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When competition plays clean: How electricity market liberalization facilitated state-level climate policies in the United States

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ABSTRACT

Why do some governments adopt policies to mitigate climate change while others do not? In this study, I illustrate the importance of industrial organization in shaping prospects for climate mitigation policy. Using a difference-in-differences analysis, I show that U.S. states which adopt electricity market liberalization laws are subsequently fifteen to forty-three percentage points more likely to adopt a renewable portfolio standard and fifteen to thirty percentage points more likely to adopt a cap-and-trade program. I argue that the forced reduction in market share of incumbent utilities associated with market liberalization laws undermined the political dominance of legacy producers and facilitated the growth of independent power producers (IPPs). Following liberalization, I show how these firms disproportionately benefited from the development of renewable energy, and how their growth in market share corresponded with a rise in political activity, thus offering a countervailing industrial interest-group influence to legacy producers. These findings demonstrate the importance of industrial organization in shaping long-run prospects for climate mitigation. More generally, this study sheds light on how government interventions can shape industrial interest-group dynamics.

1. Introduction

As the threats associated with climate change have become more salient, policymakers around the world are facing increasing pressure to adopt low-carbon energy policies. In the United States, despite the absence of national legislation to address climate change, some states have adopted major climate mitigation policies. In particular, twenty-nine states have adopted renewable portfolio standards, and ten have adopted cap-and-trade programs. What explains why these states have chosen to adopt progressive climate policies, while others have not?

The existing literature which seeks to explain variation in climate policy adoption has focused on three factors: (1) differences in public opinion (Bechtel and Urpelainen, 2015; Konisky and Woods, 2016; Stokes and Warshaw, 2017), (2) differences in the structure and party composition of political institutions (Rabe, 2004; Huang et al., 2007; Bättig and Bernauer, 2009; Lyon and Yin, 2010; Yi and Feiock, 2014), and, (3), differences in the relative strength of different interest groups (Carley, 2011b; Cheon and Urpelainen, 2013; Aklin and Urpelainen, 2013; Stokes, 2015; Meckling et al., 2015). Despite the extensiveness of this literature, limited attention has been paid to the industrial organization of the energy sector itself. Lyon and Yin (2010) point out the positive correlation between market liberalization and the adoption of the renewable portfolio standard, but do not investigate it directly. Related literatures have considered the role of electricity market competition in renewable energy development (Palmer, 1997; Burtraw et al., 2000; Delmas et al., 2007; Carley, 2011a), green technological innovation (Sanyal and Ghosh, 2013; Nesta et al., 2014), and green lobbying,[2] but do not focus on policy as an outcome variable. Finally, the few studies which have explicitly examined the causal effect of market competition on climate policy have generated conflicting findings (Kim et al., 2016; Nicolli and Vona, 2019).

In this study, I show how the introduction of market competition in the electricity sector has had a large and positive effect on the likelihood of adopting climate mitigation policies. To demonstrate this, I leverage the fact that some U.S. states adopted market liberalization reforms in the electricity sector in the late 1990s, while others did not. Employing a generalized difference-in-differences analysis, I estimate that a U.S. state that adopts electricity market liberalization laws is subsequently fifteen to forty-three percentage points more likely to

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[2] https://scholar.princeton.edu/sites/default/files/kennard/files/greenlobbying_kennard_5.12.17_0.pdf.

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adopt a renewable portfolio standard and fifteen to thirty points more likely to adopt a cap-and-trade program (Fig. 8, Table 3). I argue that this pattern is driven by a redistribution of industrial interest-group power. In particular, market liberalization leads to a decline in utilities' dominant market position and a concomitant growth in the market share of independent power producers (Fig. 5, Table 2). Following liberalization, I show that independent power producers disproportionately benefit from the development of renewable energy (Fig. 6) and that they also become more politically active (Fig. 7), thus offering a countervailing industrial interest-group influence to legacy utility producers.

This study has implications for energy and climate policy as well as industrial interest-group politics. First, consistent with Nicolli and Vona (2019), this study suggests that government-induced market competition may be an effective strategy for long-run climate mitigation. Second, this study provides new evidence in understanding how government interventions can reshape the distribution of political influence among industrial interest groups. As such, it contributes to a topic of longstanding concern in political science and economics (Stigler, 1971), and one which has received growing attention in recent years across a wide array of policy domains (Dal Bó, 2006; Stiglitz, 2012; Lindsey and Teles, 2017).

2. Industrial organization of climate politics in the energy sector

Following the recent literature on the determinants of variation in climate policy, this study takes as its premise that climate politics—in particular, the adoption of policies to promote the decarbonization of energy production—can be largely understood as a dynamic competition between industrial interest groups (Carley, 2011b; Cheon and Urpelainen, 2013; Stokes, 2015; Meckling et al., 2015; Nicolli and Vona, 2019).[3] Given how widely distributed the costs and benefits of energy are for the mass public, on the one hand, and how concentrated they are for industrial producers and consumers, on the other hand, the energy sector meets the conditions under which industrial interests are most likely to determine public policy (Stigler and Friedland, 1962; Olson, 1965; Stigler, 1971). The political influence of industry actors in the energy sector is further strengthened by the pronounced information asymmetries between industry participants and policymakers that are endemic to technologically complex industrial systems (Laffont and Tirole, 1991). For these reasons, this study begins from the premise that energy policy is, to a first order approximation, "captured" by the most powerful industrial interests (Dal Bó, 2006).

This is not to say, by any means, that non-industry actors do not have any influence on climate policy adoption. Other interest groups have been shown to be relevant as well, such as environmental advocacy groups (Doblinger and Soppe, 2013), as well as policy entrepreneurs inside the state bureaucratic system (Rabe, 2004). In addition, political parties and other political institutional features shape the prospects of climate politics. For example, it has been clearly show that "blue" states (i.e., states typically controlled by the Democratic party in the United States) are more likely to adopt a variety of renewable energy policies (Huang et al., 2007; Lyon and Yin, 2010; Yi and Feiock, 2014). A large literature in international relations has also examined the role of international political institutions and how they effect cross-country and within-country policy adoption (Keohane et al., 2011; Colgan et al., 2012; Bechtel and Urpelainen, 2015). Finally, while most of the public is not actively engaged in energy politics, voters can act as a constraint on the option set within which policymakers make decisions (Konisky and Woods, 2016; Stokes and Warshaw, 2017). Nonetheless, in this study, I choose to primarily focus on the influence of industrial interest groups. Moreover, I show that this study's findings are robust to inclusion of these non-industry influences.

Following from this premise, the key question is not *whether* energy regulation is captured by industrial interests but *which* industrial interest groups are able to exert more control. Importantly, this distribution of political power among industrial interest groups is endogenous to the institutional structure in which they operate. This brings the level of analysis up a level: the first task is to understand how different institutional structures shape the preferences and relative power of industrial interest-groups and then, in turn, how these factors influence patterns of policy adoption. In this study, the institutional structure of interest is the mode of *industrial organization*, which I define as the composition of relevant actors and their respective positions in the production and distribution of a good. The basic theoretical claim is that the degree of political influence that any given firm can exercise vis-à-vis policymakers' decisions concerning that industry is, in part, a function of the role that firm plays in the industry. This influence could be direct electoral influence through campaign contributions (Grossman and Helpman, 1994; Austen-Smith, 1995) or indirect regulatory influence through the control of information (Crawford and Sobel, 1982; Laffont and Tirole, 1991).[4]

Applied to the case at hand, the specific claim is that the forced liberalization (or "deregulation") of the electricity market—which brought about a significant decline in market share of legacy utility producers—had the effect of reducing the political influence such firms had over state policymakers' actions. Given that utilities had a historical comparative advantage in fossil fuel and nuclear energy technologies—and that, in turn, their competitors had a comparative advantage in renewable energy technologies—the central hypothesis of this study emerges: by reducing the political influence of legacy producers, market liberalization should lead to an *increase* in the likelihood of adopting climate mitigation policies and, in particular, policies which promote the deployment of renewable energy (**H1**). Relatedly, non-utility producers who gain market share following market liberalization should disproportionately benefit from the development of renewable energy (**H2**).

To substantiate these hypotheses, in this study I employ a generalized difference-in-differences analytic framework to examine the differential patterns in climate policy adoption and interest-group behavior between the U.S. states which passed market liberalization laws and those which did not. The provision of evidence in favor of the hypotheses above depends on the ability to verify that the selection process by which states choose whether or not to adopt these reforms is, after conditioning on observable controls, independent from renewable energy politics. It is to this task that I now turn: in the next section, I briefly describe what market liberalization practically meant in its historical context, and why some states chose to pursue these reforms while others did not. I then briefly outline the emergence of state-level climate policies, the variation of which I will seek to explain.

3. Historical context

3.1. Electricity market liberalization

In the early 1990s, the electricity system would have looked very similar across most of the United States. 92% of electricity generated and consumed was controlled by vertically-integrated monopoly utility companies. These regional monopolies were allowed under the "natural monopoly" argument, i.e., that the economies of scale of infrastructure investment, combined with network externalities of the distribution system, justified unified control. In exchange for these monopoly rights,

[3] An industrial interest group is defined as any organized political entity which represents the interests of industry participants. This could include firms which directly participate in the political process, and also trade associations that advocate on behalf of firms or other industry participants.

