

Electricity restructuring and plant production costs: evidence from the United States, 1995-2011

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Electricity restructuring

- In the mid 1990s, most electricity customers in the U.S. were served by investor-owned, vertically integrated utilities under cost-of-service regulation
- Between 1995 and 2002 most states considered major regulatory reforms aimed at introducing competition in various utility functions
- Restructuring was intended to improve efficiency, enhance coordination of grid operations and lower consumer costs

Literature

- Many studies have examined the impact of restructuring on plant performance and operations (Bushnell and Wolfram (2005); Chan et al. (2017); Cicala (2015); Craig and Savage (2013); Davis and Wolfram (2012); Fabrizio et al. (2007); Goto and Tsutsui (2008); Kleit and Terrell (2001); Knittel (2002); Zhang (2007))
- Bushnell et al. (2008), Hortaçsu and Puller (2008), Joskow (2006) and Mansur and White (2012) consider efficiency improvements from better coordination of operations and lowering of transaction costs within ISOs/RTOs
- A more recent strand of the literature focuses on the effects of restructuring on retail prices (Borenstein and Bushnell (2015); Hortaçsu et al. (2015); Joskow (2006); Kwoka (2008))

Contribution

- 1 Using a differences-in-differences approach, we examine the impact of restructuring on production costs reported by investor-owned fossil fuel power plants
- 2 We construct a 17 year (1995-2011) panel data set including many years of post restructuring observations

Data

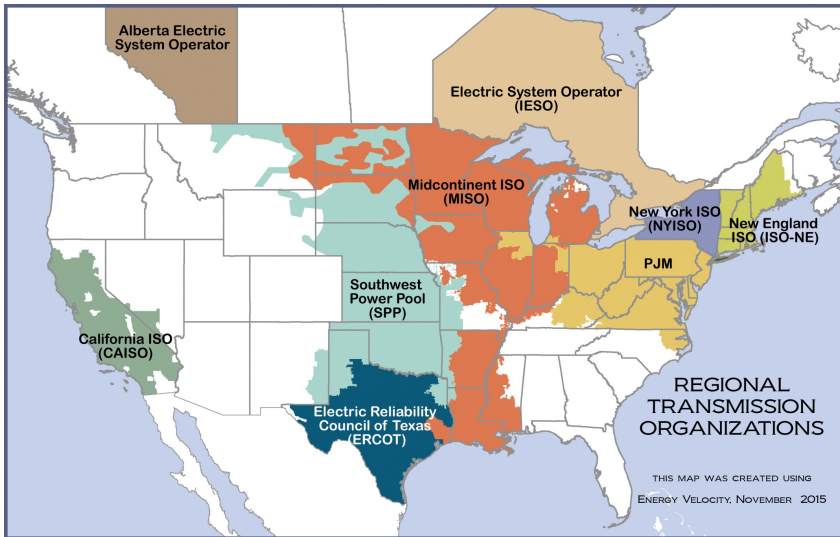
- Our primary data source is FERC Form 1
 - ▶ Plant characteristics (technology type, construction year, installed capacity, average number of employees)
 - ▶ Plant operations (net generation, net peak demand on plant)
 - ▶ Capital costs (“Total cost”)
 - ▶ Production costs (“Total production expenses”, including fuel costs)
 - ▶ Costs are presented in 2010 dollars
- Dates of restructuring are from the EIA and earlier studies (Fabrizio et al., 2007; Craig and Savage, 2013; Chan et al., 2017)

Identification strategy

- We use a differences-in-differences approach
- Restructuring is our binary treatment
- Production costs at the plant level represent our outcome variable
- Treated plants are located in states that have pursued restructuring
- Control plants are located in states that have not pursued restructuring

Definition of restructuring

- ① RST1: Access to wholesale electricity markets
 - ▶ Treatment is equal to 1 from the year in which utilities in the state were allowed to trade in a wholesale electricity market
- ② RST2: Passage and repeal of restructuring legislation
 - ▶ Treatment is equal to 1 from the year in which the state enacted restructuring legislation (and set back to zero if legislation was repealed or suspended)



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 - ▶ Treatment is equal to 1 from the year in which the state enacted restructuring legislation (and set back to zero if legislation was repealed or suspended)
- 3 RST3: Access to wholesale electricity markets for individual power plants
 - ▶ Treatment will be equal to 1 if the plant is within a ISO/RTO footprint (ISO/RTO designation is not available before 2010)

Empirical specification

$$\log(\text{Production costs}_{it}) = \beta_0 + \beta_1 \text{Restructuring}_{st} + X\gamma + \mu_i + \delta_t + \varepsilon_{it}$$

- where i , s and t refer to plant, state and year
- $\text{Restructuring}_{st} = \{RST1, RST2\}$
- β_1 is our coefficient of interest
- X includes covariates affecting production costs of electricity generation
- μ_i captures within-plant unobserved heterogeneity
- δ_t captures annual shocks common to all plants that may affect production costs
- ε_{it} is an i.i.d. error term

Identification assumptions

1 Parallel trends assumption

- ▶ Violation means that we cannot attribute the effect on production costs solely to restructuring

2 Exogeneity of treatment

- ▶ May be violated if plants select into treatment based on unobservable characteristics or if restructuring activity is affected by production costs

Preliminary results

$$\log(\text{Production costs}_{it}) = \beta_0 + \beta_1 \text{Restructuring}_{st} + X\gamma + \mu_i + \delta_t + \varepsilon_{it}$$

	(1) RST1	(2) RST1	(3) RST2	(4) RST2
Restructuring	-0.068*	-0.035	0.010	0.011
(Log) net generation		0.345***		0.345***
Capacity factor		-0.197**		-0.198**
Age		-0.001		-0.001
Avg. no. employees		5.37e-12***		5.51e-12***
Plant fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	11,182	11,135	11,182	11,135
Adjusted R^2	0.920	0.943	0.920	0.943

Standard errors are clustered by plant. *, **, *** indicate significance at 10%, 5%, and 1% levels, respectively.

Robustness checks I: Endogeneity

- Exogeneity of treatment may be violated if states initiated restructuring in response to unobserved time-varying factors affecting the dependent variable (plant generation costs)
- We believe this violation is unlikely to happen
- We used instrumental variables as an alternate method to identify variation in restructuring policy
- Instruments are state-level political variables that likely affect the restructuring decision but are not directly related to plant generation costs
- Statistical tests suggest that endogeneity bias is not a concern

Conclusions and future work

- We examine the impact of electricity restructuring on plant operating efficiency by considering production costs reported by investor-owned utilities
- We apply a differences-in-differences estimator to a panel data set from 1995 to 2011
- Preliminary results suggest that restructuring did not lead to reductions in production costs of existing fossil fuel plants
- Future work will refine model specification (through inclusion of additional covariates, e.g. input prices) and consider differences-in-differences estimation with matched plants

Questions?

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Robustness checks II: Parallel trends assumption

- We conduct placebo tests by assigning a value of 1 to treatment in 1996 for states that allowed utilities to trade in wholesale markets since 1997

Pseudo restructured	-0.011
(Log) net generation	0.556**
Capacity factor	-1.782*
Age	1.33e-06
Avg. no. employees	6.83e-12***
Plant fixed effects	Yes
Year fixed effects	Yes

Observations	1,549
Adjusted R^2	0.853

Standard errors are clustered by plant.
*, **, *** indicate significance at 10%,
5%, and 1% levels, respectively.