Deregulation, Market Power, and Prices: Evidence from the Electricity Sector

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When Should Prices Be Regulated?

Industries that provide infrastructure are often subject to special regulation, including the regulation of prices and entry

Regulated prices

- Moderate markups, since they are controlled by the regulator
- Low incentives to reduce cost

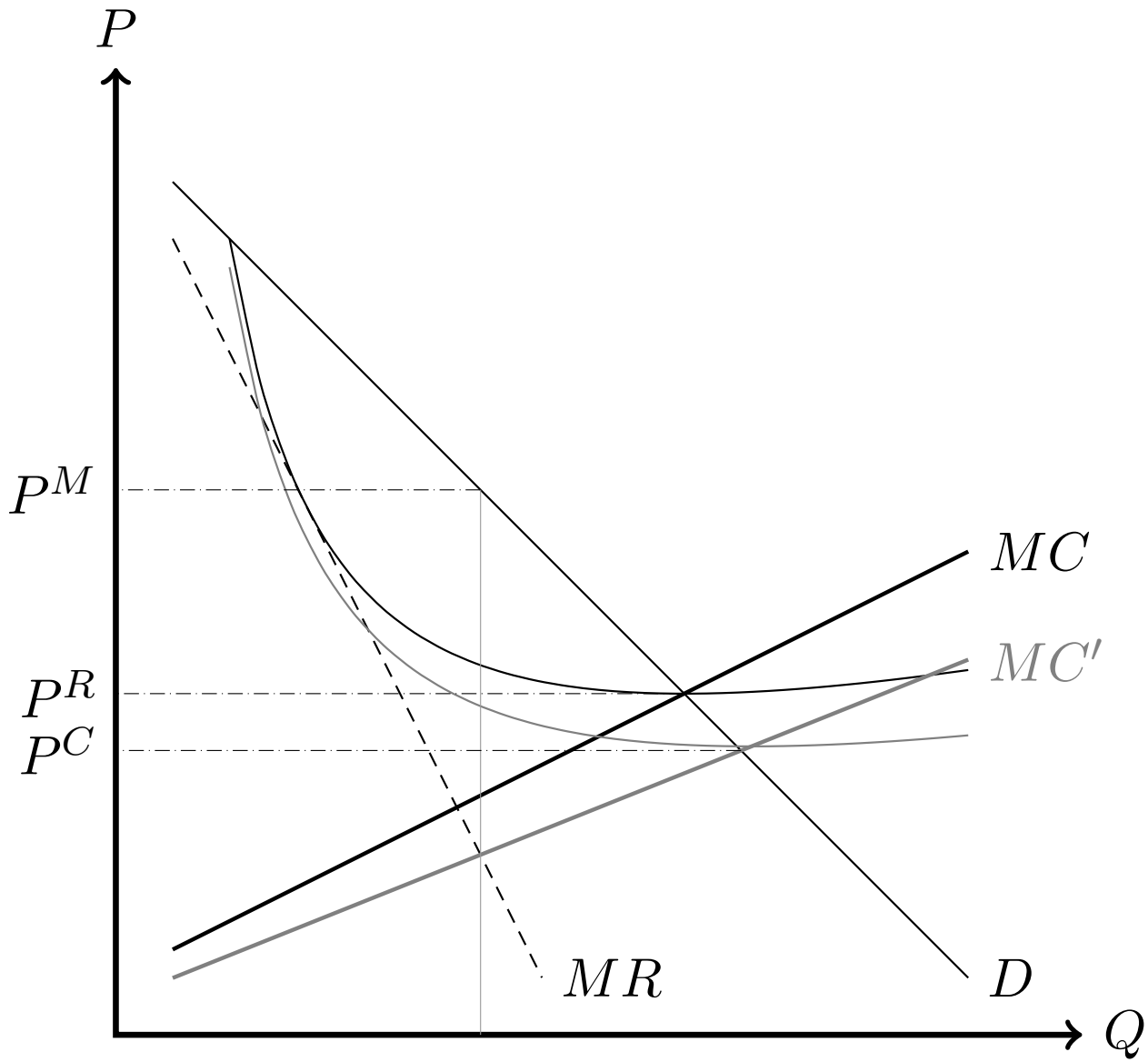
Market-based prices

- Firms have incentives to minimize costs through efficient operation and investment
- Firms may price well above marginal costs if they have market power

Which effect will prevail is an empirical question

- Market power remains a concern even in industries in which liberalization has been considered successful

Figure 1: Market-Based Prices and Regulated Prices



Electricity: A Bit of History

In the 1990s, several (state-level) initiatives were begun to restructure electricity markets in the United States

The objective was to bring down electricity prices through the introduction of markets and competition

- Following deregulation of airlines, trucking, and telecom
- Replacing regulated vertically integrated utilities by markets
- Limiting the role of regulation, introducing market-based prices

Economic reasoning:

- More efficient allocation
- More efficient long-term investment decisions

Old Model: Vertically Integrated Utility

- U.S.: Either investor owned and regulated, or municipal
- Retail rates regulated to allow a certain return on investment
- Why? Each segment was thought of as a natural monopoly

New Model: Changes in Market Structure

Generation ("Upstream")

- Open to entry by any power producer
- No longer considered a natural monopoly

Transmission: Create Independent System Operators (ISO)

- ISOs centrally coordinate the usage of the transmission grid

Distribution

- Still natural monopoly, regulated

Retail ("Downstream")

- Open to competition
- Any firm can sell power to final consumers, and distribute it using the incumbent's infrastructure

What Happened After Restructuring?

Increased productive efficiency (lower costs)

- Better plant operation (Fabrizio, Rose, and Wolfram, 2007; Davis and Wolfram, 2012)
- More efficient dispatch (Cicala, 2017)
- Evidence from non-U.S. markets (Newbery, Pollitt)

Prices?

- Borenstein and Bushnell (2015): Not much?
- Bushnell, Mansur, and Novan (2017 WP): Inconclusive

Other relevant outcomes

- Entry and exit, environmental performance
- Not enough evidence (Bushnell, Mansur, and Novan, 2017 WP)

This Paper: Effects of Deregulation on Prices and Costs

Use a rich utility-level dataset that tracks electricity transactions from generation to distribution:

- Generation amounts and costs
- Quantities and prices for wholesale and retail transactions
- We measure intermediate forms of vertical integration
  - Whether buyers and sellers are affiliated (same parent company)

Empirical Approach: Diff-in-Diff Matching

- Match utilities based on size and fuel mix
- Compare utilities in restructured and regulated states:
  1. Wholesale and retail prices
  2. Generation costs
  3. Wholesale and retail markups

Preview of Findings

1. Prices increased and costs decreased in deregulated states

- Relative to similar utilities in regulated states
- Higher markups outweighed modest gains in cost efficiency
- Effect comes primarily from market power in the wholesale market

2. Effective deregulation lagged "apparent" deregulation

- Market structure did not change immediately after deregulation.
- Wholesale market: Utilities sold their generation, but continued to buy from affiliated firms (some parent).
- Retail market: Incumbents lost market share but very gradually.

