Off-Peak	0.010	0.010	0.009	0.005	0.031	0.008	0.047

Table 3: Ownership of Greenfield Power Plants

In this table, observations are at the plant-prime-mover-month level and are weighted by power plant nameplate capacity. The dependent variable captures greenfield power plants and equals one for the first 12 months of plant operation. We measure the ownership by domestic publicly listed corporations (*DLC*), private equity, institutional investors, and foreign publicly listed corporations. We also control for the ownership by industry firms, government, cooperatives, and others. *ISO Balancing* is an indicator for power plants that participate in a wholesale market administered by an Independent System Operator. *ISO Restructured* is an indicator for power plants that participate in a wholesale market administered by an ISO balancing authority and located in areas with restructured electric utilities. *Retail Choice* is an indicator for power plants located in an area where residential or business customers can choose an electricity provider. *IPP* is an indicator for an entity that owns and operates power plants but is not regulated as a traditional vertically integrated electric utility. *Climate Concern* is the percentile ranking of the state where the plant is located based on the percentage of the state population who think that global warming is happening. *Renewables Incentives* is an aggregate index of three indicators if a state has corporate tax, property tax, and sales tax incentives for renewable energy as well as two indicators if a state has production or feed-in tariffs incentives for renewable energy. *ln Plant Capacity* is the natural logarithm of a plant's monthly capacity. The specifications include interacted fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. $^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

	All Greenfield Power Plants (Unconditional Prob. = 1.63%)					
	(1)	(2)	(3)	(4)	(5)	(6)
Domestic Listed Corp (DLC)	-1.001***		-0.137	-0.670	-0.851*	-0.203
	[0.249]		[0.441]	[0.438]	[0.441]	[0.486]
Private Equity		1.320***				
		[0.299]				
Institutional Investor		-0.794				
		[0.873]				
Foreign Corp		0.636				
		[0.426]				
DLC × ISO Balancing			-1.123***			
			[0.290]			
DLC × ISO Restructured				-1.460***		
				[0.360]		
DLC × Retail Choice					-1.803***	
					[0.375]	
IPP						0.219
						[0.355]
DLC × IPP						-1.926***
						[0.423]
DLC × Climate Concern			0.019	0.141	1.531**	0.701
			[0.634]	[0.647]	[0.749]	[0.644]
DLC × Renewables Incentives			-0.035	0.109	-0.024	-0.027
			[0.157]	[0.158]	[0.157]	[0.157]
ln Plant Capacity	0.130**	0.132**	0.148**	0.131**	0.130**	0.147**
	[0.064]	[0.064]	[0.064]	[0.064]	[0.064]	[0.064]
Other Owners	Yes	Yes	Yes	Yes	Yes	Yes
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,410,947	1,410,947	1,410,947	1,410,947	1,410,947	1,410,947
Adjusted R-squared	0.199	0.199	0.199	0.199	0.199	0.200

Table 4: Greenfield Power Plants Owner and Market Regulation

This table presents the results of OLS specifications using the ownership by domestic listed corporations (*DLC*), private equity, and foreign listed corporations as dependent variables. The analysis is limited to the subsample of greenfield power plants. Observations are at the plant-prime-mover-month level and weighted by nameplate capacity. *ISO Balancing*, *ISO Restructured*, and *Retail Choice* are indicators for power plants located in an area with a deregulated electricity market. We also control for *Climate Concern* percentile ranking and *Renewables Incentives* aggregate index. *ln Plant Capacity* is the natural logarithm of a plant's monthly capacity. The specifications include interacted fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. $*p < .10$; $**p < .05$; $***p < .01$.

	DLCs			**Private Equity**			**Foreign Corp**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: All Plants	Mean Dep. Var. = 0.462			Mean Dep. Var. = 0.246			Mean Dep. Var. = 0.131		
ISO Balancing	-0.051			0.073***			0.044**		
	[0.036]			[0.027]			[0.018]		
ISO Restructured		-0.244***			0.188***			0.046**	
		[0.034]			[0.028]			[0.021]	
Retail Choice			-0.231***			0.193***			0.047*
			[0.039]			[0.031]			[0.024]
Climate Concern	-0.225***	-0.118*	0.037	0.282***	0.207***	0.070	0.026	0.014	-0.019
	[0.062]	[0.062]	[0.079]	[0.054]	[0.056]	[0.069]	[0.035]	[0.036]	[0.046]
Renewables Incentives	0.023	0.042***	0.023	-0.016	-0.031**	-0.016	-0.024**	-0.027***	-0.024**
	[0.016]	[0.016]	[0.015]	[0.013]	[0.013]	[0.013]	[0.010]	[0.010]	[0.010]
ln Plant Capacity	0.091***	0.089***	0.095***	0.021**	0.022**	0.018*	0.019***	0.020***	0.019***
	[0.012]	[0.012]	[0.012]	[0.010]	[0.009]	[0.009]	[0.007]	[0.007]	[0.007]
Fuel-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	66,694	66,694	66,694	66,694	66,694	66,694	66,694	66,694	66,694
Adjusted R-squared	0.167	0.205	0.195	0.167	0.195	0.191	0.172	0.172	0.171
Panel B: Solar & Wind	Mean Dep. Var. = 0.419			Mean Dep. Var. = 0.253			Mean Dep. Var. = 0.240		
ISO Balancing	-0.013			-0.050			0.082***		
	[0.035]			[0.032]			[0.029]		
ISO Restructured		-0.125***			0.074**			0.062*	
		[0.035]			[0.032]			[0.033]	
Retail Choice			-0.148***			0.125***			0.061*
			[0.040]			[0.034]			[0.034]
Climate Concern	-0.381***	-0.321***	-0.203**	0.294***	0.256***	0.140**	0.059	0.033	-0.010
	[0.063]	[0.063]	[0.078]	[0.052]	[0.056]	[0.068]	[0.058]	[0.059]	[0.070]
Renewables Incentives	0.031*	0.045***	0.032*	0.007	-0.003	0.004	-0.052***	-0.057***	-0.051***
	[0.017]	[0.017]	[0.017]	[0.014]	[0.013]	[0.013]	[0.015]	[0.015]	[0.015]
ln Plant Capacity	0.084***	0.080***	0.087***	0.004	0.005	0.000	0.027***	0.030***	0.027***
	[0.013]	[0.013]	[0.013]	[0.010]	[0.010]	[0.010]	[0.009]	[0.009]	[0.009]
Fuel-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,551	51,551	51,551	51,551	51,551	51,551	51,551	51,551	51,551
Adjusted R-squared	0.096	0.108	0.110	0.061	0.064	0.072	0.107	0.104	0.103
Panel C: Natural Gas	Mean Dep. Var. = 0.520			Mean Dep. Var. = 0.239			Mean Dep. Var. = 0.036		
ISO Balancing	-0.113*			0.205***			0.014		
	[0.065]			[0.043]			[0.019]		
ISO Restructured		-0.402***			0.314***			0.049*	
		[0.057]			[0.047]			[0.025]	
Retail Choice			-0.357***			0.289***			0.041
			[0.070]			[0.055]			[0.032]
Climate Concern	-0.045	0.101	0.317**	0.226**	0.161*	-0.020	0.007	-0.011	-0.034
	[0.111]	[0.105]	[0.134]	[0.097]	[0.097]	[0.121]	[0.035]	[0.039]	[0.058]
Renewables Incentives	0.017	0.029	0.014	-0.039	-0.051**	-0.040	0.012	0.011	0.012
	[0.031]	[0.029]	[0.029]	[0.025]	[0.024]	[0.024]	[0.009]	[0.009]	[0.009]
ln Plant Capacity	0.105***	0.121***	0.111***	0.054***	0.038**	0.046**	0.011	0.009	0.010
	[0.027]	[0.025]	[0.026]	[0.019]	[0.018]	[0.019]	[0.010]	[0.011]	[0.010]
Fuel-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,081	8,081	8,081	8,081	8,081	8,081	8,081	8,081	8,081
Adjusted R-squared	0.201	0.291	0.252	0.279	0.325	0.294	0.059	0.072	0.065

Table 5: Sales and Decommissioning of Power Plants Owned by DLCs

In Panel B, observations are at the plant-prime-mover-month level and the sample includes only power plants with a nameplate capacity of at least 20MW. We present the hazard ratios of a survival analysis using a competing risks model. The sample includes all power plants that have been owned by domestic publicly listed corporations (DLC) at any moment during our sample period. In Columns (1) to (3), the event of interest is a complete sale of a power plant to a new ownership type (not a partial sale or reduced ownership stake), and the competing event is a decommissioning of a plant. In Columns (4) to (6), the event of interest is a complete decommissioning of a power plant (not partial retirement of one generator), and the competing event is a sale of a plant. *ISO Balancing*, *ISO Restructured*, and *Retail Choice* are indicators for power plants located in an area with a deregulated electricity market. We also control for *Climate Concern* percentile ranking and *Renewables Incentives* aggregate index. *ln Plant Capacity* is the natural logarithm of a plant's monthly capacity. *ln Plant Age* is the natural logarithm of plant age in years. The specifications include fuel-type fixed effects and we present the coefficients for coal, nuclear, hydro, wind, and solar power plants (the omitted category is natural gas plants). We cluster standard errors by plant-prime-mover and report standard errors in brackets. $^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

Transitions Plants from 2005	**All Plants**		**Coal & Petroleum**		**Natural Gas**	
	#Plants	%Capacity	#Plants	%Capacity	#Plants	%Capacity
Still Own & Operating	1,083	62.18	184	60.20	361	52.25
Owned & Retired	489	16.60	177	26.39	148	9.80
Sold & Operating	537	19.18	40	11.66	298	34.60
Sold & Retired	85	2.03	21	1.76	31	3.34
Competing Risks Model		**Sold Plants**			**Decommissioned Plants**	
	(1)	(2)	(3)	(4)	(5)	(6)
Events of Interest:	712	712	712	380	380	380
Competing Events:	368	368	368	697	697	697
No Events:	1,674	1,674	1,674	1,677	1,677	1,677
ISO Balancing	1.413***			0.900		
	[0.136]			[0.104]		
ISO Restructured		2.027***			0.776**	
		[0.165]			[0.091]	
Retail Choice			2.015***			0.945
			[0.215]			[0.117]
Climate Concern	4.558***	4.165***	2.291***	1.164	1.346	1.213
	[0.696]	[0.694]	[0.446]	[0.260]	[0.312]	[0.309]
Renewables Incentives	0.846***	0.806***	0.854***	1.065	1.068	1.065
	[0.036]	[0.033]	[0.036]	[0.060]	[0.060]	[0.060]
ln Plant Capacity	0.976	0.958	0.977	0.691***	0.691***	0.690***
	[0.038]	[0.038]	[0.038]	[0.032]	[0.031]	[0.032]
ln Plant Age	1.165***	1.160***	1.169***	4.698***	4.708***	4.646***
	[0.041]	[0.042]	[0.042]	[0.766]	[0.767]	[0.757]
Coal	0.379***	0.376***	0.373***	1.806***	1.823***	1.815***
	[0.066]	[0.066]	[0.065]	[0.259]	[0.260]	[0.260]
Hydro	0.198***	0.225***	0.192***	0.011***	0.011***	0.011***
	[0.047]	[0.053]	[0.045]	[0.006]	[0.006]	[0.007]
Nuclear	0.054***	0.048***	0.055***	0.902	0.928	0.906
	[0.039]	[0.035]	[0.040]	[0.327]	[0.334]	[0.327]
Solar	0.135***	0.153***	0.143***	0.000***	0.000***	0.000***
	[0.035]	[0.041]	[0.038]	[0.000]	[0.000]	[0.000]
Wind	0.688***	0.713***	0.713***	0.525*	0.496*	0.516*
	[0.085]	[0.089]	[0.087]	[0.202]	[0.190]	[0.199]
Fuel-Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	320,538	320,538	320,538	325,550	325,550	325,550

Table 6: Ownership of Decommissioned Power Plants

In this table, observations are at the plant-prime-mover-month level and the sample includes only power plants with a nameplate capacity of at least 20MW. We present the hazard ratios of a survival analysis using the Cox proportional hazard model. The event of interest is a complete decommissioning of a power plant (not partial retirement of one generator). *#Plants* reports the number of unique plant-prime-mover units included in the survival analysis, while *#Decommissioned* reports the number of unique plant-prime-mover units that are retired by the end of the survival analysis. We measure the ownership by domestic publicly listed corporations (DLC), private equity, institutional investors, and foreign publicly listed corporations. We also control for the ownership by industry firms, government, cooperatives, and others. *ISO Balancing*, *ISO Restructured*, and *Retail Choice* are indicators for power plants located in an area with a deregulated electricity market. *Independent Power Producer* is an indicator for an entity that owns and operates power plants but is not regulated as a traditional vertically integrated electric utility. The specifications include fuel-type and state fixed effects. We cluster standard errors by plant-prime-mover and report standard errors in brackets. $*p < .10$; $**p < .05$; $***p < .01$.

