Electricity Market Restructuring and Retail Rates.

Presentation by Greg Upton

Kenneth Rose
DePaul University

Brittany Tarufelli
Louisiana State University

Gregory Upton Jr.
Louisiana State University

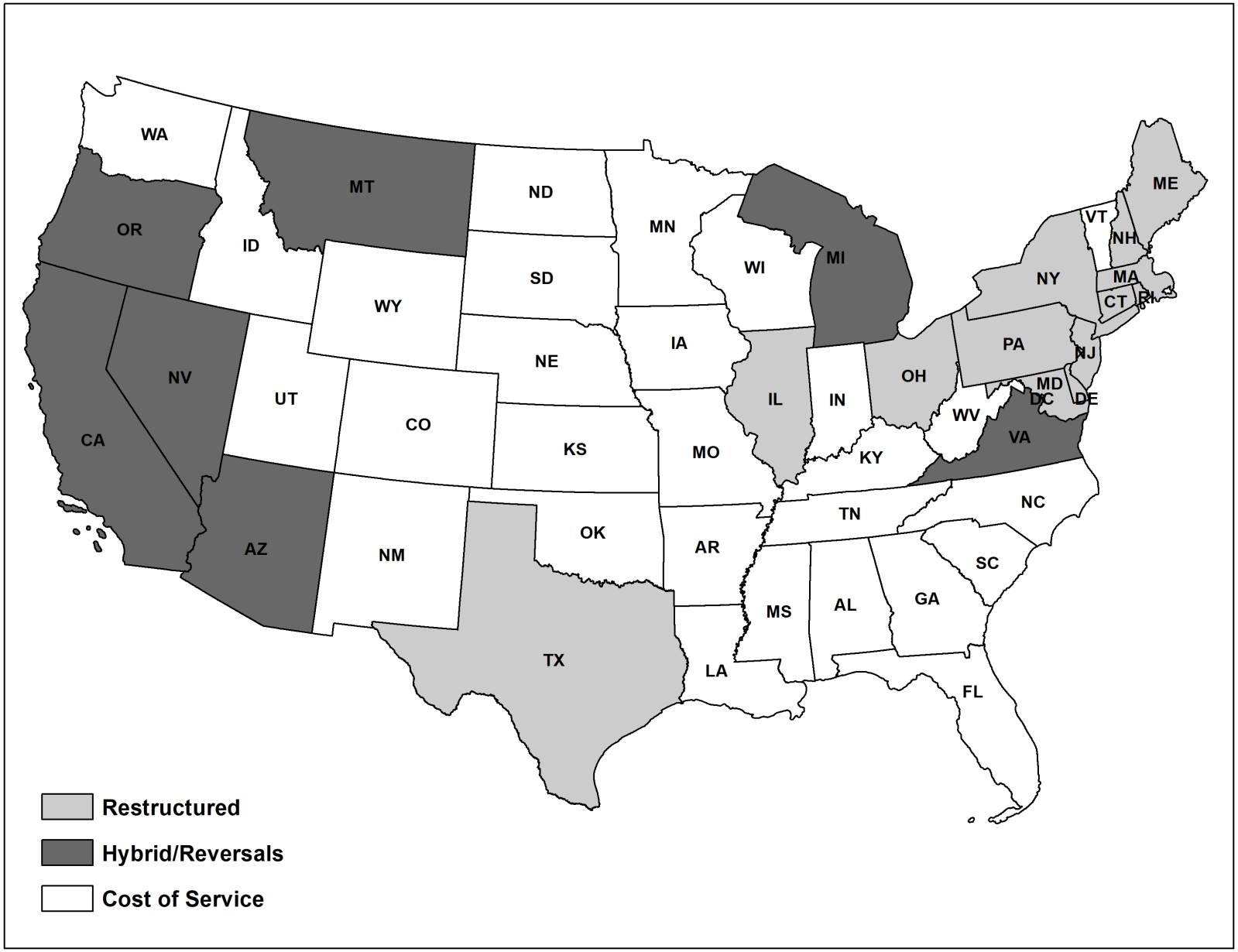
[1]Support provided by Public Sector Consultants (PSC). Lansing MI.

Introduction

- State-regulated investor-owned utilities serve over 70 percent of electricity to final end-use retail consumers in the U.S.
- Prior to the 1990s, all states used a "cost of service (COS)" regulation regime in which investor-owned utilities were allowed to recover prudently incurred costs plus a rate of return on capital expenditures.
- From 1996-2000, some states passed electricity market "restructuring" that, over time, required utilities to separate the generation portion of their operations and allowed customers to purchase power from third party providers. (i.e. "retail choice" or "retail access")
- We investigate the impact of state level electricity market restructuring on retail rates.

Introduction

- Empirical analysis is based on detailed descriptions of each state's restructuring timeline including a transition period and post-full implementation.
  - The median state took seven years for full implementation.
  - Four states took 10+ years.
  - Seven states implemented "hybrid" approaches or reversed restructuring altogether.
- We will construct synthetic control states based on data pre-passage.
  - Synthetic states constructed from: GSP per capita, mining and manufacturing GSP per capita, political party of governor and legislatures, the share of load from industrial and commercial customers, total electricity sales, and the share of generating capacity from natural gas.


WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
FL
SC
NC
VA
PA
NY
MD
DC
DE
NJ
CT
RI
MA
VT
NH
ME
Restructured
Hybrid/Reversals
Cost of Service

Restructuring Dates

Table 1: Preferred Restructuring Definition

State	Passage Date	Restructuring Transition Begins	Full Retail Market Access Begins
CT	1998	2000	2007
DE	1999	1999	2006
DC	2000	2001	2005
IL	1997	1999	2007
ME	1997	2000	2000
MD	1999	2002	2008
MA	1997	1998	2005
NH	1996	2001	2006
NJ	1999	1999	2004
NY	1996	1998	2011
OH	1999	2001	2011
PA	1996	1999	2012
RI	1996	1997	2008
TX	1999	2002	2007

Notes: The treatment year indicates the date at which a competitive retail market was opened for at least some customers. Full Retail market access begins indicates the year in all customers were subject to market pricing. Our preferred definition excludes reversed restructuring states, including AZ and CA, and hybrid restructuring states, including MI, MT, NV, OR, and VA.

Step 1: Establish Revenue Requirement

Historically, utilities rates based on "cost of service."

$$RR_t = Expenses_t + (RateBase_t \times \sigma) \tag{1}$$

Where σ is the company's approved rate of return and $Expenses_t$ are incurred in the year of reimbursement.

$$RateBase_t = (1 - \delta)RateBase_{t-1} + Capex_t \tag{2}$$

Capital expenditures ($Capex_t$) are entered into the rate base in year t and depreciated over time based on the depreciation rate (δ) approved at the time of the capital expenditure.

Step 2: Cost of Service Study

Next, a cost of service study (COSS) is conducted to allocate the burden of the revenue requirements across rate classes; residential, commercial, and industrial.

$$P_{ct} = \frac{\gamma_c RR_t}{kWh_{ct}} \tag{3}$$

Where RR_t is the revenue requirement that the utility seeks to collect and γ_c is the share of the revenue requirement to be collected from each customer class where $\Sigma_c \gamma_c = 1$.

- Rate of Return: $\uparrow \sigma \Rightarrow \uparrow RR$
- Depreciation Rate: $\downarrow \delta \Rightarrow \uparrow RR$
- Customer Class Share: $\Delta \gamma_c \Rightarrow \Delta P_c | RR$

Averch-Johnson Model

(Notation: r is the market cost of capital.)

A-J Conclusion 1: Overcapitalization

- $\sigma < r \Rightarrow$, the firm will exit the market.
- $\sigma > r \Rightarrow$ firm will substitute capital for other factors of production and therefore another allocation of inputs can produce the output at a lower cost. (I.e. firm is not producing at the minimum average cost in the LR.)

A-J Conclusion 2: Cross subsidization

- "multi-market case" in the AJ model.
- A regulated firm will enter into another regulated market, even if the revenues from this market do not offset costs.
- In this case, the A-J model finds that the firm may have an incentive to enter into the other market, even if the cost of doing so exceeds revenues in the long run.
- Should we have universal electricity access?

Literature

Restructuring and Retail Prices

- Joskow (2006), Su (2015), Ros (2017), Hartley et al. (2019), and Swadley & Yucel (2011) find that restructuring led in some instances to decreases in electricity prices for final customers.
- Showalter (2007), Tierney (2007), and Borenstein & Bushnell (2015) all point out that electricity prices actually increased in restructured states relative to COS states after restructuring.
- Papers that consider many states typically face two challenges: (1) restructuring is not randomly assigned and (2) the categorizations/dates of restructuring are complicated.

Cross-Subsidization Across Customer Classes

- Dormady et al. (2019) find that restructuring has shifted the financial burden towards residential customers in Ohio.
- Nagayama (2007) & Erdogdu (2011) consider cross-subsidization but focus on a panel of countries, in lieu of U.S. states as is the focus of this analysis.

Literature

Fuel Cost Pass-Throughs

- Knittel et al (2019) find that electric power producers were more responsive to fuel prices in vertically integrated markets than in restructured markets.
- Ohler, Mohammadi & Loomis (2020) do not support the view that restructuring increased the integration between input costs and electricity prices.
- Hartley, Medlock & Jankovska (2017) find evidence that natural gas fuel prices were passed through to customers more quickly in restructured parts of Texas. Whitworth & Zarnikau (2006) find a similar result for Texas.

Generation Plant Level Efficiency

- Fabrizio et al. 2007; Knittel et al. 2019: no evidence of improvements in thermal efficiency post restructuring.
- Bushnell & Wolfram, 2005; Zhang, 2007; Sharabaroff et al., 2009; Craig & Savage, 2013; Chan et al., 2017; Doyle & Fell, 2018: relatively modest improvements in thermal efficiency.

Literature

Regional Transmission Organizations

- Reduce transmission congestion: Kleit & Reitzes, 2008; Wolak, 2011; Mansur & White, 2012
- Gains from trade: Mansur & White, 2012; Kury, 2015
- Kury (2013) - restructured + RTO leads to price reductions.
- Market power: Borenstein, 2002; Borenstein et al., 2002; Joskow & Kahn, 2002; Wolak, 2003; Bushnell, 2004; Puller, 2007; Bushnell et al., 2008; Hortacsu & Puller, 2008; Mansur, 2008

Endogenous Policy Adoption

- Electricity prices and political influence are predictive of restructuring (Craig, 2016)
- RPS adoption not random (Upton and Snyder, 2015; Fowler and Breen, 2013; Chandler, 2009; Ming-Yuan et al., 2007; Lyon and Yin, 2010).
- Taking this non-random adoption into account has important impacts on empirical results (Upton & Snyder, 2017)

Data

- Panel of 41 states + DC from 1990 to 2019.
- Outcome variables: Prices by class and relative prices between classes.
- Synthetic controls constructed from:
  - number of members of state house and senate by political party, the political party of the governor, gross state product, mining and manufacturing gross state product, the share of industrial and commercial customers and the percent of generation capacity within the state that comes from natural gas
- We consider two mechanisms for any observed price change:
  - Renewable energy generation
  - Passthrough of wholesale rates to retail rates: We use natural gas prices as a proxy.

