

Flicking the Switch: Retail Demand-Side Response under Alternative Electricity Pricing Contracts

Tihomir Ancev
University of Sydney

Rimvydas Baltaduonis
Gettysburg College/University of Sydney

Tim Capon
University of Sydney

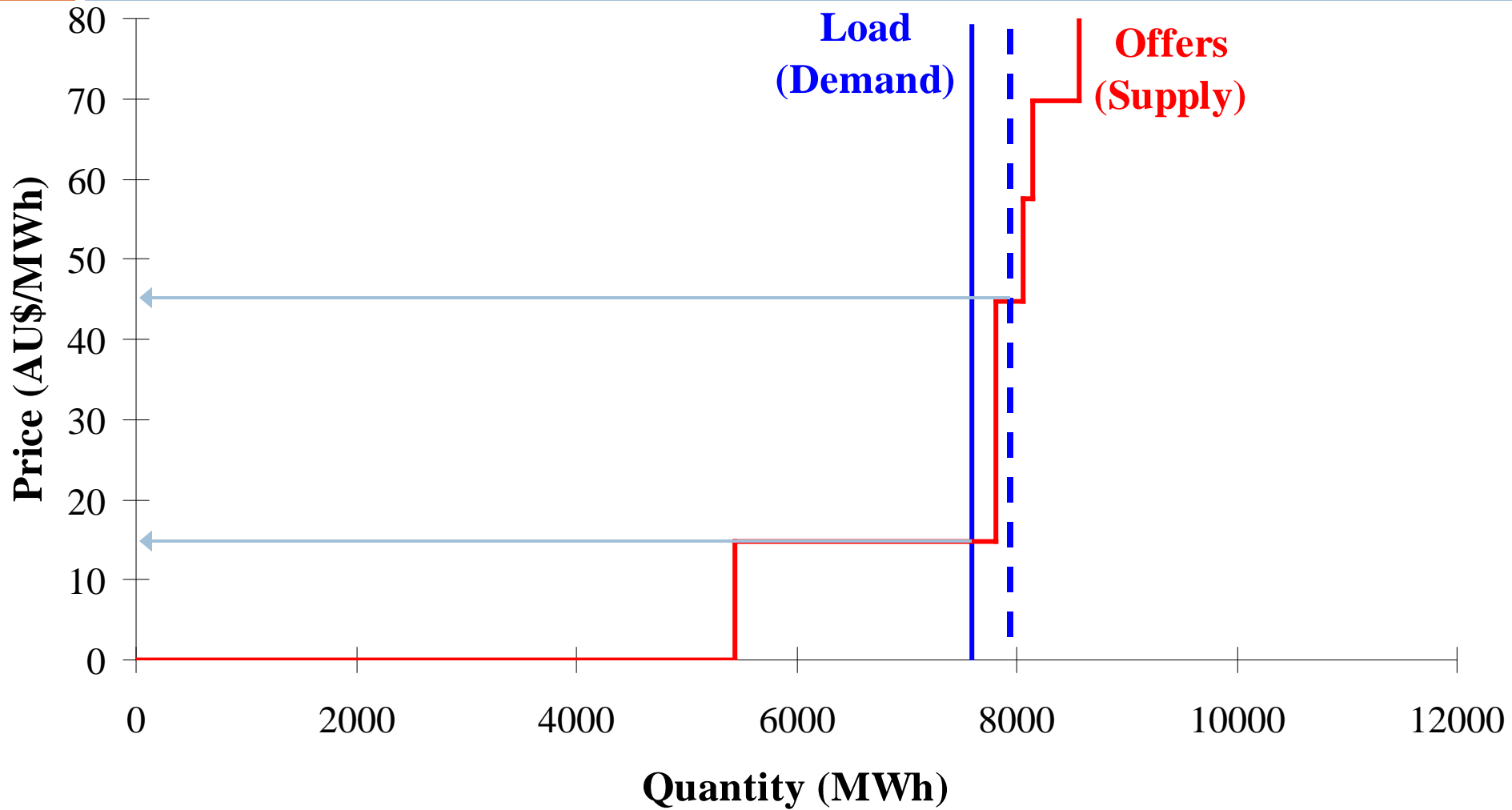
Taylor Smart '13
Gettysburg College

IRLE May 21, 2013

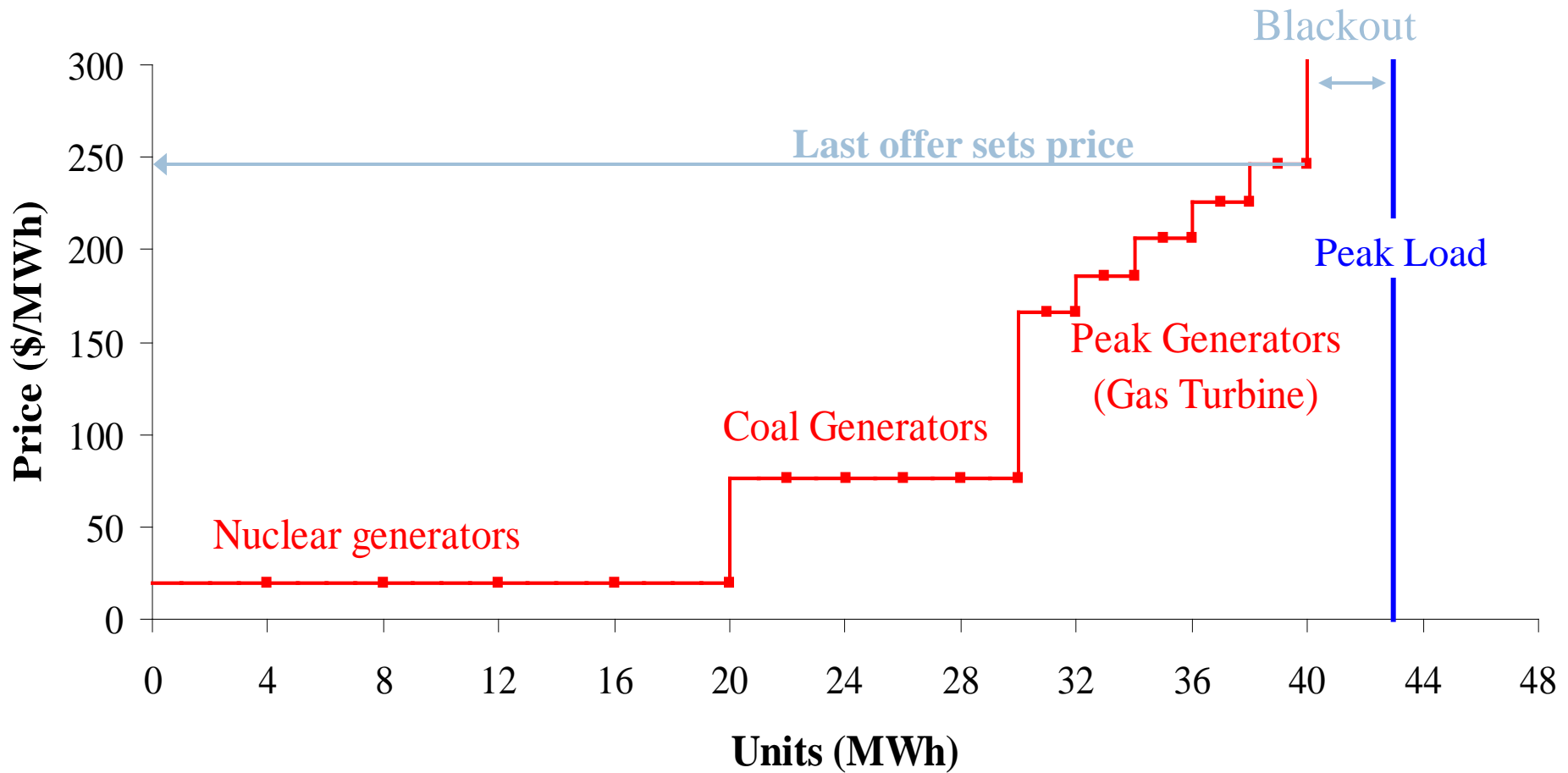
REEML

We thank the Australian Research Council under Linkage grant "Emissions trading and the design and operation of Australia's energy markets" in collaboration with the Australian Financial Markets Association. Acknowledgements are extended to Julie Weisz '12 for outstanding research assistance.