All Decommissioned Power Plants (5,406 Plants; 781 Decommissioned)						
	(1)	(2)	(3)	(4)	(5)	(6)
Domestic Listed Corp (DLC)	1.373***		1.075	1.245	1.227	1.218
	[0.163]		[0.304]	[0.319]	[0.314]	[0.356]
Private Equity		0.941				
		[0.120]				
Institutional Investor		0.002***				
		[0.004]				
Foreign Corp		0.571***				
		[0.123]				
DLC × ISO Balancing			1.191			
			[0.188]			
DLC × ISO Restructured				0.889		
				[0.143]		
DLC × Retail Choice					1.038	
					[0.182]	
Independent Power Producer (IPP)						1.026
						[0.190]
DLC × IPP						1.334
						[0.300]
DLC × Climate Concern			0.985	1.038	0.963	0.785
			[0.307]	[0.329]	[0.341]	[0.265]
DLC × Renewables Incentives			1.052	1.053	1.047	1.051
			[0.068]	[0.069]	[0.068]	[0.068]
ln Plant Capacity	0.622***	0.625***	0.620***	0.622***	0.621***	0.623***
	[0.023]	[0.023]	[0.023]	[0.023]	[0.023]	[0.023]
ln Plant Age	2.874***	2.870***	2.884***	2.873***	2.876***	2.930***
	[0.242]	[0.238]	[0.244]	[0.241]	[0.243]	[0.253]
Other Owners	Yes	Yes	Yes	Yes	Yes	Yes
Fuel-Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Plant State FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	752,784	752,784	752,784	752,784	752,784	752,784

Table 7: Operating Performance

In this table, observations are at the plant-prime-mover-month level and are weighted by power plant nameplate capacity. In Columns (1) to (4), the dependent variable is the monthly capacity factor, which is the ratio of net electricity generation in MWh to nameplate capacity. We winsorize the capacity factor at 0.5% and 99.5%. In Columns (5) to (8), the dependent variable is the monthly heat rate, which is the ratio of fuel consumption in millions of Btu to electricity generation in MWh. We observe the heat rate for fossil fuel and nuclear power plants. We measure the ownership by domestic publicly listed corporations, private equity, institutional investors, and foreign publicly listed corporations. We also control for the ownership by industry firms, government, cooperatives, and others. *ISO Balancing* is an indicator for power plants that participate in a wholesale market that is administered by an Independent System Operator (ISO) as a balancing authority. *Retail Choice* is an indicator for power plants located in an area where residential or business customers can choose an electricity provider. *ln Plant Capacity* is the natural logarithm of a plant's monthly capacity. *ln Plant Age* is the natural logarithm of plant age in years. *Greenfield 1m* is an indicator for the first month when a plant starts operating. *Greenfield 12m* is an indicator for the first 12 months when a plant starts operating. *Decommissioned 1m* is an indicator for the last month when a plant is still operating. *Decommissioned 12m* is an indicator for the last 12 months when a plant is still operating. The specifications include interacted fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. *$p < .10$; **$p < .05$; ***$p < .01$.

	Capacity Factor Mean Dependent Variable = 0.403				**Heat Rate** Mean Dependent Variable = 11.323			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Domestic Listed Corp (DLC)	0.016		0.051***	0.037***	0.611***		0.322**	0.291*
	[0.010]		[0.014]	[0.012]	[0.130]		[0.157]	[0.157]
Private Equity		-0.027**				-0.430***		
		[0.011]				[0.150]		
Institutional Investor		0.094***				-1.607***		
		[0.033]				[0.439]		
Foreign Corp		-0.014				-0.867***		
		[0.013]				[0.232]		
DLC × ISO Balancing			-0.050***				0.402**	
			[0.014]				[0.162]	
DLC × Retail Choice				-0.040***				0.588***
				[0.014]				[0.199]
ln Plant Capacity	0.018***	0.018***	0.019***	0.018***	-0.376***	-0.375***	-0.382***	-0.384***
	[0.003]	[0.003]	[0.003]	[0.003]	[0.059]	[0.059]	[0.059]	[0.058]
ln Plant Age	-0.109***	-0.110***	-0.108***	-0.109***	1.321***	1.330***	1.315***	1.317***
	[0.006]	[0.006]	[0.006]	[0.006]	[0.098]	[0.098]	[0.099]	[0.098]
Greenfield 1m	-0.168***	-0.168***	-0.168***	-0.169***	1.854***	1.851***	1.854***	1.860***
	[0.011]	[0.011]	[0.011]	[0.011]	[0.644]	[0.641]	[0.645]	[0.646]
Greenfield 12m	-0.142***	-0.142***	-0.142***	-0.143***	1.751***	1.759***	1.756***	1.768***
	[0.011]	[0.011]	[0.011]	[0.011]	[0.206]	[0.206]	[0.206]	[0.206]
Decommissioned 1m	-0.074***	-0.073***	-0.073***	-0.073***	0.435	0.430	0.432	0.426
	[0.017]	[0.017]	[0.017]	[0.017]	[0.446]	[0.446]	[0.446]	[0.447]
Decommissioned 12m	-0.124***	-0.123***	-0.122***	-0.122***	0.496***	0.489***	0.482***	0.464***
	[0.011]	[0.011]	[0.011]	[0.011]	[0.150]	[0.149]	[0.150]	[0.151]
Other Owners	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,410,947	1,410,947	1,410,947	1,410,947	589,802	589,802	589,802	589,802
Adjusted R-squared	0.644	0.645	0.645	0.645	0.336	0.336	0.336	0.337

Table 8: Operating Performance by Fuel Type

In this table, observations are at the plant-prime-mover-month level and are weighted by power plant nameplate capacity. In Panel A, the dependent variable is the monthly capacity factor, which is the ratio of electricity generation in MWh to nameplate capacity. We winsorize the capacity factor at 0.5% and 99.5%. In Panel B, the dependent variable is the monthly heat rate, which is the ratio of fuel consumption in millions of Btu to electricity generation in MWh. We do not observe the heat rate for wind, solar, and hydro power plants. Columns (1) to (3) examine the subsample of natural gas plants, Columns (4) to (6) examine the subsample of coal, waste coal, petroleum coke, and residual petroleum plants, and Columns (7) to (9) examine the subsample of solar and wind power plants. We focus on the ownership by domestic publicly listed corporations and also control for the ownership by industry firms, government, cooperatives, and others (the omitted ownership categories are private equity, institutional investors, and foreign publicly listed corporations). *ISO Balancing* is an indicator for power plants that participate in a wholesale market that is administered by an Independent System Operator (ISO) as a balancing authority. *Retail Choice* is an indicator for power plants located in an area where residential or business customers can choose an electricity provider. *ln Plant Capacity* is the natural logarithm of a plant's monthly capacity. *ln Plant Age* is the natural logarithm of plant age in years. *Greenfield 1m* is an indicator for the first month when a plant starts operating. *Greenfield 12m* is an indicator for the first 12 months when a plant starts operating. *Decommissioned 1m* is an indicator for the last month when a plant is still operating. *Decommissioned 12m* is an indicator for the last 12 months when a plant is still operating. The specifications include interacted fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. *$p < .10$; **$p < .05$; ***$p < .01$.

	Natural Gas			**Coal & Petroleum**			**Solar & Wind**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Capacity Factor	Mean Dep. Var. = 0.276			Mean Dep. Var. = 0.481			Mean Dep. Var. = 0.314		
Domestic Listed Corp (DLC)	0.030**	0.078***	0.062***	-0.025	-0.003	0.011	0.006	-0.001	0.010*
	[0.013]	[0.021]	[0.018]	[0.024]	[0.029]	[0.025]	[0.004]	[0.005]	[0.005]
DLC × ISO Balancing		-0.071***			-0.026			0.009	
		[0.021]			[0.020]			[0.006]	
DLC × Retail Choice			-0.058***			-0.067***			-0.008
			[0.021]			[0.025]			[0.008]
Plant Age and Capacity Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other Owners	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	463,608	463,608	463,608	100,459	100,459	100,459	322,139	322,139	322,139
Adjusted R-squared	0.377	0.380	0.379	0.611	0.611	0.612	0.672	0.672	0.672
Panel B: Heat Rate	Mean Dep. Var. = 11.816			Mean Dep. Var. = 10.913					
Domestic Listed Corp (DLC)	0.852***	0.412*	0.488**	-0.129	-0.255	-0.392**			
	[0.161]	[0.216]	[0.212]	[0.173]	[0.194]	[0.178]			
DLC × ISO Balancing		0.635**			0.146				
		[0.261]			[0.120]				
DLC × Retail Choice			0.655**			0.514***			
			[0.283]			[0.156]			
Plant Age and Capacity Controls	Yes	Yes	Yes	Yes	Yes	Yes			
Other Owners	Yes	Yes	Yes	Yes	Yes	Yes			
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes			
Observations	322,063	322,063	322,063	86,557	86,557	86,557			
Adjusted R-squared	0.273	0.275	0.275	0.349	0.349	0.351			

Table 9: Contractual Terms of Electricity Sales

In this table, observations are at the plant-prime-mover-month level and are weighted by power plant nameplate capacity. The dependent variables are the percentages of electricity transaction charges under three different contractual terms. First, we distinguish between short contracts with a duration of less than one year and long-term contracts. Second, we split transactions into short, medium, and long based on the increment pricing terms. Short transactions use 5-minute, 15-minute, or hourly increments (up to 6 hours). Medium transactions have daily or weekly increments (from 6 hours to 168 hours). Long transactions use monthly or yearly increments (longer than 168 hours). Third, we classify transactions into full-period, peak, and off-peak based on the peaking terms. The sample includes power plants owned by domestic publicly listed corporations, private equity, institutional investors, and foreign publicly listed corporations. We focus on the ownership by private equity, institutional investors, and foreign corporations (the omitted ownership category is domestic corporations). *ln Plant Capacity* is the natural logarithm of a plant's monthly capacity. *ln Plant Age* is the natural logarithm of plant age in years. *Greenfield 12m* is an indicator for the first 12 months when a plant starts operating. *Decommissioned 12m* is an indicator for the last 12 months when a plant is still operating. The specifications include interacted fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. *$p < .10$; **$p < .05$; ***$p < .01$.

