Market Monitoring to Control Market Power

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Outline of Talk

- Role of Market Monitoring
  - Monitor for exercise of Market Power
    - Measuring Firm-Level market power
      - Application to California Electricity Market
    - Measuring Market-Level market power
      - Application to California Electricity Market
- Local Market Power Problem
- Mitigating Spot Market Power
  - Forward Contracting
  - Transmission Upgrades
  - Symmetric Treatment of Load and Generation
- Micro versus Macro market power mitigation
  - AMP versus Competitive Benchmark Triggers
- Other outstanding issues in market monitoring

What is Market Power?

- Ability of a firm to increase the market price and profit from this price increase
- A firm exercising all available unilateral market power subject to the market rules is equivalent to
  - The firm maximizing profits, which is equivalent to
  - The firm's management serving its fiduciary responsibility to its shareholders
- Regulatory oversight issue is not whether or not a firm possesses market power or exercises it
  - Depending on systems conditions, any firm can possess substantial market power
- Regulatory oversight issue is whether the unilateral actions of market participants result in market outcomes that cause significant harm to consumers and system reliability

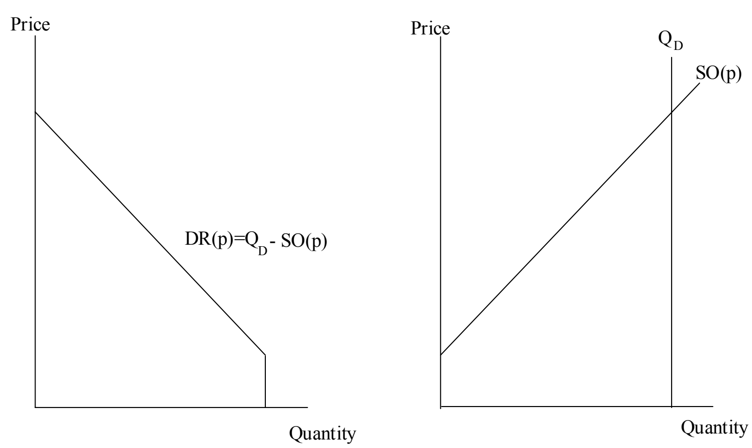
Measures of Market Power

- Direct firm-level measures of market power
  - Pivotal bidder frequency
  - Price elasticity of residual demand
- Direct market-level measures
  - Market price minus competitive benchmark price
  - Total amount of payments in excess of payments under competitive benchmark pricing
- Describe how to compute both measures
  - Present application of firm-level measure to California electricity market

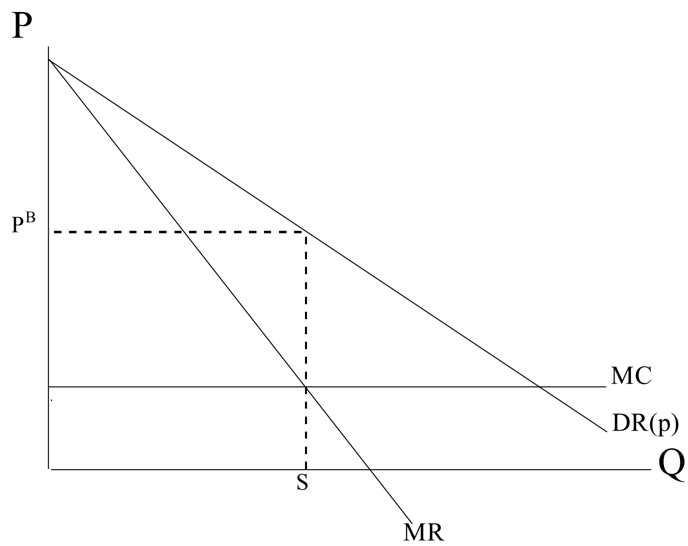
Bidding in Competitive Markets

- To understand how to measure firm-level market power must understand how firms exercise it in an bid-based electricity market
- Q_{id}: Total market demand in load period i of day d
- $SO_{id}(p)$: Amount of capacity bid by all other firms besides Firm A into the market in load period i of day d as a function of market price p
- $DR_{id}(p) = Q_{id} - SO_{id}(p)$: Residual demand faced by Firm A in load period i of day d, specifying the demand faced by Firm A as a function of the market price p
- $\pi_{id}(p)$: Variable profits to Firm A at price p, in load period i of day d
- MC: Marginal cost of producing a MWH by Firm A