Contribution

1. Importance of the tradeoff between market power and efficiency in the analysis of deregulation

- Empirical investigation of an industry in which market power outweighs the efficiency gains from restructuring.

2. First detailed description of the evolution U.S. electricity markets after deregulation

- Rich firm-level data on wholesale and retail markets offers a novel perspective on the deregulation of the industry.
  - E.g. ISO markets covered only 15% of transactions in 2015, yet most of our knowledge comes from them.
- Add a new dimension to the analysis: vertical relations.

Outline

1. **Conceptual framework**
2. Empirical strategy
3. Findings
4. Evidence of market power
5. Alternative explanations

Conceptual Framework

Under Regulation

Consider a regulated and vertically integrated utility that sells at price

$$P_1 = c_1 \cdot m_1$$

where c_1 is the marginal cost m_1 is the markup allowed by the regulator.

After Restructuring

Utility now buys at price w and sells at

$$P_2 = w(c_2) \cdot m_1$$

Therefore

$$P_2 < P_1 \Leftrightarrow w(c_2) < c_1$$

Prices After Restructuring: Two Components

$$P_2 < P_1 \Leftrightarrow w(c_2) < c_1$$

1. Efficiency
   - Efficiency gains can reduce costs: $c_2 < c_1$

2. Wholesale market
   - Perfect competition: $w = c_2 \Rightarrow$ gains are passed on to prices
   - Market power: wholesaler charges a markup

$$w = \frac{c_2}{1 + \frac{1}{\epsilon}}$$

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Data: 1994 to 2016

1. EIA (Form 861 and 923)
   - Annual utility data: generation, purchases, sales by type of customer
   - Generation costs for all power plants.

2. FERC Form 1: detailed information on investor owned utilities (IOUs)
   - Purchases: from whom, price, quantity
   - Affiliation between buyers and sellers (same parent) built manually from a combination of sources
     - Complete map of corporate structure and how it changed

Final dataset: A utility-level panel containing:

- Generation costs for the energy sold by each utility
- How much generated, how much purchased from each seller (price, quantity, affiliation)
- How much sold to each type of customer, at what price

Analysis of the Effects of Deregulation

Sample

- Investor owned utilities (IOUs), roughly 75% of sales
- Yearly transaction data

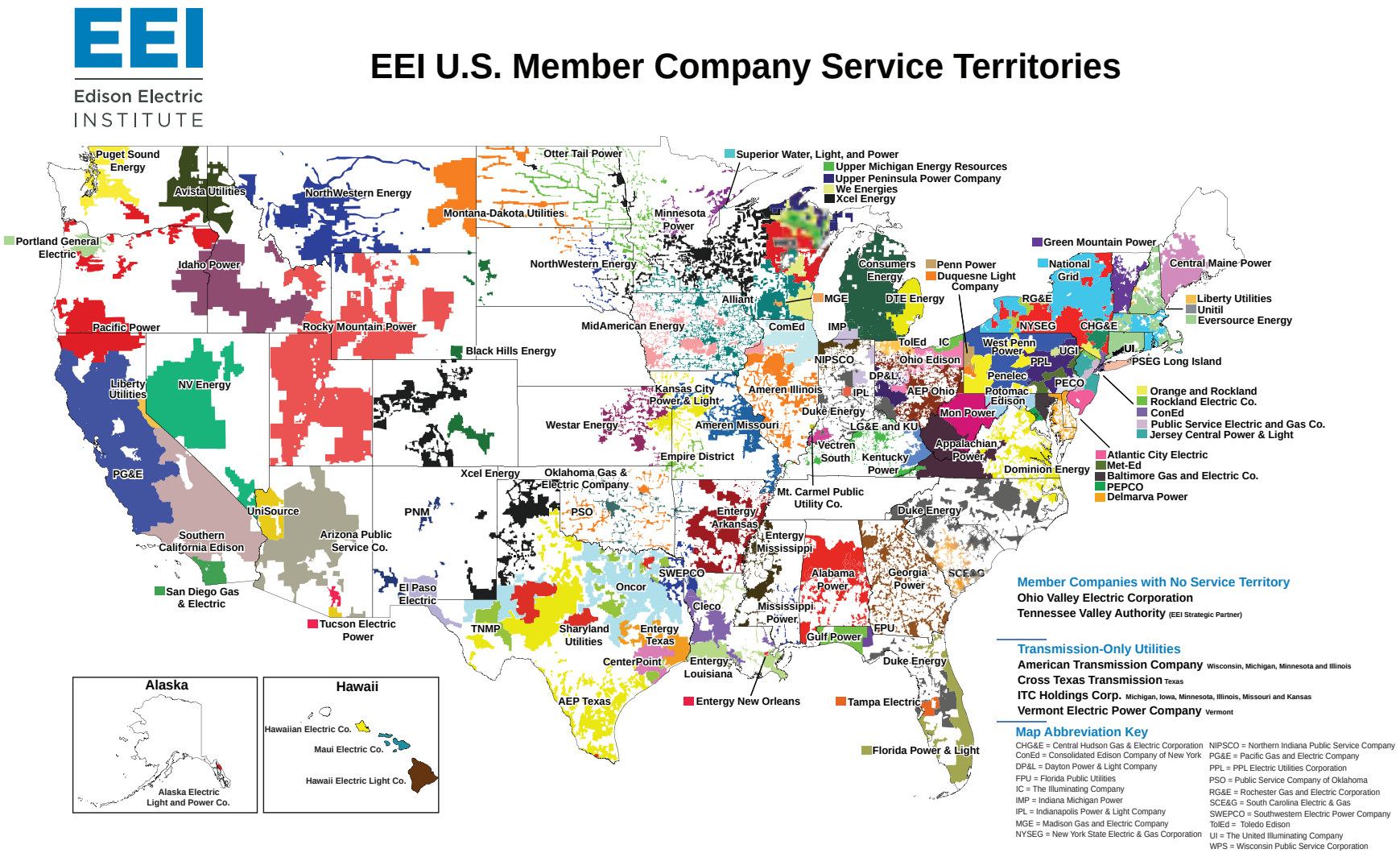
Analysis

- Conducted at the level of a utility's service territory
- Roughly unchanged while the structure of the market changed
- Compare deregulated utilities to similar ones in regulated states.
  - Deregulated: 17 states, 78 utilities
  - Regulated: 25 states, 75 utilities
- Excluded from the sample: states that passed and rescinded measures, or do not have IOUs, and Alaska and Hawaii

Year of Deregulation by State

State	Implementation Year
NY	1998
RI	1998
CA	1999
NH	1999
MA	1999
ME	1999
CT	2000
DE	2000
MD	2000
NJ	2000
PA	2000
IL	2001
OH	2001
MI	2002
OR	2002
TX	2002
VA	2002

Empirical Analysis: Investor-Owned Utilities



Produced by Edison Electric Institute. Data Source: ABB, Velocity Suite. October 2018

Key Variables

Retail Price

- Average bundled (distribution + retail) price offered to each type of customer weighted by share of consumption
- Captures "default" price available to consumers in that area