	Contract Duration		**Increment Terms**			**Peaking Period Terms**		
	Short	Long	Short	Medium	Long	Full	Peak	Off-Peak
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean Dependent Variable	0.581	0.417	0.505	0.044	0.425	0.384	0.354	0.192
Private Equity	0.093***	-0.098***	0.132***	-0.011	-0.132***	-0.022	0.069***	-0.023**
	[0.028]	[0.028]	[0.023]	[0.007]	[0.025]	[0.023]	[0.017]	[0.009]
Institutional Investor	-0.156***	0.167***	-0.256***	0.042	0.219***	0.236***	-0.143***	-0.037
	[0.059]	[0.059]	[0.057]	[0.030]	[0.072]	[0.067]	[0.041]	[0.025]
Foreign Corp	-0.006	0.010	0.073**	0.008	-0.125***	0.035	-0.021	-0.047***
	[0.037]	[0.037]	[0.033]	[0.010]	[0.035]	[0.033]	[0.021]	[0.013]
ln Plant Capacity	0.015	-0.017*	0.002	-0.002	0.007	-0.008	0.009	0.003
	[0.010]	[0.010]	[0.009]	[0.003]	[0.009]	[0.009]	[0.006]	[0.003]
ln Plant Age	-0.012	0.007	0.003	-0.005	0.003	-0.020*	0.028***	-0.002
	[0.014]	[0.014]	[0.012]	[0.004]	[0.012]	[0.012]	[0.009]	[0.004]
Greenfield 12m	0.010	-0.026	0.055**	-0.001	-0.059***	-0.066***	0.070***	0.027***
	[0.025]	[0.024]	[0.021]	[0.006]	[0.022]	[0.022]	[0.016]	[0.008]
Decommissioned 12m	0.048	-0.047	0.025	0.003	-0.006	-0.020	0.021	0.006
	[0.032]	[0.032]	[0.031]	[0.004]	[0.028]	[0.032]	[0.024]	[0.014]
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	283,361	283,361	283,361	283,361	283,361	283,361	283,361	283,361
Adjusted R-squared	0.543	0.541	0.601	0.508	0.581	0.574	0.586	0.547

Table 10: Contractual Terms of Capacity Sales

In this table, observations are at the plant-prime-mover-month level and are weighted by power plant nameplate capacity. The sample includes power plants owned by domestic publicly listed corporations, private equity, institutional investors, and foreign publicly listed corporations. In Columns (1) and (2), the dependent variable is an indicator equal to one if a power plant receives compensation for capacity sales. The sample in these specifications includes all power plants reporting in the FERC dataset. In Columns (3) to (6), the dependent variables measure the average percentage of transaction charges for capacity sales by contract length. These specifications limit attention to the subsample of power plants with capacity sales. *ln Plant Capacity* is the natural logarithm of a plant's monthly capacity. *ln Plant Age* is the natural logarithm of plant age in years. *Greenfield 12m* is an indicator for the first 12 months when a plant starts operating. *Decommissioned 12m* is an indicator for the last 12 months when a plant is still operating. The specifications include interacted fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. $^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

	Probability		**Short Contracts**		**Long Contracts**	
	(1)	(2)	(3)	(4)	(5)	(6)
Mean Dependent Variable	0.836	0.836	0.153	0.153	0.846	0.846
Domestic Listed Corp (DLC)	0.028		-0.061*		0.060*	
	[0.017]		[0.031]		[0.031]	
Private Equity		-0.008		0.094***		-0.093**
		[0.020]		[0.035]		[0.035]
Institutional Investor		0.065		-0.255***		0.255***
		[0.041]		[0.060]		[0.060]
Foreign Corp		-0.088***		0.112**		-0.112**
		[0.028]		[0.045]		[0.045]
ln Plant Capacity	0.015**	0.014**	-0.010	-0.007	0.010	0.008
	[0.007]	[0.006]	[0.008]	[0.008]	[0.008]	[0.008]
ln Plant Age	0.007	0.008	0.023**	0.025**	-0.023**	-0.025***
	[0.007]	[0.007]	[0.010]	[0.010]	[0.010]	[0.010]
Greenfield 12m	-0.015	-0.012	-0.013	-0.010	0.012	0.009
	[0.018]	[0.017]	[0.026]	[0.026]	[0.026]	[0.026]
Decommissioned 12m	-0.000	0.000	-0.007	-0.005	0.007	0.006
	[0.023]	[0.022]	[0.034]	[0.034]	[0.035]	[0.034]
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	293,098	293,098	184,342	184,342	184,342	184,342
Adjusted R-squared	0.561	0.563	0.476	0.485	0.475	0.485

Table 11: Pricing of Electricity Sales

In this table, observations are at the plant-prime-mover-month level and are weighted by the quantity of sold electricity. The dependent variables are the mean and median of monthly electricity prices per MWh. We winsorize the dependent variables at 0.5% and 99.5%. The sample includes power plants owned by domestic publicly listed corporations, private equity, institutional investors, and foreign publicly listed corporations. We focus on the ownership by private equity, institutional investors, and foreign corporations (the omitted ownership category is domestic corporations). *ln Plant Capacity* is the natural logarithm of a plant's monthly capacity. *ln Plant Age* is the natural logarithm of plant age in years. *Greenfield 12m* is an indicator for the first 12 months when a plant starts operating. *Decommissioned 12m* is an indicator for the last 12 months when a plant is still operating. The specifications include interacted fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. $^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

	Mean Price		**Median Price**	
	(1)	(2)	(3)	(4)
Mean Dependent Variable	33.391	33.391	30.200	30.200
Private Equity	4.627***	2.044*	4.518***	2.086**
	[1.043]	[1.073]	[1.001]	[1.022]
Institutional Investor	1.138	1.270	0.279	0.169
	[2.646]	[2.220]	[2.299]	[1.851]
Foreign Corp	1.370	-1.107	1.274	-0.935
	[1.553]	[1.446]	[1.449]	[1.461]
ln Plant Capacity	-0.441	-0.154	-0.365	0.063
	[0.505]	[0.558]	[0.484]	[0.553]
ln Plant Age	1.169**	0.887*	1.135**	0.729
	[0.493]	[0.530]	[0.485]	[0.515]
Greenfield 12m	-5.198***	-5.774***	-5.075***	-5.864***
	[1.279]	[1.213]	[1.191]	[1.127]
Decommissioned 12m	-1.259	-1.271	-1.994	-2.638
	[1.418]	[1.509]	[1.823]	[2.157]
State-Year-Month FE	Yes		Yes	
Fuel FE	Yes		Yes	
Fuel-State-Year-Month FE		Yes		Yes
Observations	236,302	217,122	236,302	217,122
Adjusted R-squared	0.591	0.706	0.522	0.661

Online Appendix

The Shifting Finance of Electricity Generation

A.1 Power Plants and Electricity Generation

The percentage of electricity generated by power plants owned by domestic publicly listed corporations (DLCs) declines from 71% in 2005 to 54% in 2020. Private equity (PE), institutional investors, and foreign corporations replace domestic corporations as their share jointly increases from 6% in 2005 to 24% in 2020. The generation share of governments, cooperatives, and industry firms remains constant. The ownership changes while the total output remains constant. Online Appendix Figure A.1 Panel A shows that U.S. produced around 4.1 trillion kWh of electricity in 2005 and the total output has remained constant over our sample period. Panel B plots the total imports and exports of electricity, which also remain stable over our analysis and are economically marginal as they account for less than 1.5% of the U.S. electricity market.

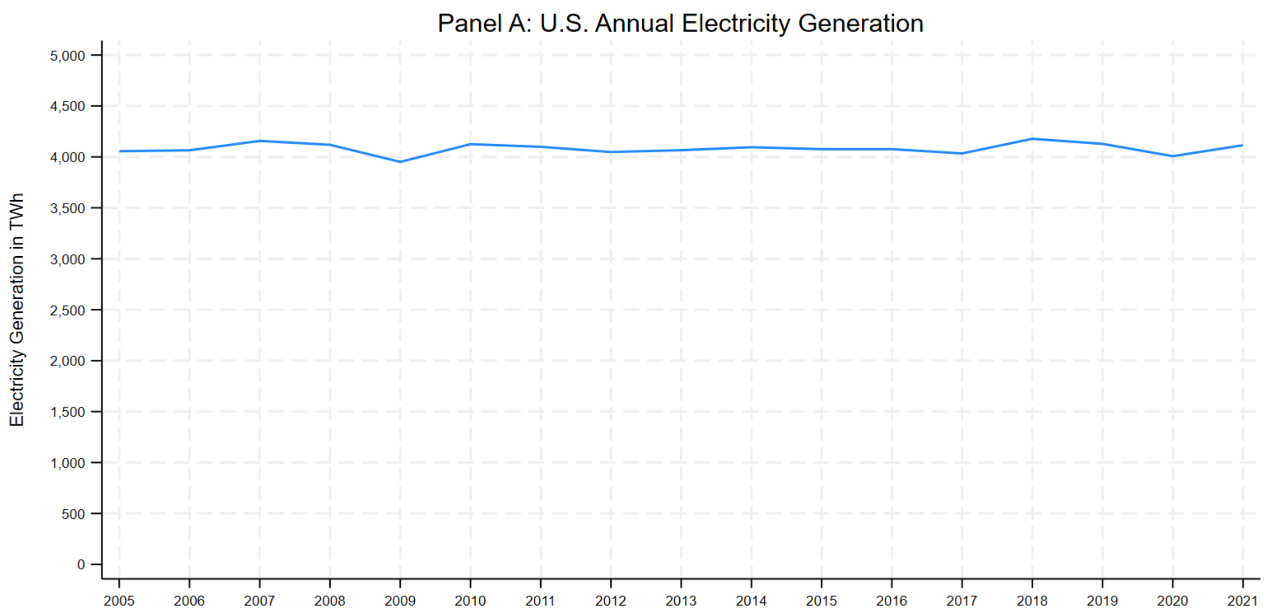
In our analysis, all values are weighted by power plant nameplate capacity. We present weighted statistics and regression estimates, as the sample of power plants contains many small power plants that contribute very little to overall net generation. Online Appendix Table A.1 reports summary statistics without weighting the power plants and focuses only on the subsample of power plants with a capacity of at least 20MW.

Online Appendix Table A.2 shows how many power plants in each state operate under a deregulated wholesale and retail market. This table shows that the *ISO Balancing* measure is broader as it covers also states that did not restructure their utilities but agreed to operate in a competitive wholesale market. On the other hand, the vast majority of power plants located in an area that offers a *Retail Choice* participate in an *ISO Restructured* wholesale market.

We use the Database of State Incentives for Renewables & Efficiency from the N.C. Clean Energy Technology Center to collect information on the policy incentives introduced by different states to stimulate the transition to renewable energy sources. We split the policy initiatives into three types of tax incentives: Renewables Corporate Tax, Renewables Property Tax, and Renewables Sales Tax; and two types of production incentives: Renewables Production and Renewables Tariffs. Renewables Corporate Tax Incentives capture programs that provide a corporate tax credit, corporate tax deduction, and corporate depreciation. Renewables Property Taxes capture programs offering property tax exemption or reduction. Renewables Sales Taxes incentives offer an exemption or reduction from sales and use tax for equipment, generation, etc. Renewables Production incentives offer monetary compensation per KWh that can differ by fuel type and plant capacity. Renewables Tariffs incentives capture primarily feed-in tariffs, which offer long-term contracts with an above-market price to renewable energy producers. In our analysis, we include a *Renewables Incentives* index, which aggregates the three tax indicators and the two production indicators. Online Appendix Table A.3 presents the average value of the five indicators and aggregate renewables incentives index by state over the 2005–2020 period. The index varies from 0.00 in Arkansas to 3.91 incentive types in Vermont.

Figure A.1: Total U.S. Electricity Market

Panel A presents the total U.S. electricity generation over the 2005–2021 period. The data is based on the Energy Information Administration (EIA) Monthly Energy Review Table 7.2a and includes generation from power plants with at least 1 MW electric generation capacity. Panel B shows the total U.S. electricity imports and electricity exports to Canada and Mexico over the 2011–2021 period. The data is based on the Energy Information Administration (EIA) Table 2.14. (Sources: 2016–2021, U.S. Energy Information Administration, Form EIA-111, Quarterly Electricity Imports and Exports Report; 2006–2015 data, National Energy Board of Canada; FERC 714, Annual Electric Balancing Authority Area and Planning Report; California Energy Commission; and EIA estimates.)