Empirical Strategy

Event Study

$$P_{st} = \alpha + \Sigma_{\tau=-7}^{17} \sigma_t Rest_{\tau,st} + \gamma_s + \gamma_t + \varepsilon_{st} \quad (4)$$

Standard Difference-in-Differences

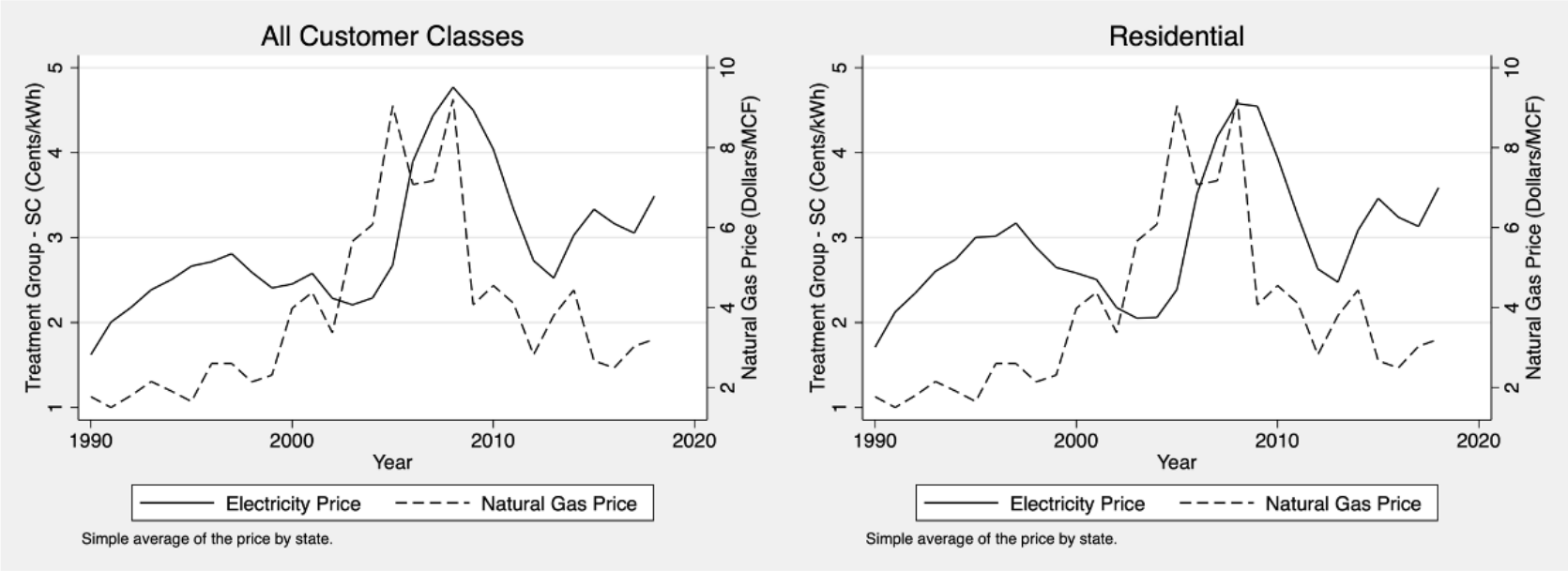
$$P_{st} = \alpha + \delta Rest_{st} + \gamma_s + \gamma_t + \varepsilon_{st} \quad (5)$$

Natural Gas Price Passthrough to Electricity Prices

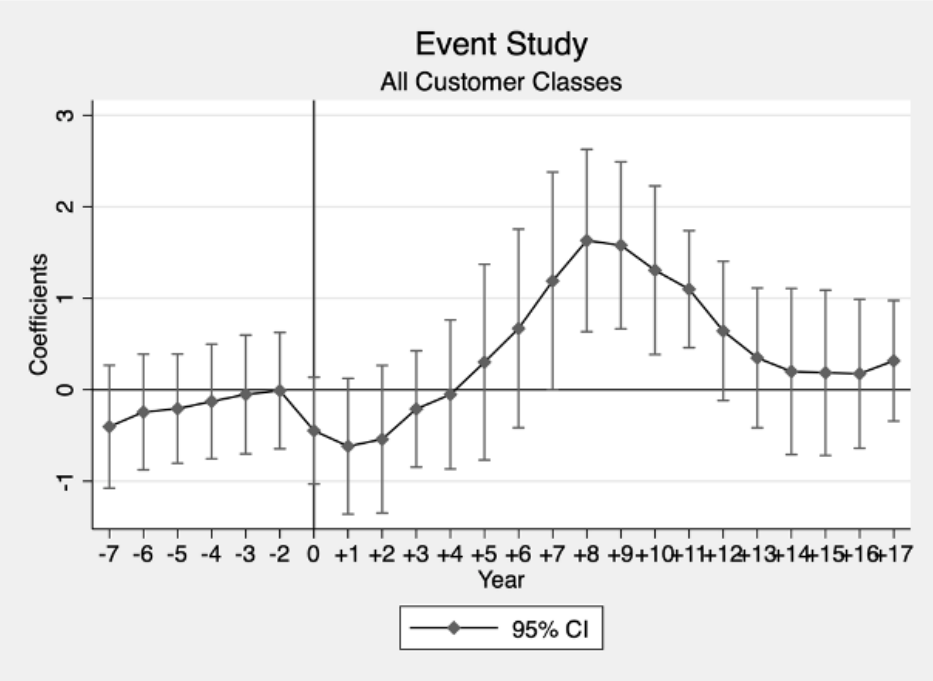
$$P_{st} = \alpha + \delta(Rest_{st} \times NGP_{st}) + \phi((1 - Rest_{st}) \times NGP_{st}) + \gamma_s + \gamma_t + \varepsilon_{st} \quad (6)$$

If $\delta > \phi \Rightarrow$ evidence that restructuring strengthened the contemporaneous relationship between natural gas prices paid by electricity generators and retail prices.