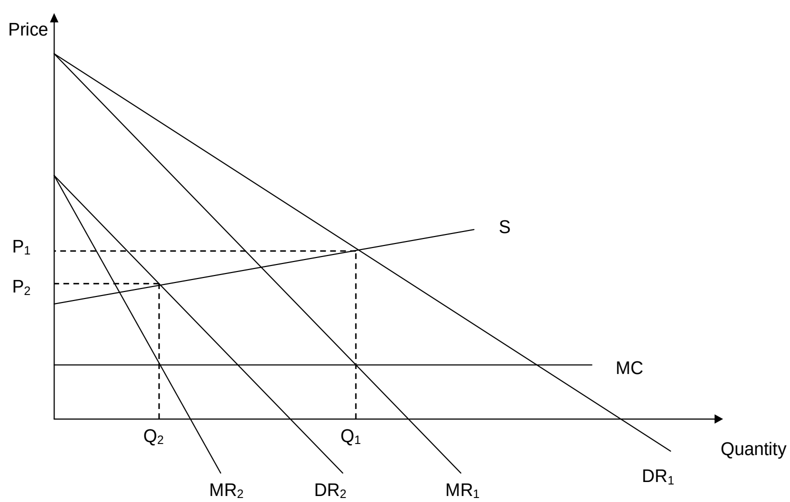
Residual Demand Curve faced by Firm



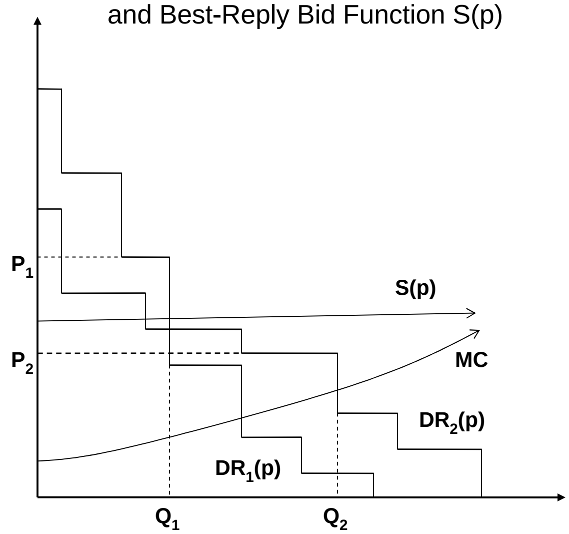
Bid to Maximize Profits Subject to Residual Demand



Simplified Model of Bidding to Maximize Expected Profits (Differentiable Residual Demand Functions)



Actual (Step Function) Residual Demands and Best-Reply Bid Function S(p)



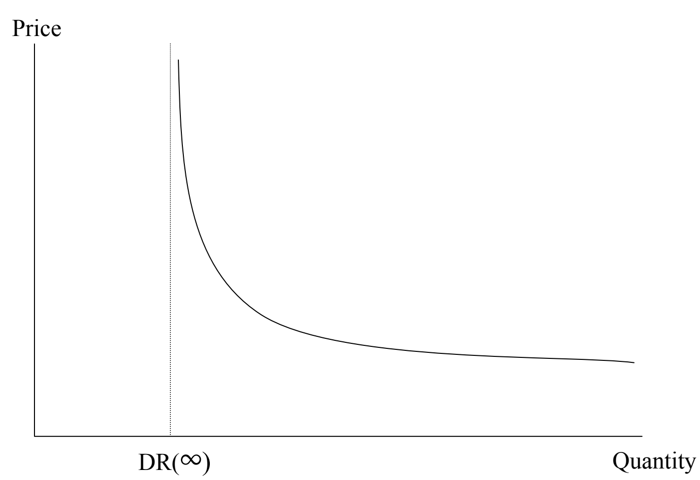
Goal of Optimal Bidding in Simplified Model

- For each hour h, each firm j tries to cause this equation to hold:
  - $(P_h - MC_{jh})/P_h = -1/\varepsilon_{hj}$
  - ε_{hj} = elasticity of realized residual demand of firm j in hour h
  - P_h = market price in hour h
  - MC_{jh} = marginal cost of firm j in hour h
  - Let $L_{hj} = - 1/\varepsilon_{hj}$
  - Value of L_{hj} is measure of unilateral market power that firm j possesses in hour h

Measuring Market Power without Bids

- Pivotal bidder frequency
  - Firm is pivotal if some of its capacity is needed to serve market demand
  - Firm can name any price it would like for the pivotal quantity of demand
    - Firm is a monopolist facing a perfectly inelastic demand for the pivotal quantity of energy
    - Regulatory intervention needed to set price in these circumstances
- Frequency that firm is a pivotal bidder in a given market is a measure of its market power
  - Low frequency of being a pivotal bidder implies that firm possesses limited market power

Pivotal Firm's Residual Demand



Advantages of Pivotal Bidder Frequency

- Pivotal bidder frequency can be computed without actual bids, production or prices
- Use each firm's capacity and duration curve for aggregate demand
  - Compute pivotal bidder frequency assuming all firms besides firm under consideration bids all or a fraction of its capacity into the market
  - Can incorporate transmission path outage distribution with load duration curve in analysis
    - Crude model of impact of transmission constraints on extent of market power firm or generating unit possesses
  - Can incorporate random generation unit forced outages by competitors into pivotal bidder analysis