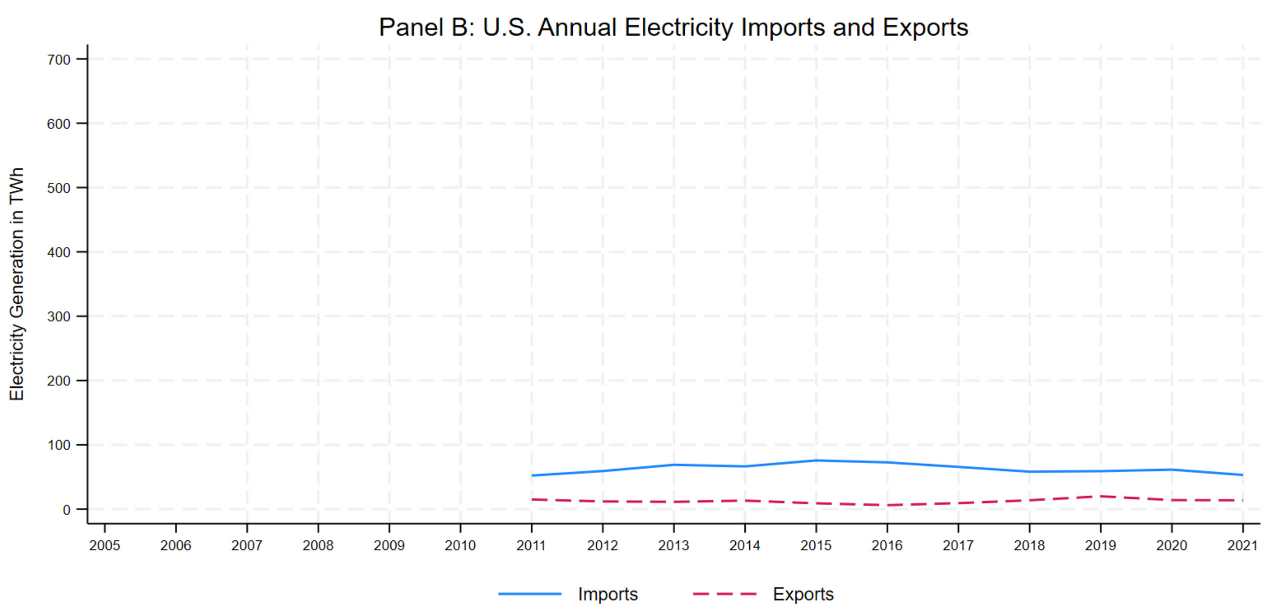


Table A.1: EIA Power Plants (Not Weighted Observations)

Robustness statistics of Table 1: We do not weight observations by power plant nameplate capacity, but we limit attention to the subsample of power plants with a nameplate capacity of at least 20MW.

The table presents summary statistics on a plant-prime-mover-month level for all power plants together as well as separately for the main fuel types: natural gas, coal, nuclear, hydro, wind, and solar plants. The sample includes only power plants with a nameplate capacity of at least 20MW. Panel B reports statistics for the power plant characteristics: *Capacity*, *Capacity Factor*, *Heat Rate*, *Age*, *Independent Power Producer*, *Greenfield 12m*, and *Decommissioned 12m*. Panel C reports the average ownership by the eight categories in percent. If a power plant is owned by multiple ownership types, we divide the ownership and generation equally across the ownership types. Panel D presents statistics on electricity markets. *ISO Balancing* is an indicator for power plants that participate in a wholesale market administered by an Independent System Operator. *ISO Restructured* is an indicator for power plants that participate in a wholesale market administered by an ISO balancing authority and are located in areas with restructured electric utilities. *Retail Choice* is an indicator for power plants located in an area where residential or business customers can choose an electricity provider. *Climate Concern* is the percentile ranking of the state where the plant is located based on the percentage of the state population who think that global warming is happening. *Renewables Incentives* is an aggregate index of three indicators if a state has corporate tax, property tax, and sales tax incentives for renewable energy as well as two indicators if a state has production or feed-in tariffs incentives for renewable energy.

	All	**NatGas**	**Coal**	**Nuclear**	**Hydro**	**Wind**	**Solar**
Panel A: Power Plants Sample							
# Unique Plants	4,458	1,961	651	66	457	881	502
# Unique Plants-Prime-Mover	5,406	2,797	729	66	457	881	502
# Unique Greenfield	1,889	518	36	0	5	779	501
# Unique Decommissioned	816	536	249	10	5	28	1
Observations	753,711	420,606	102,630	12,215	86,146	88,184	21,062
Panel B: Power Plant Characteristics							
Capacity (GWh)	0.285	0.257	0.635	1.689	0.163	0.114	0.063
Capacity Factor	0.318	0.263	0.478	0.857	0.373	0.321	0.257
Heat Rate		11.981	10.768	10.459			
Age (Years)	28.530	22.904	42.951	33.668	61.290	7.059	2.701
Independent Power Producer	0.525	0.536	0.416	0.478	0.138	0.869	0.871
Greenfield 12m	0.028	0.015	0.004	0.000	0.001	0.099	0.251
Decommissioned 12m	0.013	0.013	0.028	0.009	0.001	0.004	0.001
Panel C: Power Plant Ownership							
Domestic Listed Corp (DLC)	0.419	0.390	0.504	0.864	0.345	0.414	0.529
Private Equity	0.144	0.160	0.075	0.013	0.074	0.242	0.273
Institutional Investor	0.016	0.018	0.003	0.000	0.005	0.039	0.055
Foreign Corp	0.074	0.053	0.022	0.016	0.031	0.262	0.098
Industry	0.067	0.084	0.129	0.000	0.012	0.001	0.011
Government	0.198	0.192	0.169	0.106	0.512	0.017	0.002
Cooperative	0.051	0.067	0.071	0.000	0.020	0.009	0.004
Other	0.031	0.035	0.028	0.000	0.001	0.017	0.027
Panel D: State Electricity Markets							
ISO Balancing	0.637	0.668	0.641	0.700	0.399	0.774	0.555
ISO Restructured	0.333	0.376	0.331	0.494	0.144	0.330	0.097
Retail Choice	0.490	0.520	0.350	0.515	0.429	0.486	0.579
Climate Concern	0.572	0.592	0.442	0.560	0.573	0.534	0.738
Renewables Incentives	2.216	2.223	2.066	2.107	2.033	2.575	2.515

Table A.2: Regulatory Policy by State

We present the number of plant-prime-mover-month observations by state based on the electricity market regulatory status. *ISO Balancing* is an indicator for power plants that participate in a wholesale market administered by an Independent System Operator as a balancing authority and electric power transmission system operator. *ISO Restructured* is an indicator for power plants that participate in a wholesale market administered by an ISO balancing authority and are located in areas with restructured electric utilities. *Retail Choice* is an indicator for power plants located in an area where residential or business customers can choose an electricity provider. *Traditional* markets do not offer retail choice and vertically integrated local electric utilities own power plants generating electricity as well as the transmission system and delivery network.

State	ISO Balancing	ISO Restructured	Retail Choice	Traditional	Total Plants
Alabama	0	0	0	18,698	18,698
Alaska	0	0	0	28,251	28,251
Arizona	261	0	0	22,266	22,527
Arkansas	9,250	0	0	3,144	12,394
California	174,300	0	210,757	0	210,757
Colorado	162	0	0	30,559	30,721
Connecticut	18,038	18,038	18,038	0	18,038
Delaware	5,024	5,024	5,024	0	5,024
District of Columbia	503	503	503	0	503
Florida	0	0	0	42,660	42,660
Georgia	0	0	0	29,475	29,475
Hawaii	0	0	0	12,156	12,156
Idaho	0	0	0	22,249	22,249
Illinois	41,237	41,237	41,237	882	42,119
Indiana	24,455	0	0	361	24,816
Iowa	37,390	0	0	5,248	42,638
Kansas	23,054	0	0	3,095	26,149
Kentucky	3,283	0	0	6,861	10,144
Louisiana	17,677	0	0	2,654	20,331
Maine	18,335	18,335	20,048	0	20,048
Maryland	15,671	15,671	15,671	0	15,671
Massachusetts	47,365	47,365	47,365	0	47,365
Michigan	46,559	46,559	47,492	0	47,492
Minnesota	59,868	0	0	3,127	62,995
Mississippi	4,786	0	0	7,611	12,397
Missouri	17,634	0	0	8,511	26,145
Montana	1,100	0	8,953	0	8,953
Nebraska	14,559	0	0	4,946	19,505
Nevada	983	0	15,771	0	15,771
New Hampshire	12,712	12,712	12,712	0	12,712
New Jersey	38,933	38,933	38,933	0	38,933
New Mexico	3,502	0	0	11,270	14,772
New York	82,290	82,290	82,290	0	82,290
North Carolina	7,172	0	0	56,390	63,562
North Dakota	7,868	0	0	579	8,447
Ohio	30,402	30,402	30,958	0	30,958
Oklahoma	17,399	0	0	3,193	20,592
Oregon	0	0	27,856	0	27,856
Pennsylvania	42,789	42,789	43,035	0	43,035
Rhode Island	5,676	5,676	5,676	0	5,676
South Carolina	0	0	0	22,093	22,093
South Dakota	3,231	0	0	3,267	6,498
Tennessee	368	0	0	12,804	13,172
Texas	84,507	84,507	68,837	3,888	88,395
Utah	0	0	0	15,457	15,457
Vermont	14,099	0	0	0	14,099
Virginia	27,509	27,509	24,008	820	28,596
Washington	0	0	0	26,114	26,114
West Virginia	6,159	0	0	942	7,101
Wisconsin	36,358	0	0	2,249	38,607
Wyoming	0	0	0	11,207	11,207

Table A.3: Renewable Policy Index by State

We use the Database of State Incentives for Renewables & Efficiency from the N.C. Clean Energy Technology Center to collect information on the renewable policy incentives by state-year-month. We split the policy initiatives into three types of tax incentives: Corporate Tax, Property Tax, and Sales Tax; and two types of production incentives: Production and Tariffs. For each type of incentive, we create an indicator variable equal to one if a state has at least one incentive in that category in a given month. The table presents the average values of these indicators over the 2008–2020 period by state. In our analysis, we include a *Renewables Incentives* index, which aggregates the three tax indicators and the two production indicators.