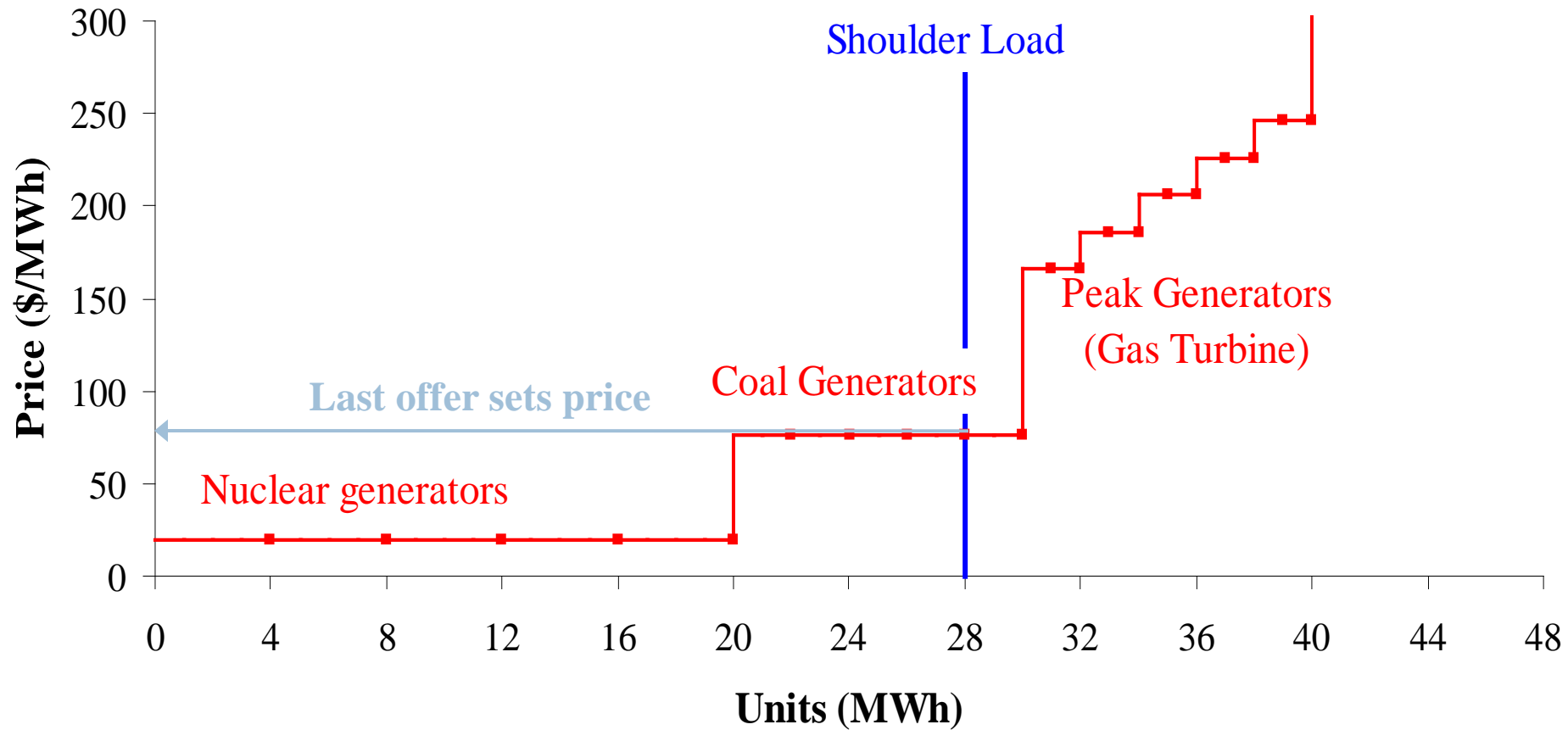
Price Determination in Australia



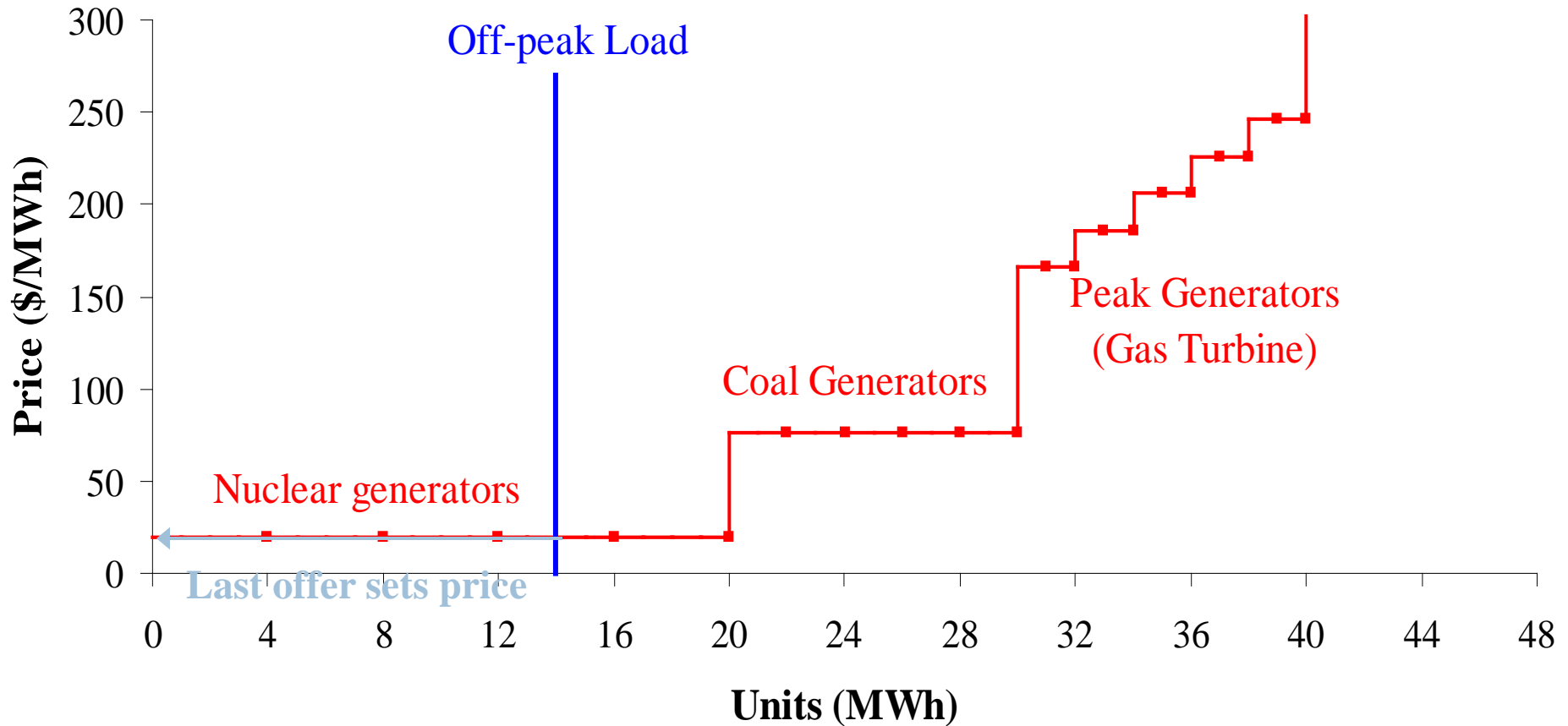
Electricity Market



Electricity Market

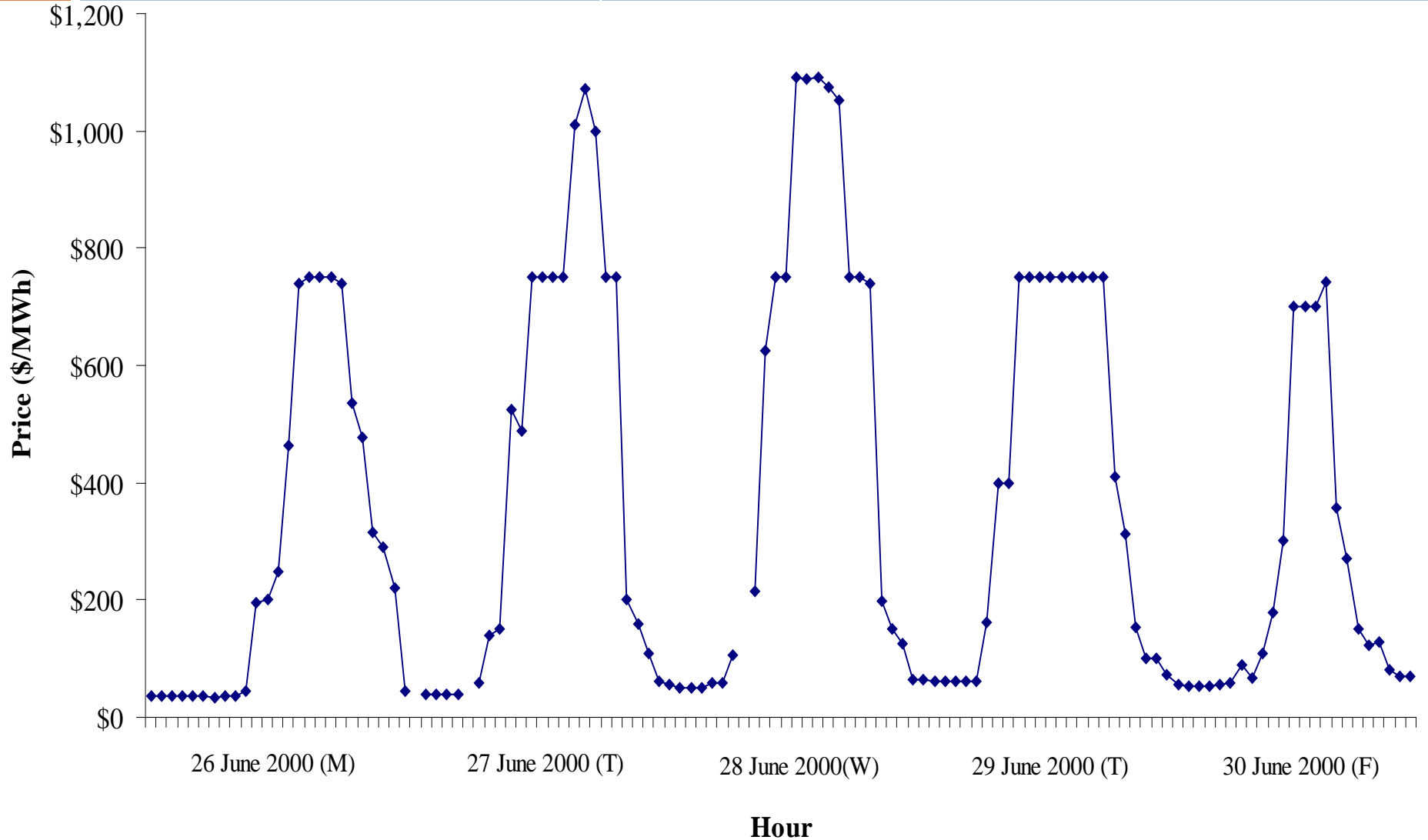


Electricity Market



California Power Exchange Prices

Unconstrained Day-Of/Hour-Ahead Market

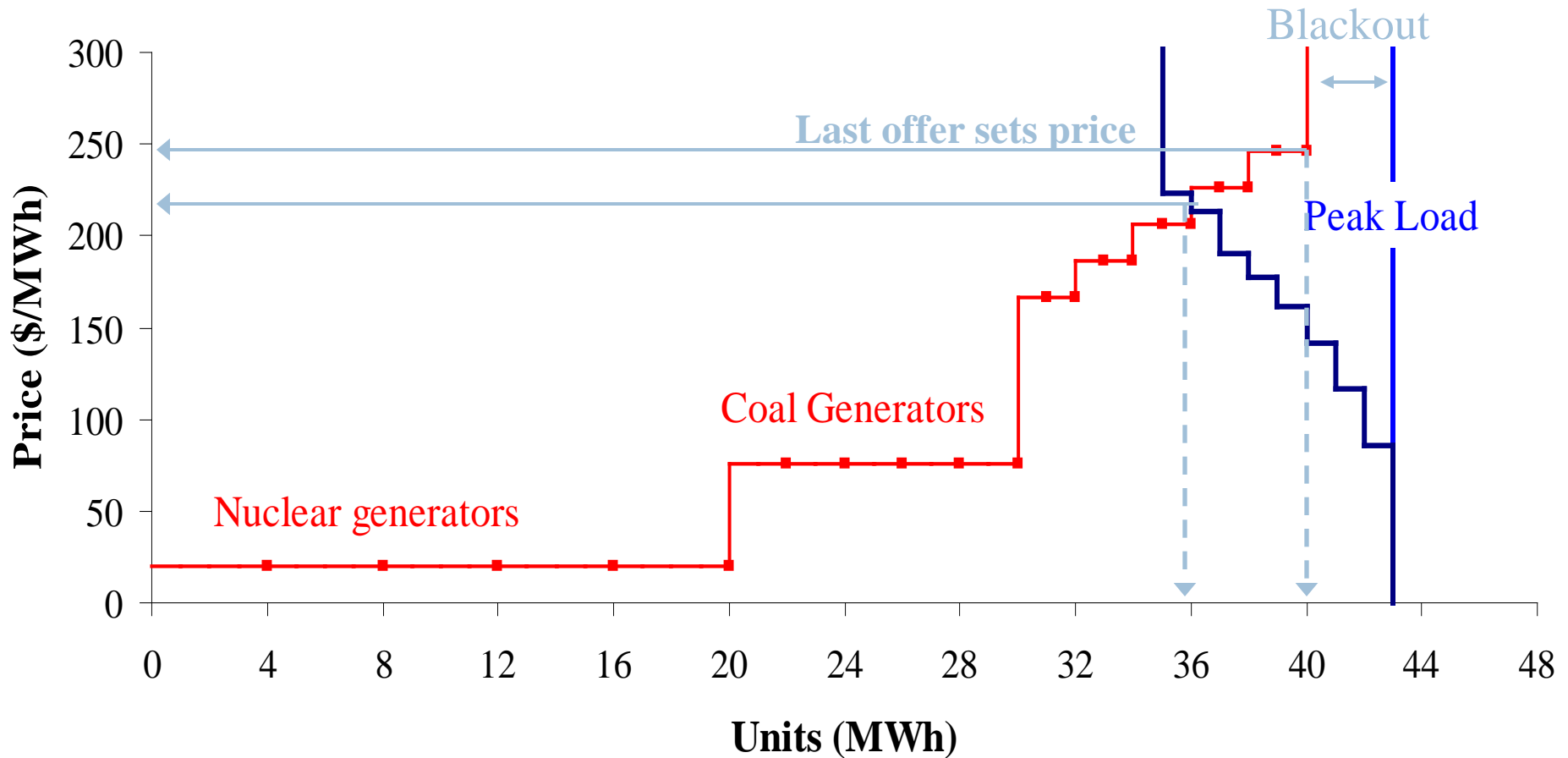


Electricity Market

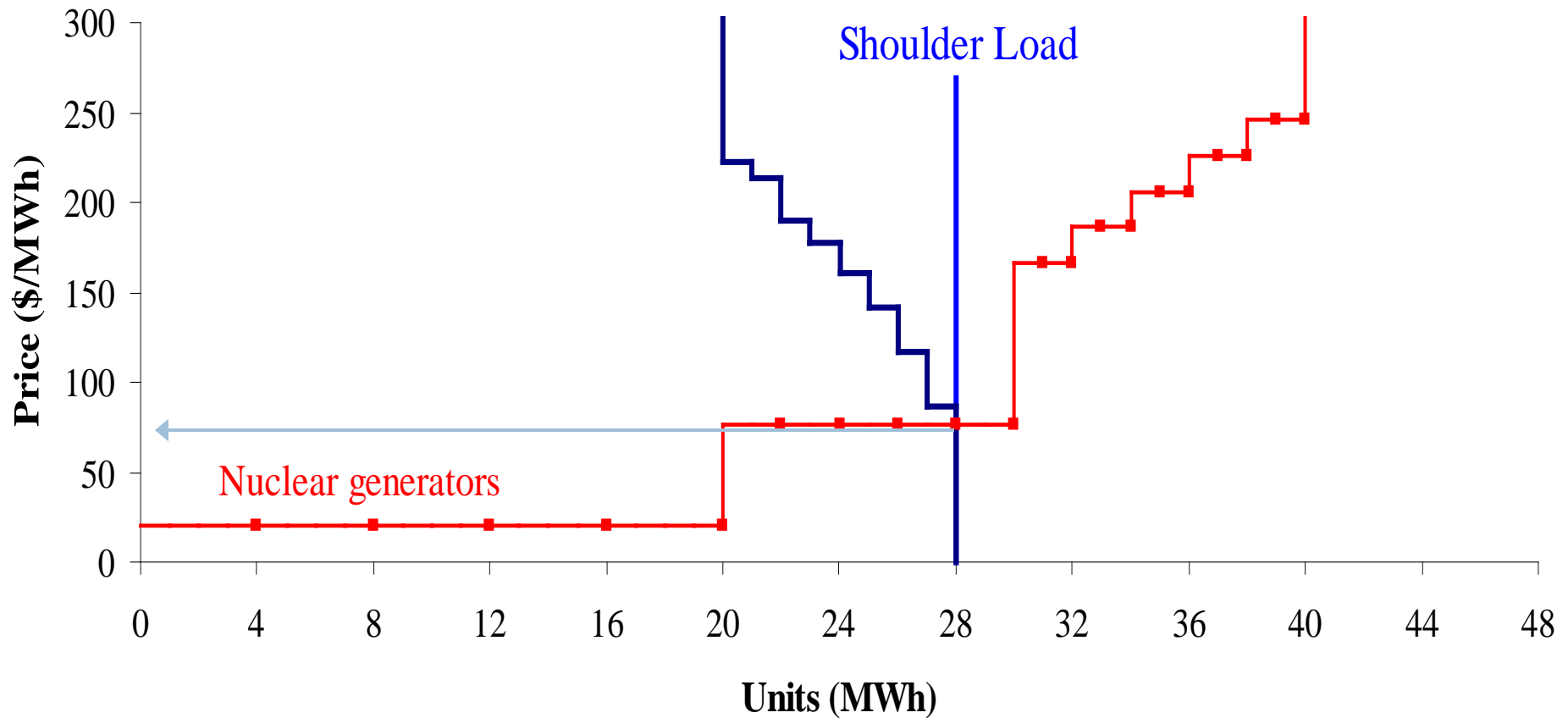
Rassenti, Smith & Wilson (2003):

- What is missing in this market?

A Responsive Demand on Peak