[4] The findings in this study are consistent with both of these pathways.

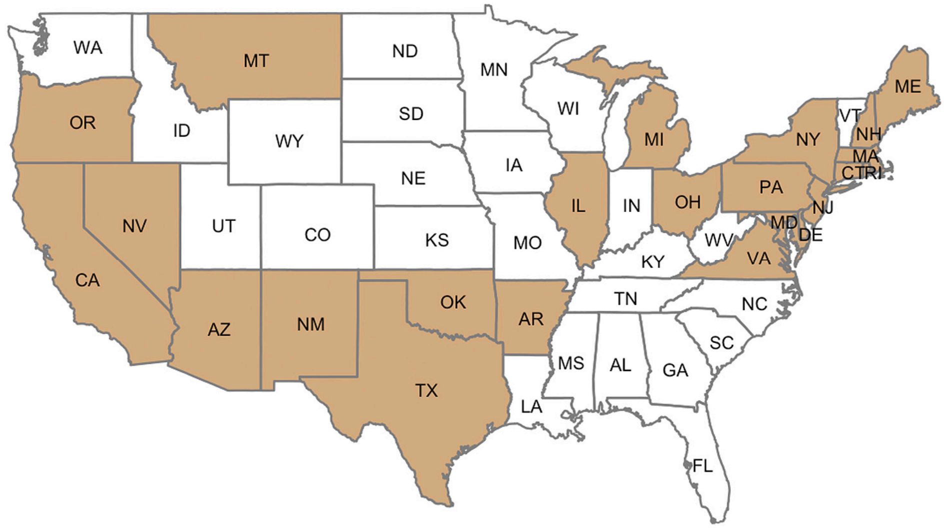

Fig. 1. Twenty-three states which passed electricity market liberalization laws (1996–2000).

regulators would ensure that utility companies would provide reliable access to electricity to all consumers at cost-of-service prices. This "regulatory compact" characterized the electricity industry in the United States for nearly a century, as well as most countries around the world (Joskow, 1997).

However, the seeming stasis of the system had already begun to come undone as early as 1978 with the passage of the Public Utility Regulatory Policies Act (PURPA), a federal legislative response to the 1970s energy crises. PURPA created a new legal entity known as a "qualifying facility,"[5] which referred to a non-utility generator that the utility would be required to compensate at "avoided cost" (the utility's marginal cost) if it relied on pre-approved domestic energy sources (Devine et al., 1987).[6] However, PURPA did not go so far as to facilitate genuine market competition in electricity production. It was not until the passage of the 1992 National Energy Policy Act, and the subsequent Federal Energy Regulatory Commission's rule-making process which began thereafter and culminated with the issuance of Order 888 in 1996, that non-utility electricity generation truly became viable. That is because it is only with these new laws that utilities were prohibited from leveraging their ownership of the transmission infrastructure to discriminate in favor of their own generators, thus eliminating the principal barrier to entry for third-party firms. Thus, by 1996, the legal framework necessary for a transition to a competitive market in electricity production had been set. However, this transition was not a federal mandate: each state was left to choose for itself whether to ratify these reforms (Joskow, 1997). From 1996 to 2000, twenty-three states passed legislation to do so (see Fig. 1).[7,8]

Why did market liberalization occur when it did, and why did some states choose to pass these reforms while others did not? As for the question of timing, at least three factors are worth mentioning. First, the emergence of lower fixed-cost power plants—like combined-cycle natural gas plants and wind farms—challenged the natural-monopoly argument which held sway in a system dominated by coal and nuclear power plants. Second, there was growing political momentum for such reforms following the deregulation of the natural gas and airline industries in the United States in 1978 and the deregulation of the electricity sector in the United Kingdom in 1990 (Hirsh, 1999; Joskow, 2005). The third factor, the California Electricity Crisis of 2000–2001, explains not why market liberalization began, but why it ended. California had been one of the first states to implement market liberalization under Republican Governor Pete Wilson in 1996. This new regulatory system was soon put to the test in the summer of 2000 when an unusually bad drought reduced the available hydropower across the western United States. While this led to elevated electricity prices across several states, the effects were most pernicious in California, where residents experienced immense price surges and rolling blackouts (Sweeney, 2002).[9] While the relative importance of the various factors which contributed to this crisis continue to be debated by scholars, what is clear is that it undermined whatever political support existed for passing electricity liberalization in states which had not yet done so (Hogan, 2002; Wolak, 2003; Griffin and Puller, 2005).[10]

Thus, there was effectively a four-year window, from 1996 to 2000, that state governments might have passed these reforms. So why did some states do so while others did not? The existing literature on the subject consistently points to the same primary factor: electricity prices. Because incumbent monopolies were naturally opposed to market liberalization, the successful passage of such reforms required highly motivated and well-organized political coalitions to support them. In states where the traditional regulatory compact seemed to be working for most consumers, no such coalitions formed. However, where electricity prices were higher—for example, in the states most

[5] The "qualifying facility" was the historical antecedent to modern-day independent power producers.

[6] These pre-approved domestic sources included but were not limited to renewable energy technologies (Devine et al., 1987).

[7] In addition to the formation of a competitive market in wholesale electricity production, most of these liberalization laws called for the development of a competitive market in retail distribution of electricity as well. However, for the purposes of this paper, I focus exclusively on the former.

[8] Eight of these states would later suspend these reforms following the California Electricity Crisis of 2000–2001 (Arizona, Arkansas, California, Montana, Nevada, New Mexico, Oklahoma, and Virginia). However, even in most of these states, some degree of market competition emerged in wholesale electricity production. These suspensions had more of an effect on stopping the implementation of retail competition than wholesale competition. Nonetheless, in the Appendix, I demonstrate that the findings in this study are robust to the exclusion of these states.

[9] This was almost certainly a contributing factor in the recall of Governor Gray Davis (Bushnell, 2004).

[10] In the aftermath, it became clear that critical flaws in the new institutional structures were important factors in precipitating this crisis. In particular, the disjointed governance structure, which was split between the new Independent System Operator (ISO) and the newly-created "Power Exchange" for short-term trading, proved inadequate to preventing market manipulation by the new trading companies entering the industry (Enron being the most infamous among them) (Sweeney, 2002).

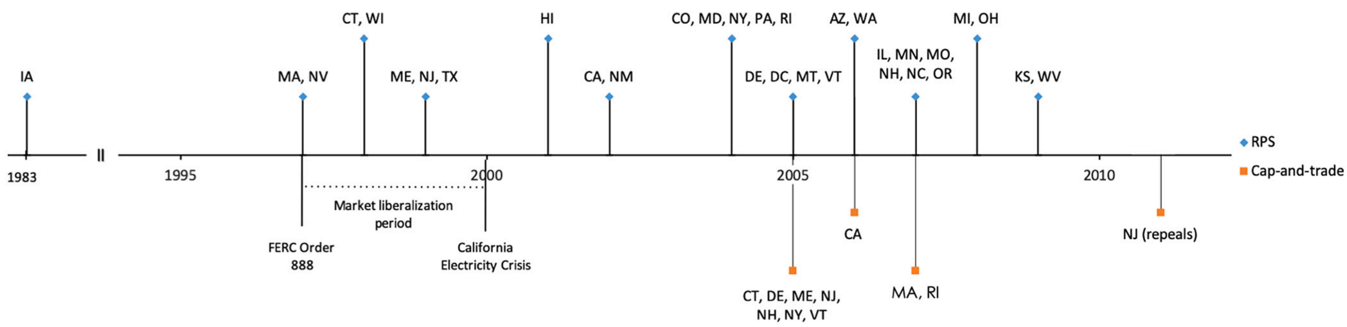

Fig. 2. Evolution of state-level climate policies in the United States (1990–2014).

exposed to the cost overruns associated with the rapid build-out of nuclear power plants in the decades prior (Devine et al., 1987)—consumers, and especially large-scale industrial consumers, were able to overcome the collective action problem and lobby state policymakers to pass market liberalization (Ando and Palmer, 1998; Hirsh, 1999; Borenstein and Bushnell, 2000).

The empirical pattern is consistent with this explanation. Table 1 displays the results of a variety of ordinary least squares (OLS) regression models which evaluate the cross-sectional correlation between pre-liberalization electricity prices and the likelihood of adopting the reforms. Electricity price positively predicts the likelihood of adoption across all models. In particular, a one-cent increase in the 1995 electricity price ($/kW-hr) is associated with a ten percentage-point increase in the subsequent likelihood of adoption. This correlation is robust to inclusion of other plausible predictors of electricity market liberalization: from the party composition of state government, to incumbent utilities' existing market share, to a state's estimated renewable energy potential.[11] While this correlation by no means substantiates a causal claim, it does provide empirical evidence consistent with the existing literature.

Table 1
State-level predictors of electricity market liberalization. The ordinary least squares (OLS) regression models below test the correlation between electricity price and the likelihood of adopting market liberalization laws across the fifty states. The outcome variable takes the value of '1' if the state liberalized and '0' otherwise. Selected covariates employ 1995 values to avoid post-treatment bias. The electricity price refers to the average residential price in each state (cents-per-kilowatt-hour). The first two state politics variables refer to the proportion of Democrats in each chamber of the state legislature, and the third variable is a binary indicator for whether the state's governor is a Democrat. The final two variables refer to the proportion of electricity produced from renewable resources and the estimated long-run potential for renewable electricity generation (measured in Terawatts), respectively. Across all models, electricity price is the key predictor of adoption. All standard errors are corrected for heteroscedasticity. See Table A.1 in the Appendix for alternative generalized linear model specifications.