State	Corporate Tax	Property Tax	Sales Tax	Production	Tariffs	Renewables Incentives
Alaska	0.00	0.00	0.00	1.00	0.00	1.00
Alabama	0.00	0.00	0.00	0.62	0.52	1.14
Arkansas	0.00	0.00	0.00	0.00	0.00	0.00
Arizona	0.94	1.00	1.00	0.00	0.00	2.94
California	0.06	0.00	0.19	1.00	0.90	2.15
Colorado	0.37	0.84	0.91	0.93	0.00	3.04
Connecticut	0.00	0.00	0.84	0.49	0.00	1.34
DC	0.00	0.53	0.00	0.49	0.00	1.03
Delaware	0.00	0.00	0.00	0.97	0.00	0.97
Florida	0.62	0.78	1.00	0.30	0.00	2.70
Georgia	0.40	0.00	0.00	0.58	0.00	0.98
Hawaii	1.00	0.70	0.00	0.49	0.71	2.91
Iowa	1.00	1.00	1.00	0.00	0.56	3.56
Idaho	0.00	0.81	0.98	0.00	0.00	1.80
Illinois	0.00	0.88	0.72	0.65	0.00	2.24
Indiana	0.00	0.68	0.00	0.67	0.36	1.71
Kansas	0.31	1.00	0.00	0.00	0.00	1.31
Kentucky	0.81	0.00	0.81	0.62	0.00	2.24
Louisiana	0.62	0.00	0.00	0.00	0.00	0.62
Massachusetts	1.00	1.00	0.00	1.00	0.00	3.00
Maryland	0.87	1.00	0.78	0.49	0.00	3.15
Maine	0.00	0.05	0.00	0.58	0.00	0.63
Michigan	0.00	1.00	0.00	0.71	0.37	2.08
Minnesota	0.00	1.00	1.00	0.93	0.48	3.41
Missouri	0.00	0.59	0.00	0.00	0.00	0.59
Mississippi	0.00	0.00	0.00	0.62	0.38	0.99
Montana	0.69	1.00	0.00	0.00	0.00	1.69
North Carolina	0.68	0.78	0.00	0.98	0.00	2.44
North Dakota	0.62	1.00	0.34	0.00	0.00	1.96
Nebraska	0.88	0.67	0.83	0.00	0.00	2.38
New Hampshire	0.00	1.00	0.00	0.00	0.00	1.00
New Jersey	0.00	0.77	1.00	1.00	0.00	2.77
New Mexico	1.00	0.69	0.84	0.67	0.00	3.20
Nevada	0.00	1.00	0.75	0.93	0.00	2.68
New York	0.37	1.00	0.96	0.07	0.21	2.61
Ohio	0.31	1.00	1.00	0.71	0.00	3.03
Oklahoma	1.00	0.38	0.00	0.00	0.00	1.38
Oregon	0.97	0.66	0.00	0.99	0.00	2.63
Pennsylvania	0.00	0.88	0.00	0.49	0.00	1.37
Rhode Island	0.63	1.00	1.00	0.60	0.00	3.23
South Carolina	0.94	0.00	0.00	0.81	0.00	1.75
South Dakota	0.00	0.84	0.67	0.00	0.00	1.51
Tennessee	0.00	1.00	0.66	0.58	0.00	2.24
Texas	1.00	1.00	0.00	0.66	0.52	3.18
Utah	1.00	0.00	1.00	0.00	0.00	2.00
Virginia	0.00	1.00	0.00	0.62	0.00	1.62
Vermont	0.20	1.00	1.00	0.71	1.00	3.91
Washington	0.00	0.00	0.72	0.96	0.90	2.58
Wisconsin	0.00	0.00	1.00	0.89	0.00	1.89
West Virginia	1.00	1.00	0.00	0.00	0.00	2.00
Wyoming	0.00	0.00	1.00	0.00	0.00	1.00

A.2 FERC Data on Electricity Transactions

Panel A of Table 2 reports the average percentage of transaction charges for electricity sales by different contractual terms, while Online Appendix Table A.4 presents the average percentage of the quantity of electricity sold by different contractual terms. Around 58% of the electricity charges in our sample are for sales under contracts with short durations and 50% of the transactions use short increments to determine the price. Transactions covering the full period account for 39% of the quantity sold and charges. Peak period sales are more expensive as they account for 31% of the quantity and 35% of the charges, while off-peak sales are smaller and cheaper. Power plants using fossil fuels, such as coal and natural gas, are more flexible to adjust operation hours so they rely relatively more on short-term contracts, short increment pricing, and peak-term production for electricity sales. Solar and wind power plants depend on weather conditions and have limited flexibility in operating hours, so they use relatively more long-term contracts, long increment pricing, and full-period contractual terms for electricity sales.

Table A.4: FERC Electricity Pricing and Contracting

Robustness statistics of Table 2 Panel B: We present the average percentage of electricity quantity sold by different contractual terms instead of the average percentage of transaction charges for electricity sales by different contractual terms.

Observations are on a plant-prime-mover-month level weighted by nameplate capacity. The sample includes power plants owned by domestic listed corporations (DLC), private equity, institutional investors, and foreign corporations. The table reports the average percentage of electricity quantity sold by different contractual terms. We split the electricity sales based on three contractual terms. First, we analyze contract duration and distinguish between short contracts with a duration of less than one year and long-term contract duration. Second, we split the transactions into short, medium, and long based on the increment terms. Short transactions use 5-minute, 15-minute, or hourly increments (up to 6 hours). Medium transactions have daily or weekly increments (from 6 hours to 168 hours). Long transactions use monthly or yearly increments (longer than 168 hours). Third, we classify transactions into full-period, peak, and off-peak based on the peaking terms.

	All	**NatGas**	**Coal**	**Nuclear**	**Hydro**	**Wind**	**Solar**
Contractual Terms of Electricity Sales Based on Quantity Sold							
Contract Duration - Short	0.564	0.586	0.607	0.491	0.664	0.380	0.245
Contract Duration - Long	0.434	0.413	0.389	0.509	0.335	0.614	0.755
Increment Terms - Short	0.501	0.557	0.533	0.407	0.380	0.346	0.197
Increment Terms - Medium	0.041	0.033	0.053	0.045	0.085	0.012	0.028
Increment Terms - Long	0.431	0.395	0.398	0.504	0.404	0.595	0.727
Peaking Terms - Full Period	0.391	0.353	0.366	0.468	0.357	0.550	0.593
Peaking Terms - Peak	0.314	0.331	0.349	0.256	0.267	0.18	0.187
Peaking Terms - Off-Peak	0.223	0.253	0.219	0.215	0.21	0.174	0.092

A.3 The Determinants of Ownership Changes

Panel B of 3 shows that private equity, institutional investors, and foreign listed corporations are more likely to own a greenfield power plant as compared to their overall ownership share. For instance, private equity owns on average 24.6% of the greenfield power plants versus 10.9% of all power plants. Appendix Figure **??** shows that most of the newly created power plants use wind and solar technology, but there is also a significant share of new natural gas power plants which were supported by the shale gas boom (see Gilje, Loutskina, and Strahan (2016) for discussion on the rapid growth of shale gas production). This figure suggests that ownership structures could differ in their relative importance in the creation of both renewable and natural gas power plants.

Online Appendix Table A.5 shows that our results are robust to using logit specifications instead of pooled OLS, and without weighting the observations by nameplate capacity. However, we rely more on the OLS specification as the weighted coefficients are economically more relevant, and they include a more saturated set of fixed effects.

In Online Appendix Table A.6, we estimate a robustness test by limiting attention to the subsample of power plants with a nameplate capacity above 20MW as we cannot weigh the observations by power plant capacity instead of weighting power plants by nameplate capacity. In this test, we want to test that the results are not driven by a few large newly created power plants (we also do not include all power plants to avoid that the results are driven by micro solar plants). The unconditional baseline probability in this unweighted subsample equals 2.75% as compared to 1.63% in the weighted broad sample, which shows that the newly create power plants tend to be on average smaller than the existing power plants. The results confirm that DLCs are less likely to create new power plants than private equity and foreign corporations. The difference in the probability to create new electricity generating assets is concentrated in states with deregulated wholesale and retail electricity markets.

In Online Appendix Table 6, we estimate a robustness test on the differences in decommissioning power plants across ownership types using a Cox proportional hazard model instead of pooled OLS model. We estimate the hazard rate of decommissioning a power plant, defined as the probability that a decommissioning will be completed in month t conditional on it not becoming complete prior to month t. These robustness specifications focus on the subsample of power plants with a nameplate capacity of at least 20MW and do not weigh the observations by nameplate capacity. One limitation of the hazard models is that we cannot include interacted fixed effects, but we still control for fuel and state fixed effects. The Cox proportional hazard model is robust to time-specific common factors, which is analogous to controlling for time fixed effects (Dinc and Gupta, 2011). The results suggest that DLCss are marginally more likely to shut down power plants than other ownership types, which provides some evidence supporting the leakage hypothesis, but PE is the second most likely ownership type to decommission power plants. The difference in the probability to retire electricity generating assets again seems to be concentrated in states with deregulated markets.

Table A.5: Ownership of Greenfield Power Plants (Logit Specifications)

Robustness check of Table 3: We use logit specifications and do not weight observations by power plant nameplate capacity, but we limit attention to the subsample of power plants with a nameplate capacity of at least 20MW.

In this table, observations are at the plant-prime-mover-month level and the sample includes only power plants with a nameplate capacity of at least 20MW. The dependent variable captures greenfield power plants and equals one for the first 12 months of plant operation. We measure the ownership by domestic publicly listed corporations (DLC), private equity, institutional investors, and foreign publicly listed corporations. We also control for the ownership by industry firms, government, cooperatives, and others. *ISO Balancing*, *ISO Restructured*, and *Retail Choice* are indicators for power plants located in an area with a deregulated electricity market. *Independent Power Producer* is an indicator for an entity that owns and operates power plants but is not regulated as a traditional vertically integrated electric utility. The specifications include fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. *$p < .10$; **$p < .05$; ***$p < .01$.

Greenfield Power Plants with Capacity ≥ 20MW (Unconditional Prob. = 2.75%)						
	(1)	(2)	(3)	(4)	(5)	(6)
Domestic Listed Corp (DLC)	-0.845***		-0.270	-0.736**	-0.947***	-0.448
	[0.143]		[0.393]	[0.365]	[0.364]	[0.567]
Private Equity		1.084***				
		[0.171]				
Institutional Investor		-0.982*				
		[0.542]				
Foreign Corp		0.726***				
		[0.181]				
DLC × ISO Balancing			-0.894***			
			[0.233]			
DLC × ISO Restructured				-1.345***		
				[0.285]		
DLC × Retail Choice					-1.409***	
					[0.294]	
Independent Power Producer (IPP)						-0.091
						[0.461]
DLC × IPP						-1.047**
						[0.486]
DLC × Climate Concern			-0.222	-0.111	1.187**	0.126
			[0.481]	[0.478]	[0.564]	[0.488]
DLC × Renewables Incentives			0.076	0.150	0.049	0.093
			[0.116]	[0.118]	[0.115]	[0.116]
ln Plant Capacity	0.786***	0.792***	0.790***	0.792***	0.790***	0.787***
	[0.080]	[0.080]	[0.080]	[0.080]	[0.079]	[0.079]
Other Owners	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Fuel FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	741,318	741,318	741,318	741,318	741,318	741,318

Table A.6: Ownership of Greenfield Power Plants (Not Weighted Observations)

Robustness check of Table 3: We do not weight observations by power plant nameplate capacity, but we limit attention to the subsample of power plants with a nameplate capacity of at least 20MW.

In this table, observations are at the plant-prime-mover-month level and the sample includes only power plants with a nameplate capacity of at least 20MW. The dependent variable captures greenfield power plants and equals one for the first 12 months of plant operation. We measure the ownership by domestic publicly listed corporations (*DLC*), private equity, institutional investors, and foreign publicly listed corporations. We also control for the ownership by industry firms, government, cooperatives, and others. *ISO Balancing*, *ISO Restructured*, and *Retail Choice* are indicators for power plants located in an area with a deregulated electricity market. *Independent Power Producer* is an indicator for an entity that owns and operates power plants, but is not regulated as a traditional vertically integrated electric utility. The specifications include interacted fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. $^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

	Greenfield Power Plants with Capacity ≥ 20MW (Unconditional Prob. = 2.75%)					
	(1)	(2)	(3)	(4)	(5)	(6)
Domestic Listed Corp (DLC)	-1.453***		-0.815	-1.441***	-1.616***	-0.970*
	[0.253]		[0.499]	[0.490]	[0.486]	[0.532]
Private Equity		1.802***				
		[0.294]				
Institutional Investor		-0.855				
		[0.943]				
Foreign Corp		1.239***				
		[0.445]				
DLC × ISO Balancing			-1.231***			
			[0.303]			
DLC × ISO Restructured				-1.155***		
				[0.351]		
DLC × Retail Choice					-1.517***	
					[0.393]	
Independent Power Producer (IPP)						0.089
						[0.307]
DLC × IPP						-1.828***
						[0.418]
DLC × Climate Concern			-0.115	-0.181	1.270*	0.417
			[0.622]	[0.616]	[0.736]	[0.647]
DLC × Renewables Incentives			0.122	0.217	0.095	0.142
			[0.156]	[0.156]	[0.156]	[0.156]
ln Plant Capacity	0.725***	0.728***	0.746***	0.738***	0.729***	0.744***
	[0.071]	[0.071]	[0.072]	[0.072]	[0.071]	[0.071]
Other Owners	Yes	Yes	Yes	Yes	Yes	Yes
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	676,537	676,537	676,537	676,537	676,537	676,537
Adjusted R-squared	0.151	0.151	0.151	0.151	0.151	0.152

Table A.7: Ownership of Greenfield Power Plants by Fuel Type

Robustness check of Figure 4: We present the regression estimates for the full sample of all plants.

