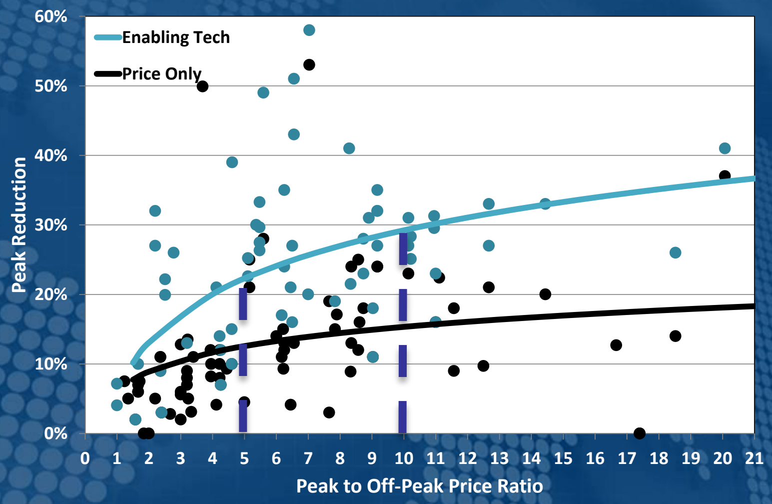
The Brattle Group

Consistency of Results in Dynamic Pricing Experiments – Toward a Meta Analysis



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Agenda

1. **The Issue**
2. **Defining “Consistency”**
3. **Dynamic Pricing Experiments**
4. **Determining the Consistency of Results**
5. **Conclusion**

The Issue

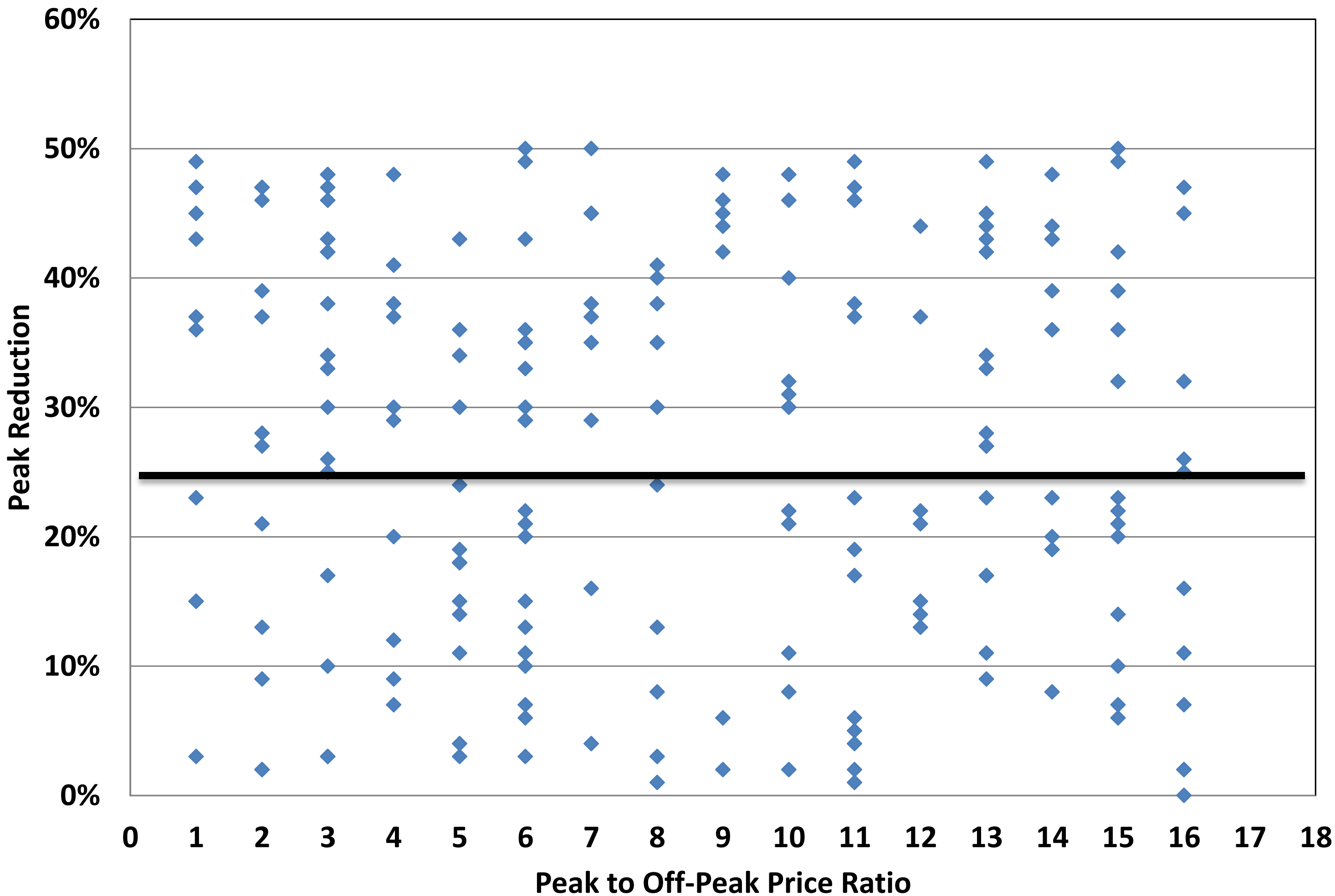
It is important to examine the results of dynamic pricing experiments for consistency