	Likelihood of adopting market liberalization reforms					
Electricity Price	0.10***	0.08**	0.09***	0.10***	0.11***	0.07*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Dem_house		1.09				1.11
		(0.94)				(0.95)
Dem_senate		−1.03				−1.13
		(1.03)				(1.08)
Dem_governor		−0.24				−0.22
		(0.16)				(0.17)
Utilities' Market Share			−0.19			−0.37
			(0.28)			(0.37)
Proportion of Renewables				-0.12		-0.42
				(3.99)		(3.45)
Renewables Potential					0.01	0.01
					(0.01)	(0.01)
Observations	50	50	50	50	50	50
Adjusted R^2	0.21	0.24	0.19	0.19	0.21	0.20

*p<0.1; **p<0.05; ***p<0.01.

3.2. Emergence of state-level climate policies in the United States

In the last twenty-five years, there have been a proliferation of state-level policy instruments aimed at promoting renewable energy or energy efficiency in the United States (for a review, see Carley (2011a)). The most substantive and widespread among these has undoubtedly been the renewable portfolio standard (RPS), which creates a minimum standard for the portion of a state's electricity production which should come from renewable sources (Rabe, 2006). The original RPS in the United States was passed in Iowa in 1983; and it remained the only state with such a policy for thirteen years. The policy was given new life during the period of market liberalization (1996–2000), during which an additional seven states passed a mandatory RPS. The policy continued to spread thereafter: twenty-three more states and DC had passed similar legislation by 2014, the last year included in the time period of analysis for this study. Fig. 2 displays the timeline of adoption, and Fig. 3 shows the geographic distribution of adoption.

The proliferation of the RPS is generally described as having occured in two waves. The first wave largely coincided with the rollout of electricity deregulation, during which time renewable eneregy advocates took advantage of the existing omnibus legislative activity to advance their own aims (Kim et al., 2016). Inspired by the perceived success of the policy in these early-adopting states, the second wave or "second generation" of RPS legislation occurred over the course of the first decade of the 2000s Rabe (2013). Notably, proposals to adopt an RPS were not always explicitly linked to climate change; instead, they were often promoted in terms of economic development or energy independence. This was especially likely in states with a more conservative electorate (Rabe, 2004, 2006). A number of studies have examined which states have been more likely adopt the RPS than others; factors which have been identified include the presence of a Democratically-controlled state legislature, an organized renewable energy industry, lower reliance on natural gas, higher wind and solar potential, higher GDP, lower unemployment, and electricity market liberalization (Chandler, 2009; Huang et al., 2007; Lyon and Yin, 2010; Delmas and Montes-Sancho, 2011; Jenner et al., 2012, 2013).

Following the RPS, the emergence of subnational cap-and-trade programs represents a second major milestone in the evolution of state-level climate policy in the United States. A cap-and-trade program assigns a limited number of allowances for greenhouse gas emissions to firms who can then trade them to optimize costs. The first cap-and-trade program for carbon emissions began as a proposal in 2003 by George Pataki, then governor of New York, to other governors in the Northeast and Mid-Atlantic regions of the United States to form a

[11] In the Appendix, I demonstrate that this correlation holds using various generalized linear models as well (Table A.1).

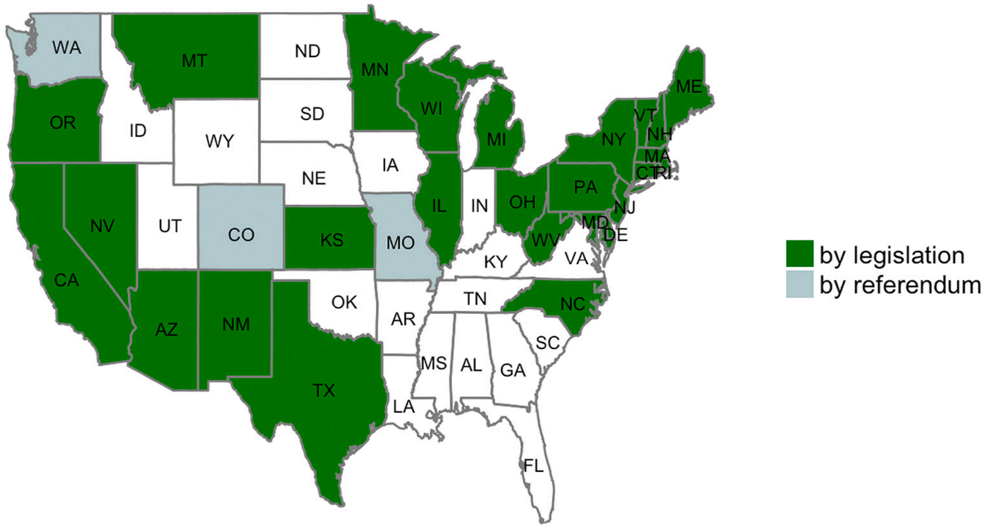

Fig. 3. States which adopted renewable portfolio standards (1996–2014).

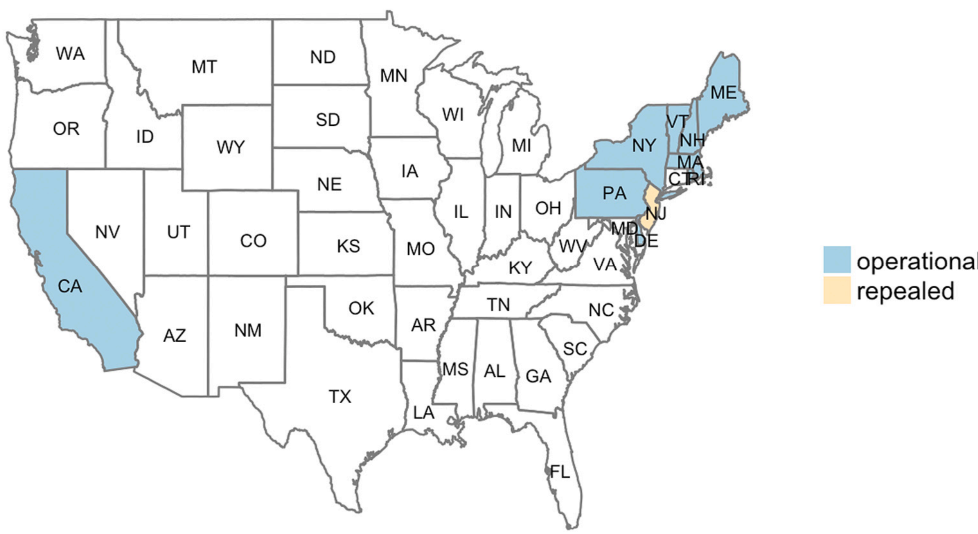

Fig. 4. States which adopted cap-and-trade programs (2005–2014).

regional program. Pataki, a Republican, framed this proposal as a bipartisan effort to take a major step to address climate change following repeated failed proposals in the U.S. Congress and an unwillingness by the George W. Bush Administration to support a binding global climate policy (Wogan, 2018). Six states, in addition to New York, formed the Regional Greenhouse Gas Initiative (RGGI) in 2005. Between 2006 and 2014, two more states would join RGGI, and California would pass its own economy-wide cap-and-trade program. Fig. 2 provides a timeline of the evolution of this policy, and Fig. 4 shows the geographic distribution of adoption.

4. Empirical strategy

4.1. Data

I constructed a panel dataset from 1990 to 2014 for the 50 U.S. states. A brief summary of the key variables follows.

Policy Outcome Variables. In this study, the outcome of interest is the rate of adoption of major state-level climate mitigation policies and, in particular, policies which encourage the development of renewable energy in the power sector. The two policies chosen for the analysis are the renewable portfolio standard and the cap-and-trade program. These two policies were selected for three reasons. First, they have the widest scope among the various state-level renewable-energy policies and subsidies that have been adopted across the United States and, consequently, have the greatest potential for climate mitigation. Second and relatedly, utilities and independent power producers — the key actors in my argument—have a significant stake in whether such policies are adopted. Third and finally, they reflect two of the standard policy instruments considered for climate mitigation strategies at both the national and international level, and therefore provide the greatest external validity beyond the specific case under study. The data for these policy outcome variables were collected from the Database for State Incentives and Renewable Energy (DSIRE)[12] and the National Council of State Legislatures (NCSL),[13] and were cross-checked against individual state government websites. For each policy outcome, a state takes the value of '1' if it has passed the policy in that year or a previous year (and has not repealed it), and '0' otherwise.

[12] http://www.dsireusa.org.

[13] http://www.ncsl.org/research/energy/renewable-energy-legislative-update-2014635499961.aspx.