In this table, observations are at the plant-prime-mover-month level and weighted by plant capacity. In Columns (1) to (4), the dependent variable equals one for the first 12 months of operation for solar and wind greenfield plants. In Columns (5) to (8), the dependent variable equals one for the first 12 months of operation for natural gas greenfield plants. We measure the ownership by domestic publicly listed corporations (DLC), private equity, institutional investors, and foreign corporations. We also control for the ownership by industry firms, government, cooperatives, and others. Panel A presents the results of baseline specifications, while Panel B presents the results of specifications with interaction terms of DLCs and market regulation. *ISO Balancing* is an indicator for power plants that participate in a wholesale market administered by an ISO balancing authority. *ISO Restructured* is an indicator for power plants participating in an ISO balancing wholesale market and located in areas with restructured electric utilities. *Retail Choice* is an indicator for power plants located in an area where residential or business customers can choose an electricity provider. *IPP* is an indicator for an independent power producer. We also control for interaction terms with *Climate Concern* percentile ranking variable and *Renewables Incentives* aggregate index. *ln Plant Capacity* is the natural logarithm of a plant's monthly capacity. The specifications include interacted fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. $^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

	Solar & Wind Power Plants Unconditional Prob. = 13.66%				**Natural Gas Power Plants** Unconditional Prob. = 1.47%			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Specifications with Baseline Coefficients on Ownership Categories								
Domestic Listed Corp (DLC)	-4.248***				-0.480*			
	[0.996]				[0.282]			
Private Equity		6.489***				0.707**		
		[1.183]				[0.341]		
Institutional Investor		-4.376*				0.714		
		[2.312]				[0.968]		
Foreign Corp		3.657***				-0.334		
		[1.244]				[0.446]		
Plant Capacity	Yes	Yes			Yes	Yes		
Other Owners	Yes	Yes			Yes	Yes		
Fuel-State-Year-Month FE	Yes	Yes			Yes	Yes		
Observations	322,139	322,139			518,935	518,935		
Adjusted R-squared	0.167	0.169			0.150	0.151		
Panel B: Specifications with Interaction Terms of Domestic Listed Corporation and Market Regulation								
Domestic Listed Corp (DLC)	-1.981	-4.405*	-4.412*	0.911	0.458	-0.302	-0.536	0.261
	[2.768]	[2.603]	[2.590]	[3.652]	[0.578]	[0.540]	[0.548]	[0.707]
DLC × ISO Balancing	-2.193				-1.520***			
	[1.751]				[0.400]			
DLC × ISO Restructured		-4.801**				-2.018***		
		[2.365]				[0.452]		
DLC × Retail Choice			-6.823***				-1.869***	
			[2.296]				[0.445]	
IPP				1.352				0.326
				[2.613]				[0.508]
DLC × IPP				-6.379**				-2.037***
				[2.948]				[0.610]
Plant Capacity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interaction with Climate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interaction with Incentives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other Owners	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	322,139	322,139	322,139	322,139	518,935	518,935	518,935	518,935
Adjusted R-squared	0.168	0.168	0.169	0.169	0.151	0.152	0.151	0.152

Table A.8: Sales and Decommissioning of Power Plants Owned by DLCs

Robustness check of Table 5: We estimate a multinomial logit model on four outcomes instead of a competing risk model.

In this table, observations are at the plant-prime-mover-month level and the sample includes only power plants with a nameplate capacity of at least 20MW. We present the marginal effects at the means of multinomial logit specifications. The sample covers power plants that were owned by domestic corporations at the beginning of our sample, in January 2005. We analyze four potential outcomes based on the latest observation in our dataset (December 2020 for plants that are not retired): *Still Own & Operating* covers plants that are still owned and operated by domestic corporations; *Owned & Retired* covers plants that remained in domestic corporations' ownership, but were retired during the sample period; *Sold & Operating* captures plants that were sold to other ownership types and are still operating; *Sold & Retired* captures plants that were sold to other ownership types and were retired by these other owners during the sample period. *ISO Balancing* and *Retail Choice* are indicators for power plants located in an area with a deregulated electricity market. We also control for *Climate Concern* percentile ranking and *Renewables Incentives* aggregate index. *ln Plant Capacity* is the natural logarithm of a plant's monthly capacity. *ln Plant Age* is the natural logarithm of plant age in years. The specifications include fuel-type fixed effects and we present the coefficients for coal, nuclear, hydro, wind, and solar power plants (the omitted category is natural gas plants; the solar indicator is automatically dropped from the specifications). We cluster standard errors by plant-prime-mover and report standard errors in brackets. *$p < .10$; **$p < .05$; ***$p < .01$.

	Still Own & Operating		**Owned & Retired**		**Sold & Operating**		**Sold & Retired**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
# Unique Plants	839	839	348	348	404	404	61	61
Unconditional Prob.	0.508	0.508	0.211	0.211	0.245	0.245	0.037	0.037
ISO Balancing	-0.264***		-0.017		0.237***		0.044***	
	[0.028]		[0.022]		[0.025]		[0.012]	
Retail Choice		-0.182***		-0.019		0.171***		0.030***
		[0.029]		[0.021]		[0.025]		[0.010]
Climate Concern	-0.030	-0.103**	0.012	0.008	0.006	0.064	0.012	0.031
	[0.050]	[0.051]	[0.041]	[0.040]	[0.045]	[0.045]	[0.021]	[0.021]
Renewables Incentives	0.004	0.010	0.011	0.012	-0.020*	-0.026**	0.005	0.004
	[0.012]	[0.013]	[0.010]	[0.010]	[0.011]	[0.011]	[0.005]	[0.005]
ln Plant Capacity	0.087***	0.082***	-0.052***	-0.052***	-0.023**	-0.020**	-0.012**	-0.011**
	[0.011]	[0.011]	[0.008]	[0.008]	[0.009]	[0.009]	[0.005]	[0.005]
ln Plant Age	-0.042***	-0.040***	0.164***	0.165***	-0.119***	-0.121***	-0.003	-0.003
	[0.015]	[0.015]	[0.015]	[0.015]	[0.010]	[0.010]	[0.006]	[0.006]
Coal	-0.078**	-0.074*	0.099***	0.099***	-0.035	-0.038	0.014	0.013
	[0.038]	[0.039]	[0.026]	[0.026]	[0.036]	[0.037]	[0.018]	[0.018]
Hydro	0.588***	0.582***	-0.588***	-0.589***	0.043	0.049	-0.043	-0.042
	[0.061]	[0.060]	[0.073]	[0.073]	[0.044]	[0.044]	[0.034]	[0.034]
Nuclear	0.478***	0.501***	0.149**	0.153**	-0.206	-0.230	-0.421***	-0.424***
	[0.111]	[0.118]	[0.061]	[0.061]	[0.141]	[0.147]	[0.058]	[0.059]
Wind	0.194***	0.176***	0.053	0.057	-0.271***	-0.259***	0.024	0.025
	[0.066]	[0.068]	[0.059]	[0.059]	[0.059]	[0.061]	[0.016]	[0.017]
Fuel Type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,652	1,652	1,652	1,652	1,652	1,652	1,652	1,652

Table A.9: Ownership of Decommissioned Power Plants

Robustness check of Table 6: We estimate pooled OLS instead of Cox proportional hazard model.

In this table, observations are at the plant-prime-mover-month level and are weighted by power plant nameplate capacity. The dependent variable captures decommissioned power plants and equals one for the last 12 months of plant operation. We measure the ownership by domestic publicly listed corporations, private equity, institutional investors, and foreign publicly listed corporations. We also control for the ownership by industry firms, government, cooperatives, and others. *ISO Balancing*, *ISO Restructured*, and *Retail Choice* are indicators for power plants located in an area with a deregulated electricity market. *Independent Power Producer* is an indicator for an entity that owns and operates power plants, but is not regulated as a traditional vertically integrated electric utility. *Climate Concern* is the percentile ranking of the state where the plant is located based on the percentage of the state population who think that global warming is happening. *Renewables Incentives* is an aggregate index of three indicators if a state has corporate tax, property tax, and sales tax incentives for renewable energy as well as two indicators if a state has production or feed-in tariffs incentives for renewable energy. *ln Plant Capacity* is the natural logarithm of plant's monthly capacity. *ln Plant Age* is the natural logarithm of plant age in years. The specifications include interacted fuel-type, state, and year-month fixed effects. We double cluster standard errors by plant-prime-mover and time, and report standard errors in brackets. *$p < .10$; **$p < .05$; ***$p < .01$.

	All Decommissioned Power Plants (Unconditional Prob. = 1.05%)					
	(1)	(2)	(3)	(4)	(5)	(6)
Domestic Listed Corp (DLC)	0.164		-0.770*	-0.384	-0.315	0.031
	[0.213]		[0.404]	[0.389]	[0.399]	[0.505]
Private Equity		0.147				
		[0.277]				
Institutional Investor		-1.058***				
		[0.229]				
Foreign Corp		-0.727***				
		[0.207]				
DLC × ISO Balancing			0.747***			
			[0.249]			
DLC × ISO Restructured				0.248		
				[0.360]		
DLC × Retail Choice					0.889**	
					[0.376]	
Independent Power Producer (IPP)						0.654*
						[0.385]
DLC × IPP						0.109
						[0.446]
DLC × Climate Concern			1.591***	1.706***	0.892	1.392**
			[0.601]	[0.622]	[0.742]	[0.605]
DLC × Renewables Incentives			-0.216	-0.233	-0.219	-0.210
			[0.143]	[0.151]	[0.142]	[0.144]
ln Plant Capacity	-0.643***	-0.642***	-0.662***	-0.651***	-0.650***	-0.655***
	[0.078]	[0.077]	[0.078]	[0.077]	[0.077]	[0.077]
ln Plant Age	1.035***	1.047***	1.018***	1.029***	1.025***	1.040***
	[0.117]	[0.118]	[0.116]	[0.117]	[0.116]	[0.117]
Other Owners	Yes	Yes	Yes	Yes	Yes	Yes
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,410,947	1,410,947	1,410,947	1,410,947	1,410,947	1,410,947
Adjusted R-squared	0.170	0.170	0.170	0.170	0.170	0.170

Table A.10: Ownership of Decommissioned Power Plants by Fuel Type

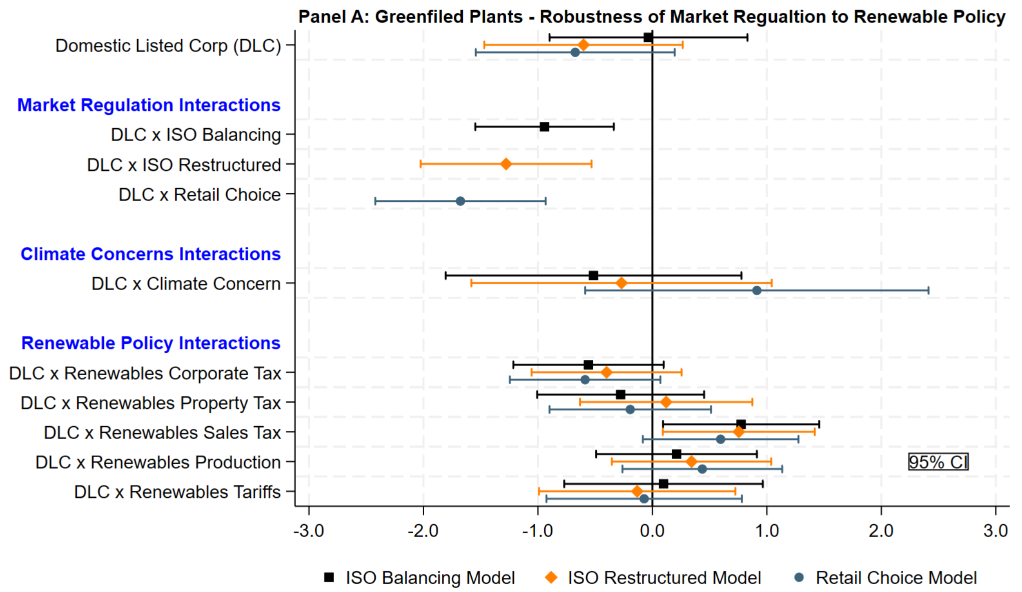
Robustness check of Figure 5: We present the regression estimates for the full sample of all plants.