A full-blown test of consistency will require the analyst to normalize for differences in experimental design, in particular for the selection of participants

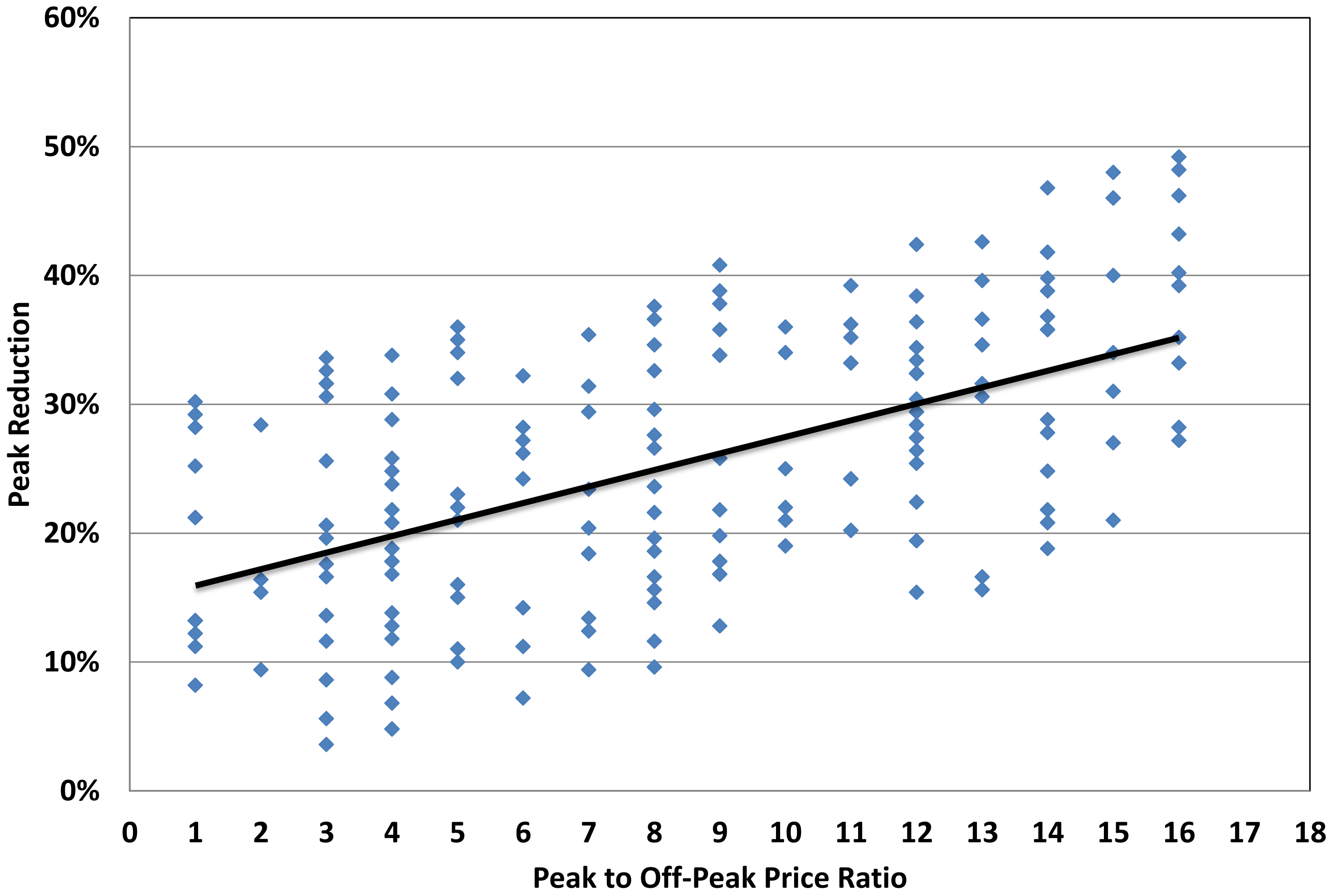
This would require that primary data on individual customers be collected across all the experiments, allowing the execution of a full blown meta analysis