Treatment Variable. The key treatment variable is a lagged binary indicator variable for market liberalization, which is assigned to '1' if the state liberalized in that year (or any year previously) and '0' otherwise. This data was collected from the Energy Information Agency (EIA, 2015) and cross-checked against individual state government websites. For each of the outcome variables, the lag was chosen to reflect a plausible timeline that would coincide with the emergence of each of the three outcome variables. Specifically, I employ a 2-yr lag to identify the effect of market liberalization on utility market share, because implementation of a massive restructuring of the electricity sector could not happen instantaneously. I employ a 5-yr lag to identify the effect of liberalization on the renewable portfolio standard, because this timeline roughly coincides with the beginning of the "second generation" of RPS adoption (see Section 3.2). Finally, I employ a 10-yr lag to identify the effect of liberalization on cap-and-trade because this approximately coincides with the emergence of the first serious discourse in the United States on subnational cap-and-trade legislation for carbon emissions following the repeated failure to pass national legislation (see Section 3.2). Importantly, the estimated effects I provide are robust to alternative lag specifications (see Appendix A.2).

Mediators. I argue that market liberalization led to a redistribution of political power between incumbent utilities and independent producers. The key proxy I use for this is the proportion of electricity in the market produced by each industry group in each state in each year. Another claim underpinning my argument is that independent producers disproportionately benefited from renewable energy development over time. To examine this, I encode the proportion of renewable electricity produced by utilities and independent producers in each state in each year. This is defined as the total electricity produced by solar, wind, geothermal, and biomass for the given category of producers in each state-year divided by the total electricity produced in that state-year. The data for both these mediators were collected from the Energy Information Agency (EIA, 2015).

A third and final mediator of interest is the political influence each industry group exercises vis-à-vis state policymakers. While this is not directly observable, one source of evidence is the observable resources expended on campaign contributions and lobbying. To this end, I collected data on these measures from The National Institute on Money in State Politics.[14] This dataset provides all recorded donations made to candidates for state offices from 1990–2016 at the level of the donor, as well as state lobbying expenditures at the level of the lobbyist for a subset of these state-years.

Controls. I also include observable time-varying factors which may both correlate with market liberalization and renewable energy policy adoption. One such confound is which political party holds control of state government, since several scholars have pointed out that "blue states" are more likely to adopt renewable energy policies (Huang et al., 2007; Lyon and Yin, 2010; Yi and Feiock, 2014). To address this, I encode the party affiliation of the governor ('1' if Democrat, '0' otherwise) as well as the proportion of Democrats in each legislative chamber for each state-year. These variables come from the "Partisan Balance" database.[15] Another potential confound is residential electricity price, since this correlates with the likelihood of adopting market liberalization in the first place (see Table 1). To this end, I encode each state's average annual price for residential customers, also from the Energy Information Agency. However, this variable may also be affected *by* the treatment, so I include this additional control only as a robustness check.

[14] http://www.followthemoney.org.

[15] https://dataverse.harvard.edu/dataverse/cklarner.

4.2. Identification strategy

There are two core empirical claims made in this study. The first is that market liberalization of the electricity sector increases the likelihood of adopting climate mitigation policies. The second is that this effect is mediated by the decline in political influence of legacy producers (using utilities' market share as a proxy). To substantiate these claims, I leverage the exogenous variation in the timing of market liberalization among U.S. states to obtain estimates of the effects of market liberalization on climate policy and incumbent market share, respectively. To estimate these effects, I employ a generalized difference-in-differences identification strategy using an Ordinary Least Squares (OLS) regression. The choice to use OLS rather than a generalized linear model (GLM), despite the binary nature of the dependent variable, follows the work of Angrist and Pischke (2009), who prove that the former approach can provide an unbiased estimate of the average treatment effect on the treated (ATT) in the presence of two-way fixed effects, whereas the latter cannot.

For the main analysis, I use the following fixed effects model:

$$Y_{it} = \eta_i + \delta_t + \psi_i t + \alpha Liberalization_{i(t+L)} + X'_{it}\beta + \epsilon_{it} \tag{1}$$

where Y_{it} is either the probability of having a given climate policy or the utilities' market share in each state-year. On the right hand side, η_i is a vector of state fixed effects that control for unobserved characteristics that are time invariant during the time period of analysis (e.g., political culture, climatic conditions), δ_t is a vector of year fixed effects which control for time-varying characteristics which are constant across states (e.g., changes in technology costs), and ψ_i controls for state-specific characteristics which vary linearly over time (e.g., changes in demographics, environmental attitudes). $Liberalization_{i(t+L)}$ is the treatment variable, where L is the number of years that the variable is lagged. Finally, X_{it} is a vector of time-varying state-level covariates (e.g., electricity price, party of governor), and ϵ_{it} is an idiosyncratic error term.

Consequently, only breaks from the within-state trends in the outcome variable that are uncorrelated with the included control variables are incorporated into the estimate of α. Thus the key identification assumption is that there is no unobserved state-specific factor which varies nonlinearly that both affects the likelihood of adopting market liberalization laws and also the outcome variable of interest. Conditional on this assumption, α provides an unbiased estimate of the effect of market liberalization on the outcome variable (for states that liberalized). In the results section, I provide both graphical and quantitative evidence that this identification assumption is satisfied. I also include alternative model specifications in the Appendix for robustness, including difference-in-differences identification with matching (Imai et al., 2019), the Cox-proportional Hazard model, and various generalized linear models (e.g., logistic, probit).

5. The effect of market liberalization on climate politics

I argue that market liberalization improved long-run prospects for climate mitigation by restructuring the distribution of political power among competing industrial interest groups. This process played out over a sequence of four steps: (1) market liberalization leads to a shift in market share from utilities to independent power producers (IPPs); (2) IPPs adopt renewable energy technologies more quickly than utilities; (3) IPPs join the political process, providing an alternative to utilities in representing the preferences of the electricity industry; and, (4), states with weaker utilities and stronger IPPs adopt pro-renewable energy policies. The following four sections provide evidence for each step in this chain, respectively.

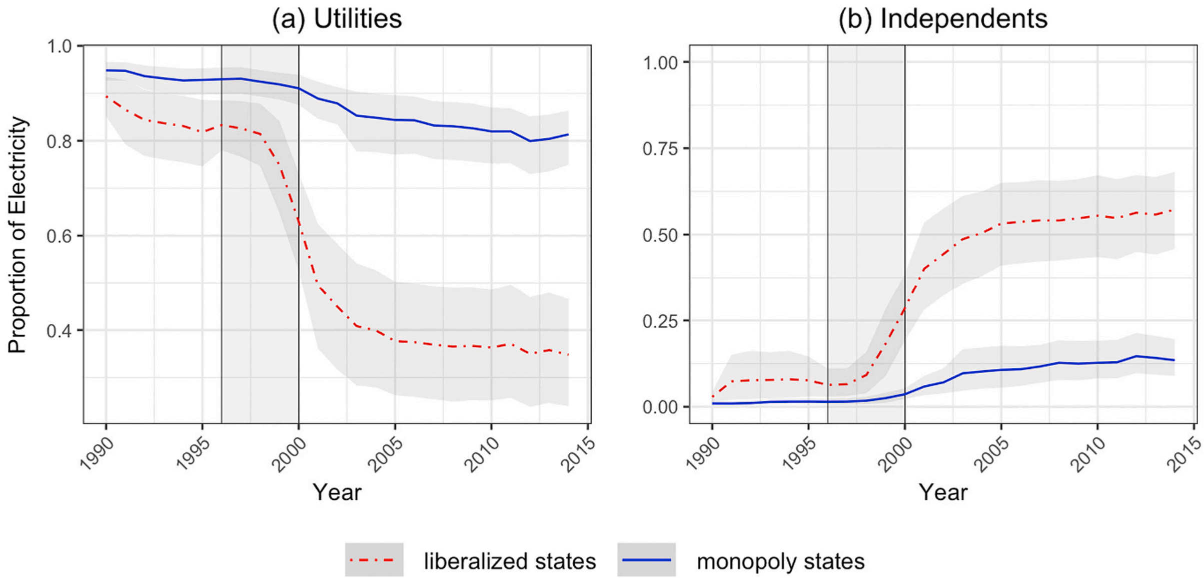

Fig. 5. Market liberalization and the redistribution of market share. The *y*-axis is the average market share for utilities (or independents) for states which liberalized compared with states which did not, measured as a proportion of a state's electricity production in each year. The shaded region indicates the period of time in which market liberalization occurred (1996–2000).

Table 2
Effect of market liberalization on utilities' market share. Using a generalized differences-in-difference identification strategy, I estimate the effect of market liberalization on the market share of incumbent utilities (1990–2014). Market share is a continuous variable from zero to one measured as a proportion of the electricity produced by utilities. The treatment variable is a lagged dummy variable which takes a '1' if the state has implemented market liberalization and '0' otherwise. All models are ordinary least squares (OLS) regressions and include fixed effects for state and year. Controls include the proportion of seats controlled by Democrats in each state legislative chamber (between 0 and 1), the party of the governor ('1' for Democrat and '0' for Republican), and the residential electricity price. Standard errors are clustered by state.

	Utilities' market share			
Liberalization$_{t+2}$	−0.32*** (0.07)	−0.28*** (0.07)	−0.27*** (0.07)	−0.21*** (0.06)
State Politics Controls		✓	✓	✓
Electricity Price Control			✓	✓
State-specific Time Trends				✓
Number of States	50	50	50	50
Number of Years	25	25	25	25

*p<0.1; **p<0.05; ***p<0.01.