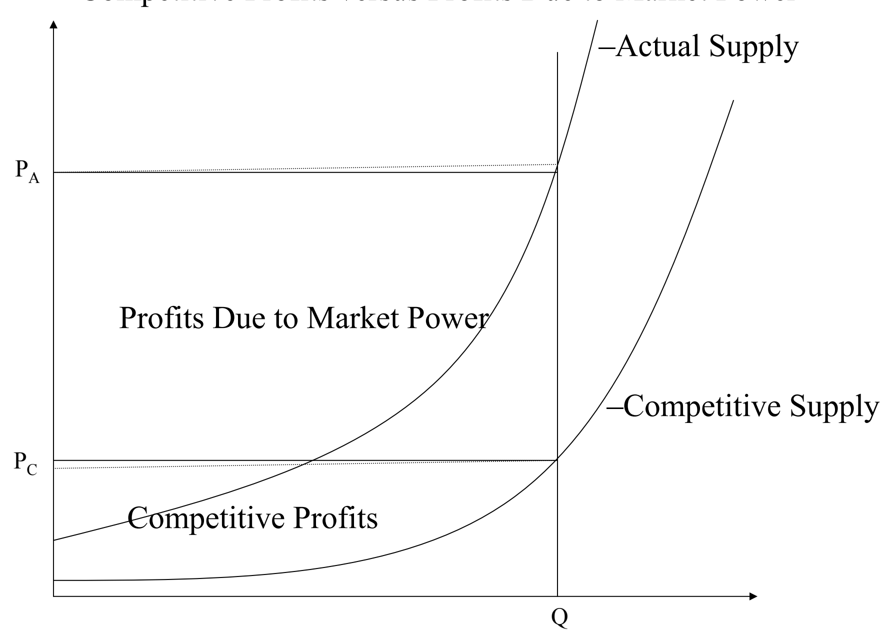
Cost of Market Power

- If firm faces sufficiently elastic distribution of residual demand curves it will bid its marginal cost curve
- For all realizations of residual demand
  - Marginal Revenue = Average Revenue = Price
- Monopoly solution (produce where MR = MC)
  - Bid Price = MC for relevant range of output
- Optimal selling rule--supply a unit if the price is above the marginal cost of providing that unit.

Measuring Market Inefficiencies

- Borenstein, Bushnell and Wolak, "Diagnosing Market Inefficiencies in California's Re-structured Wholesale Electricity Market," (2002), *American Economic Review*.
- Intuitive view market power measure--Compare actual market price to market price that would result if all firms behaved as if they had no ability to raise market price (no market power)
  - Industry supply curve is aggregate marginal cost curve.

Competitive Profits versus Profits Due to Market Power



Supply Side Complications

- Account for daily fluctuations in prices of natural gas and other fossil fuels in California
- Extremely important to analysis for Autumn and Winter of 2000
  - Natural gas prices where more than four times higher than in two previous years
- Account for fluctuations in daily costs of NOx emissions permits to produce electricity for units in emissions-constrained areas
  - Primarily LA Basin--Could add more $50/MWh to variable cost of production for some units
  - For more on this issue see, Kolstad and Wolak (2003) "Using Environmental Emissions Permit Prices to Raise Electricity Prices: Evidence from the California Electricity Market," available from web-site.
- Account for forced outages of generation units

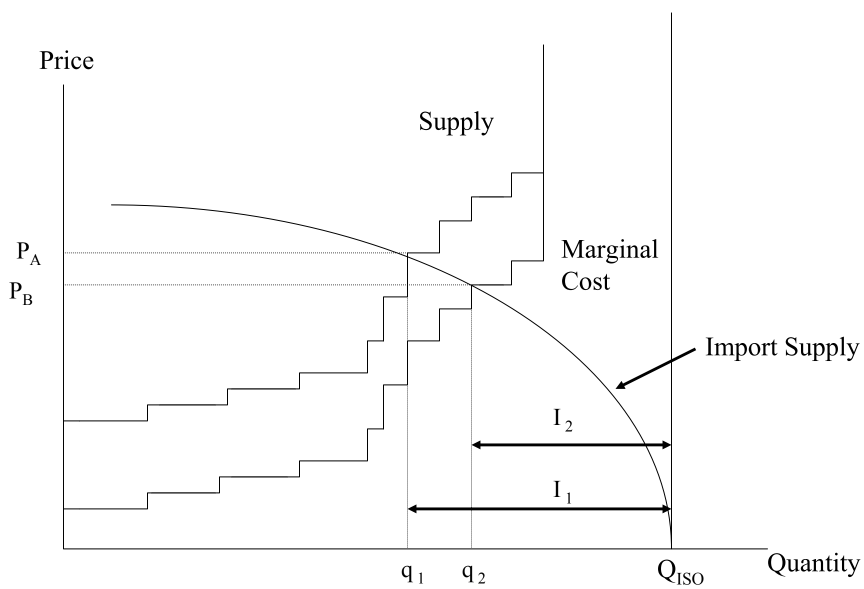
Complications in Estimation: Supply Side