In this presentation, we present some initial findings on consistency using the aggregate results from 31 dynamic pricing experiments, as a first step toward a meta analysis

If there was no consistency in results, we would get this type of random display



If there was consistency, we would see something like this



To test the hypothesis of consistency, we rely on results from 31 experiments (containing 144 treatments) spanning 7 countries in 4 continents

No.	Experiment	Location	Year	Rates	Enabling Technologies	Number of Treatments
1	Ameren Missouri	Missouri	2004, 2005	CPP	CPP w/Tech	4
2	Anaheim CPP Experiment	California	2005	CPP	Not tested	1
3	Automated Demand Response System (ADRS)	California	2004, 2005	TOU, CPP	TOU w/ Tech, VPP w/ tech	4
4	Baltimore Gas & Electric (BGE)	Maryland	2008, 2009, 2010	CPP, PTR	CPP w/ Tech, PTR w/ Tech	17
5	BC Hydro	Ontario, Canada	2008	TOU, CPP	Not tested	8
6	California Statewide Pricing Pilot (SPP--Pacific Gas & Electric, San Diego Gas & Electric, Southern California Edison)	California	2003, 2004	TOU, CPP	CPP w/ Tech	4
7	Commonwealth Edison (ComEd)	Illinois	2010	TOU, CPP, PTR	Not tested	3
8	Connecticut Light & Power (CL&P)	Connecticut	2009	TOU, CPP, PTR	TOU w/ Tech, CPP w/ Tech, PTR w/ Tech	18
9	Consumers Energy	Michigan	2010	CPP, PTR	CPP w/ Tech	3
10	Country Energy	Australia	2005	CPP	CPP w/ Tech	1
11	GPU	New Jersey	1997	TOU	TOU w/ Tech	2
12	Gulf Power	Florida	2000	CPP	CPP w/ Tech	1
13	Hydro Ottawa	Canada	2006	TOU, CPP, PTR	Not tested	6
14	Idaho Power	Idaho	2006	TOU, CPP	Not tested	2
15	Integral Energy	Australia	2007, 2008	CPP	CPP w/ Tech	2

The 31 experiments (concluded)