5.1. Changes in market share by firm type

Prior to market liberalization, 92% of electricity in the United States was generated, transported, and distributed by privately-owned, vertically-integrated utility companies which were permitted regional monopolies in exchange for regulated pricing. Market liberalization—which would involve the liberalization of electricity prices—required changes to this distribution of market power so that no one firm could exercise monopoly power. Consequently, all of the states which elected to liberalize their electricity sectors also mandated or highly incentivized utilities to divest a significant portion of the power plants they owned (see Fig. 5 and Table 2). In most cases, many of these assets went to "independent power producers" (IPPs). On average, market liberalization resulted in a twenty percentage-point decrease in a utility's market share, and a similar increase in the share for IPPs.

5.2. Adoption of renewable energy by firm type

Meanwhile, the costs of renewable energy technologies were gradually falling—wind first, and later solar—and concerns for domestic energy independence and the environment were growing. This put pressure on governments and industry stakeholders to incorporate renewable energy technologies. However, most utility companies were already strongly invested in the use of large-scale, conventional energy technologies like coal and nuclear power. Not only had they already invested billions of dollars in an existing fleet of power plants, they had well-developed expertise in these energy production processes. Given their legal obligation to insure system-wide reliability, utilities were especially risk-averse to adopting new forms of energy production. Consequently, utilities tended to resist the adoption of these new technologies (Troesken, 2006; Sovacool, 2008).[16]

IPPs, on the other hand, were far less resistant to renewable energy technologies. First, they were not burdened with the same responsibility of insuring system-wide reliability, so they could focus exclusively on return-on-investment for new generation infrastructure without directly bearing the associated system-wide risks such changes might create (e.g., intermittency issues). More importantly, unlike legacy utilities, they did not have a vested interest in the existing system of production based on coal and nuclear power. On the contrary, precisely because utilities had a comparative advantage in these energy technologies, it was in the interest of IPPs to invest in alternative energy technologies. At first, a majority of these producers focused on combined-cycle natural gas plants. But as the costs of renewables declined over time, IPPs began to capitalize on opportunities for renewable energy development (see Fig. 6).

5.3. The rise of pro-renewable energy industry groups in liberalized states

The redistribution of market share from utilities to IPPs— combined with the asymmetric incentives for investment in renewable energy infrastructure by IPPs— fundamentally reconfigured interest-group politics concerning renewable energy politics in states which liberalized their electricity sectors. Prior to electricity liberalization, utilities were able to leverage their dominant market position to ensure their policy preferences were heard. As a general matter, their policy preferences with respect to new renewable energy technologies were

[16] Notably, some utilities were also heavily invested in conventional hydropower. However, by this time, most of the technical potential for conventional hydropower in the United States had already been exploited.

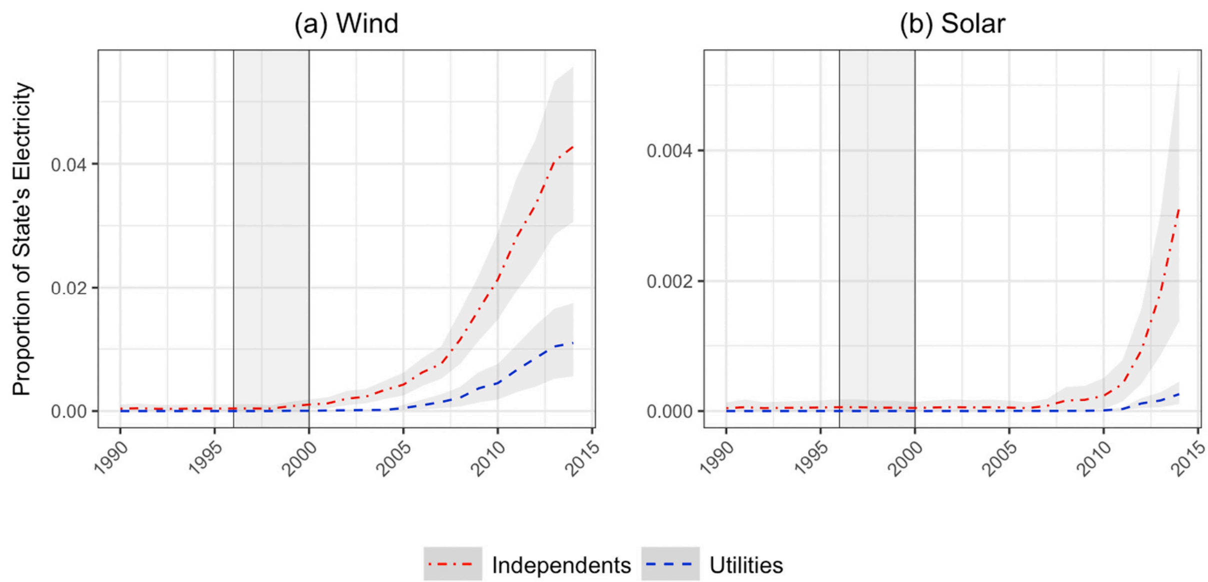

Fig. 6. Which firms invest in renewable energy development? The *y*-axis is the average proportion of electricity produced from solar (or wind) energy divided by utilities vs. independent producers. The shaded region indicates the period of time in which market liberalization occurred (1996–2000).

to slow down, rather than accelerate, their deployment. Given their monopoly position in the industry, this meant that legislative proposals to promote the deployment of renewable energy technologies tended to face unified and decisive opposition from the electricity industry.

After market liberalization, what had been a singular voice of opposition was replaced by competing voices: still-powerful legacy utility producers continued to express clear opposition to policies supporting accelerated deployment of renewable energy; however, as IPPs grew in stature, they began to offer a countervailing industry voice in politics. They formed industry associations like the Independent Energy Producers (IEP) of California and the Independent Power Producers of New York (IPPNY). And as IPPs moved beyond their initial focus on natural gas and discovered their comparative advantage in renewable energy technologies as well, these firms also joined the ranks of existing renewable energy industry groups like the American Wind Energy Alliance (AWEA) and the Solar Energy Industry Association (SEIA).

Evidence consistent with the entrance of IPPs into the political arena can be found in the data on campaign contributions to state elections (see Fig. 7). As one can see, as IPPs grew in market share in states which liberalized, so too did their campaign contributions. Conversely, in states which did not liberalize, contributions from independent producers remained relatively flat. While I do not analyze the recipient data for IPPs versus utilities, other studies have shown that new entrants have been systematically more likely to donate to Democrats than incumbent firms, and that Democrats, in turn, tend to be more likely to support renewable energy policies (Jenner et al., 2013). This pattern appears to be similar in the state-level lobbying data that is publicly available as well, although the number of years and states covered is far smaller (see followthemoney.org).

This is not to say, by any means, that utilities ceased to be a major force in electricity politics. Indeed, in all states, regardless of the structure of the electricity industry, utilities far outspent independent power producers in campaign contributions (Fig. 7). Moreover, even where production became a competitive market, utilities continued to exert monopoly control over the transmission and distribution grid. But whereas before, a state's electricity industry was effectively represented by the singular voice—hat of the monopoly utility—now an alternative set of voices for the industry could be heard, namely, IPPs and their representative organizations. With respect to renewable energy legislation, this meant a change from united industry opposition to a multiplicity of conflicting industry voices. Alongside more conventional environmental activist organizations, IPPs were able to provide crucial industry credibility in support of proposed renewable energy policies.[17]

5.4. *Asymmetric adoption of climate policies in liberalized states*

With the declining costs of renewable energy technologies and the growing salience of climate change in the 2000s, an increasing number of states began adopting major policies to promote low-carbon electricity production, in general, and greater investment in renewable energy infrastructure, in particular. For example, the number of states with a mandatory renewable portfolio standard grew from eight in the year 2000 (at the end of the market liberalization period) to twenty-nine in the year 2014. For cap-and-trade, the number of states grew from zero in 2000 to nine in 2014.

However, this dramatic increase in state-level climate policies did not happen randomly. The proliferation of these policies disproportionately occurred in states with liberalized electricity markets. Among the twenty-one states that adopted the RPS since 2000, thirteen of them had previously liberalized their electricity markets. Among the nine states that adopted cap-and-trade laws, eight of them had done so. Put another way, while only seventeen of the fifty U.S. states implemented electricity liberalization (34%), these states account for 61% of those which adopted an RPS and 89% of those which have adopted cap-and-trade.

This differential rate of climate policy adoption between liberalized and non-liberalized states is demonstrated graphically by comparing the annual predicted likelihoods of adopting each of the two policies mentioned above for the states that liberalized and for states that did not (see Fig. 8). As one can see for both renewable portfolio standards and cap-and-trade programs, the trend in adoption between these two groups of states is identical before market liberalization begins in 1996. However, following this point in time, the predicted likelihood of having these policies increases significantly more in states which are liberalized relative to states which are not. Although insufficient by itself, this provides prima facie evidence for the positive effect of market liberalization on climate policy adoption.

[17] These points were underscored by conversations with Nancy Rader who formerly worked with American Wind Energy Alliance and Steven Kelly who works with California's Independent Energy Producers.