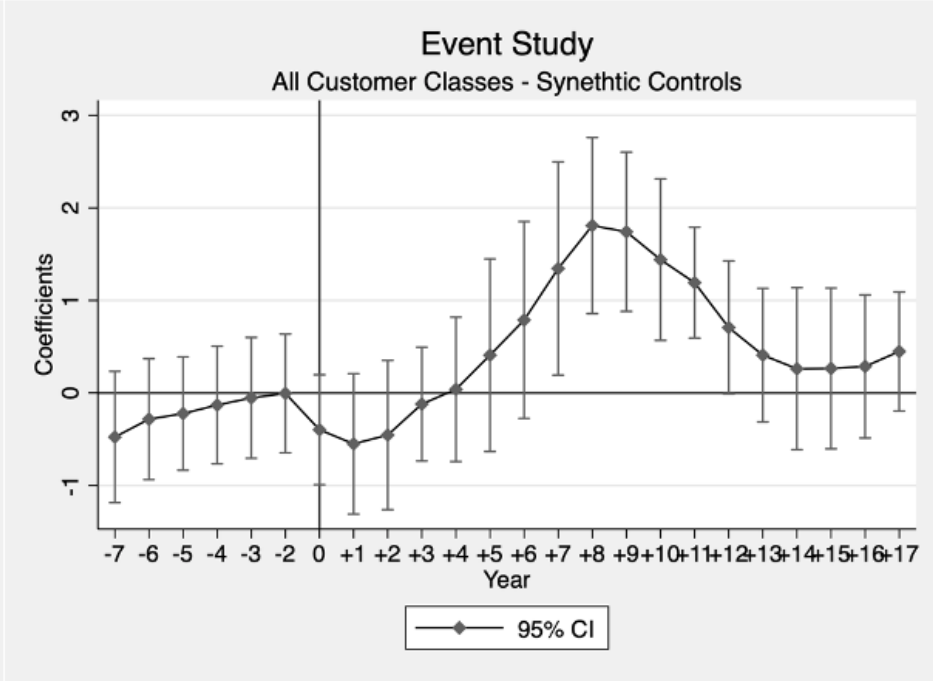
Results


All Customer Classes
Residential
Commercial
Industrial
Treatment Group - SC (Cents/kWh)
Natural Gas Price (Dollars/MCF)
Year
1990
2000
2010
2020
Electricity Price
Natural Gas Price
Simple average of the price by state.