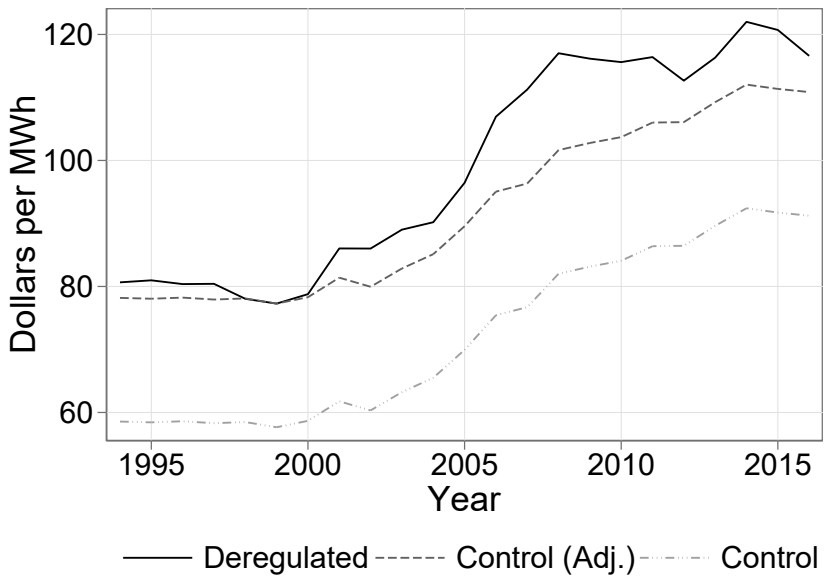
Wholesale Price

- Average price of purchased energy for each utility (FERC Form 1)
- Reflects local market conditions

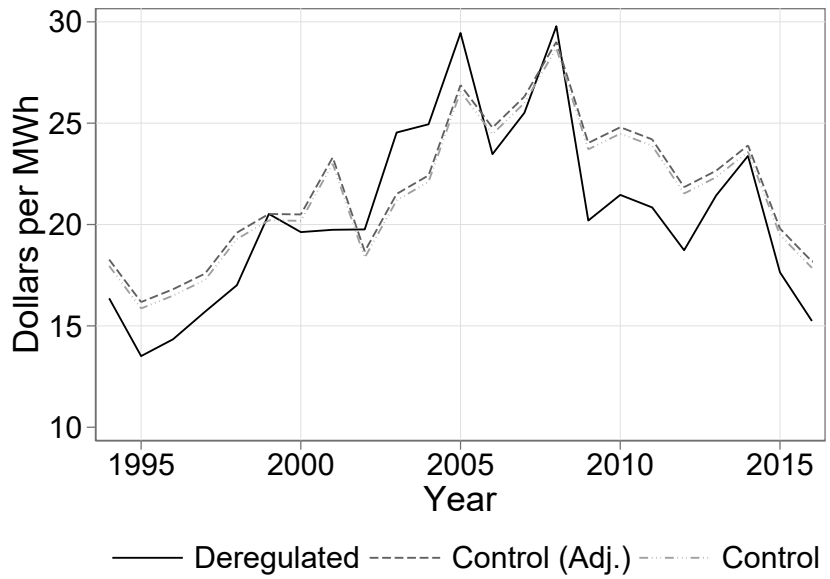
Generation Cost

- Each generator is assigned to its owner in 1994 (a utility's area)
- Average fuel costs constructed from generator-specific fuel receipts
- Alternative measure: fuel costs for all generators in the state

Aggregate Prices and Costs

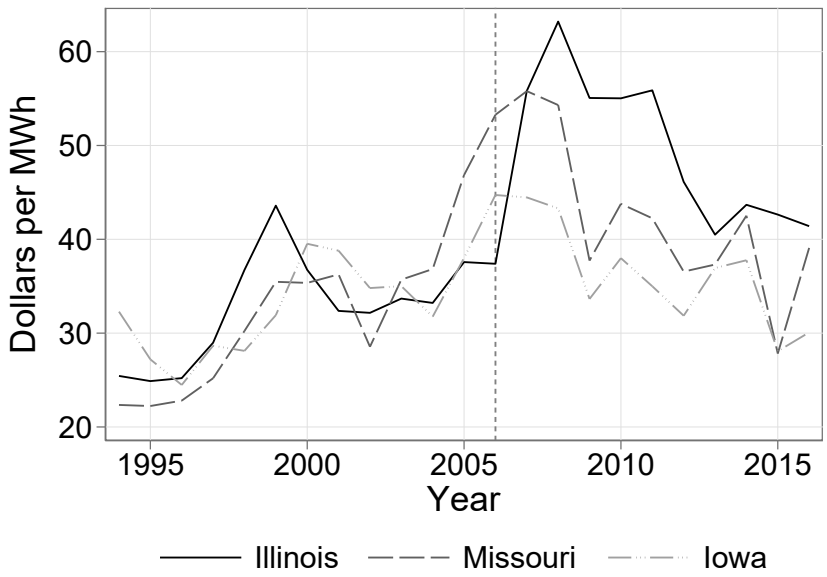


Retail Prices

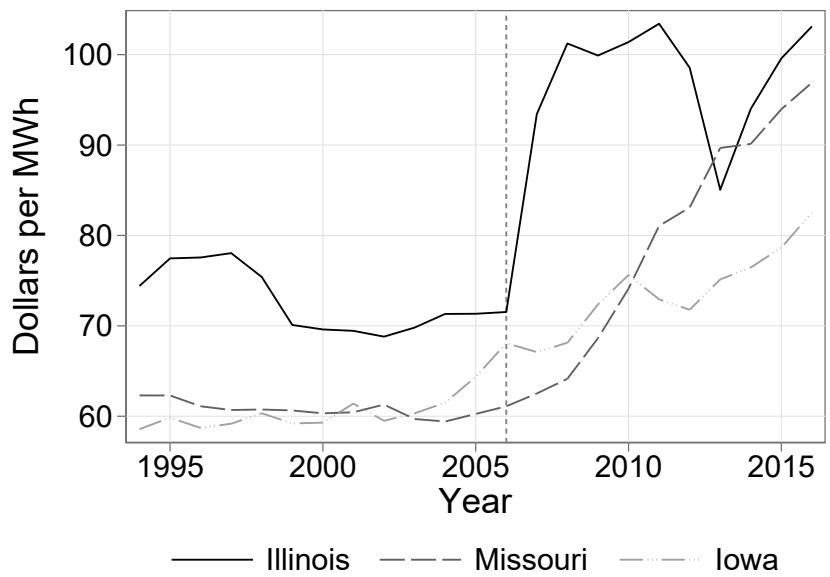


Generation Fuel Costs

Example State: Illinois



Upstream (Wholesale)



Downstream (Retail)