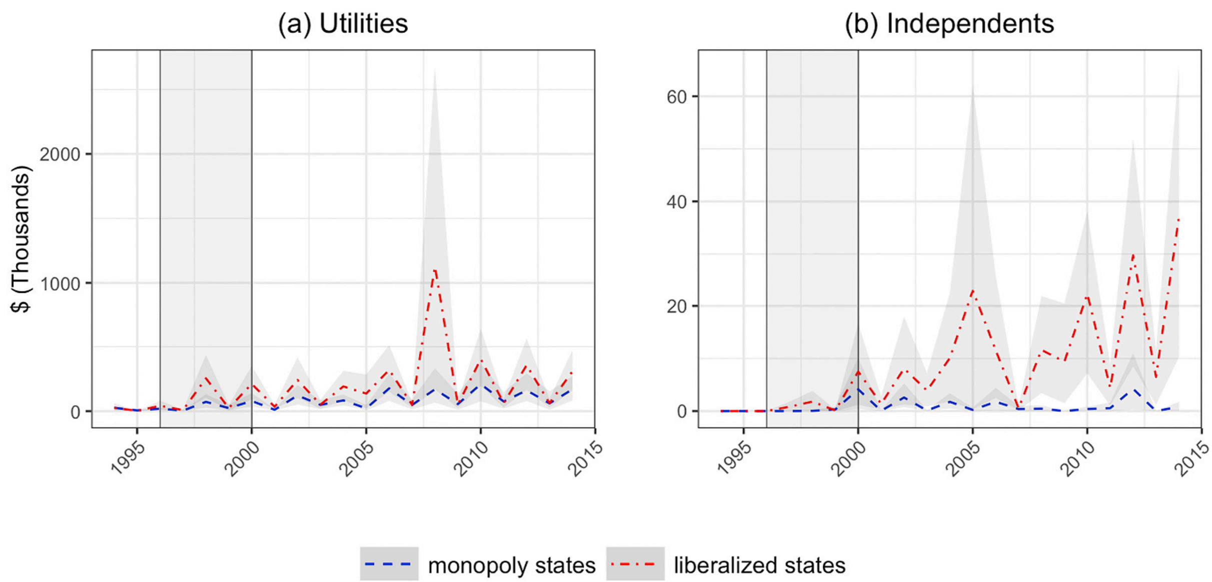

Fig. 7. Campaign contributions by industry group. The *y*-axis is the average sum of campaign contributions to state elections from utilities (or independents) for states which liberalized compared with states which did not. The shaded region indicates the period of time in which market liberalization occurred (1996–2000).

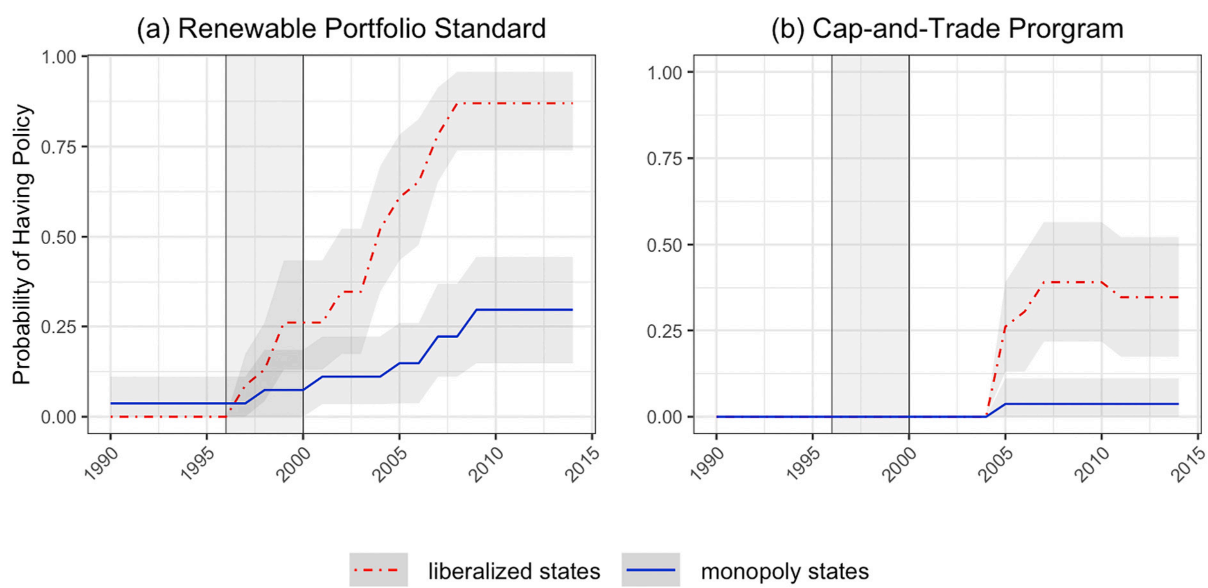

Fig. 8. Market liberalization and climate policy adoption. The *y*-axis is the average probability of having a renewable portfolio standard or cap-and-trade program for states which liberalized compared with states which did not. The shaded region indicates the period of time in which market liberalization occurred (1996–2000).

5.5. Estimation of effect of market liberalization on climate policy adoption

To estimate the effect of market liberalization on climate policy adoption, I use a generalized difference-in-differences identification strategy as specified in Section 4.2. This identification strategy addresses the potential for any spatial or temporal confounders which may be correlated with both the onset of market liberalization and the adoption of climate policies. Table 3 presents these estimates under a variety of specifications. The coefficient on market liberalization reveals that switching from a traditional regulated-monopoly system to a liberalized competitive system is associated with a substantive and statistically significant increase in the likelihood of adopting both climate policies that were considered. In particular, market liberalization is associated with an increase in the likelihood of adopting a renewable portfolio standard of between fifteen and forty-three percentage points and an increase in the likelihood of adopting a cap-and-trade program of between fifteen and thirty percentage points.

How robust are these findings? The principal threat to identification in the difference-in-differences framework is the possibility that there exists some unobserved, time-varying factor which both influences the treatment and the outcome of interest. While it is not possible to rule out all such potential confounders, the existence of parallel trends in Figs. 5 and 8 provides some encouraging evidence. I take two further steps to address this concern within the main difference-in-differences model used for analysis. The first is the inclusion of fixed effects for state-specific linear time trends, which control for state-specific characteristics which vary gradually over time (e.g., changes in the composition of the state's electorate). Second, I examine what the important (measurable) predictors of treatment are which can vary over time and explicitly control for these variables in the regression estimates. Table 1 indicates the primary predictor of whether or not a state chose to require market liberalization following federal authorization in 1996 was its price of electricity. Table 3 demonstrates that the estimates of the effect of liberalization on climate policy

Table 3

Effect of market liberalization on likelihood of adopting climate policy. Using a generalized differences-in-difference identification strategy, I estimate the effect of market liberalization on the adoption of major climate policies (1990–2014). Each outcome variable takes the value of '1' if the state has passed the policy in that year or a previous year (and has not repealed it), and '0' otherwise. The treatment variable is a lagged dummy variable which takes a '1' if the state has implemented market liberalization and '0' otherwise. All models are ordinary least squares (OLS) regressions with fixed effects for state and year. Controls include the proportion of seats controlled by Democrats in each state legislative chamber (between 0 and 1), the party of the governor ('1' for Democrat and '0' for Republican), and the residential electricity price. Standard errors are clustered by state.

	Renewable portfolio standard [a]				Cap-and-trade Program			
$\text{Liberalization}_{t+5}$	0.43***	0.37***	0.35***	0.15*				
	(0.09)	(0.09)	(0.08)	(0.08)				
$\text{Liberalization}_{t+10}$					0.30***	0.24***	0.23**	0.15**
					(0.10)	(0.09)	(0.09)	(0.07)
State Politics Controls		✓	✓	✓		✓	✓	✓
Electricity Price Control			✓	✓			✓	✓
State-specific Time Trends				✓				✓
Number of states	45	45	45	45	50	50	50	50
Number of years	25	25	25	25	25	25	25	25

*p<0.1; **p<0.05; ***p<0.01.

[a]Excludes states which adopted deregulation and RPS simultaneously.

Table 4

Cross-sectional variation in RPS adoption by presidential voteshare and market liberalization. The first column divides the fifty states into roughly equal terciles by the voteshare for Bush in 2000. The second column further divides states within each tercile between those that did and did not undergo market liberalization. The third column provides a count of the states that fall into each of these six categories. Finally, the fourth column measures the proportion of states within each category that adopted the RPS. Consistent with the "blue state" explanation, all sixteen states with the lowest share voting for Bush adopted the RPS. However, within each of the other two terciles, the states that liberalized were much more likely to pass an RPS than states that did not.

Bush voteshare (2000 Pres. Election)	Market liberalized?	Number of states	RPS (Likelihood)
0–46%	No	4	1.00
	Yes	12	1.00
46–56%	No	9	0.44
	Yes	8	0.75
56–100%	No	14	0.07
	Yes	3	0.67

are robust to the inclusion of state-specific time trends, electricity price, as well as various measures of state politics. Beyond the main analysis, I also employ a variety of alternative methods, including a difference-in-differences estimator with matching (Imai et al., 2019), the Cox-proportional Hazard model, and various generalized linear models. The estimated effects from the main analyses are qualitatively similar to those found across these alternative specifications (see Appendix A.2).