- Cannot implement procedure on the supply side for must-take, hydro, or out-of-state production
- Adjust for must-take supply, which is all inframarginal, by removing it from cost curve and remove equal quantity of demand
- Assume that *actual* hydro dispatch is cost minimizing (that is, no exercise of market power) so remove it from cost curve and remove equal amount of demand
- Imports should decline if price declines as a result of price-taking behavior by in-state suppliers

Import Adjustment to Competitive Bidding

- All generators and importers submit adjustment bids along with day-ahead energy schedules
  - Willingness to reduce and increase imports and exports as a function of market price
  - Use these bids to compute net import supply curve (imports – exports) at each tie point
  - This allows the computation of counterfactual net imports and residual in state generation demand in response to lower market-clearing prices
- This methodology should under-estimate extent of market power
  - Does not impose market separation in congestion management process
  - Assumes no exercise of market power by importers

Net Imports Reduced by Competitive Bidding



Empirical Results

For various sets of days, D, and sets of hours ,H, compute
PCOMP(D,H) = Average competitive price
PACT(D,H) = Average actual price

MP(D,H) = PACT(D,H) - PCOMP(D,H)

$$PCOMP(D,H) = \sum_{d \in D} \sum_{h \in H} E(c_{hd})(Q_{hd}^{ISO} - Q_{hd}^{MT}) / (\sum_{d \in D} \sum_{h \in H} (Q_{hd}^{ISO} - Q_{hd}^{MT}))$$

$$PACT(D,H) = \sum_{d \in D} \sum_{h \in H} P_{hd}(Q_{hd}^{ISO} - Q_{hd}^{MT}) / (\sum_{d \in D} \sum_{h \in H} (Q_{hd}^{ISO} - Q_{hd}^{MT}))$$

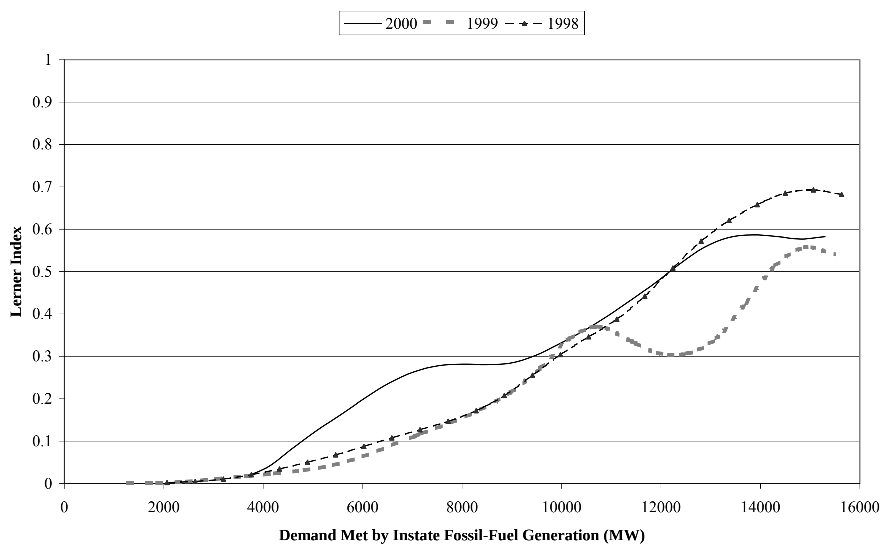
Energy, A/S Costs and Market Power Markup from 6/98 to 12/00