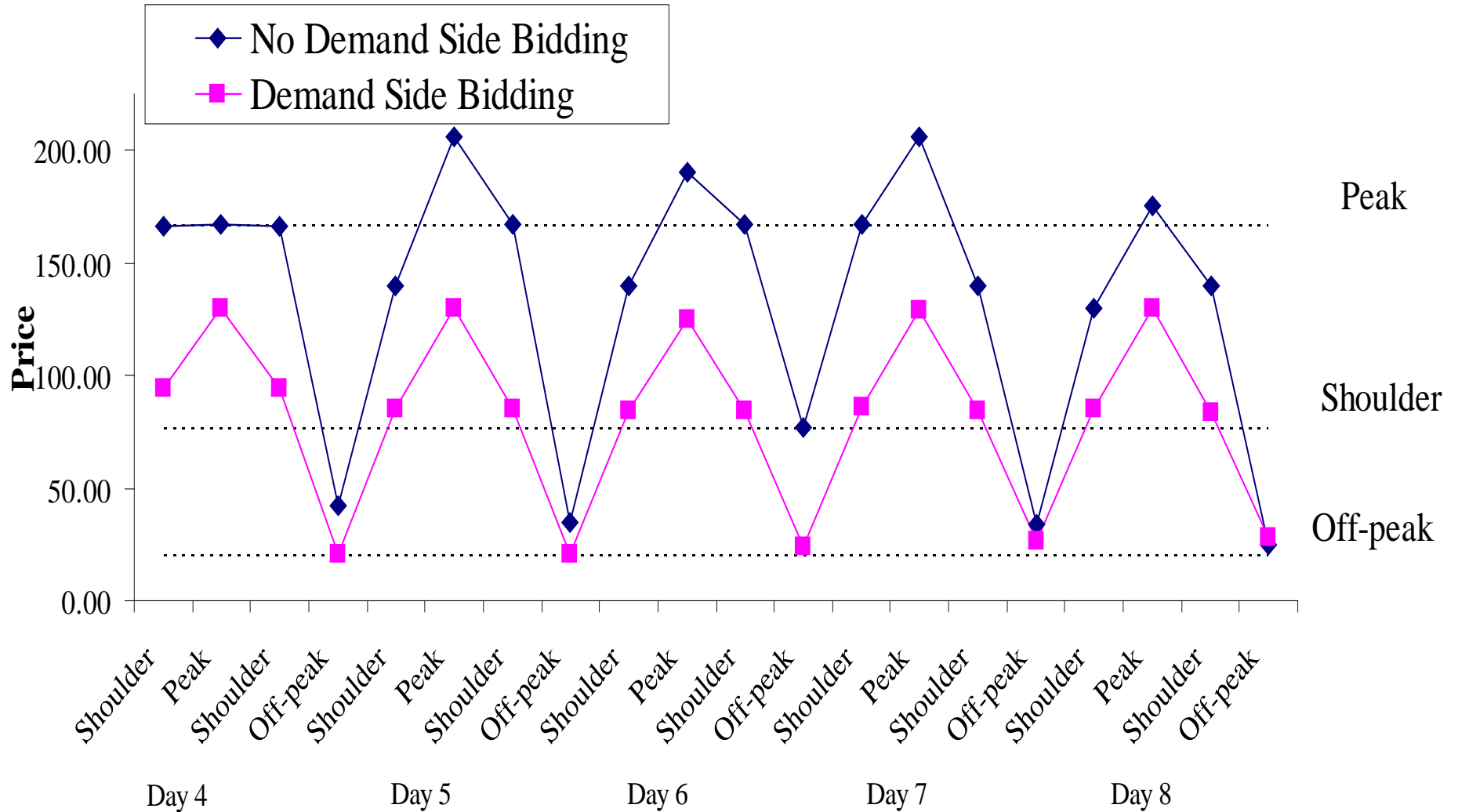


A Responsive Demand on Shoulder



Demand Side Bidding

Lower Prices & Less Volatility



Need for Reduced Demand



- In US alone, peak demand without demand response programs is estimated to grow at an annual average growth rate of 1.7%, reaching 950 GW in 2019
- To avoid need for new generation and transmission, demand response can decrease demand, leading to fewer blackouts, lower costs, and less need for new generation
- Under highest level of demand response, peak load could be reduced by as much as 150 GW
 - ▣ Typical peaking power plant about 75 megawatts
 - ▣ Reduction equal to 2000 such power plants

Environmental Benefits

- Smart grid technology could reduce CO2 emissions by 12%
- In Australia, implementation of smart grid could reduce country's carbon emissions by as much as 3.5 megatons
- Dynamic pricing eliminates/reduces subsidy needs for solar generation



A Question

- How exactly should we implement demand-side response into electricity markets?

