Market Power in Power Markets

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Questions:

- **Why isn't the market power problem much worse? (Chap. 4-3)**
- **Do we need some market power? (Chap. 2-1)**
- **What's the precise definition? (Chap. 4-1)**
- **How can it be controlled? (Chap. 4-4)**
- **Recent evidence on gaming.**

Why Is There So Little Market Power?

- **With a demand elasticity of 10% or less, Cournot's theory of competition predicts 10 suppliers will set the price of power infinitely high.**
- **Present power markets have much less demand elasticity and often fewer than 10 suppliers. Why aren't prices infinite?**

Monopoly Pricing

- **The Lerner index:** $L = (P - MC) / P$
- **Demand elasticity:** $e = -(dQ/dP) * (P/Q)$
- **For a monopoly:** $L = 1/e$
- **If $e = 1$, $L = 1$.** ➔ **$P =$ infinity**
- **If $e < 1$, $L > 1$.** ➔ **$P >$ infinity (more or less)**

Monopoly Power and Demand Elasticity

Example with a monopoly & elasticity = 1:
(a 1% increase in price causes a 1% decrease in demand)

- e = 1 ➔ when price doubles demand is cut in half.
- If the monopolist doubles its price, it will sell half as much.
- Revenue is unchanged.
- Costs are cut in half.
- Profit increases.
- If the monopoly doubles price again, the same thing happens.
- As long as demand elasticity is < 1 or = 1,
- it keeps raising its price without limit

Cournot Oligopoly Pricing

- For a Cournot player: L = s/e, s = q/Q.
- Suppose e = 0.1.
- If there are 10 suppliers, one must have s > 0.1.
- So, one supplier must have L > 1.
- It will withhold until the price reaches infinity or elasticity increases above its share of the market.
- Producing 1 less MW increases price enough that revenue stays constant, assuming all other suppliers maintain their outputs (Cournot).

The Puzzle and The Two Keys

- In current power markets, e < 5%
- Market share is often > 5%.
- Why isn't price infinite all of the time?

1. Long-term forward contracts and obligations. (4-4.3)
2. Supply-curve (non-Cournot) bidding. (4-4.4)

How Do Forwards Stop Market Power?

- Say a supplier has 10 GW of capacity with a marginal cost of $30/MWh.
- Say it can raise the market price by 10% for every 0.5 GW it withholds.
- Say the market price is MP = $40/MWh.
- Consider 2 cases:
  1. No forward contracts.
  2. A long-term contract for 8 GW at a fixed price.
- How would the supplier maximize profits in each case?

Remember: Raising the spot price does not increase profits on power previously sold in forward markets.

Profits as a Function of Withholding

"Profit" means the increase in profit from market power.

No Forward Contracts

With-holding	MP* $/MWh	Profit $/h
0 GW	40	0
1	48	65,600
3	71	186,037
5	104	268,748
6	**126**	**282,149**
7	152	265,700

8 GW of Forwards

With-holding	MP $/MWh	Profit $/h
0 GW	40.00	0
0.1	40.77	463
0.2	41.55	798
0.3	42.35	1,002
0.4	**43.17**	**1,071**
0.5	44.00	1,000

*** market price rounded to nearest $.**

- **With 9 GW of forward contracts there would be no withholding and no exercise of market power.**

How Far Forward Do they Need to Be?

- **The day ahead market is a forward market, but It has little effect of the type just analyzed.**
- **Consider forward contracts for 1 week ahead.**
- **When a supplier sells such a contract it knows that the buyer will pay more if today's price is high.**
- **So a seller of forwards has two reasons to exercise market power today.**
  1. To increase profits in today's energy market.
  2. To increase profits on sales of forward contracts.
- **For very short term forwards, the two add up to exactly as much motivation for market power as if no forwards were sold.**