No.	Experiment	Location	Year	Rates	Enabling Technologies	Number of Treatments
16	Irish Utilities[1]	Ireland	2010	TOU	TOU w/ Tech	16
17	Istad Nett AS	Norway	2006	TOU	Not tested	1
18	Mercury Energy	New Zealand	2008	TOU	Not tested	3
19	Newmarket Hydro	Ontario, Canada	2007	CPP	CPP w/ Tech	1
20	Newmarket Tay Power Distribution	Ontario, Canada	2009	TOU	Not tested	1
21	Oklahoma Gas & Electric (OG&E)	Oklahoma	2010	TOU, VPP	TOU w/ Tech, VPP w/ Tech	14
22	Olympic Peninsula Project	Washington	2007	CPP	CPP w/ Tech	1
23	Pacific Gas & Electric (PG&E) (Full scale rollout)	California	2009, 2010	TOU, CPP	Not tested	4
24	Pepco DC	District of Columbia	2008, 2009	CPP, PTR	CPP w/ Tech, PTR w/ Tech	4
25	Public Service Electric and Gas Company (PSE&G)	New Jersey	2006, 2007	TOU, CPP	TOU w/ Tech, CPP w/ Tech	8
26	Pudget Sound Energy	Washington	2001	TOU	Not tested	1
27	Sacramento Municipal Utility District (SMUD)	California	2011	CPP	CPP w/ Tech	2
28	Salt River Project	Arizona	2008, 2009	TOU	Not tested	2
29	San Diego Gas & Electric (SDG&E)	California	2011	PTR	PTR w/ Tech	2
30	Sioux Valley Energy (SVE)	South Dakota	2011	CPP	Not tested	4
31	Smart Community Pilot Project in Kitakyushu	Japan	2012	VPP	Not tested	4
					Total	**144**