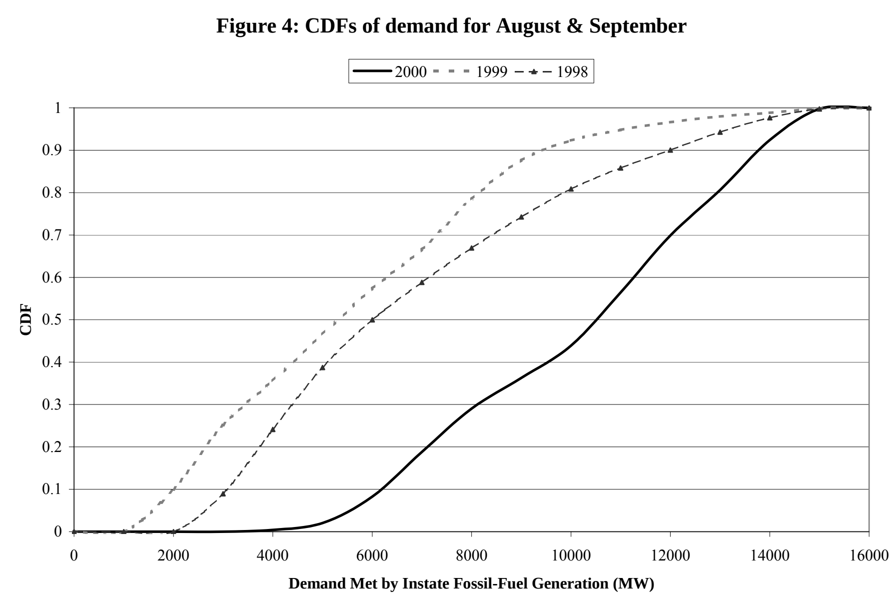
Month	Energy Cost $/MWh	A/S Costs $/MWh of Load	Total Costs per MWh	MP(S) $/MWh
Jun-98	13.52	2.95	16.47	-9.39
Jul-98	35.85	5.18	41.03	8.48
Aug-98	44.04	6.18	50.22	16.31
Sep-98	37.62	4.37	41.99	11.53
Oct-98	27.43	2.69	30.12	1.63
Nov-98	26.65	2.24	28.89	-0.62
Dec-98	30.17	2.99	33.16	4.88
Jan-99	21.73	1.75	23.48	-0.78
Feb-99	19.70	1.14	20.84	-1.65
Mar-99	19.40	1.51	20.91	-1.53
Apr-99	24.80	2.1	26.90	0.39
May-99	24.91	2.37	27.28	-0.46
Jun-99	25.85	2.26	28.11	-0.07
Jul-99	31.84	2.6	34.44	3.95
Aug-99	35.13	1.85	36.98	0.63
Sep-99	35.46	1.52	36.98	5.25
Oct-99	49.40	2.28	51.68	15.24
Nov-99	38.35	1.19	39.54	9.90
Dec-99	30.35	0.55	30.90	2.93
Jan-00	31.85	0.62	32.47	4.61
Feb-00	30.49	0.58	31.07	1.30
Mar-00	29.49	0.06	29.55	-1.92
Apr-00	27.76	0.95	28.71	-5.00
May-00	51.81	3.16	54.97	10.88
Jun-00	141.40	20.19	161.59	85.52
Jul-00	121.93	5.71	127.64	42.14
Aug-00	181.59	12.18	193.77	101.71
Sep-00	122.85	7.39	130.24	43.96
Oct-00	103.84	2.95	106.79	35.55
Nov-00	172.29	6.13	178.42	60.66
Dec-00	388.21	22.65	410.86	143.50

What Explains Differences Across Years in Market Power?

- Borenstein, Bushnell and Wolak (2002) Compute hourly Lerner Index as a function of amount energy produced by in-control-area fossil-fuel units
- LI = (P(actual) - P(comp))/P(actual)
- LI = Lerner Index
  - LI is bounded by 0 and 1
  - High values of LI indicate more market power
- LI = f(Instate Thermal Production) + error

Figure 3: Kernel Regressions of Lerner Index for August & September





Summary of Market Performance for April 1998 to Dec 2000

- Market power historically exercised during months of August to September
- Little market power exercised during months of October to April
- More market power exercised in 1998 than 1999
- Competitive benchmark outcome over period October 1998 to September 1999
  - P(actual) – P(bench) is approximately zero over this 12-month period
- Substantially more unilateral market power exercised in 2000 relative to 1998 and 1999
  - P(actual) – P(bench) approximately $45/MWh for year 2000

Explaining Market Performance for April 1998 to Dec 2000

- Major question is whether decrease in market performance due to unilateral actions or coordinated actions to raise prices
  - The former violates "just and reasonable price" standard of Federal Power Act of 1935 and the latter violates US antitrust law
- Compute average hourly firm-level measures of unilateral market power for three summers for five merchant suppliers
  - Duke, Dynergy, Reliant, AES/Williams and Mirant
- Unilateral market power analysis will compare the period June 1 to September 30 each year
  - For each hour and for each supplier compute $-1/\varepsilon_{hj}$
    - Inverse elasticity of residual demand curve
    - Computed "smoothed" version of $-1/\varepsilon_{hj}$
      - Recall that residual demand curves are step functions
  - $-1/\varepsilon_{hj}$ depends on all bids (but that supplier's) submitted to ISO's real-time energy market and total demand for this market

Summary of ISO's Real-Time Market

- ISO operates real-time energy market to maintain system balance
  - Generation unit owners first self-schedule their generating units
  - ISO then runs real-time market relative to these schedules
- There are number of ways that a supplier's bid can enter the ISO's real-time energy market
  - Win in ancillary services (reserve capacity) market
    - Spinning reserve, Non-Spinning reserve, Replacement reserve
    - Loads can bid to supply Non-Spinning and Replacement reserves
  - Can bid into supplemental energy market without providing reserve
    - In-state suppliers, imports, and dispatchable load can bid
- Real-time energy bids are extremely flexible
  - Each hour each unit can be up to 10 price-quantity pairs
  - Multiple generating units at each power plant
  - Around 1 million hourly bid increments submitted during June 1 to September 30 time period each year
    - Approximately 3 bid steps per unit per hour