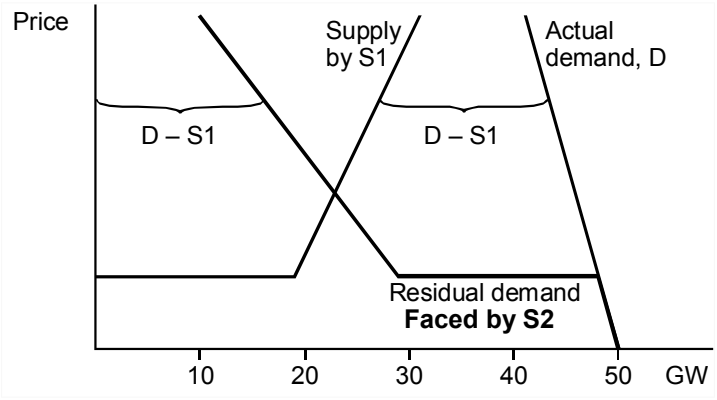
Long-Term Contracts

- **Four reasons longer term forwards are more effective at reducing market power:**

1. **Discounting reduces the value of profiting from a long-term forward.**
2. **Uncertainty about demand conditions causes supply-curve bidding in the forward market. (Assertion, not checked.)**
3. **There is more demand elasticity in the long run.**
4. **There is competition from new entry in the very long run.**

- **All of these reasons help disconnect current spot prices from the forward price, and all increase in strength as the term of the contract increases.**

Supply Curve Bidding (4-4.4)



Supply Curve Bidding (#2)

- **If all suppliers bid supply curves, then each faces a residual demand curve that is more elastic than actual demand.**
- **But why don't suppliers bid quantities?**
  1. Any equilibrium can be achieved with a set of pure supply-side quantity bids equal to the quantities traded in that equilibrium.
  2. A pure quantity bid encourages the maximum exercise of market power by competitors because it does not increase effective demand elasticity.
     (It is always best to have competitors exercising market power.)

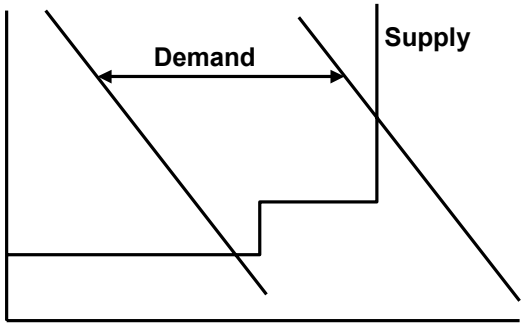
Supply-Curve Bidding (#3)

- **Suppliers bid supply curves because of demand uncertainty.**
- **The more uncertainty, the more elastic their bid.**
- **Equivalently, they bid supply curves if they must choose one bid that holds for many different demand levels, for example, over an entire day.**
- **The theory of supply curve bidding is not well understood and is very complex.**
- **We should not expect optimal supply curve bids, but the theory does explain why we do not see Cournot bids.**

Question 2: Do we need market power?

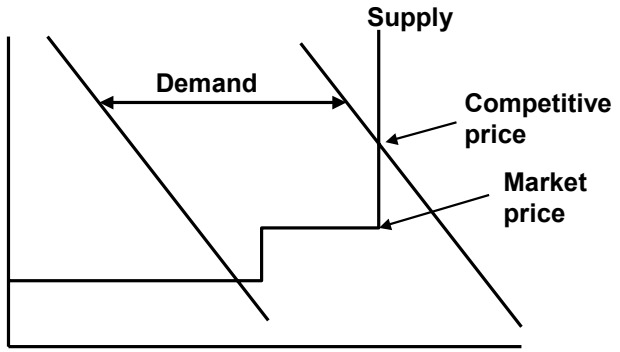
- **The short answer:**

  Not with a market-clearing price.



What if Price = Highest Supply Bid (PJM)

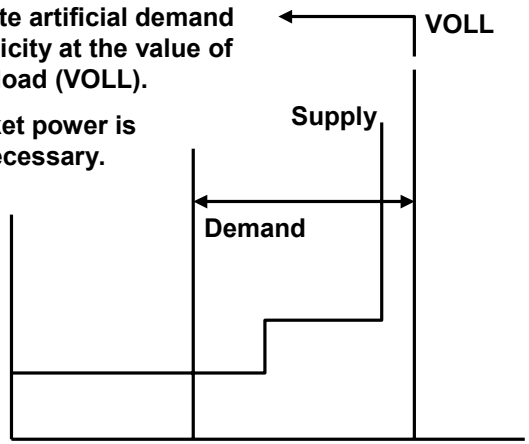
- **PJM requires market power to cover peaker fixed costs.**



What if Demand is Inelastic (Vertical)?