Observations are at the plant-prime-mover-month level and the sample includes power plants with a capacity of at least 20MW. We estimate a survival analysis using the Cox proportional hazard model and the event of interest is a complete decommissioning of a power plant. In Columns (1) to (4), the sample covers coal, waste coal, petroleum coke, and residual petroleum plants. In Columns (5) to (8), the sample covers natural gas plants. *#Plants* reports the number of unique plants included in the survival analysis, while *#Decommissioned* reports the number of plants that are retired by the end of the analysis. Panel A presents the hazard ratios of baseline specifications, while Panel B presents the hazard ratios of specifications with interaction terms of domestic listed corporations (DLC) and market regulation. We measure the ownership by DLC, private equity, institutional investors, and foreign corporations. We also control for the ownership by industry firms, government, cooperatives, and others. *ISO Balancing*, *ISO Restructured*, and *Retail Choice* are indicators for power plants operating in a deregulated electricity market. *Independent Power Producer* is an indicator for an entity that owns power plants but is not regulated as a traditional vertically integrated electric utility. The specifications include fuel-type and state fixed effects. We cluster standard errors by plant-prime-mover and report standard errors in brackets. *$p < .10$; **$p < .05$; ***$p < .01$.

	Coal and Petroleum Power Plants (989 Plants; 314 Decommissioned)				**Natural Gas Power Plants** (2,320 Plants; 342 Decommissioned)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Specifications with Baseline Coefficients on Ownership Categories								
Domestic Listed Corp (DLC)	1.567**				1.120			
	[0.333]				[0.198]			
Private Equity		0.681*				1.247		
		[0.156]				[0.238]		
Institutional Investor		0.000				0.004***		
		[0.000]				[0.008]		
Foreign Corp		0.551				0.652		
		[0.222]				[0.221]		
Plant Capacity and Age	Yes	Yes			Yes	Yes		
Other Owners	Yes	Yes			Yes	Yes		
Fuel Type FE	Yes	Yes			Yes	Yes		
State FE	Yes	Yes			Yes	Yes		
Observations	132,781	132,781			343,814	343,814		
Panel B: Specifications with Interaction Terms with Market Regulation								
Domestic Listed Corp (DLC)	0.917	1.046	0.995	0.816	0.950	1.094	1.087	1.273
	[0.422]	[0.444]	[0.421]	[0.417]	[0.412]	[0.416]	[0.414]	[0.570]
DLC × ISO Balancing	1.281				1.183			
	[0.335]				[0.315]			
DLC × ISO Restructured		1.323				0.816		
		[0.388]				[0.209]		
DLC × Retail Choice			1.795**				1.076	
			[0.533]				[0.298]	
Independent Power Producer (IPP)				0.778				1.233
				[0.261]				[0.367]
DLC × IPP				2.306**				1.376
				[0.947]				[0.500]
Plant Capacity and Age	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interaction with Climate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interaction with Incentives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other Owners	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fuel Type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	132,781	132,781	132,781	132,781	343,814	343,814	343,814	343,814

Figure A.2: Renewable Policy Index Split into Five Separate Indicators

In this robustness test, we include five separate interaction terms with the indicators if a state has corporate tax, property tax, sales tax, production, or feed-in tariffs incentives for renewable energy instead of including an interaction term of DLCs with the aggregate *Renewable Incentives* index. In Panel A, the dependent variable captures greenfield power plants and we present the coefficient estimates of three specifications that replicate Columns (3) to (5) of Table 3. Panel B presents the coefficient estimates from Cox hazard model specifications that estimate survival analysis on power plant decommissioning events and replicate Columns (3) to (5) of Table 6.



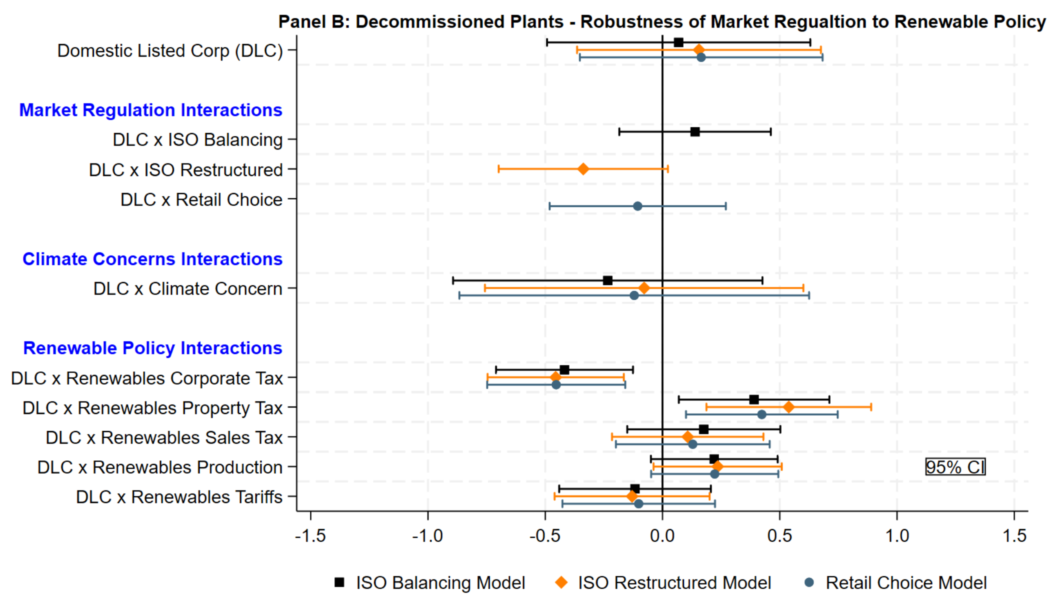


Figure A.3: Domestic Listed Corp (DLC) Split by ESG Ratings or Credit Ratings and Greenfield Plants

This figure presents coefficient estimates and confidence intervals of multiple specifications. In all models, observations are at the plant-prime-mover-month level and weighted by power plant nameplate capacity. The dependent variable captures greenfield power plants and equals one for the first 12 months of plant operation.

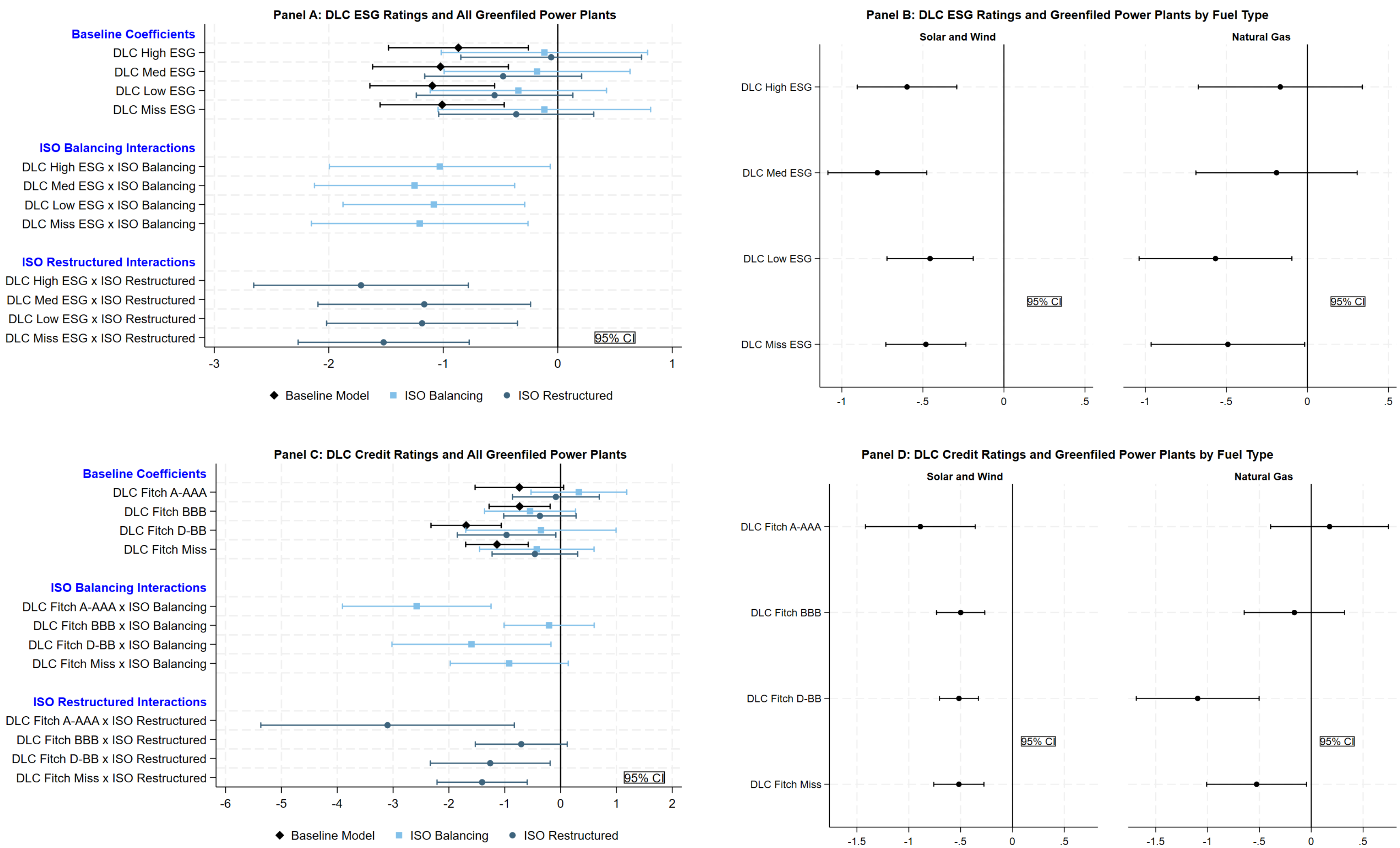
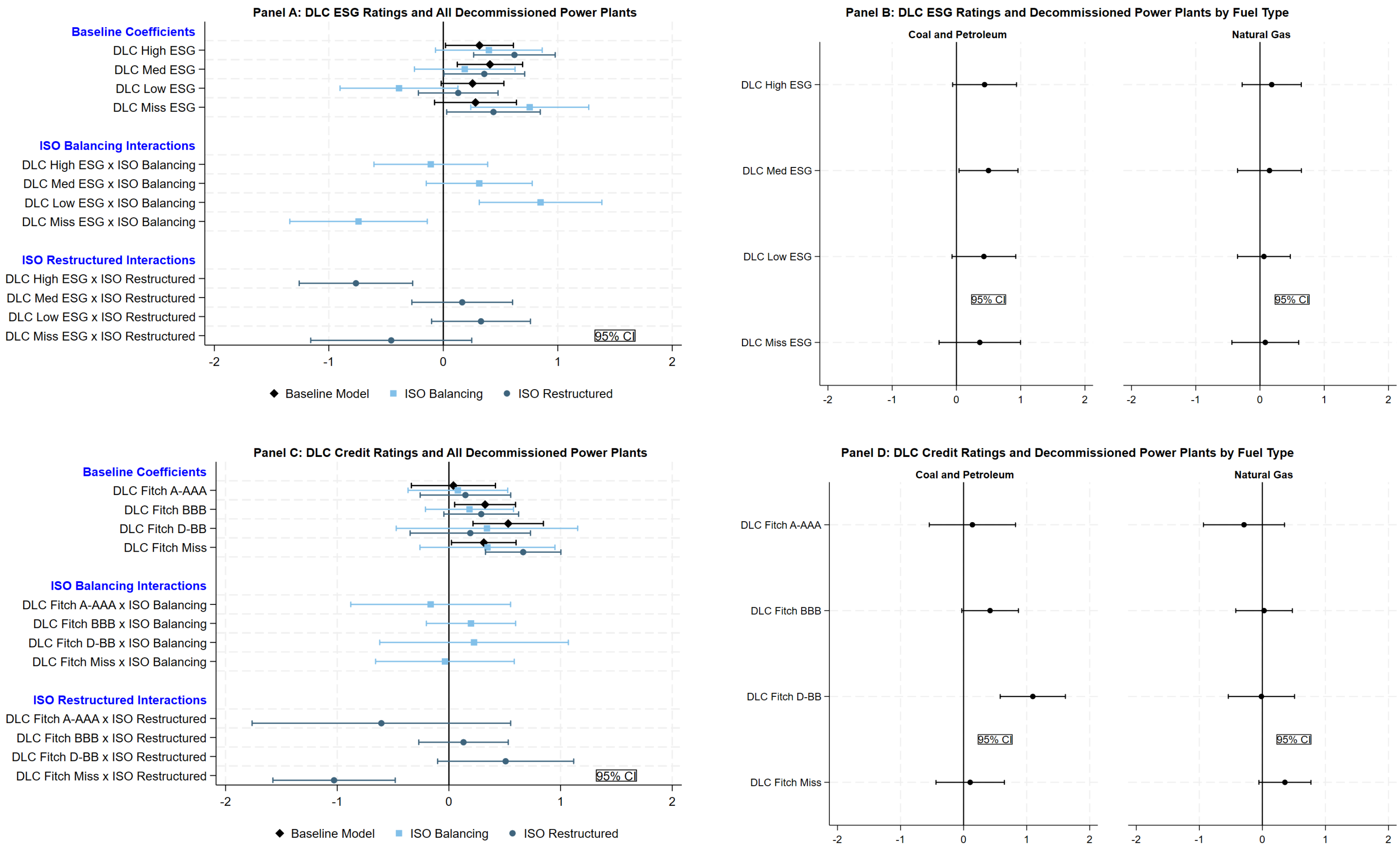