Summary of ISO's Real-Time Market

- Unlikely that market rules on feasible bid curves significantly constraint ability of firms to satisfy
  - $(P_h - MC_{jh})/P_h = -1/\varepsilon_{hj}$ each hour for each firm
- Because real-time market is an incremental market demand can be either positive or negative
  - Low-prices occur when demand is negative
  - Exclude all hours with prices below \$20/MWh
    - \$20/MWh is slightly below to system-MC in 1998 and 1999
    - \$20/MWh is far below system-marginal cost in 2000
    - At prices below \$20/MWh we would expect firms to exercise market power by driving prices down—need to know QC_{jh} to infer market power
- Market can separate on a zonal basis if there are transmission constraints between northern and southern California
  - Separate market prices for each zone
  - Exclude hours with transmission congestion
- Both of these exclusions should bias against finding differences in firm-level market power across years

Computing Residual Demand Elasticity--ε_{hj}

- Recall that each bid is step function with up to 10 steps
  - Must compute an arc-elasticity at P_h
- $DR_{jh}(P)$ = residual demand of firm j during hour h at price P
  - $P_h(h)$ first price above P_h with smaller residual demand than $DR_{jh}(P_h)$
  - $P_h(l)$ first price below P_h with larger residual demand than $DR_{jh}(P_h)$
- $\varepsilon_{hj} = \{[DR_{jh}(P_h(h)) - DR_{jh}(P_h(l)]/[P_h(h)) - P_h(l)]\} \times$
  $\{[P_h(h)) + P_h(l)]/[DR_{jh}(P_h(h)) + DR_{jh}(P_h(l)]\}$
- Also computed results for $P_h(h) = P_h + x$ and $P_h(l) = P_h - x$
  - For x = \$1 and x = \$5
- Computed results using smoothed residual demand
- $-1/\varepsilon_{hj}$ is "ordinal index" of extent of unilateral market power
  - Scale depends on how you compute DR'(p)

Results for June to September

Average Hourly Value of L_{hj} for June to September for Hours with Prices Above $20/MWh			
Firm	1998 Mean (Std Error)	1999 Mean (Std Error)	2000 Mean (Std Error)
1	0.0455 (0.0075)	0.0349 (0.0081)	0.1643 (0.0289)
2	0.0398 (0.0073)	0.0278 (0.0065)	0.1637 (0.0294)
3	0.0544 (0.0098)	0.0315 (0.0077)	0.0948 (0.0284)
4	0.0649 (0.0128)	0.0323 (0.0072)	0.1897 (0.0318)
5	0.0547 (0.0098)	0.0347 (0.0080)	0.1605 (0.0289)

Results Broadly Consistent with BBW (2002)

All numbers in column for 2000 are statistically significantly greater than corresponding number in columns for 1998 and 1999 with high degree of statistical precision

Most numbers in column for 1998 are statistically significantly greater than corresponding number in column for 1999

Little unilateral firm level-market power exercised by five large generation owners in 1998 and 1999
- Firm-level market power during 1998 slightly higher than firm-level market power in 1999

Substantial higher firm-level market power exercised in 2000 relative to 1999 and 1998
- All five firms had unilateral incentive to withhold output from market by either bidding higher or withholding capacity from market

Conclusion from Firm-Level Market Power Analysis

• Results answer the often asked question: Why would suppliers in California unilaterally withhold output from market given how high prices were during 2000 versus 1999 and 1998?

- It was in their unilateral profit-maximizing interest given the bids submitted by their competitors!

• For more details see Wolak (2003) "Measuring Unilateral Market Power in Wholesale Electricity Markets: The California Market 1998 to 2000" *American Economic Review*, May, available from web-site.

Origins of Local Market Power

- Wholesale market has independent system operator (ISO) to allocate transmission network capacity
  - Owner of local generation financially independent of ISO
    - In both short-term and long-term, ISO cannot take advantage of economies to scope between transmission and generation that current transmission network was designed to utilize
      - Economies to scope exist if joint operation of transmission network and local generation yields lower annual cost of supplying local energy
    - Local generators have strong incentive to cause transmission constraints into their local area under ISO regime
      - Raise local prices for energy (either by withholding capacity or bidding high prices) to cause congestion under ISO regime
  - In US, state public utilities commissions (PUCs) sold off generation assets of former vertically integrated monopolists in bundles of units located in small geographic areas
  - Very little transmission investment in past 25 years
    - Both of these facts exacerbated local market power problems

Origins of Local Market Power

- Because of the way state regulators currently price retail electricity hourly wholesale demand is virtually inelastic with respect to wholesale price
  - Little deployment of interval metering technology necessary to support active end-user participation in wholesale market
- Transmission network configuration, geographic distribution of wholesale electricity demand, concentration in local generation ownership, and production decisions of other generation units combine to create system conditions when a single firm may be only market participant able to meet a given local energy need
  - This firm is monopolist facing completely inelastic demand
  - No limit to price it can bid to supply this local energy need
- Congestion management or locational-pricing scheme does not solve locational market power problem
  - ISO must have the ability to mitigate bids of units that it determines possess local market power