Create artificial demand elasticity at the value of lost load (VOLL).

Market power is unnecessary.



Nearly-Vertical Demand & No Price Cap

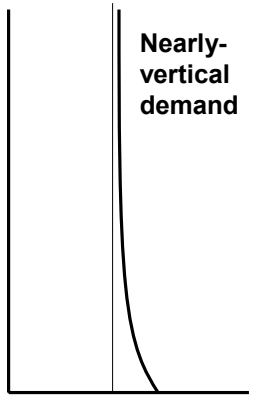
- Without a price cap,

  even with nearly-vertical demand,

  there is no long-run equilibrium without market power.

  A nearly-vertical supply curve also does not solve the problem.

"Nearly" is defined in Chap. 2-4.6.



Vertical Demand and a Low Price Cap

- If market price reaches the cap of $20,000/MWh for 3 h/year, that is enough to cover the fixed cost of a peaker.
- So the VOLL equilibrium sheds load for 3 h/year and this is optimal.
- A price cap of $200/MWh that is reached only when load is shed results in an equilibrium with 300 h/year of load shedding. This is inefficient.
- By setting price to the cap when Load + Operating reserves > supply, the price will reach the cap for 300 h/year even though load is only shed for 3 h/year. This is optimal.

A "Price Cap" Is a Price Limit on Demand

- If the system operator sets a limit on the price it will pay when supply or operating reserves fall short, that limit will cap the real-time market and all forward markets.
- This is because (in current systems) loads have the option of buying power in the real-time market.
- There is no point in paying $X+1 in a forward market if you know you can buy for $X in the real-time market.
- When it becomes possible to cut off loads that exceed their forward contract purchases, this will change.

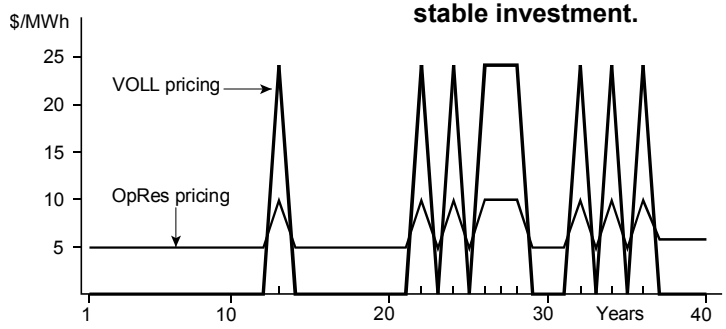
Summary and Conclusions

- As long as demand is too nearly vertical, either market power or a price limit is required.
- If the limit is set low, and prices are set to the limit when operating reserves are short, the long-run equilibrium will be optimal.
- In this case, no market power will be needed to cover fixed costs with optimal installed generating capacity.

Advantages of a Low Price Cap

1. Less price volatility.
2. Less market power.

Reducing annual volatility is crucial for stable investment.



High Price Spikes Increase Market Power

- Although lower price spikes occur for more hours, the total revenue transferred due to market power appears to be less with low price spikes and greater with high price spikes.
- This is discussed in Section 2-6.1.

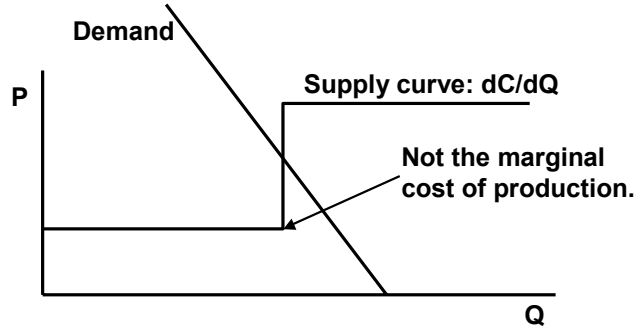
  See Result 2-6.3

Question 3: The Definition of Market Power

- "The ability to alter profitably prices away from competitive levels." (Mas-Collel et al. 1995, p. 383)
- Monopoly power is the ability of the supply side to raise price.
- Monopsony power is the ability of the demand side to lower price.