Different Retail Electricity Pricing Contracts

- Flat rate pricing (FRP)
- Time of use pricing (TOU)
- Critical peak pricing (CPP)
- Real time pricing (RTP)
- Peak time rebates (PTR)
- Automated demand response
- Enabling technology
- Demand aggregation and curtailment

California Statewide Pricing Pilot



California Automated Demand Response System Pilot



Community Energy Cooperative's Energy-SmartPricing Plan



GridWise Olympic Peninsula Project



Smart Meter Rollouts



- In U.S. (2009): \$11 billion from the stimulus package for smart grid investments
- In Victoria (2010): a big issue in recent elections

Our Questions

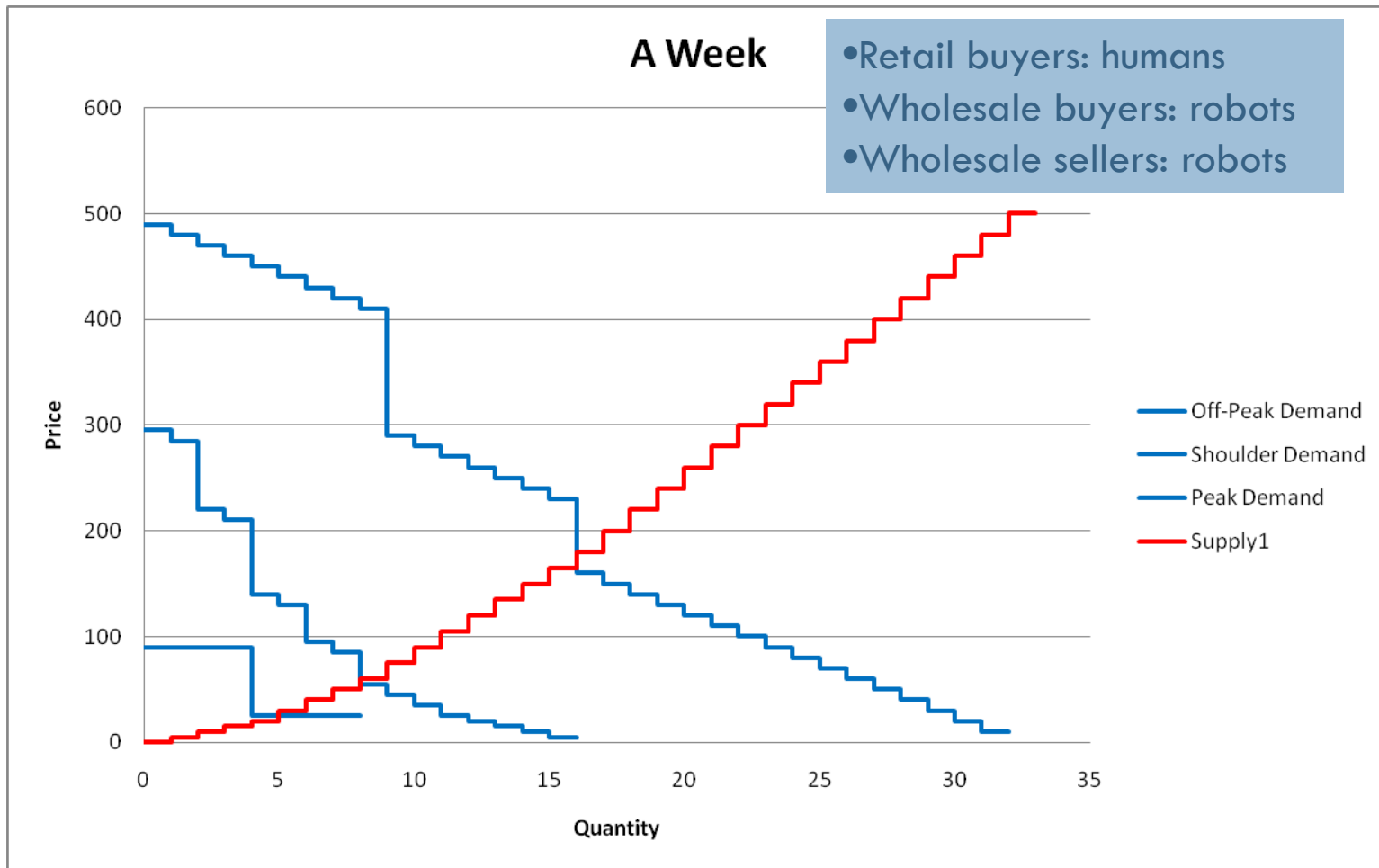
- 1) How do different retail electricity pricing contracts affect market allocative efficiency?
- 2) How good (bad?) are the consumers at responding to supply-side cost shocks under different pricing contracts?
- 3) How does the access to market information affect consumer behavior?

Laboratory Experimental (why?) Approach

We consider four types of pricing contracts:

- 1) FRP
- 2) TOU-L
- 4) TOU-H
- 3) RTP

Experimental Environment: Months 1-15



Experimental Treatments

		FRP	TOU-L	TOU-H	RTP
<i>Market Information Access</i>	<i>No</i>	(5; 33)	(5; 33)	(5; 33)	(5; 33)
	<i>Yes</i>				(5; 33)

- Total number of subjects: 100
- Average subject earnings: 33.03 AUD
- Participation fee: 10 AUD

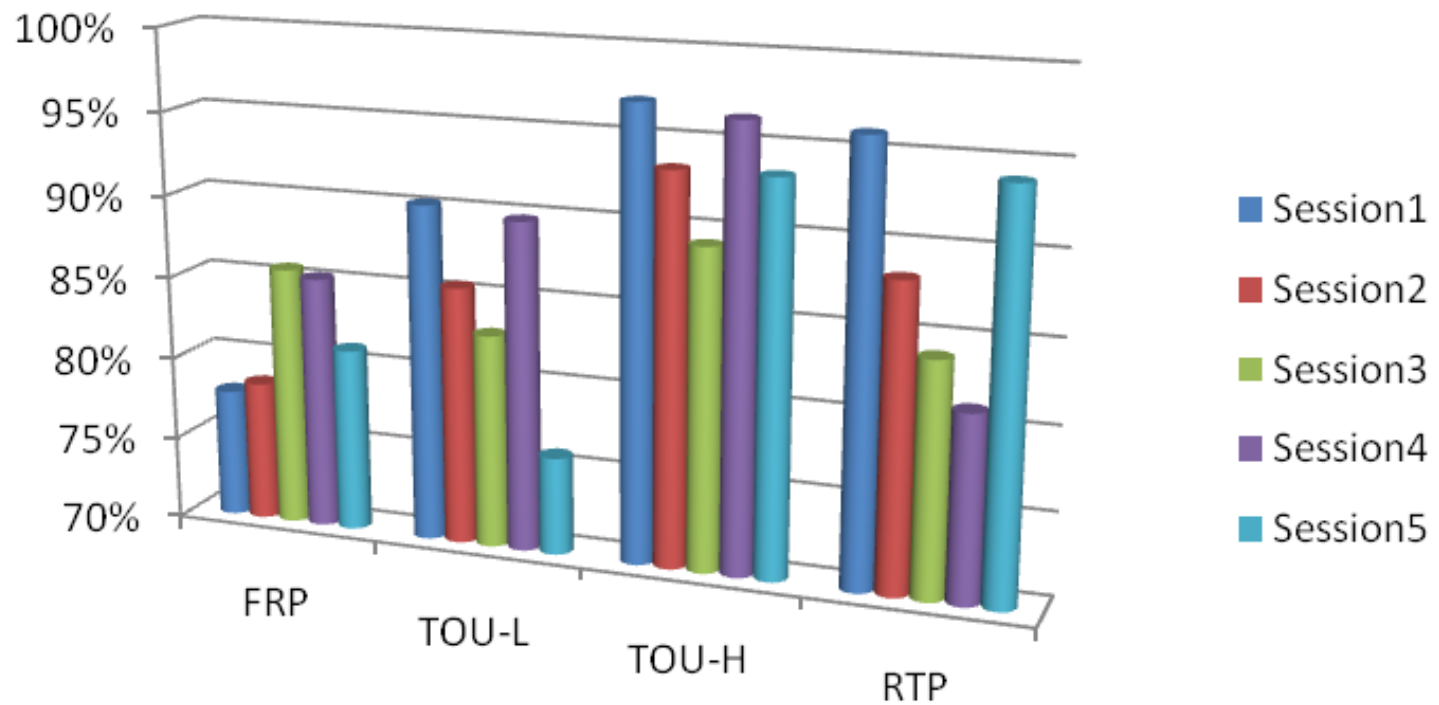
Predicted Efficiency Levels for Months 1-15

- Efficiency = (Realized Total Surplus / Maximum Total Surplus) * 100

	FRP	TOU-L	TOU-H	RTP
<i>Efficiency</i>	88%	92%	100%	100%

Results

Efficiency Months 1-15



A Behavioral Puzzle

- Why is RTP less efficient relatively to TOU-H?