A different set of challenges to estimating the effect of market liberalization on climate policy arises around the potential for mismeasurement of the treatment variable. In particular, is the relevant measure *passage* of market liberalization laws or implementation of these laws? This distinction becomes relevant when considering California and the seven other states which, having not fully implemented these laws when the California Electricity Crisis of 2000–2001 occurred, subsequently repealed or suspended these reforms indefinitely. Thus this raises the possibility that these states did not fully "receive treatment." However, to the extent that this is the case, it is likely this would lead to an underestimate of the treatment effect. Consistent with this point of view, in the Appendix, I demonstrate that the exclusion of these eight states from the analysis leads to larger estimates of the positive effect of market liberalization on climate policy adoption (see Table A.2).

6. Alternative explanations

In the previous section, I demonstrated that there is a clear correlation between the onset of market liberalization and the subsequent adoption of major state-level climate policies associated with the power sector. I argue that this correlation is casual; in particular, that market liberalization led to a decline in the relative political power of incumbent utilities and, in turn, increased the probability of adopting climate policies. In this section, I will consider three alternative explanations to the observed empirical pattern, and whether any of these offer a better fit to the evidence than my own argument does. These are the (1) 'blue state" explanation, the (2) "issue linkage" explanation, and the (3) "weak incumbent" explanation.

Perhaps the most commonplace explanation for why some states adopt climate policies while others do not is that blue states (states with more liberal voters) tend to care more about climate change than red states and, consequently, are more likely to pass legislation to address the issue. Importantly, my argument does not hinge on this explanation being false; only that the estimate of the causal effect of market liberalization on climate policy adoption is not confounded by it. To this end, it is noteworthy that the difference-in-differences analyses presented are insensitive to time-invariant differences in blue versus red states and that, the findings are robust both to inclusion of controls for observable time-varying features related to state politics (Table 3 as well as matching on these covariates (Tables A.5–A.8).

However, we need not turn to the regression analyses to demonstrate the limitations of this alternative explanation. Consider Table 4, which divides the fifty states into terciles based on their presidential voteshare in 2000. Consistent with the blue state alternative explanation, twelve of the sixteen states with the lowest share voting for Bush adopted market libearlization, and all sixteen adopted the RPS. However, the blue state explanation cannot explain why some states in the other two terciles also adopted the RPS. Market liberalization, on the other hand, can offer an answer: in particular, conditional on 2000 presidential vote share, states which liberalized are much more likely to pass an RPS than states which did not. Moreover, the difference in likelihood in passing an RPS between liberalized and non-liberalized states is greater the higher the voteshare for Bush, which is consistent with the fact that Democrats in blue states could plausibly muster the political force needed to overcome utility opposition to adopting the RPS even without market liberalization. On the other hand, the reconfiguration of industrial interest-group politics that market liberalization would bring about was more likely to be a necessary antecedent to the passage of the RPS in red states. This fact was borne out in multiple

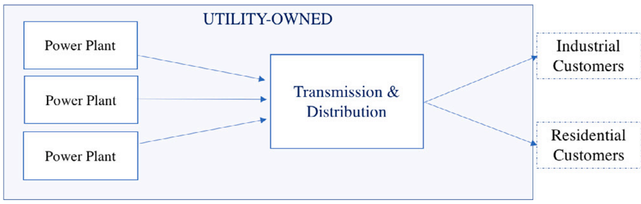

Fig. A.1. Industrial organization of electricity sector without market competition.

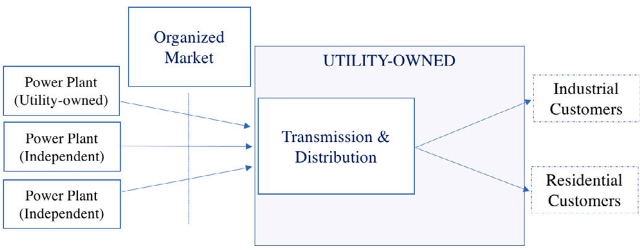

Fig. A.2. Industrial organization of electricity sector with market competition.

interviews conducted with environmental advocates who were involved in lobbying for the RPS.[18]

A second alternative explanation for the correlation between market liberalization and climate policy adoption is referred to as "issue linkage" and has been put forth by Kim et al. (2016). In this study, they argue that the appearance of a correlation is a reflection of the fact that environmental policy entrepreneurs took advantage of the legislative activity associated with market liberalization to pursue their renewable energy agenda. Like the blue state explanation, the issue-linkage explanation is surely correct, as far as it goes. Most notably, five states adopted the RPS concurrently with market liberalization reforms. In these states, just as Kim et al. (2016) argue, my own interviews with key leaders of environmental organizations at the time suggest that they took advantage of market liberalization in precisely this way.[19] However, for these very reasons, my own estimates for the effect of liberalization on the RPS exclude these five states. Furthermore, this argument cannot explain the relationship between liberalization and cap-and-trade, since the first cap-and-trade program was adopted more than five years after the market-liberalization period ended. In light of the above, while the issue-linkage explanation has historical validity, it cannot offer an alternative explanation for the empirical evidence I present.

A third explanation for the correlation between market liberalization and climate policies is what I will refer to as the "weak incumbent" explanation, which is predicated on the idea that a politically weak monopoly utility would be less able to stop market liberalization, in the first place, and also less able to block renewable energy legislation, in the second. While the logic of this explanation is intuitive, the evidence presented in this study is not consistent with it. First, there is no evidence that market liberalization was more likely to occur in states with weaker utilities than in states with stronger utilities, as measured in terms of pre-liberalization utility market share. Rather, as Table 1 demonstrates, the primary correlate of market liberalization was high electricity prices. However, the mere absence of a cross-sectional pattern does not rule out the possibility. Thus I return to the findings from the generalized difference-in-differences estimation strategy: importantly, for this to be a valid alternative explanation, the states with the weaker utilities during the market liberalization period would have to also be the states with the weaker utilities during the renewable energy legislation period. Fortunately, the inclusion of fixed effects for states in the difference-in-differences estimation strategy controls for precisely this kind of time-invariant factor. Consequently, this explanation cannot account for the positive and significant estimate of the effect of market liberalization on climate policy adoption.

Table A.1
State-level predictors of electricity market liberalization using a generalized linear model. The regression models below test the correlation between electricity price and the likelihood of adopting market liberalization laws across the fifty states. The outcome variable takes the value of '1' if the state liberalized and '0' otherwise. The regressions use a generalized linear model (GLM) with a probit link function. Selected covariates employ 1995 values to avoid post-treatment bias. The electricity price refers to the average residential price in each state (cents-per-kilowatt-hour). The first two state politics variables refer to the proportion of Democrats in each chamber of the state legislature, and the third variable is a binary indicator for whether the state's governor is a Democrat. The final two variables refer to the proportion of electricity produced from renewable resources and the estimated long-run potential for renewable electricity generation (measured in Terawatts), respectively.

	Likelihood of adopting market liberalization reforms					
Electricity Price	0.30** (0.12)	0.28** (0.12)	0.27** (0.12)	0.30** (0.12)	0.31*** (0.11)	0.24 (0.16)
Dem_house		3.77 (3.82)				4.12 (4.02)
Dem_senate		−3.77 (4.11)				−4.34 (4.26)
Dem_governor		−0.80 (0.57)				−0.75 (0.60)
Utilities' Market Share			−0.70 (1.18)			−2.26 (2.79)
Proportion of Renewables				−0.32 (2.68)		−4.25 (5.21)
Renewables Potential					0.02 (0.02)	0.01 (0.02)
Constant	−2.59*** (0.94)	−2.06 (1.31)	−1.72 (1.67)	−2.61*** (0.99)	−2.90*** (0.97)	0.45 (3.57)
Number of states	50	50	50	50	50	50

*p<0.1; **p<0.05; ***p<0.01.

7. Conclusion and policy implications

Why are some governments more likely than others to adopt policies to mitigate climate change? In this study, I argue that the industrial organization of the energy sector is crucial to understanding this question. In particular, I show how the transition from a regulated-monopoly to a competitive-market system in the production of electricity that occured in some U.S. states broke the political dominance of incumbent utilities with legacy interests in conventional electricity generation and facilitated the entrance and growth of competing firms more supportive of low-carbon energy policies. In turn, these states were subsequently much more likely to adopt landmark climate mitigation policies such as renewable portfolio standards and cap-and-trade programs.

[18] For example, Montana was one of the three states in the most conservative tercile in Table 4 which passed an RPS. Chuck Magraw, a longtime environmental advocate with the National Resource Defense Council in Montana who was involved in the passage of the RPS, said the following,"The RPS passed over utility opposition in 2005. Had the IOUs not lost political power as a result of deregulation (relative to what they had before), the RPS might not have passed." Going on to explain just how significant the consequences for deregulation were, he said, "The main IOU, Montana Power Company (MPC), was a central institution in the state's identity. During deregulation, when MPC sold off much of its infrastructure to two out-of-state corporations, it was almost as if Montana was losing a part of itself" (personal interview, November 21, 2019).

[19] I acknowledge Alan Nogee (Clean Energy Consulting) and Nancy Rader (California Wind Energy Association) for their input on this matter.

Table A.2
Sensitivity of estimates of market liberalization effects to lag specifications and measurement error. The difference-in-differences treatment estimates from Table 3 are robust to changes in the lag period (models 2–3 and 6–7) as well as to the exclusion of states which passed market liberalization laws but later suspended them (models 4 and 8). All models are OLS regressions with state and year fixed effects and standard errors clustered by state.