Local Market Power Problem

- Local market power problem is a short-term problem that could last for a very long time without coordinated action by regulators---Actions needed include
  - Local market power mitigation measures in place approved by regulator
  - Symmetric treatment of load and generation
    - Reduce frequency that mitigation must occur
  - Transmission upgrades to create a network that supports a competitive energy market rather than enhancing opportunities to exercise local market power
    - Economic reliability of transmission network versus engineering reliability of transmission network
    - Requires coordination between state and federal regulators to determine and approve transmission upgrades
  - Spot price risk management by load-serving entities
    - Requires regulator to allow full retail competition or approval of prudent purchasing by regulated monopoly retailer

Lessons for Designing Mitigation Mechanisms

- If mitigate too much can destroy incentives for least-cost production by suppliers
  - Suppliers take actions to maximize profits by exploiting mitigation mechanism
  - When market can be relied upon to set prices this will lead to higher prices
- If mitigate too much in spot market can destroy incentives for load-serving entities to hedge risk of high spot prices
  - Stronger argument against mitigation of system-wide market power versus local market power
  - Signing a forward contract with supplier that knows it will be needed to provide local energy will not result in a lower price unless this supplier faces competition to supply this energy at some time horizon up to delivery
    - Local market power in San Francisco
    - Prospective mitigation mechanism provides transparency in opportunity cost of forward contract for local supplier

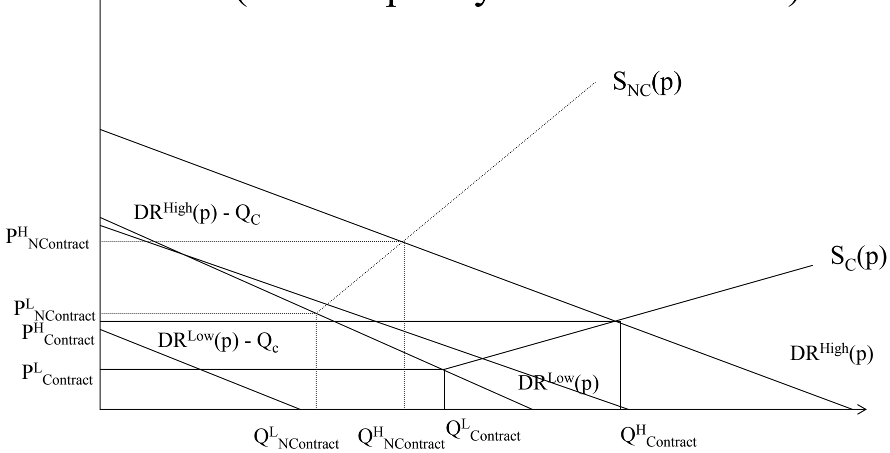
Market Design = Limiting Market Power of Firms

- Make residual demand curves perceived by all unit owners as elastic as possible
  - Generators facing infinitely elastic residual demand curve perceive themselves as being unable to impact the market price by their bids
  - Optimal strategy for generation unit owner facing infinitely elastic residual demand curve is to bid marginal cost curve (MC) as willingness to supply curve [S(p)]
  - This will lead to market prices as close as possible to market designer's optimum

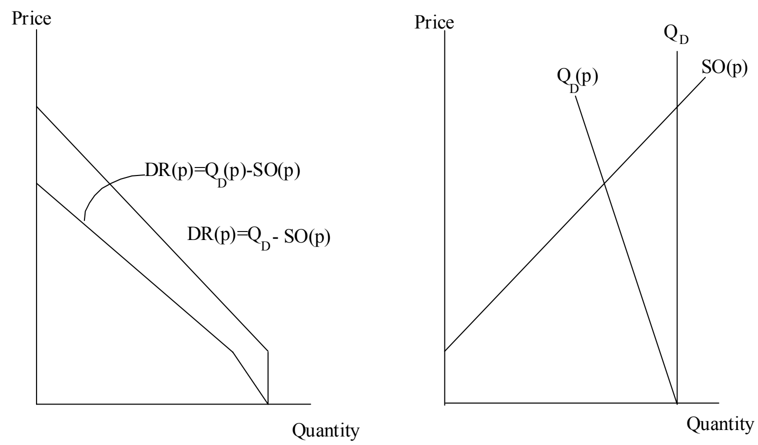
Limiting Market Power of Firm

- Market Power problem increasingly more extreme the closer market gets to real-time
  - Set of potential competitors increases as time between price negotiation and delivery increases
  - Only those plants operating with unloaded capacity can deliver energy in real-time
- Forward Financial commitments make firm bid more aggressively in spot market
  - This makes other firms want to bid more aggressively