Results



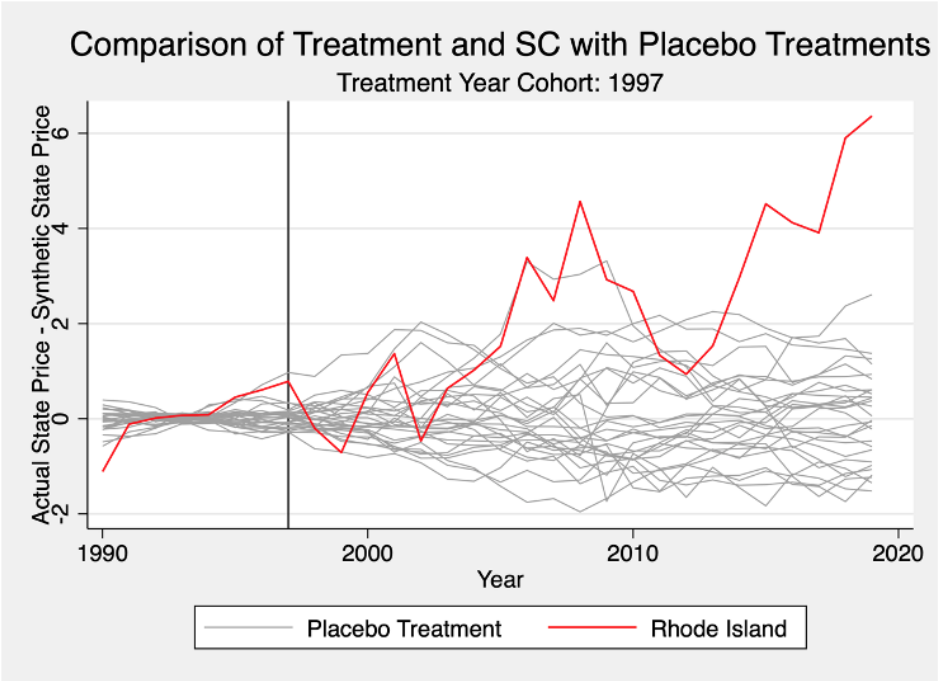
(a) All Controls

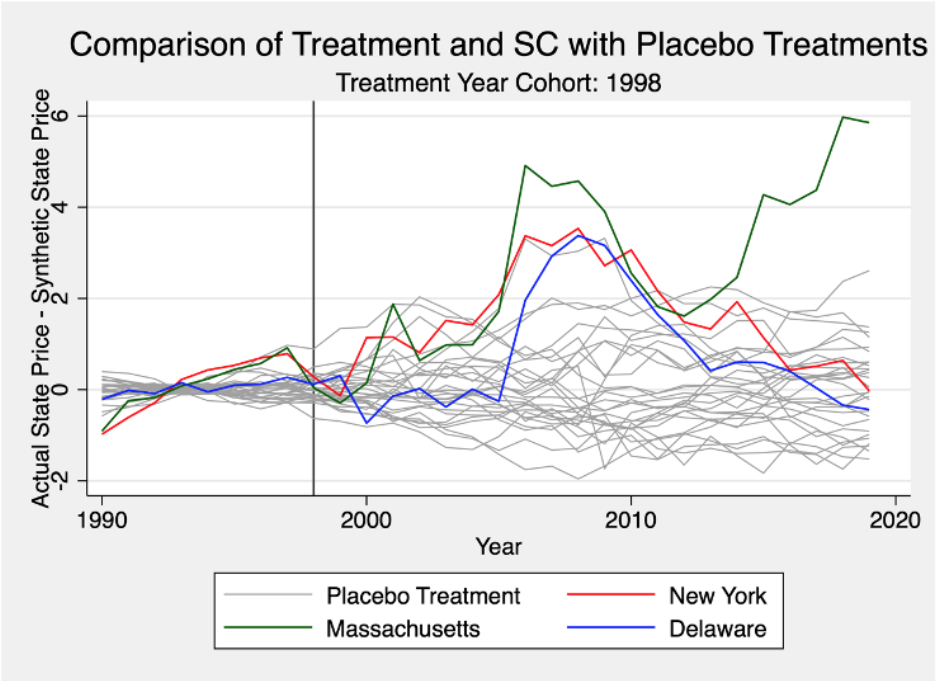


(b) Synthetic Controls

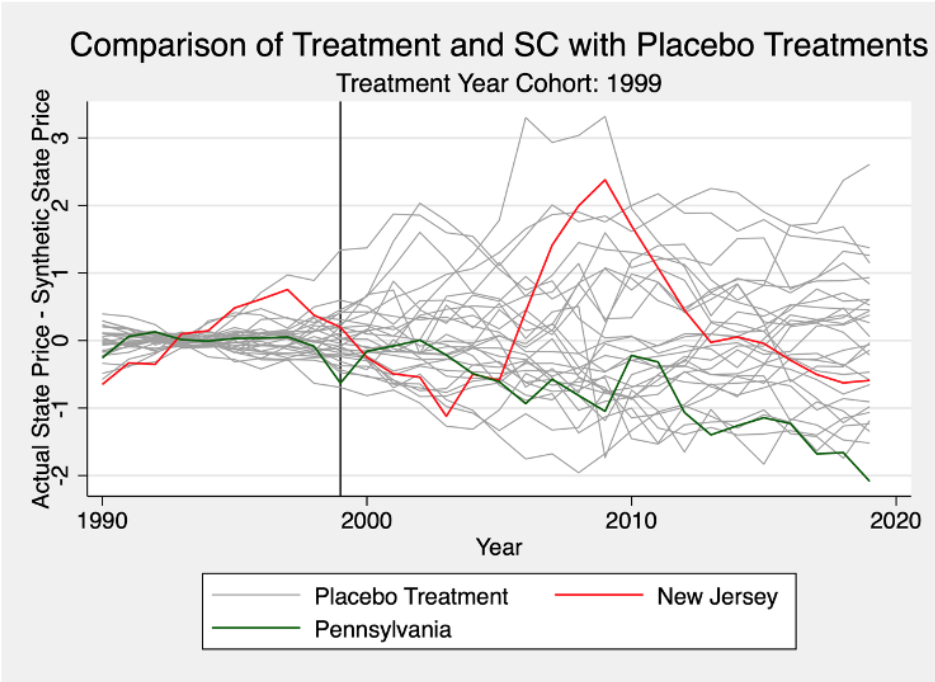
Figure 4: Event Study

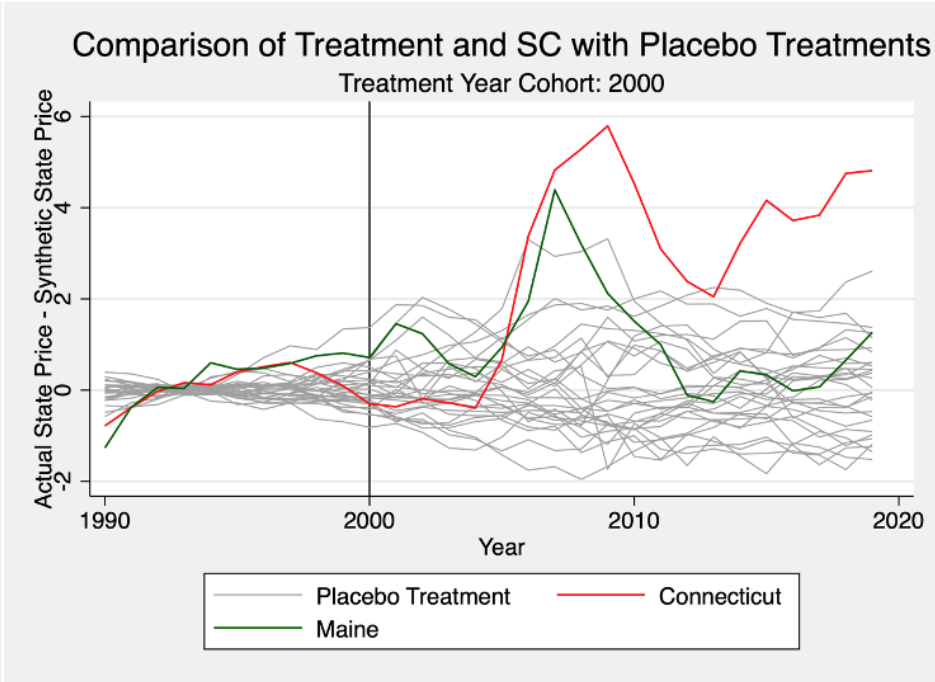
Results


Comparison of Treatment and SC with Placebo Treatments
Treatment Year Cohort: 1997
Actual State Price - Synthetic State Price
-2
0
2
4
6
1990
2000
2010
2020
Year
Placebo Treatment
Rhode Island