Varying Information

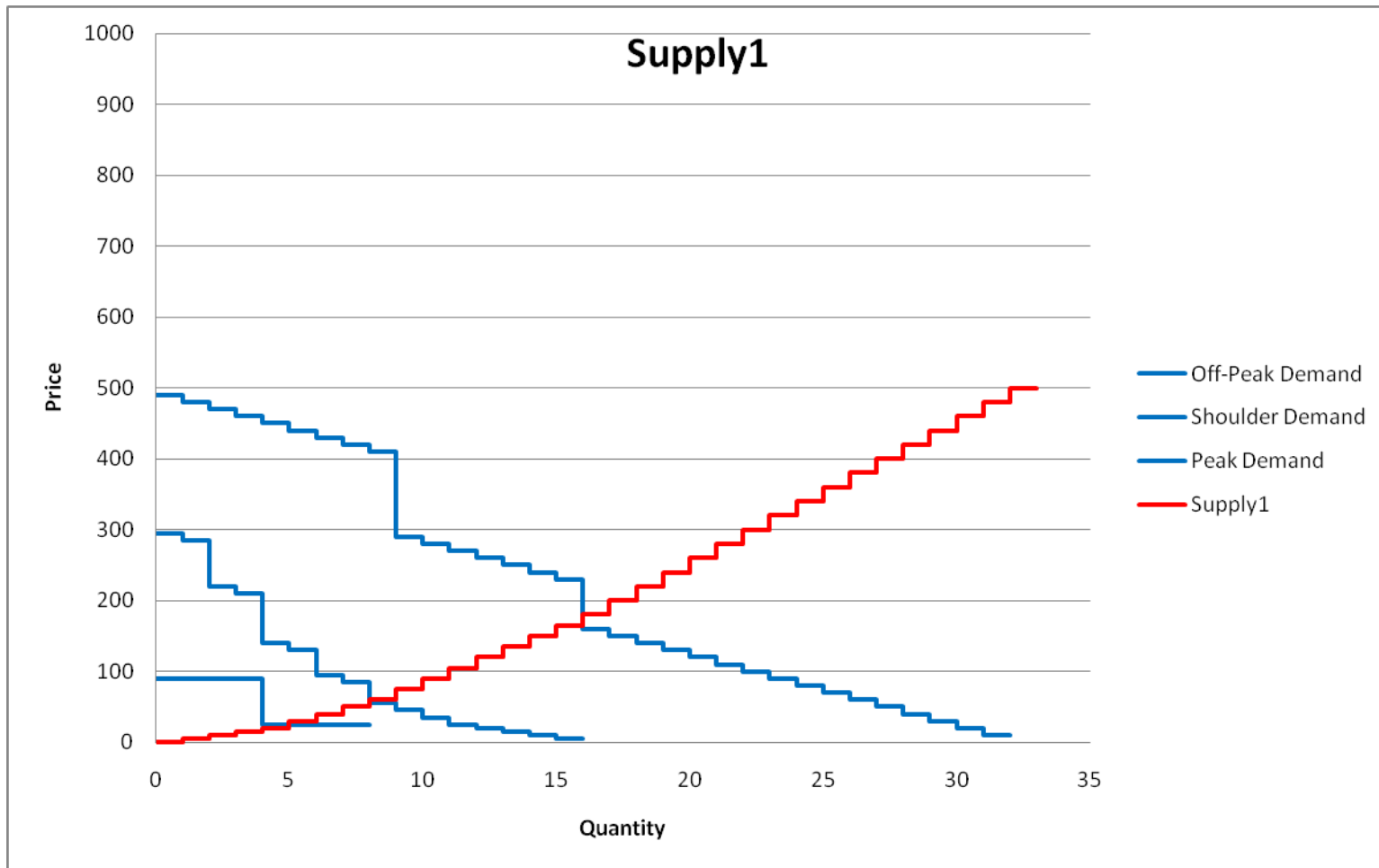


- Introducing instantaneous market information access
- Treatment RTP+

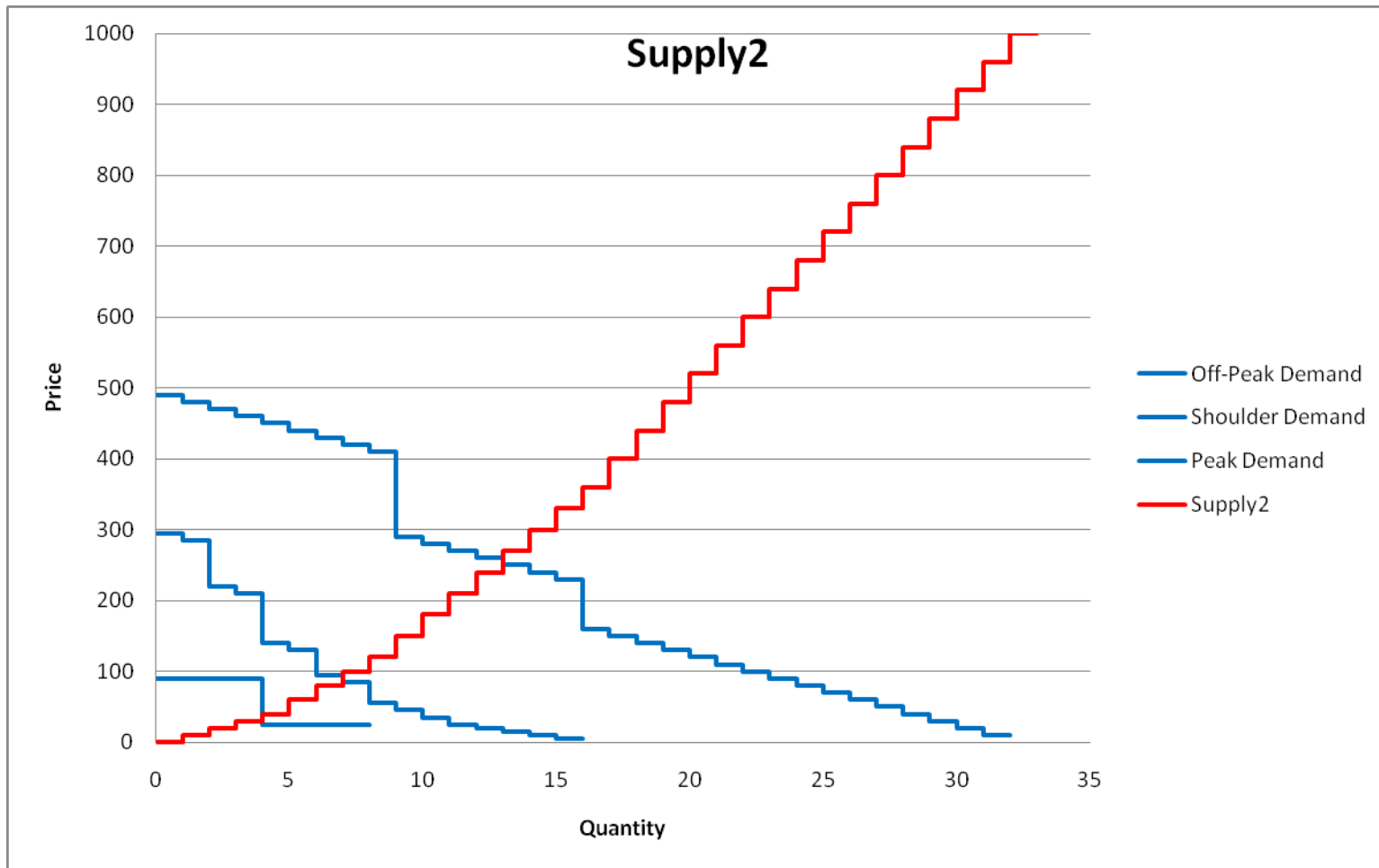
Results: Efficiency Levels for Months 1-15