Table 1: Summary Statistics in 1994

	(1)	(2)	(3)	(4)	(5)
	Dereg.	Control		Matched Controls	
	Mean	Mean	p-value	Mean	p-value
ln(MWh Retail)	15.21	15.24	0.944	15.39	0.704
ln(MWh Generated)	14.66	14.71	0.933	14.66	0.995
Generation Share: Coal	0.40	0.53	0.186	0.47	0.501
Generation Share: Gas	0.20	0.12	0.383	0.13	0.431
Generation Share: Nuclear	0.13	0.08	0.203	0.12	0.867
Generation Share: Oil	0.12	0.03	0.081	0.06	0.314
Generation Share: Water	0.14	0.23	0.456	0.22	0.510
Fuel Costs	50.57	22.34	0.087	29.37	0.268
Retail Price	78.76	58.84	0.001	58.83	0.001
Net Markups	28.19	36.51	0.579	29.46	0.943
Number of Unique Utilities	78	75		73	

Differences-in-Differences Matching Estimator

- For each of the 78 deregulated utilities, find three nearest neighbors from the 75 regulated utilities based on:
  - Size: log generation MWh, log retail MWh
  - Fuel mix: share generated MWh coming from coal, natural gas, oil, nuclear, water, and other renewables.
- For each outcome of interest Y_{it} for utility i in period t, we compute

$$\widehat{\Delta Y}_{it} = Y_{it}(1) - \widehat{Y}_{it}(0).$$

  where
  - $Y_{it}(1)$ is the observed outcome for deregulated utilities
  - $\widehat{Y}_{it}(0)$ is the average of the three nearest regulated neighbors
  - Outcomes are indexed such that $Y_{i1999}(1) - \widehat{Y}_{i1999}(0) = 0$
- Aggregate outcomes are weighted by utility size (retail MWh in 1994)

Assumptions Required for a Causal Interpretation

1. No different ongoing trends other than restructuring

Seems reasonable before deregulation started:

- Deregulated prices were initially higher
- But markups were similar
- And costs and prices followed similar trends

2. Shocks unrelated to deregulation did not affect the two groups differently

Match utilities by size and fuel mix to account for this.

- The effect of cost shocks depends primarily on the fuel mix.

Assumptions Required for a Causal Interpretation

3. No spillover into neighboring regulated states

Restructuring integrated markets across states and could have affected retail prices in regulated states.

- We observe large increases in prices and markups in regulated states.
- This suggests our findings may be a lower bound on the effect of deregulation.

4. Other determinants of market power and cost efficiency might have developed differently after deregulation

E.g. Entry and exit dynamics will respond to different incentives.

These differences are part of the effect that we want to capture.

Outline

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2. Empirical strategy
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4. Evidence of market power
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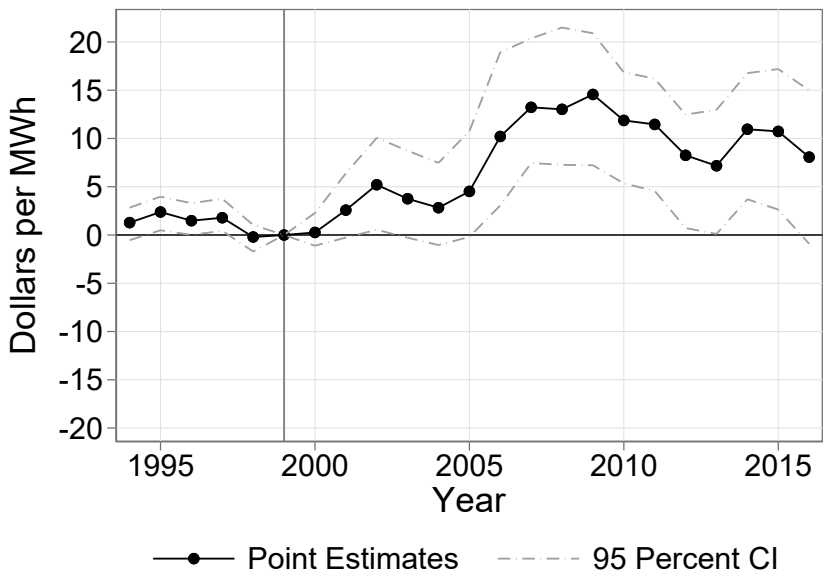
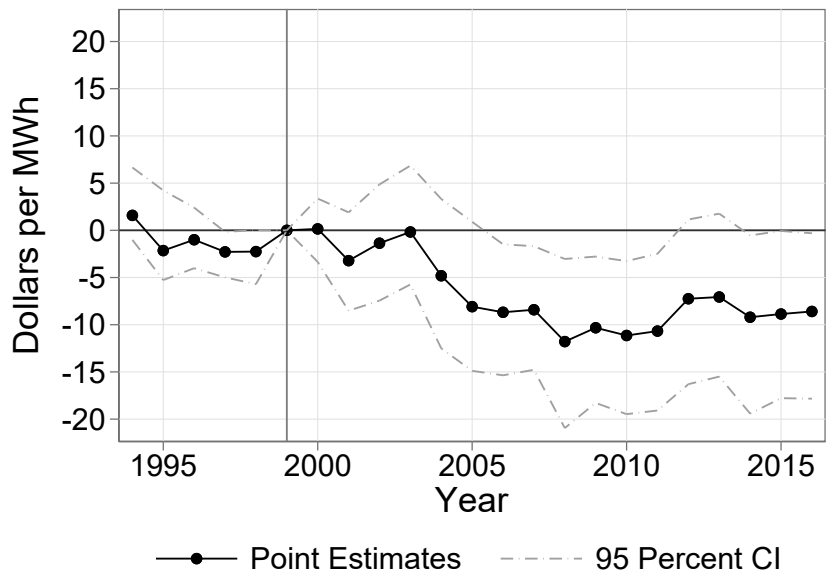
Aggregate Prices and Costs: DiD Estimate