1. Run by the Commission for Energy Regulation (CER)

Types of experimental treatments

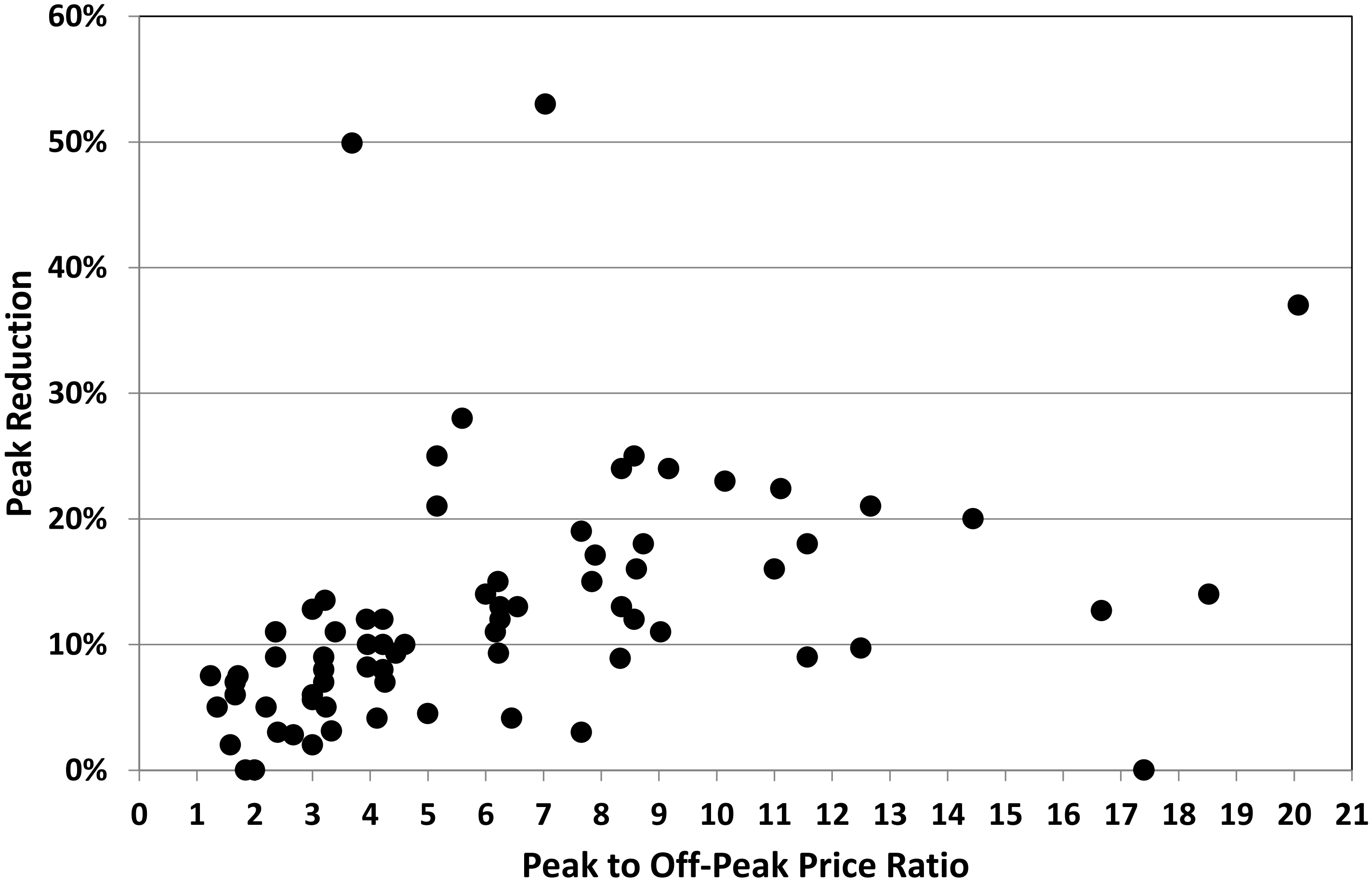
Pricing-only experimental treatments

- Time-Of-Use (TOU)
- Critical Peak Pricing (CPP)
- Peak Time Rebate (PTR)