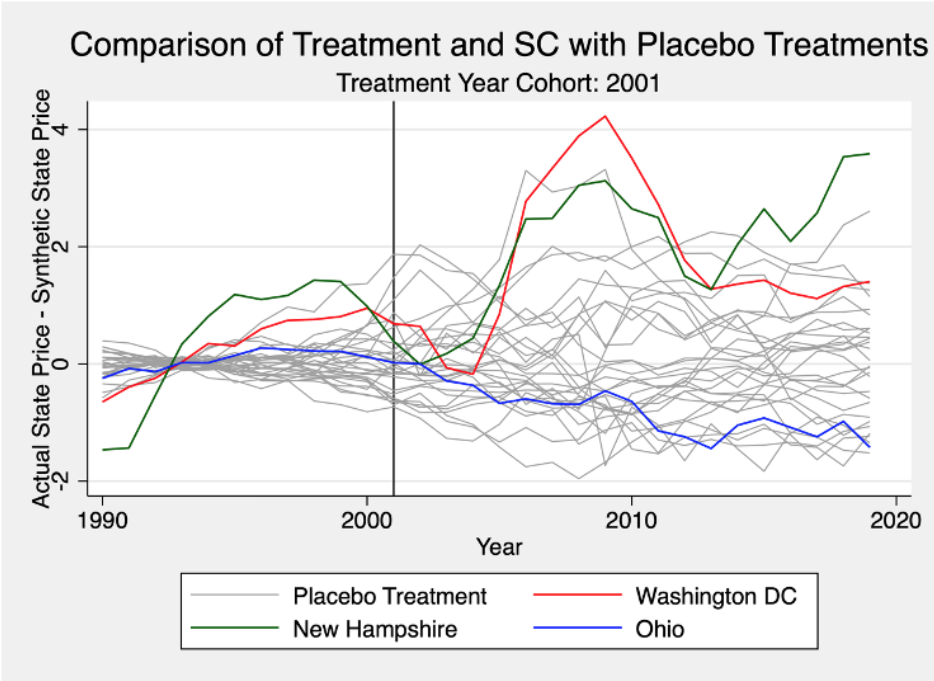

Comparison of Treatment and SC with Placebo Treatments
Treatment Year Cohort: 1998
Actual State Price - Synthetic State Price
-2
0
2
4
6
1990
2000
2010
2020
Year
Placebo Treatment
New York
Massachusetts
Delaware

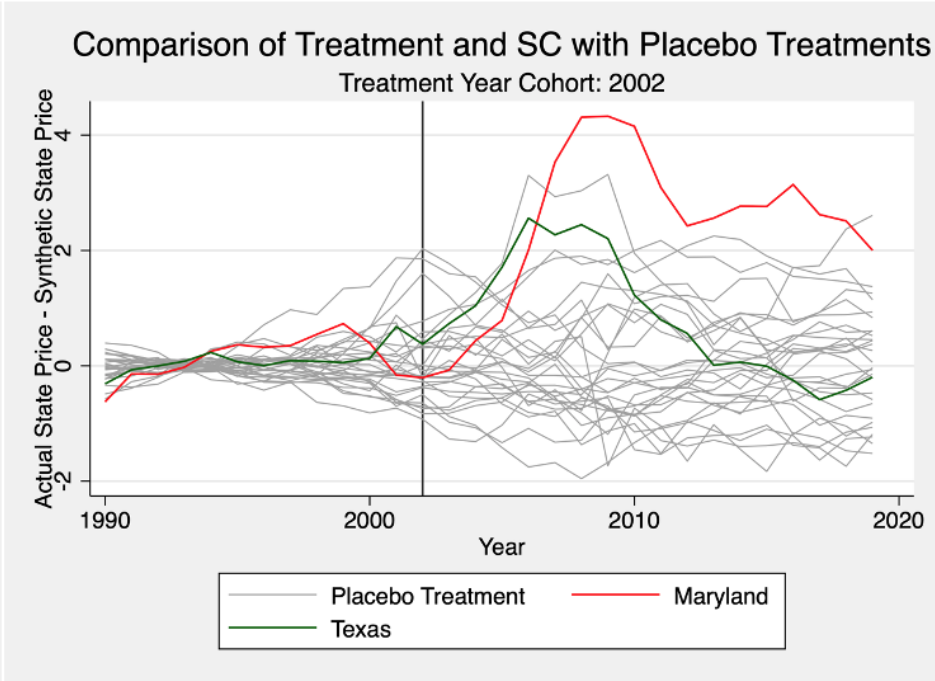
Results


Comparison of Treatment and SC with Placebo Treatments
Treatment Year Cohort: 1999
Actual State Price - Synthetic State Price
-2
-1
0
1
2
3
1990
2000
2010
2020
Year
Placebo Treatment
New Jersey
Pennsylvania


Comparison of Treatment and SC with Placebo Treatments
Treatment Year Cohort: 2000
Actual State Price - Synthetic State Price
-2
0
2
4
6
1990
2000
2010
2020
Year
Placebo Treatment
Connecticut
Maine

Results


Comparison of Treatment and SC with Placebo Treatments
Treatment Year Cohort: 2001
Actual State Price - Synthetic State Price
-2
0
2
4
1990
2000
2010
2020
Year
Placebo Treatment
Washington DC
New Hampshire
Ohio


Comparison of Treatment and SC with Placebo Treatments
Treatment Year Cohort: 2002
Actual State Price - Synthetic State Price
-2
0
2
4
1990
2000
2010
2020
Year
Placebo Treatment
Maryland
Texas

Results

Table 3: Estimated Treatment Effect of Restructuring on Electricity Rates by Customer Class.