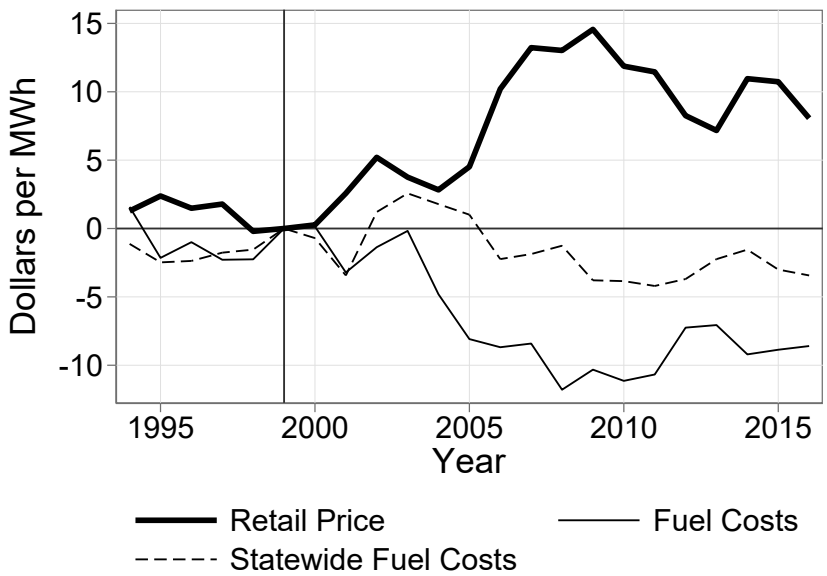


Retail Prices

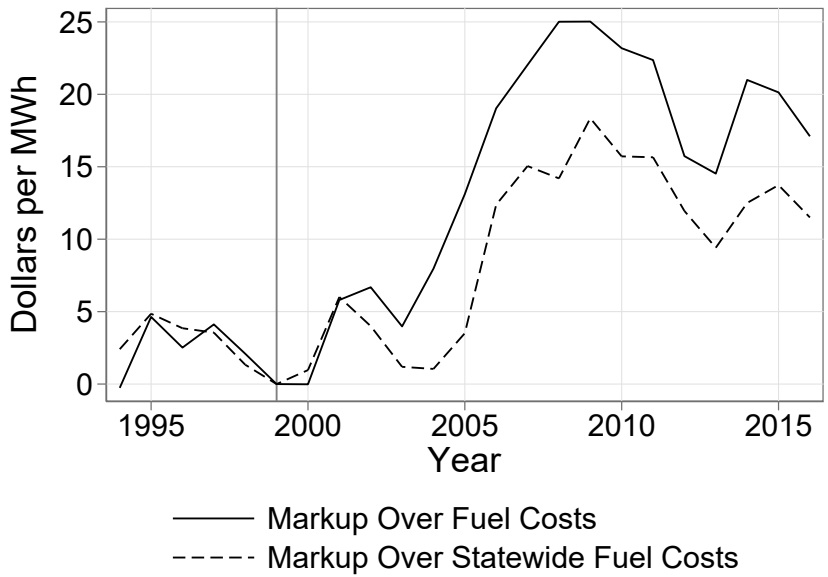


Generation Fuel Costs

Prices, Costs, and Net Markups

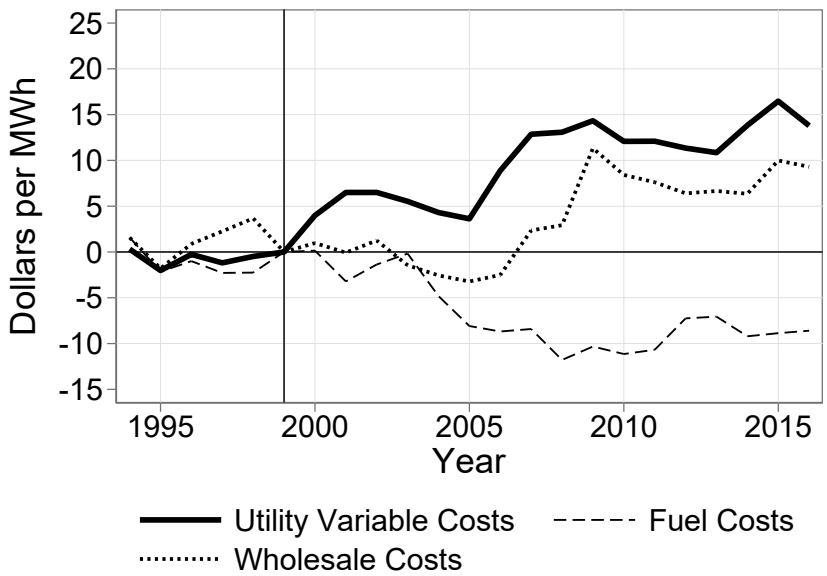


Prices and Costs

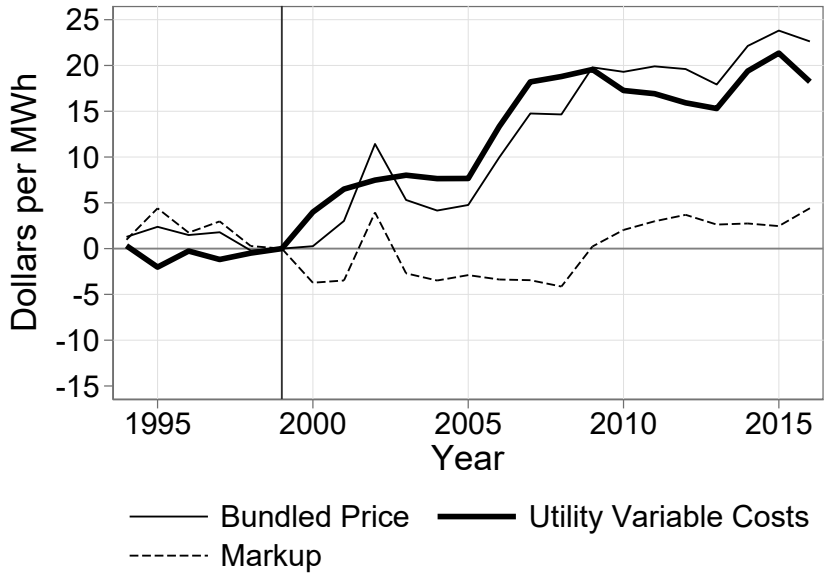


Net Markups

Utility Costs and Markups



Utility Variable Costs



Utility Prices, Costs, and Markups

Summary: Magnitudes

	(1) Retail Price	(2) Wholesale Price	(3) Generation Cost	(4) Retail Markup	(5) Wholesale Markup	(6) Net Markup
1999 Values	78.06	42.81	27.21	34.95	16.49	50.82
2000-2005	3.18	−0.70	−2.92	4.18	2.40	6.24
2006-2011	12.40	5.04	−10.17	7.73	15.25	22.80
2012-2016	9.04	7.74	−8.18	5.56	15.45	17.66
2000-2016	8.14	3.71	−7.00	5.67	10.59	15.38

Markets After Restructuring

Market power outweighs efficiency gains

- Generation costs decreased
- Retail and wholesale prices increased

The effect primarily comes from the wholesale market

- Wholesale prices increased
- Retail prices increased in response to increased costs for utilities

Market power is more widespread than previously thought

- Previous research has found evidence of market power in the centralized market
- Degree of market power in the contract market largely unknown

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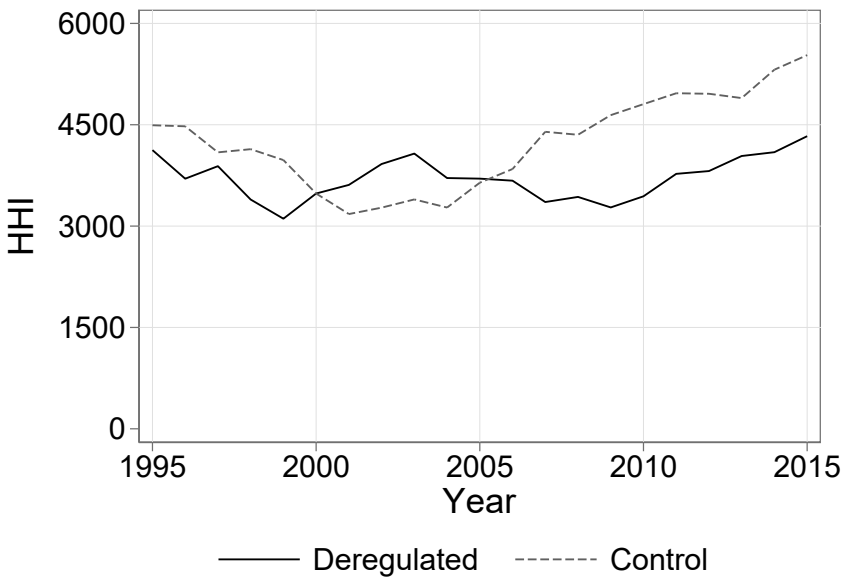
Market Power in Electricity Markets