The Confusion Over Market Power

- The confusion in power markets is the result of pretending that supply curves are vertical and marginal cost equals the savings from producing less.



The Problem with defining MC Incorrectly

- The incorrect definition of MC (which is not found in any text book) leads to the following statements.

1. The competitive price is sometimes above marginal cost.
2. Since price needs to be above marginal cost, market power is necessary.
3. Market power is beneficial in power markets.

The Correct Definition of MC:

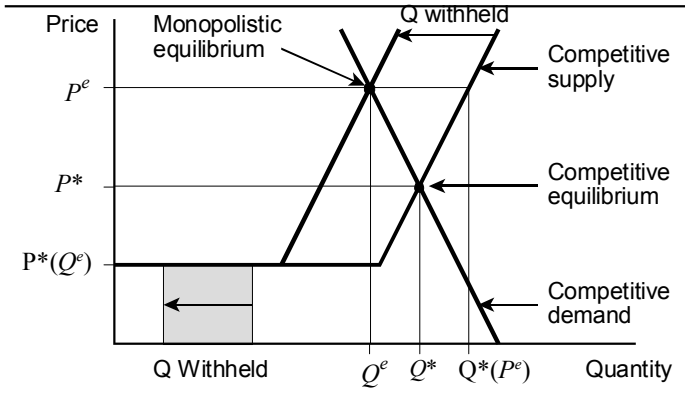
- At a vertical region of a supply curve, marginal cost is undefined, but . . .
- Left-hand marginal cost = left hand dC/dQ.
- Right-hand marginal cost = right hand dC/dQ.
- The marginal cost range, MCr = { MC_{LH} , MC_{RH} }.
- In place of competitive price = MC, we have:

  The competitive price is always in the marginal cost range.

The Relationship of MC to Market Power

- The definition of market power refers to the competitive price, not to marginal cost.
- An ambiguity in marginal cost causes no problem because the competitive price is still defined.
- In any case, the competitive price is never greater than marginal cost.

Withholding, Distortion, and Markup



$Q^* - Q^e$ = the quantity distortion.
$P^e - P^*$ = the price distortion.

$Q^*(P^e) - Q^e$ = Q withheld
$P^e - P^*(Q^e)$ = the markup

Withholding, Distortion and Markup

- **Monopoly equilibrium ← → competitive equilibrium.**

  Quantity distortion is the main source of inefficiency.

  Price distortion is the best indicator of market power, at least in power markets.

- **Monopoly equilibrium ← → competitive supply curve:**

  Quantity withholding is > 0 if and only if, market power has been exercised. (Not true of quantity distortion.)

  Price-cost markup divided by actual price is the relative markup or Lerner index. (Often used, but inaccurate in power markets.)

The Problem with the Lerner Index

- **The Lerner index increases when price goes up, but also when marginal cost goes down.**
- **In a power market, market power is typically exercised when the supply curve is steep. In this case, the Lerner index may indicate mostly a decrease in marginal cost.**
- **The average Lerner index can be negative when the markup is positive. This occurs when some suppliers are "short" (have more load than generation) and exercise monopsony power.**

Question 4: How Can MP Be Controlled?

1. **Increase demand elasticity.**
2. **Build more wires.**
3. **Use a low price limit ($200--$800/MWh).**
4. **Encourage (or initially require) long-term contracts.**
5. **Require supply-curve bidding (?) or bidding over longer time periods (e.g. one bid for the whole day).**

1. Demand Elasticity

1. Can easily be introduced in the operating reserve requirement.
2. Large consumers should be offered hedged real-time prices. Here's how:

- The idea is to hedge a change in the average monthly price but not hedge real-time wholesale price fluctuations.
- The load serving entity buys long-term contracts for power and offers (a) fully hedged rates, and (b) hedged real-time rates.