	Baseline Control Group				Synthetic Control Group			
	Total	Residential	Commercial	Industrial	Total	Residential	Commercial	Industrial
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: All Post Treatment								
Treatment Effect	0.855***	0.647*	0.538*	0.771***	0.714**	0.483	0.442	0.620**
	(0.295)	(0.338)	(0.313)	(0.262)	(0.299)	(0.352)	(0.327)	(0.256)
Panel B: Transition and Full Implementation								
Treatment Effect x Transition	0.185	-0.189	0.202	0.262	0.119	-0.228	0.136	0.106
	(0.220)	(0.258)	(0.233)	(0.180)	(0.213)	(0.263)	(0.244)	(0.180)
Treatment Effect x Full Implementaton	1.264***	1.158**	0.744*	1.082***	1.124**	0.974**	0.653	0.975**
	(0.410)	(0.448)	(0.439)	(0.390)	(0.415)	(0.467)	(0.448)	(0.381)
Observations	1,260	1,260	1,260	1,260	840	840	840	840

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Standard errors clustered at state level. State and year fixed effects include in all regressions. Electricity prices in cents per kWh of electricity. Baseline differences-in-differences specification uses non-restructured states as control group. Synthetic control specification utilizes synthetic states as controls.

Results

Table 4: Estimated Effect of Restructuring on Relative Rates Between Customer Classes

	Baseline Control Group		Synthetic Control Group	
	$\log\left(\frac{Industrial}{Residential}\right)$	$\log\left(\frac{Commercial}{Residential}\right)$	$\log\left(\frac{Industrial}{Residential}\right)$	$\log\left(\frac{Commercial}{Residential}\right)$
	(1)	(2)	(3)	(4)
Panel A: All Post Treatment				
Treatment Effect	0.036	0.015	0.011	0.005
	(0.023)	(0.013)	(0.009)	(0.008)
Panel B: Transition and Full Implementation				
Treatment Effect x Transition	0.063**	0.049***	0.015	0.019**
	(0.024)	(0.016)	(0.010)	(0.009)
Treatment Effect x Full Implementaton	0.020	-0.006	0.008	-0.005
	(0.029)	(0.016)	(0.010)	(0.009)
Observations	1,260	1,260	840	840

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Standard errors clustered at state level. State and year fixed effects include in all regressions. Electricity prices in cents per kWh of electricity. Baseline differences-in-differences specification uses non-restructured states as control group. Synthetic control specification utilizes synthetic states as controls.