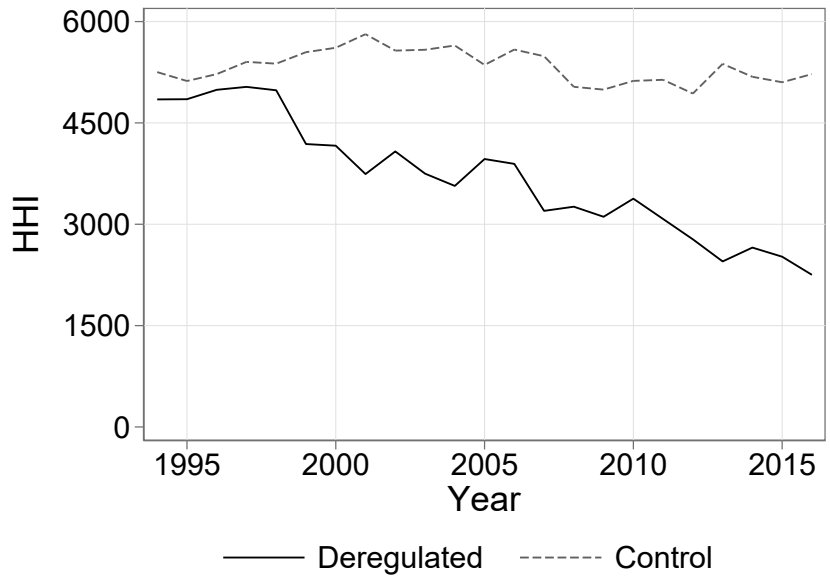
- It is known that electricity markets are prone to market power (Borenstein et al., 2002; Puller, 2007; Hortacsu and Puller, 2008)
  - Inelastic demand and supply yet supply must meet demand at every moment
  - Not storable
  - Transportation governed by laws of physics

- Extreme case: During the crisis in California, no generator had more than 10% of the market yet they were able to charge markups of about 100% (Borenstein et al., 2002, Borenstein 2002)