	Renewable Portfolio Standard (RPS)[a]				Cap-and-trade Program			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liberalization$_{t+4}$		0.41***						
		(0.09)						
Liberalization$_{t+5}$	0.43***			0.56***				
	(0.09)			(0.07)				
Liberalization$_{t+6}$			0.46***					
			(0.10)					
Liberalization$_{t+9}$						0.28***		
						(0.09)		
Liberalization$_{t+10}$					0.30***			0.44***
					(0.10)			(0.12)
Liberalization$_{t+11}$							0.29***	
							(0.10)	
Excludes Suspensions[b]				✓				✓
Number of States	45	45	45	37	50	50	50	42
Number of Years	25	25	25	25	25	25	25	25

*p<0.1; **p<0.05; ***p<0.01.
[a]Excludes states which adopted deregulation and RPS simultaneously.
[b]States which passed but later suspended deregulation (AZ, AR, CA, MT, NV,NV, NM, OK).

Table A.3
Alternative model specifications for estimating market liberalization effects. This table re-estimates the treatment effects from Table 3 using various non-OLS models. The first two columns display estimates using a Cox-proportional Hazard model. The subsequent four columns show estimates obtained using a generalized linear model with probit and logistic link functions, respectively.

	RPS[a]	CAT	RPS[a]	CAT	RPS[a]	CAT
Liberalization	1.00***	2.30***				
	(0.13)	(0.34)				
Liberalization$_{t+5}$			1.64***		2.76***	
			(0.10)		(0.18)	
Liberalization$_{t+10}$				1.72***		3.30***
				(0.13)		(0.26)
Model	Hazard	Hazard	Probit	Probit	Logistic	Logistic
Number of States	45	50	45	50	45	50
Number of Years	25	25	25	25	25	25

*p<0.1; **p<0.05; ***p<0.01
[a]Excludes states which adopted deregulation and RPS simultaneously.

This study sheds light on an unresolved puzzle in the study of climate politics. A longstanding literature has argued that the promotion of low-carbon energy is hampered by the political dominance of fossil-fuel legacy producers who are able to "capture" the regulatory process (Hirsh, 1999; Unruh, 2000; Troesken, 2006; Sovacool, 2008). However, a more recent line of work has suggested that this opposition can be overcome by countervailing pro-renewable energy industry groups (Carley, 2011b; Cheon and Urpelainen, 2013). This study shows that the relative strengths of these competing groups are shaped by antecedent policy decisions regarding the structure of the energy industry itself. In this way, this study reinforces the importance of considering policy feedback mechanisms in climate policy formation (Aklin and Urpelainen, 2013; Meckling et al., 2015; Stokes, 2015) and, in particular, how different institutional frameworks can promote or undermine "green industrialization."[20]

Alongside Nicolli and Vona (2019), this study suggests a potential instituional reform for promoting decarbonization that remains largely unrealized, both in the United States and around the world. In such

Table A.4
Difference-in-differences sequential lags model. This table explores the temporal dimension of the treatment effects shown in Tables 2–3. Each lag or lead is a market liberalization indicator variable which is assigned to '1' for the single year in which liberalization occurs (plus/minus the value of the lag/lead), and '0' otherwise. The final lag remains '1' in subsequent years.

	Utility_prop	RPS_bin	cap_n_trade
t − 3	−0.02	0.01	−0.02
	(0.02)	(0.02)	(0.01)
t − 2	−0.04*	0.01	−0.02
	(0.03)	(0.02)	(0.01)
t − 1	−0.03	0.004	−0.02
	(0.02)	(0.03)	(0.01)
t + 0	−0.02	0.21**	−0.02
	(0.03)	(0.10)	(0.02)
t + 1	−0.06	0.20*	−0.02
	(0.04)	(0.10)	(0.02)
t + 2	−0.16**	0.23**	−0.02
	(0.08)	(0.10)	(0.02)
t + 3	−0.27***	0.25**	−0.02
	(0.09)	(0.11)	(0.02)
t + 4	−0.31***	0.25**	−0.01
	(0.09)	(0.12)	(0.02)
t + 5	−0.33***	0.27**	−0.01
	(0.09)	(0.12)	(0.03)
t + 6	−0.35***	0.33***	0.04
	(0.08)	(0.13)	(0.08)
t + 7	−0.37***	0.32**	0.07
	(0.08)	(0.13)	(0.10)
t + 8	−0.37***	0.55***	0.08
	(0.08)	(0.12)	(0.10)
t + 9	−0.38***	0.57***	0.15
	(0.08)	(0.12)	(0.10)
t + 10	−0.38***	0.62***	0.25**
	(0.08)	(0.12)	(0.11)
t + 11	−0.38***	0.64***	0.33***
	(0.08)	(0.12)	(0.11)
Constant	0.98***	−0.10**	−0.03
	(0.02)	(0.04)	(0.02)
State and year fixed effects	✓	✓	✓
Number of states	50	50	50
Number of years	25	25	25

*p<0.1; **p<0.05; ***p<0.01

[20] https://drodrik.scholar.harvard.edu/files/dani-rodrik/files/green_industrial_policy.pdf.

Table A.5
Balance table for estimating effect of market liberalization on RPS adoption through difference-in-differences with matching ("PanelMatch"). Balance between treated and control units are shown after using the Covariate Balance Proximity Score (CBPS) refinement method. Through CBPS, control units are matched to treated units through reweighting based on the pre-treatment history of the time-varying state politics variables as well as the lagged dependent variable. Balance is shown at the time of treatment as well as at each of the five years prior.

	Governor	House	Senate
t − 5	0.017	0.185	0.082
t − 4	−0.022	0.122	0.061
t − 3	0.030	0.124	0.088
t − 2	0.036	0.029	0.038
t − 1	0.040	0.036	0.043
t − 0	0.021	0.045	0.058

Table A.6
Estimated effects of market liberalization on RPS adoption using difference-in-differences with matching ("PanelMatch"). These effects are estimated using PanelMatch, a difference-in-differences estimator which first matches the treated and control units. Corresponding balance table shown in Table A.5.

	Estimate	Std.error	2.5%	97.5%
t+0	−0.010	0.008	−0.023	0.000
t+1	−0.031	0.025	−0.070	0.000
t+2	0.019	0.050	−0.073	0.094
t+3	0.074	0.065	−0.066	0.181
t+4	0.071	0.064	−0.068	0.177
t+5	0.123	0.073	−0.059	0.245
t+6	0.196	0.081	0.035	0.351
t+7	0.189	0.080	0.029	0.339
t+8	0.501	0.096	0.303	0.679
t+9	0.488	0.107	0.248	0.678
t+10	0.541	0.105	0.307	0.726

Table A.7
Balance table for estimating effect of market liberalization on cap-n-trade adoption through difference-in-differences with matching ("PanelMatch"). Balance between treated and control units are shown after using the Covariate Balance Proximity Score (CBPS) refinement method. Through CBPS, control units are matched to treated units through reweighting based on the pre-treatment history of the time-varying state politics variables as well as the lagged dependent variable. Balance is shown at the time of treatment as well as at each of the five years prior.

	Governor	House	Senate
t − 5	−0.023	−0.019	−0.075
t − 4	−0.061	0.031	−0.090
t − 3	−0.097	0.080	−0.101
t − 2	−0.024	0.038	−0.125
t − 1	−0.047	0.061	−0.091
t − 0	−0.052	0.080	−0.060

Table A.8
Estimated effects of market liberalization on cap-n-trade adoption through difference-in-differences with matching ("PanelMatch"). These effects are estimated using PanelMatch, a difference-in-differences estimator which first matches the treated and control units. Corresponding balance table shown in Table A.7.

	Estimate	Std.error	2.5%	97.5%
t+0	0.000	0.000	0.000	0.000
t+1	0.000	0.000	0.000	0.000
t+2	0.000	0.000	0.000	0.000
t+3	0.000	0.000	0.000	0.000
t+4	0.000	0.000	0.000	0.000
t+5	0.000	0.000	0.000	0.000
t+6	0.087	0.048	−0.000	0.166
t+7	0.080	0.048	−0.022	0.155
t+8	0.113	0.059	−0.026	0.209
t+9	0.167	0.066	0.037	0.295
t+10	0.254	0.072	0.119	0.392

circumstances where incumbent monopoly producers have legacy interests in fossil-fuel technologies, the introduction of market competition in electricity production could facilitate better alignment of private-sector interests with the promotion of low-carbon energy. While the overall welfare impacts of market libearlization should be carefully considered before choosing to implement such reforms, the potential benefit for climate change mitigation must not go unrecognized.

Beyond climate policy, this study contributes to our understanding of the endogenous nature of industrial interest-group dynamics, more generally. The case examined in this study demonstrates how one government-induced reform to an industry led to a dramatic redistribution of interest-group power which, in turn, led to different policy outcomes. While the distribution of industrial interest-group power in driving policy outcomes is well studied in economics and political science (Stigler, 1971; Stiglitz, 2012; Carpenter, 2013; Igan and Lambert, 2018), the decisive role of *government* in shaping that distribution is less so. More research should investigate the policy antecedents to existing interest-group dynamics.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

A.1. Diagrams of industrial organization of electricity sector

See Figs. A.1 and A.2.

A.2. Robustness checks

See Tables A.1–A.8.

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