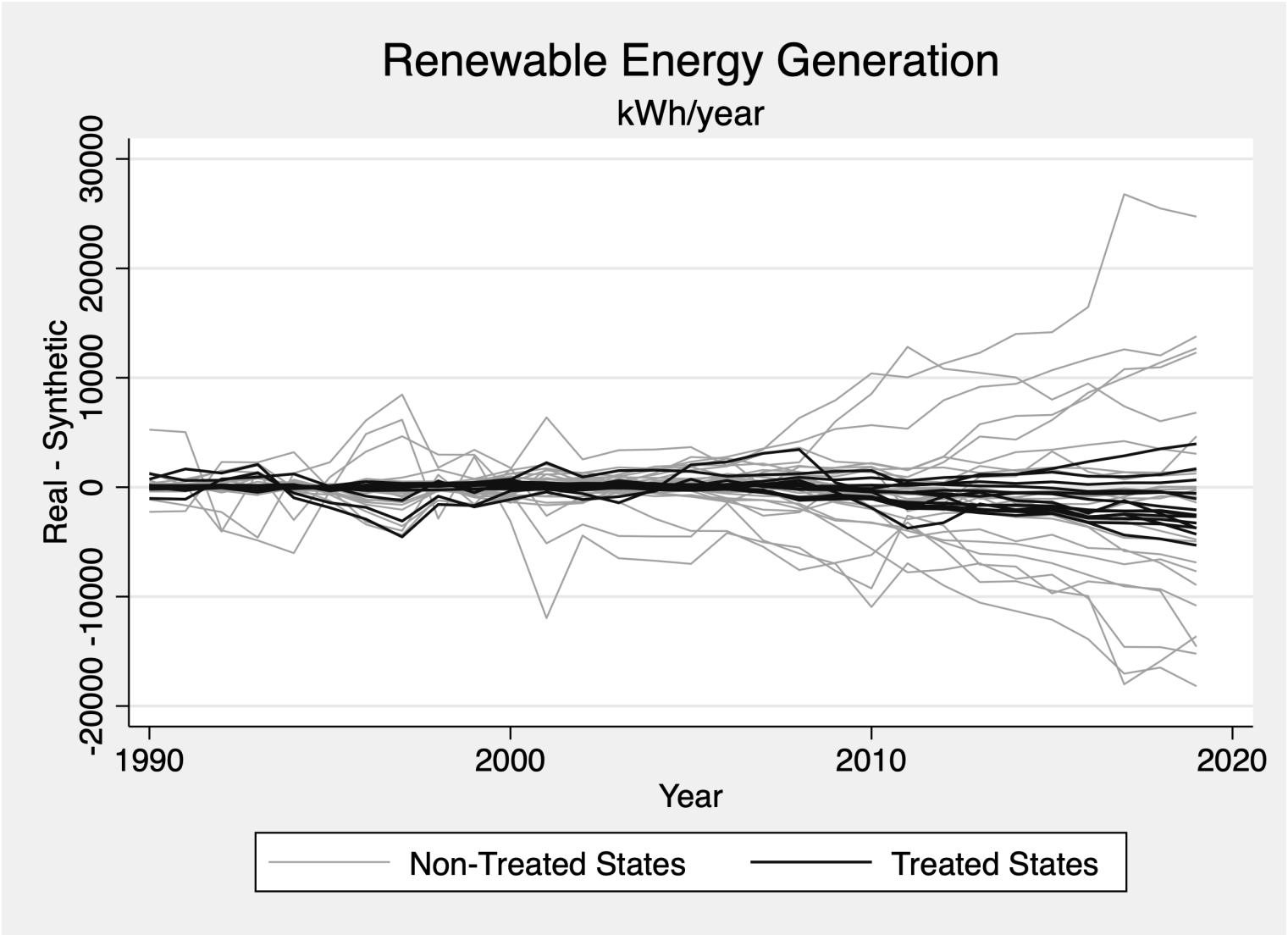
Results

Table 5: Estimated Impact of Restructuring on Renewable Energy Generation

	Baseline		Synthetic Control	
	All Post-Transition Beginning	Transition and Full Implementation	All Post-Transition Beginning	Transition and Full Implementation
	(1)	(2)	(3)	(4)
Panel A: Baseline Difference in Differences				
Treatment Effect	-742.7	362.7	-344.6	165.0
	(604.7)	(300.8)	(243.3)	(160.8)
Treatment Effect x Full Implementation		-1417.8		-696.6**
		(850.0)		(318.5)
Observations	1,260	1,260	840	840

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Standard errors clustered at state level. State and year fixed effects include in all regressions. RE/Pop is renewable energy generation per 1,000 people. Baseline differences-in-differences specification uses non-restructured states as control group. Synthetic control specification utilizes synthetic states as controls.

Results


Renewable Energy Generation
kWh/year
Real - Synthetic
-20000
-10000
0
10000
20000
30000
1990
2000
2010
2020
Year
Non-Treated States
Treated States

Results

Table 6: Restructuring and Sensitivity to Natural Gas Prices

	Total		Residential		Commercial		Industrial	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: All Post Treatment								
Treatment x NG Price (δ)	0.182***	0.184***	0.123	0.129**	0.204***	0.205***	0.219***	0.212***
	(0.044)	(0.061)	(0.078)	(0.062)	(0.054)	(0.058)	(0.049)	(0.053)
(1 - Treatment) x NG Price (φ)	0.045	0.048	0.053	0.056	0.034	0.037	0.034	0.037
	(0.044)	(0.042)	(0.061)	(0.058)	(0.047)	(0.062)	(0.035)	(0.049)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
$\delta - \varphi$	0.137***	0.136***	0.071	0.073*	0.169***	0.169***	0.185***	0.175***
	(0.043)	(0.047)	(0.045)	(0.40)	(0.036)	(0.042)	(0.045)	(0.043)
Panel B: Transition and Full Implementation								
Transition x NG Price ($\delta 1$)	0.115**	0.123**	0.043	0.054	0.162***	0.166*	0.166**	0.161**
	(0.054)	(0.058)	(0.080)	(0.071)	(0.061)	(0.085)	(0.065)	(0.073)
Full Implementaton x NG Price ($\delta 2$)	0.315***	0.306***	0.282***	0.279***	0.287***	0.284***	0.326***	0.314***
	(0.052)	(0.069)	(0.069)	(0.077)	(0.064)	(0.080)	(0.041)	(0.052)
(1 - Treatment) x NG Price (φ)	0.063*	0.064	0.075	0.076	0.046	0.047	0.049	0.051
	(0.034)	(0.051)	(0.054)	(0.068)	(0.046)	(0.070)	(0.034)	(0.038)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
$\delta_1 - \varphi$	0.051	0.059	-0.031	-0.022	0.116**	0.119**	0.117*	0.111
	(0.057)	(0.050)	(0.055)	(0.063)	(0.048)	(0.056)	(0.067)	(0.070)
$\delta_2 - \varphi$	0.252***	0.243***	0.207***	0.203***	0.241***	0.237***	0.277***	0.263***
	(0.056)	(0.066)	(0.061)	(0.071)	(0.061)	(0.057)	(0.049)	0.051
Observations	1,104	1,104	1,104	1,104	1,104	1,104	1,104	1,104

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Standard errors clustered at state level. State and year fixed effects include in all regressions. Electricity prices in cents per kWh of electricity. Natural gas prices paid by electric power producers.

Conclusions

- We find that rates increased in restructured states relative to plausible counterfactuals in the years post-restructuring.
  - But by twelve years after restructuring, we no longer observe any difference.
- We do not find evidence that restructuring has impacted relative rates between customer classes after full implementation.
- We investigate plausible mechanisms, finding evidence that retail prices became more responsive to natural gas price due to restructuring which timing coincided with increases in natural gas prices nationally.

The End

Thank You!