Upstream and Downstream Concentration

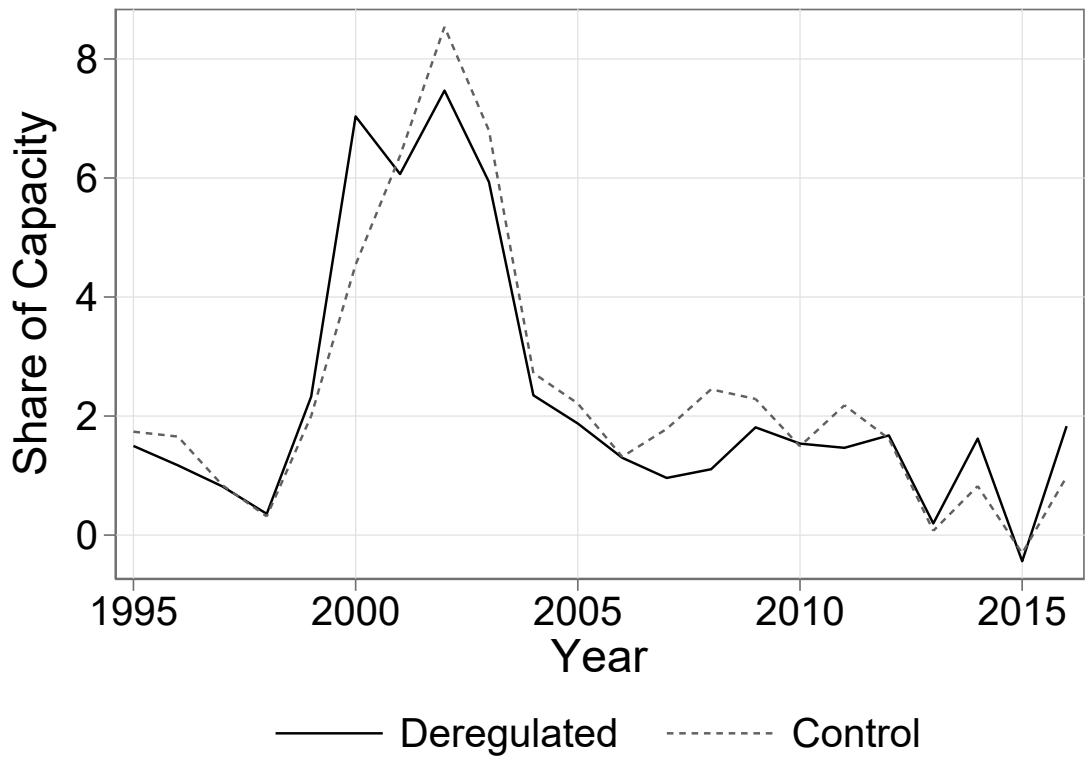


Seller

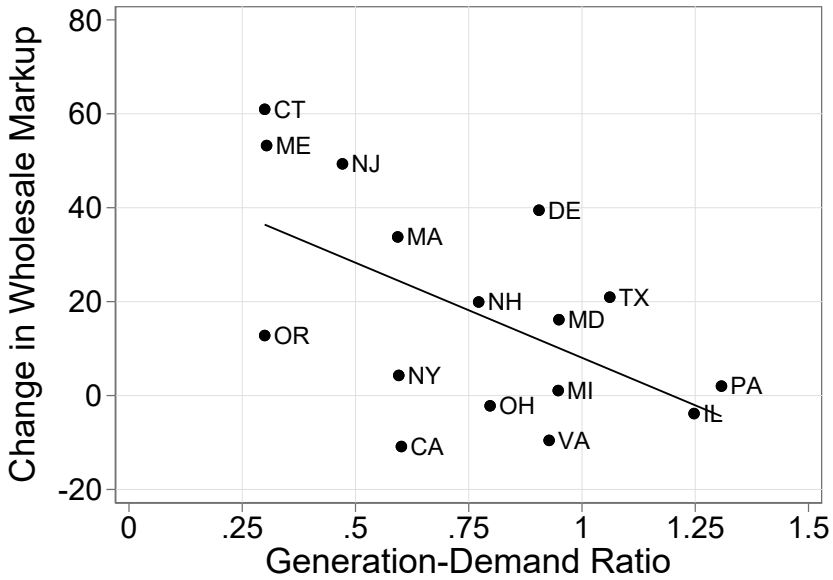


Buyer

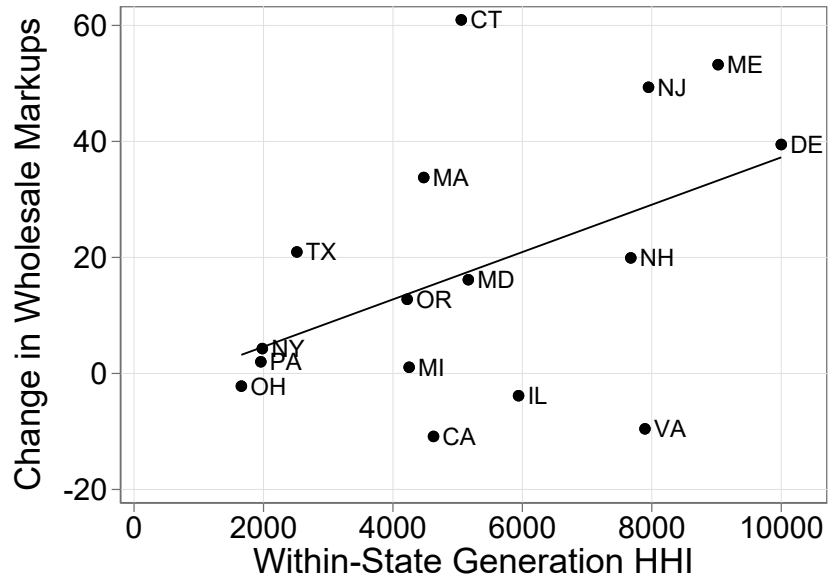
Net Entry of New Capacity



Potential Competition and Markups

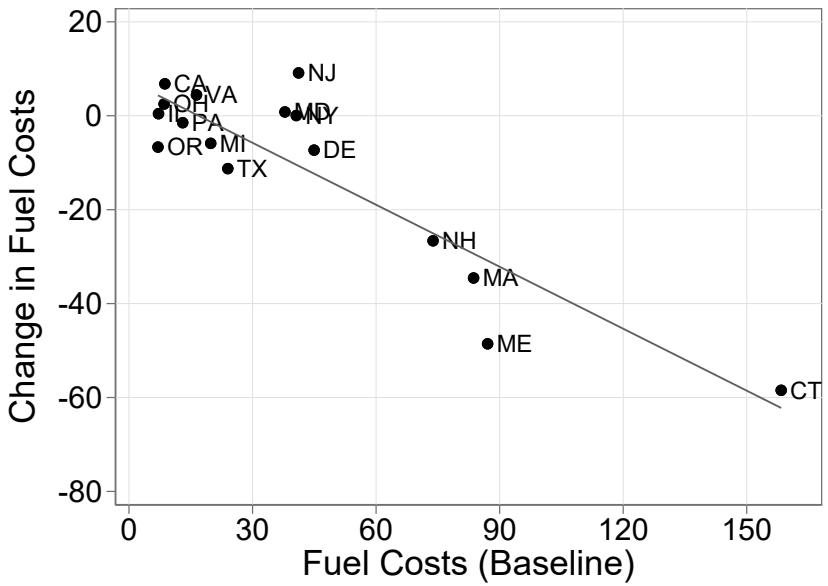


Within-Market Competition

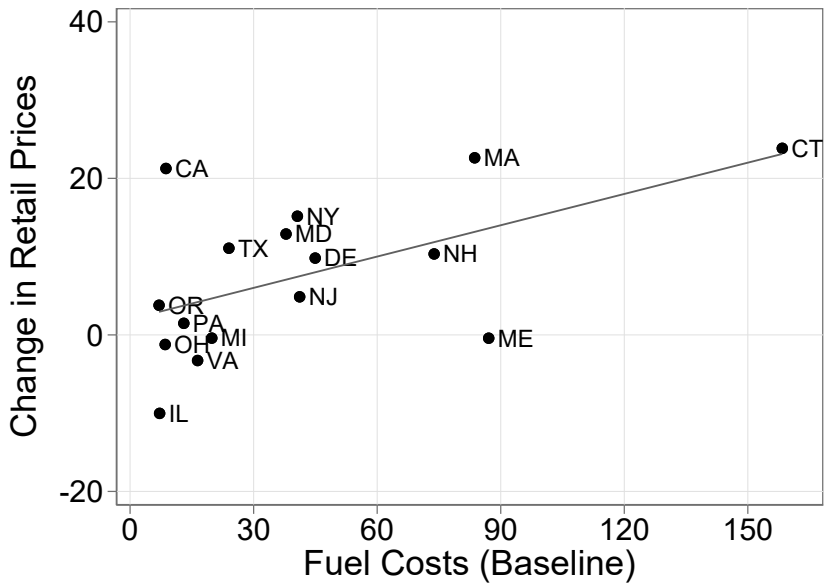


Cross-Market Competition

Changes in Fuel Costs



Fuel Costs



Retail Prices

Markups and Demand Elasticity

	Net Markup		Wholesale Markup	
	(1)	(2)	(3)	(4)
Share Residential 1999	82.61***		44.48**	
	(16.87)		(19.06)	
Share Industrial 1999		-73.85***		-38.89***
		(9.189)		(10.15)
Constant	-11.65	39.94***	-10.93	16.24***
	(7.719)	(6.279)	(8.386)	(6.232)
Year FE	Yes	Yes	Yes	Yes
Observations	743	743	619	619
R^2	0.030	0.078	0.015	0.027