- Variable Peak Pricing (VPP)

Price + Enabling Tech experimental treatments

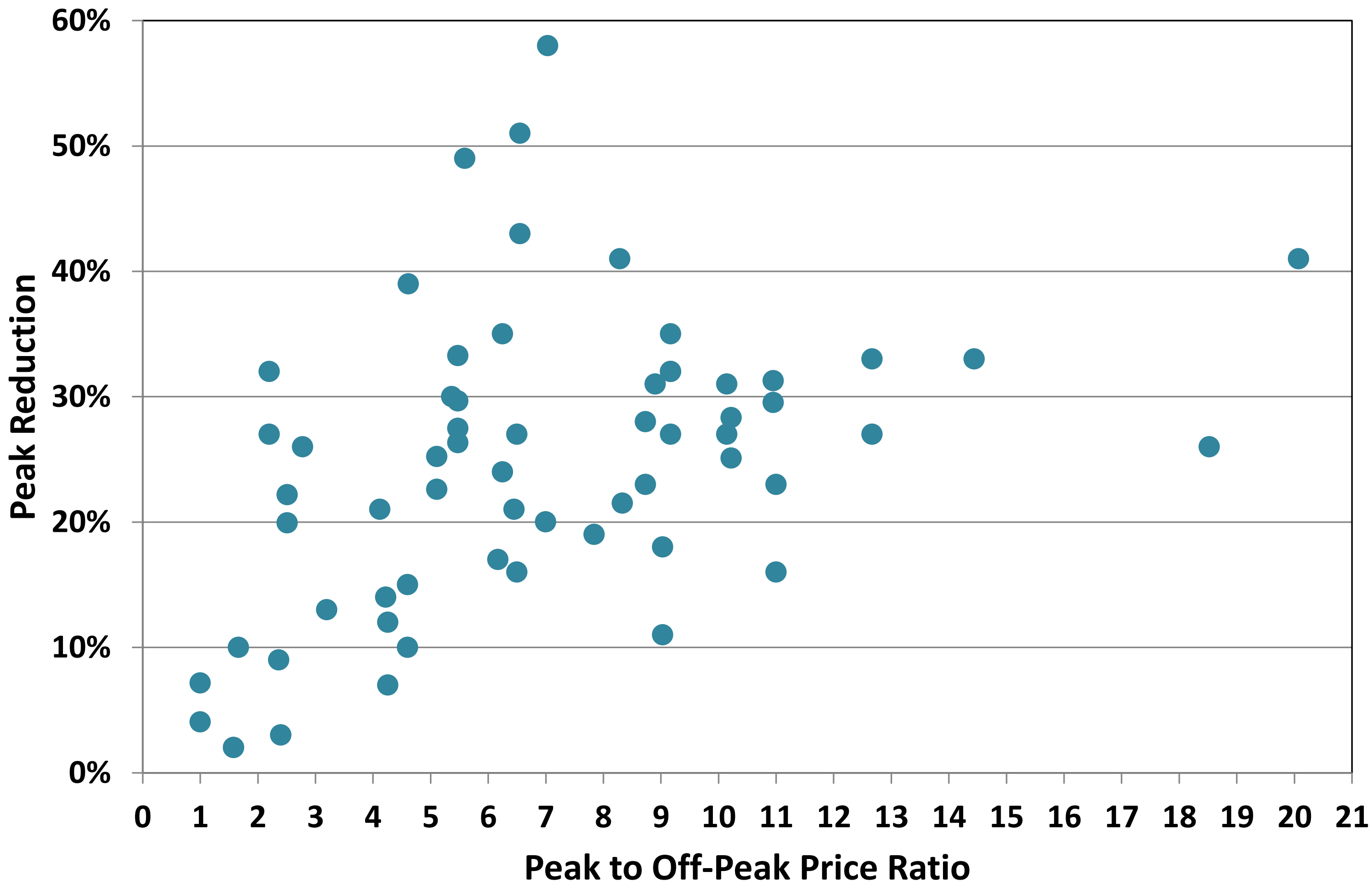
- Enabling technologies such as programmable thermostats and in-home displays (IHDs) can be offered with dynamic rates