Figure A.4: Domestic Listed Corp (DLC) Split by ESG Ratings or Credit Ratings and Decommissioned Plants

This figure presents coefficient estimates and confidence intervals of multiple specifications. In all models, observations are at the plant-prime-mover-month level and ... The dependent variable captures decommissioned power plants.



A.4 Electricity Pricing and Contractual Terms

In Table 9, we examine the contractual terms of electricity transactions. The dependent variables are the percentage of the transaction charges for electricity sales under different contractual terms. Online Appendix Table A.11 shows that our results are robust to defining all contractual-term dependent variables as a percentage of the quantity sold instead of the transaction charges.

Online Appendix Table A.12 shows that the differences in contractual terms of electricity sales between new entrants and incumbent domestic corporations are entirely driven by fossil fuel power plants. When selling electricity from natural gas and coal power plants PE firms use contracts with a shorter duration and shorter pricing increments, and target peak-period sales. The contractual terms of fossil fuel power plants dominate the aggregate results because we weigh the observations by nameplate capacity and fossil fuel power plants are economically substantially more significant than renewable power plants. Panel C shows that wind and solar power plants owned by PE seem to be selling more electricity actually under long-term contracts and increments.

Table A.11: Contractual Terms of Electricity Sales

Robustness check of Table 9: The dependent variables capture the percentage of electricity quantity sold instead of the percentage of transaction charges under various contractual terms.

In this table, observations are at the plant-prime-mover-month level and are weighted by power plant nameplate capacity. The dependent variables are the percentages of electricity quantity sold under three different contractual terms. First, we distinguish between short contracts with duration of less than one year and long-term contracts. Second, we split transactions into short, medium, and long based on the increment pricing terms. Short transactions use 5-minute, 15-minute or hourly increments (up to 6 hours). Medium transactions have daily or weekly increments (from 6 hours to 168 hours). Long transaction use monthly or yearly increments (longer than 168 hours). Third, we classify transactions into full-period, peak, and off-peak based on the peaking terms. The sample includes power plants owned by domestic publicly listed corporations, private equity, institutional investors, and foreign publicly listed corporations. We focus on the ownership by private equity, institutional investors, and foreign corporations (the omitted ownership category is domestic corporations). *ln Plant Capacity* is the natural logarithm of plant's monthly capacity. *ln Plant Age* is the natural logarithm of plant age in years. *Greenfield 12m* is an indicator for the first 12 months when a plant starts operating. *Decommissioned 12m* is an indicator for the last 12 months when a plant is still operating. The specifications include interacted fuel-type, state, and year-month fixed effects. We cluster standard errors by plant-prime-mover, and report standard errors in brackets. *$p < .10$; **$p < .05$; ***$p < .01$.

	Contract Duration		**Increment Terms**			**Peaking Period Terms**		
	Short	Long	Short	Medium	Long	Full	Peak	Off-Peak
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean Dependent Variable	0.563	0.434	0.501	0.041	0.432	0.391	0.313	0.222
Private Equity	0.106***	-0.109***	0.134***	-0.010	-0.132***	-0.026	0.078***	-0.024**
	[0.027]	[0.028]	[0.023]	[0.009]	[0.025]	[0.025]	[0.018]	[0.011]
Institutional Investor	-0.175***	0.185***	-0.276***	0.025	0.259***	0.238***	-0.143***	-0.061**
	[0.063]	[0.063]	[0.058]	[0.033]	[0.073]	[0.074]	[0.037]	[0.030]
Foreign Corp	0.039	-0.034	0.076**	0.002	-0.122***	0.021	-0.019	-0.045***
	[0.040]	[0.040]	[0.036]	[0.011]	[0.039]	[0.037]	[0.021]	[0.017]
ln Plant Capacity	0.009	-0.012	-0.001	-0.003	0.011	-0.003	0.006	0.001
	[0.011]	[0.011]	[0.009]	[0.003]	[0.010]	[0.010]	[0.006]	[0.004]
ln Plant Age	-0.004	-0.000	0.003	-0.003	0.002	-0.023*	0.030***	0.001
	[0.014]	[0.014]	[0.013]	[0.004]	[0.013]	[0.013]	[0.009]	[0.005]
Greenfield 12m	0.013	-0.028	0.052**	-0.000	-0.055**	-0.064***	0.063***	0.037***
	[0.025]	[0.025]	[0.023]	[0.006]	[0.023]	[0.024]	[0.015]	[0.009]
Decommissioned 12m	0.030	-0.029	0.009	0.000	0.012	-0.002	0.008	-0.000
	[0.034]	[0.034]	[0.032]	[0.004]	[0.029]	[0.034]	[0.022]	[0.018]
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	306,080	306,080	306,080	306,080	306,080	306,080	306,080	306,080
Adjusted R-squared	0.608	0.607	0.652	0.624	0.635	0.621	0.625	0.611

Table A.12: Contractual Terms of Electricity Sales by Fuel Type

Robustness check of Table 9: The dependent variables capture contractual terms of electricity sales by fuel type.

In this table, observations are at the plant-prime-mover-month level and are weighted by power plant nameplate capacity. The dependent variables are the percentages of electricity transaction charges under three different contractual terms. The contractual terms focus on the contract duration, increment pricing, and peaking period. Panel A examines the subsample of natural gas plants, Panel B examines the subsample of coal, waste coal, petroleum coke, and residual petroleum plants, and Panel C examines the subsample of solar and wind power plants. The sample includes power plants owned by domestic corporations, private equity, institutional investors, and foreign corporations. We focus on the ownership by private equity, institutional investors, and foreign corporations (the omitted ownership category is domestic corporations). We include the same control variables for plant size, age, greenfield stage, and decommissioning stage. The specifications include interacted fuel-type, state, and year-month fixed effects. We cluster standard errors by plant-prime-mover, and report standard errors in brackets. *$p < .10$; **$p < .05$; ***$p < .01$.

	Contract Duration		**Increment Terms**			**Peaking Period Terms**		
	Short	Long	Short	Medium	Long	Full	Peak	Off-Peak
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Natural Gas Power Plants								
Private Equity	0.113***	-0.113***	0.153***	-0.015	-0.145***	-0.029	0.104***	-0.039***
	[0.039]	[0.040]	[0.031]	[0.011]	[0.034]	[0.035]	[0.026]	[0.013]
Institutional Investor	-0.281***	0.299***	-0.393***	-0.007	0.416***	0.395***	-0.232***	-0.093***
	[0.083]	[0.084]	[0.071]	[0.040]	[0.080]	[0.078]	[0.050]	[0.030]
Foreign Corp	0.021	-0.017	0.071	0.019	-0.095*	0.047	-0.020	-0.058***
	[0.057]	[0.058]	[0.051]	[0.019]	[0.057]	[0.049]	[0.035]	[0.019]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	82,641	82,641	82,641	82,641	82,641	82,641	82,641	82,641
Adjusted R-squared	0.399	0.397	0.546	0.413	0.491	0.514	0.499	0.471
Panel B: Coal and Petroleum Power Plants								
Private Equity	0.322***	-0.322***	0.304***	0.005	-0.291***	0.017	-0.002	0.008
	[0.101]	[0.101]	[0.101]	[0.009]	[0.111]	[0.044]	[0.044]	[0.019]
Institutional Investor	-2.220***	2.218***	-1.772***	-0.109**	2.114***	2.163***	-0.806***	-0.589***
	[0.287]	[0.286]	[0.284]	[0.053]	[0.280]	[0.186]	[0.116]	[0.068]
Foreign Corp	0.490***	-0.490***	0.420**	0.053	-0.465***	-0.013	-0.043	0.049*
	[0.164]	[0.164]	[0.174]	[0.046]	[0.166]	[0.027]	[0.034]	[0.029]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	29,372	29,372	29,372	29,372	29,372	29,372	29,372	29,372
Adjusted R-squared	0.600	0.602	0.659	0.880	0.685	0.659	0.628	0.600
Panel C: Solar and Wind Power Plants								
Private Equity	-0.124***	0.102**	-0.084**	-0.008	0.027	-0.017	-0.005	0.009
	[0.046]	[0.047]	[0.040]	[0.006]	[0.045]	[0.051]	[0.026]	[0.017]
Institutional Investor	-0.023	0.020	-0.125**	0.106**	-0.028	-0.069	0.035	0.059*
	[0.082]	[0.082]	[0.060]	[0.043]	[0.082]	[0.093]	[0.047]	[0.035]
Foreign Corp	-0.097**	0.098**	-0.096**	-0.013**	-0.014	0.085	-0.094***	-0.062***
	[0.049]	[0.049]	[0.041]	[0.005]	[0.048]	[0.052]	[0.024]	[0.016]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fuel-State-Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	106,782	106,782	106,782	106,782	106,782	106,782	106,782	106,782
Adjusted R-squared	0.243	0.233	0.287	0.236	0.225	0.190	0.275	0.296