	FRP	TOU-L	TOU-H	RTP	RTP+
<i>Predicted Efficiency</i>	88%	92%	100%	100%	100%
<i>Observed Efficiency</i>	82%	85%	94%	89%	98%

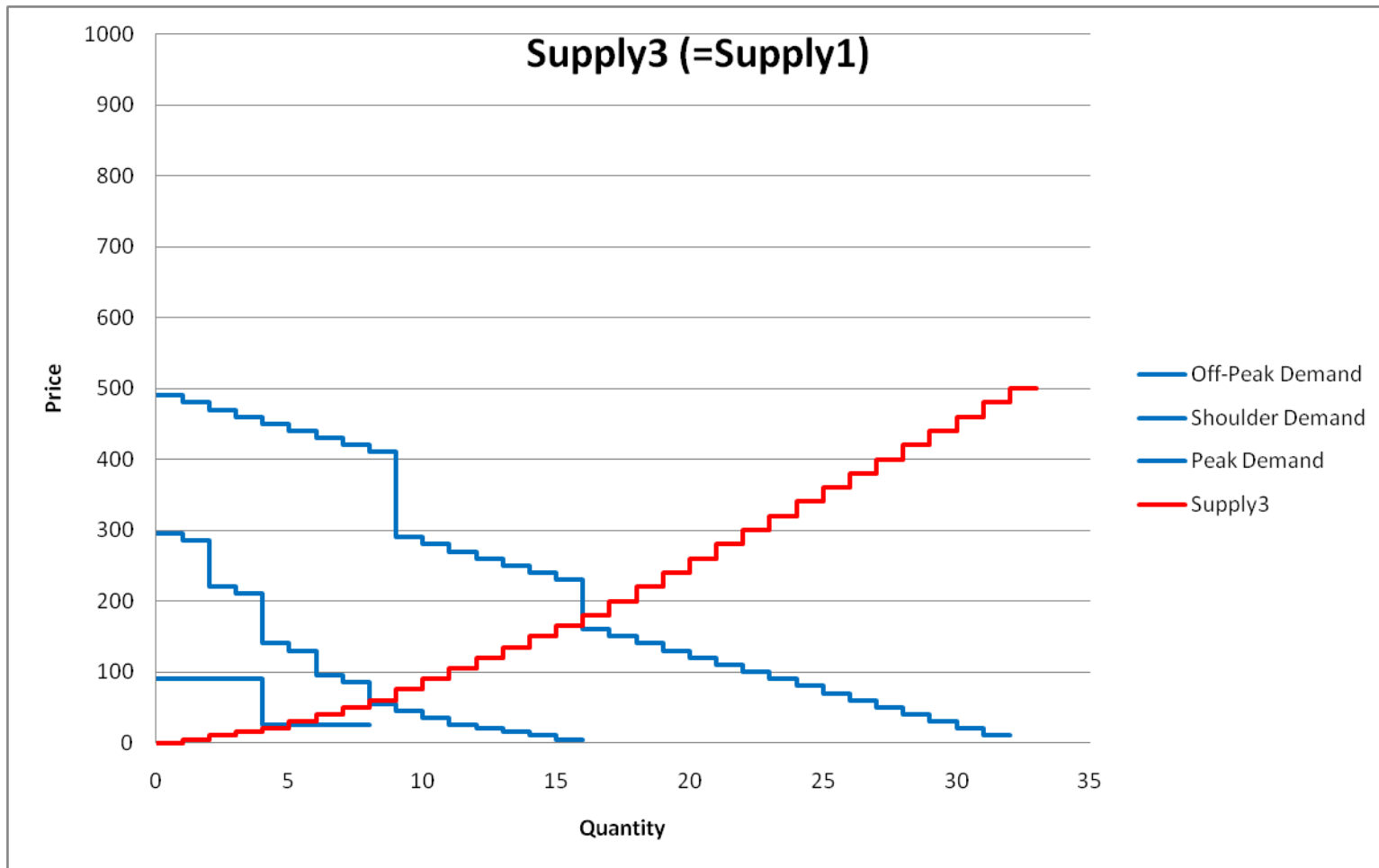
Experimental Environment: Months 1-15



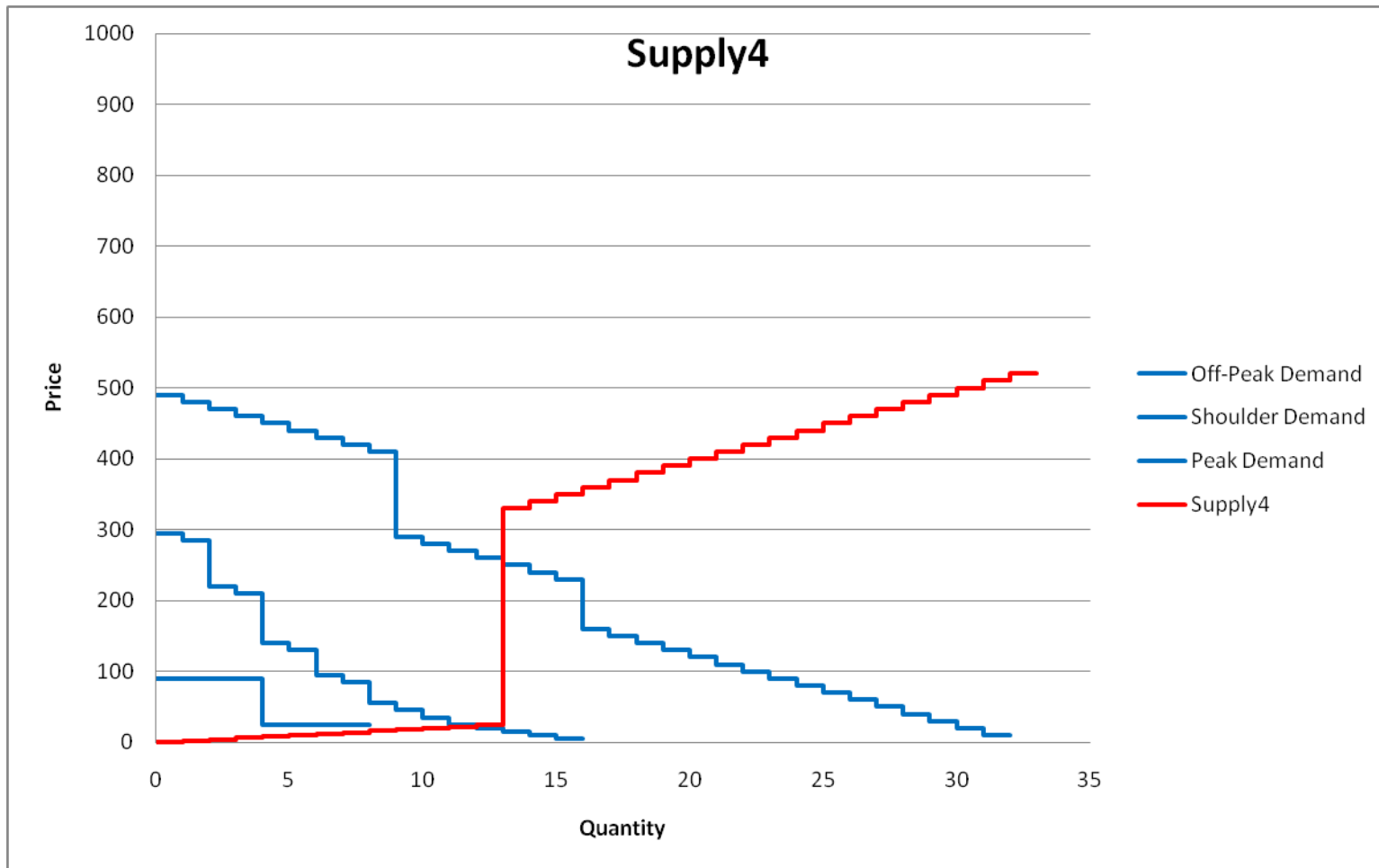
Experimental Environment: Months 16-21



Experimental Environment: Months 22-27



Experimental Environment: Months 28-33



Results

<i>Efficiency</i>		FRP	TOU-L	TOU-H	RTP
<i>Month 10-15</i>	<i>Predicted</i>	88%	92%	100%	100%
	<i>Observed</i>	84%	88%	98%	92%
<i>Month 16-21</i>	<i>Predicted</i>	78%	93%	95%	100%
	<i>Observed</i>	81%	86%	91%	89%
<i>Month 22-27</i>	<i>Predicted</i>	88%	92%	100%	100%
	<i>Observed</i>	74%	88%	91%	88%
<i>Month 28-33</i>	<i>Predicted</i>	72%	89%	98%	100%
	<i>Observed</i>	76%	78%	92%	90%

Varying Information

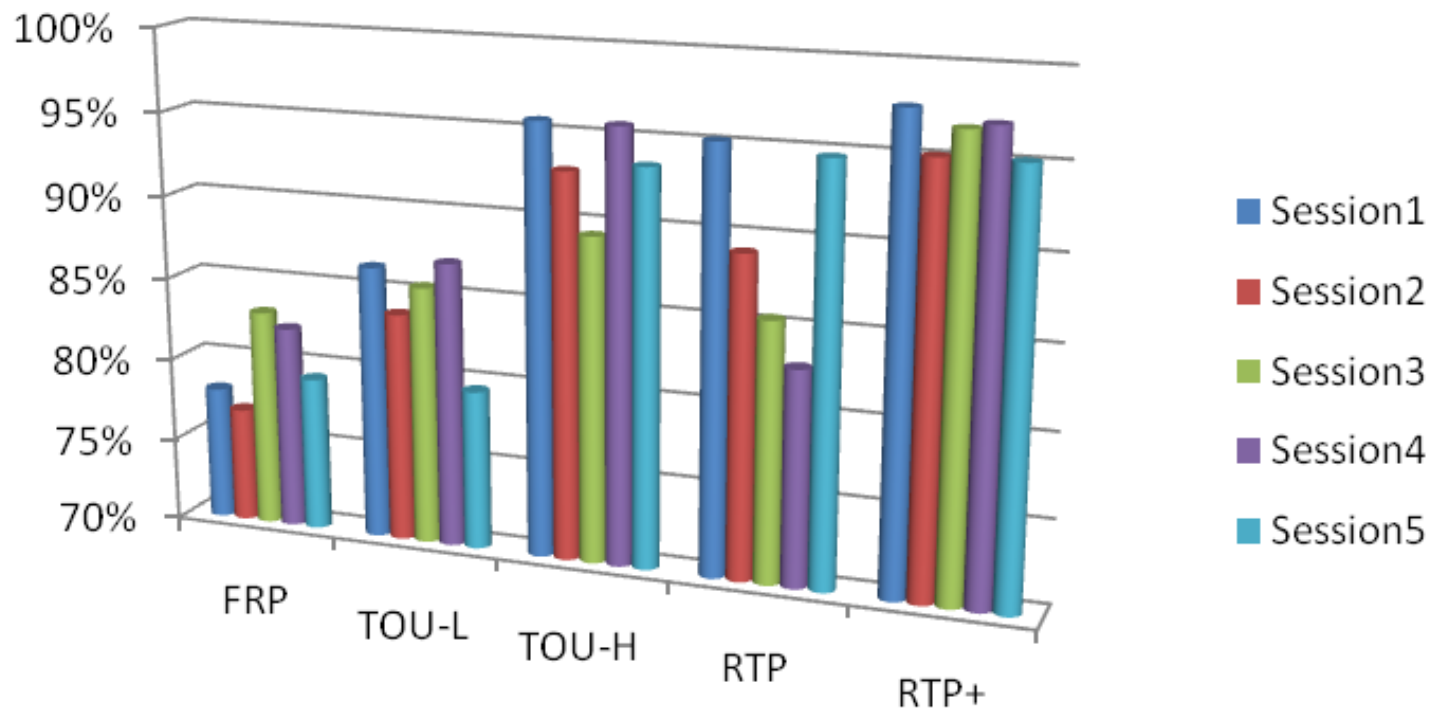
- Introducing instantaneous market information access
- Treatment RTP+

Results

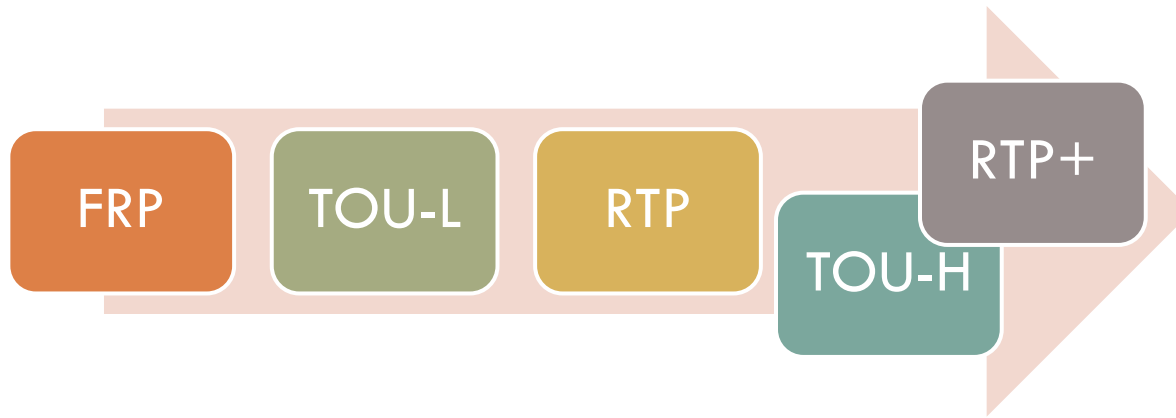
<i>Efficiency</i>		FRP	TOU-L	TOU-H	RTP	RTP+
<i>Month 10-15</i>	<i>Predicted</i>	88%	92%	100%	100%	100%
	<i>Observed</i>	84%	88%	98%	92%	98%
<i>Month 16-21</i>	<i>Predicted</i>	78%	93%	95%	100%	100%
	<i>Observed</i>	81%	86%	91%	89%	97%
<i>Month 22-27</i>	<i>Predicted</i>	88%	92%	100%	100%	100%
	<i>Observed</i>	74%	88%	91%	88%	98%
<i>Month 28-33</i>	<i>Predicted</i>	72%	89%	98%	100%	100%
	<i>Observed</i>	76%	78%	92%	90%	95%

Results

Efficiency Months 1-33



Conclusions



- 1) Contracts with simply more dynamic pricing do not necessarily increase allocative market efficiency: RTP produced relatively low efficiency when compared to TOU-H.

Conclusions

- 2) The type of TOU pricing matters. Separate price for peak demand is better.

Conclusions

- 3) Contracts with more dynamic pricing allow customers to respond to supply-side shocks better (?)

Conclusions

- 4) Providing an instantaneous access to market information significantly improves allocative efficiency with RTP contracts.



LET'S TAKE A LOOK AT YOUR DATA!