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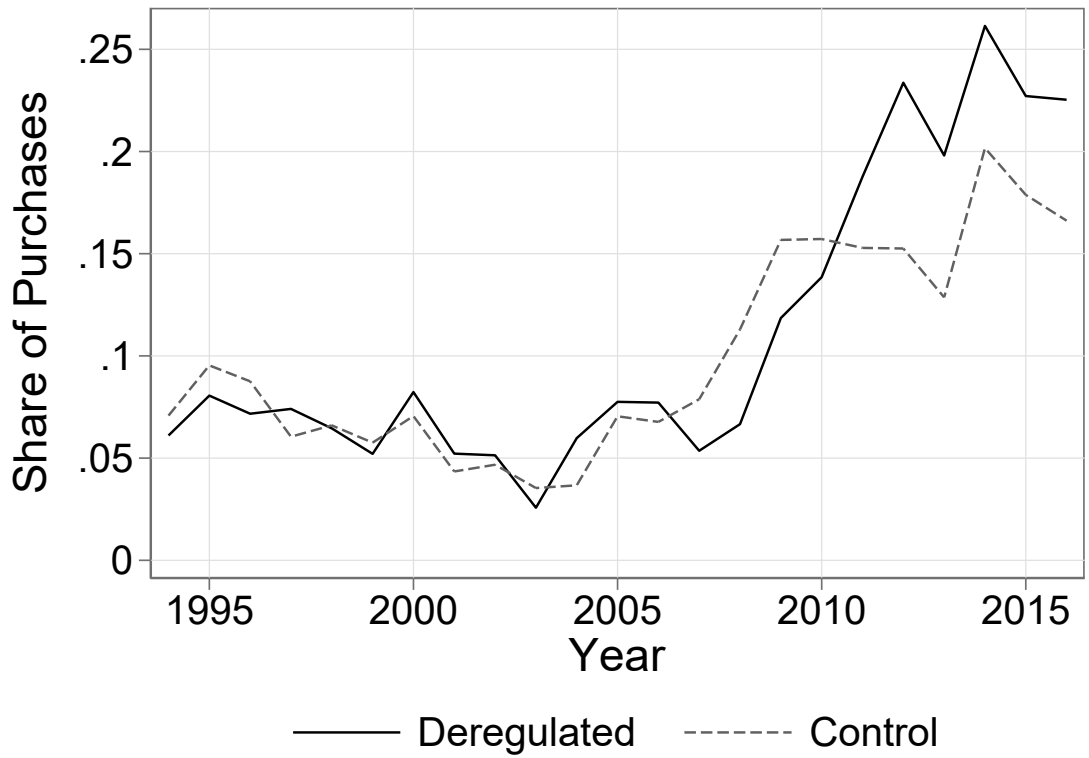
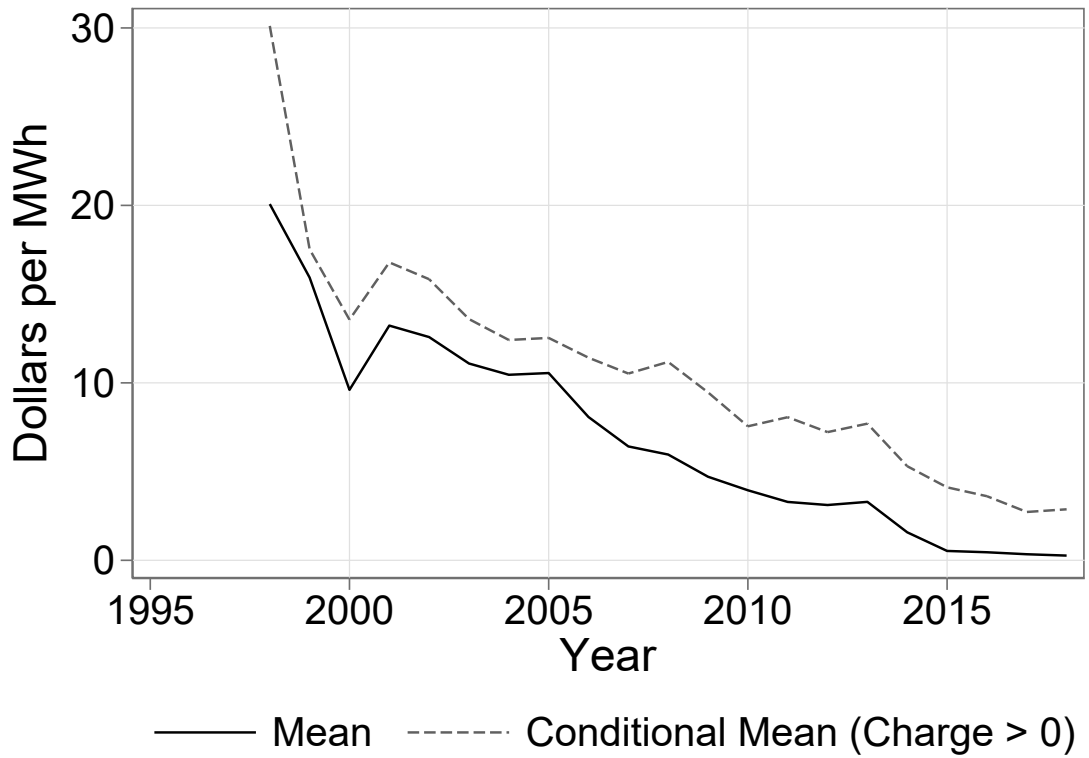
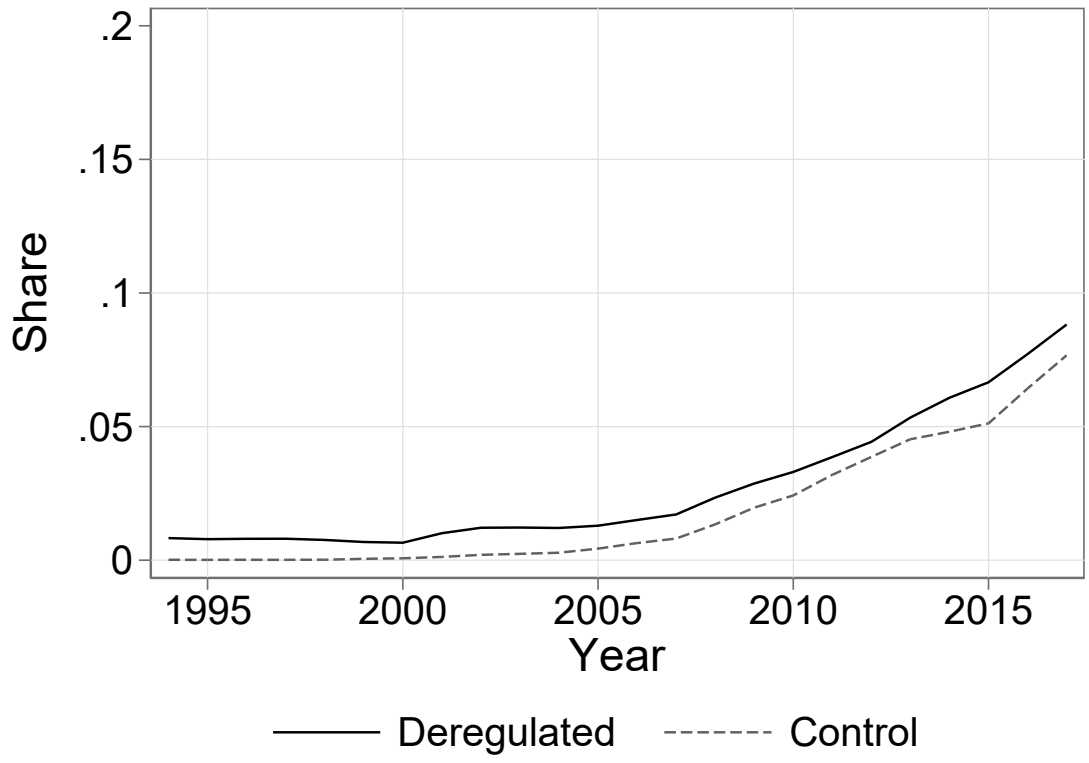
Centralized Spot Markets: ISOs and Power Pools



Transition Charges



Renewable Portfolio Standards (RPS)



Renewables (No Hydro)

Conclusion

After deregulation, higher markups prevented efficiency gains from translating into lower prices for consumers

- This finding highlights the importance of market power in electricity markets
- It calls for further research to investigate its sources and how to best mitigate it
- Regulators may prefer regulated monopoly rates over market-based prices

Deregulation takes time to effectively change market structure

- Intermediate degrees of vertical integration are relevant
- Empirical analysis has to be careful with the timing when analyzing the consequences of deregulation

Thank You

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