The 79 price-only treatments fall into a tight pattern



Note: Data points from Japan and PSE&G are omitted because of extremely high price ratios

The 65 treatments involving price and enabling technologies have a more diffuse pattern



Note: One data point from PSE&G is omitted because of its extremely high price ratio

We estimate the following regression model

Coefficient	Regression
Ln(Price Ratio)	0.0401 ***
	(0.0118)
Ln(Ratio_EnablingTech)	0.0603 ***
	(0.0086)
Intercept	0.0612
	(0.0205)
Adjusted R-Squared	0.3806
F-Statistic	44.94
Observations	144

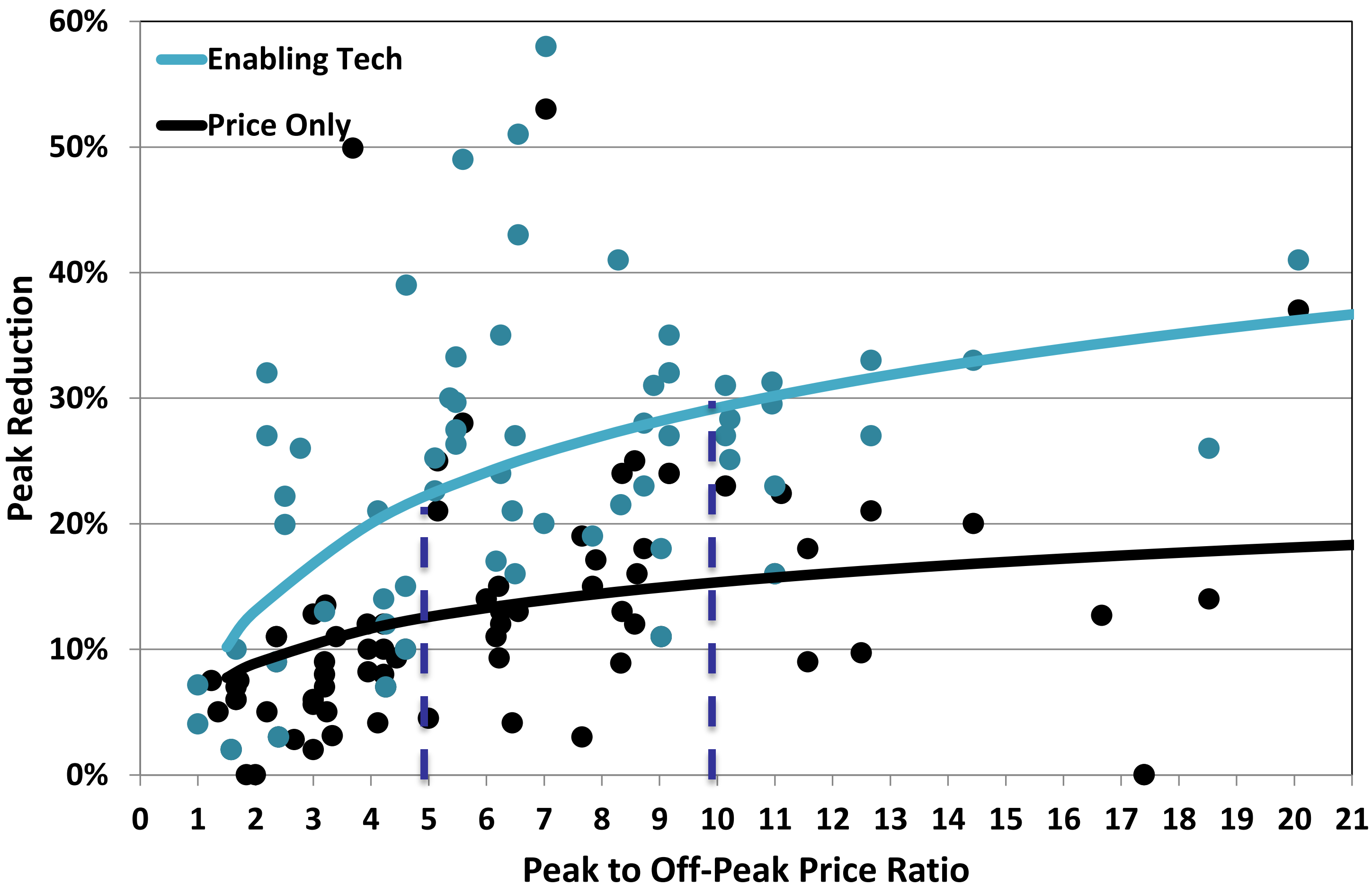
Standard errors are shown in parentheses below the estimates