A Hedged Real-Time Rate

- If a fully-hedged customer's bill would be H for a particular month,

  the same customer with a hedged real-time rate would pay

  H × (its real-time cost of q) / (average real-time cost of q).
- q is the customers consumption that month.
- Average over what? The whole system or just one customer class?
- The design is incomplete and deserves research in several respects.

The Benefits of Accepting a Real-Time Rate

- A change in the <u>average</u> real-time price does not affect the hedged real-time customer.
- The real-time rate gives full credit to any response to the real-time to wholesale price.

2. Build More Wires

- Local market power may be the worst market-power problem.
- Some generators will need to be regulated.
- Improved transmission can be used to solve the problem. This is being considered in NY City.
- For this reason transmission is more expensive in a competitive market than in a regulated market.

3. Use a Low Price Limit

- The appropriate operating reserve requirement is needed to ensure adequate investment.
- Price spikes are still desirable to encourage demand side response.
- With a fully developed demand side, price spikes might be quite low.
- Large spikes will induce faster change on the demand side, but may not be worth the price.

4. Encourage Long-Term Contracts

- When generation is first divested from regulated utilities or privatized, the new owners are often required to sign long-term contracts to supply load.
- This dramatically reduces the incentive of the new owners to exercise market power.
- There is little theory concerning how to induce long-term contracts after divestiture.
- I know of no theory that predicts the extent of long-term contracting.
- Another good area for research.

5. Require Supply Curve Bidding

- PJM requires full-day bids, while the NYISO allows bids to be changed hourly. NY has more trouble with market power.
- NY addresses this problem through complex restrictions on bids that amount to a limit on how much bids can be changed over a 3-month period.
- Both approaches are based on the benefits of supply-curve bidding. Both are ad-hoc. Why not 2-day bids?
- Another good area for research.

Gaming

- Gaming takes advantage of flaws in the market's design.
- Pure gaming does not require a large market share or market power, but with more market power more games become possible.
- Rules should tested.
- The market should be monitored and changes in design should not be too difficult.

Perot Systems: The Accusations

Has been accused of :

1. **Rigging the CA-ISO rules so that they would be easy to game.**
2. **Setting up a "Crime School" to sell gaming secrets and teach Enron etc. how to game the ISO.**
3. **Providing the actual strategies that Enron used and that were found in the recently revealed Enron memo.**

Perot was a popular third party candidate for President against Clinton and George Bush Senior.

Perot System Corporation: Evidence

- **So far there is no evidence for these charges.**
- **However, documents that have now been posted on the Perot System web site in response to a subpoena contain the following: (SCE = second largest utility in CA.)**

"In 1986 (not 1996), PAC and SSI developed the Competitive Industry Gaming Model (CIGMOD) to analyze the dynamics of deregulation for the State of Illinois. . . . When the conventional models used in the UK to analyze deregulation failed to reproduce the unfolding events, it was the re-parameterized US CIGMOD model that reproduced the gaming dynamics.

Perot Continued

"Apparently Willie was satisfied because he wants George to set up a system and process for SCE [2nd largest CA utility] *to evaluate gaming options when deregulation starts. Willie told him to get whatever additional help he needs and doesn't care if it's from PSC* [Perot]*, Arthur Anderson, or McKinsey. The project is very confidential within Edison."*

George sees the following as what needs to be put together.

1) George's SD model. [CIGMOD?]

2) Paul's insights (and model) into how the ISO works, where are the holes in the ISO process, which ones should be plugged, which should be used, etc.

3) Massive data input from the ISO/PX when it's running.

Perot Continued

4) Expert statistical skills (with a commodities emphasis) in order to analyze whether results are due to model recommendations or just coincidence.

5) Set up a data "intelligence" process to determine when PG&E, Enron, Southern, or any other entity is manipulating the market vs. just random market activity. How can Edison's maneuvers be "hidden" or "obscured".

Simplicity vs. Gaming

- **To guard against gaming:**
  1. Don't ask the market participants to design the market.
  2. Avoid complex rules.
  3. Test the rules with market simulations..

The End