*** p <= 0.001

** p <= 0.01

* p <= 0.05

The analysis yields two "arcs of price responsiveness"



The arcs can be used to make simple predictions

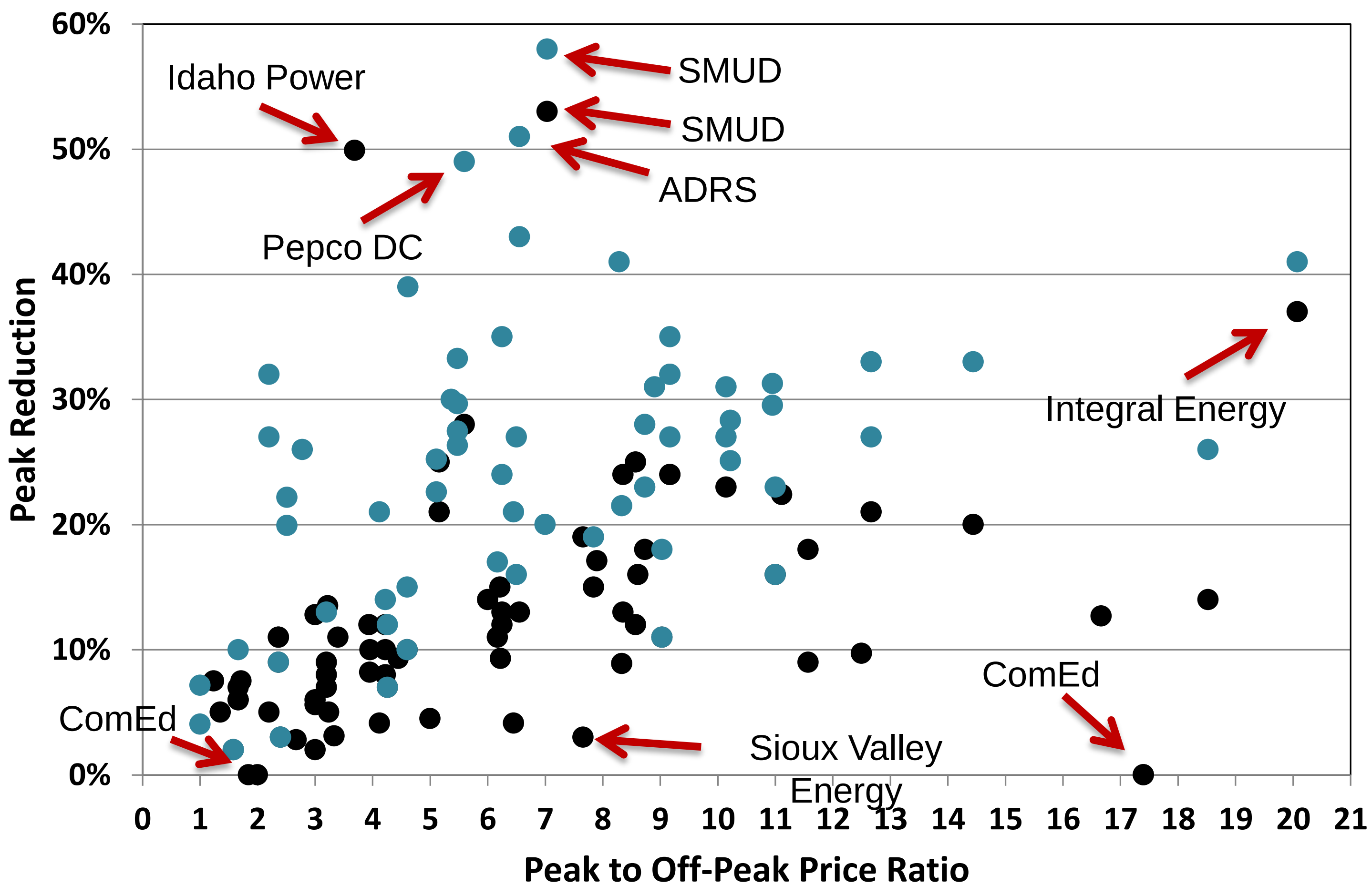
Peak to Off-Peak Price Ratio = 5

- Pricing-Only: ~12.6% peak reduction
- Pricing + Tech: ~22.3% peak reduction

Peak to Off-Peak Price Ratio = 10

- Pricing-Only: ~15.3% peak reduction
- Pricing + Tech: ~29.2% peak reduction

Of the 31 experiments, seven yield outliers that warrant further research



Note: Experiments with extremely high impacts (~50% for pricing+tech and >~40% for pricing-only) or extremely low impacts (~0%) are categorized as outliers

Conclusions

The amount of demand response increases as the peak to off-peak price ratio increases but at a diminishing rate

- Enabling technologies boost price responsiveness even more

There are many drivers of demand response besides the price ratio

- Length of peak period
- Number of pricing periods
- Climate and appliance ownership
- How the rate was marketed to customers
- How customers were selected into the experiment

Because we were unable to control for these factors in this initial analysis, there are some outliers along the arc of price responsiveness

Even then, the surprising amount of consistency in the results shows that utilities and policymakers can be confident in successfully achieving load reductions from dynamic pricing programs

References

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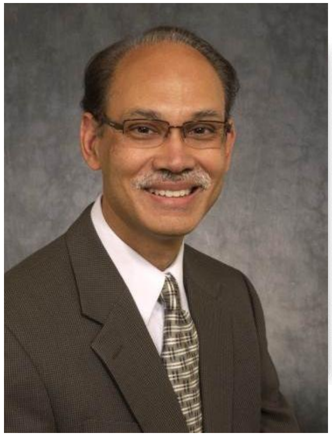
Speaker Bio and Contact Information



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Dr. Faruqui has developed hourly, daily and monthly demand models to estimate the impact of dynamic pricing in pilot and full-scale modes of operation. He has managed the design and evaluation of large-scale dynamic pricing experiments in California, Connecticut, Florida, Illinois, Maryland and Michigan.

He has been working on rate design issues since the beginning of his career and his early work summarizing the results of 14 time-of-use pricing pilots is cited in Professor Bonbright's text on public utility rates.

His research on pricing issues has been cited in publications such as The Economist, The New York Times, and USA Today and he has appeared on Fox News and National Public Radio.

The author, co-author or editor of four books and more than 150 articles, papers and reports on efficient energy use, he holds a Ph.D. in economics and an M.A. in agricultural economics from The University of California at Davis, and B.A. and M.A. degrees from the University of Karachi.