Profit-Maximizing Bidding
With $Q_C > 0$ and $Q_C = 0$
(For Simplicity Assume MC = 0)



Benefits of a Price Responsive Demand



Symmetric Treatment of Load and Generation

- Question: Which retail pricing scheme is more likely to prevent the exercise of market power?
  - Retail price at each node equal to expected annual average hourly price at that node
  - Retail price each hour set equal to the average (spatial) average hourly at each node
- Answer: Hourly pricing of retail electricity far more important to preventing exercise of market power
- Best market power mitigation measure is symmetric treatment of all consumers and producers
  - **Default price all consumers pay is real-time energy price**

How to Make Competition Benefit Consumers

- Symmetric treatment of producers and consumers of electricity
  - From perspective of grid reliability, a consumer is a supplier of "negawatts"--SN(p) = D(0) - D(p)
- Default price for all consumers should be hourly wholesale price
  - Consumer is not required to pay this price for any of its consumption, just as generator is not required to sell any output at spot price
  - To receive fixed price, consumer must sign a hedging arrangement with load-serving entity or electricity supplier
  - Option to return fixed default price at any time is extremely costly option to offer—Ask California consumers
- There is nothing unusual about hedging spot price risk
  - Health, automobile and home insurance, cellular telephone

Oversight of risk management

- Electricity retailing = spot price risk management
  - Regulators must ensure that retailers don't gamble with ratepayers money
  - Monitor forward contract holdings and obligations
    - 500 MWh fixed price retail obligation 1 year from now requires 400 MWh fixed price wholesale commitment 1 year from now
  - May be expected profit-maximizing to satisfy fixed price retail obligation from spot wholesale market
    - Go bankrupt if spot price increases too much
- Analogy to retail banking sector
  - Banks take in deposits and may be tempted speculate with deposits to earn higher returns
  - Regulators set short-term reserve requirements to prevent this

Transmission as a Facilitator of Competition

- Transmission upgrades increase number of independent suppliers that can compete to supply electricity at given location in network
  - Reduces extent to which all of these suppliers bid in excess of minimum cost marginal cost of supplying electricity
  - Suppliers have little incentive to undertake upgrades under this scheme
    - Strong incentive to oppose upgrades to preserve local market power
- Engineering Reliability was criterion for determining upgrades in vertically integrated regime
  - Enough transmission capacity so that
    - Demand at all locations in network can be met with pre-specified probability
    - Assuming that virtually all generation units in network are owned and operated by same entity

Transmission as a Facilitator of Competition

- Economic Reliability should be criteria in wholesale market regime because configuration of transmission network impacts extent of market power suppliers can exercise
- Sufficient transmission capacity so that all locations in the network face significant competition from enough independent suppliers to cause them to bid close to their marginal cost curve the vast majority of hours of the year
  - All suppliers face sufficiently elastic residual demand curves a large fraction of hours of the year
- Generation divestiture decisions can increase the economic reliability of a given transmission network
  - Conversely, to the extent that significant generation divestiture cannot be implemented, more transmission investment may be needed to achieve economic reliability
- Transmission network facilitates commerce in same way that interstate highway system facilitates commerce US economy
  - US Highway system built at a cost of 330 billion 1996 dollars
  - Net benefits from system vastly in excess of this magnitude

Need for Independent Assessment of Value of Transmission Upgrades

- Supplier's expected profit-maximizing bids depend on distribution of residual demand curves faced
- Distribution of residual demand curves any supplier faces depends on transmission network configuration
  - With more transmission capacity, faces suppliers with competition from more independent suppliers
  - Reduces slope of residual demand curve this supplier faces
- In quantifying net benefits of given transmission configuration must recognize that
  - Changes in network configuration will change expected profit-maximizing bidding behavior of suppliers
- Conclusion--Transmission network configuration choice *should recognize and anticipate* expected-profit maximizing responses of suppliers in selecting welfare-maximizing network configuration

Assessing Need for Transmission Upgrades

- Time lag to build transmission facilities substantially longer than lag to build generation facilities provide further justification for economic reliability approach
- Building transmission in response to generation entry will be a continual process of catching up with consumers always bearing the cost of catching up
- Building transmission network recognizing that supplier
  - Will enter where it is profit-maximizing to do so
  - They will bid to maximize profits once they enter
- Current cost of transmission network is small part of delivered price of electricity
  - Roughly 0.4 cents/KWh delivered is average cost of transmission network for California ISO control area
  - Average retail price of electricity close to 13 cents/KWh

Assessing Need for Transmission Upgrades

- Undertaking upgrades that double transmission charge would come much closer to economically reliable transmission network for California
  - More competitive wholesale market would very likely lead to average wholesale energy price reductions greater than increase in transmission charge, so that delivered price of electricity would fall and retail prices would fall
- Conclusion--Larger role (than in previous regime) for regulatory oversight in determining configuration of transmission network to maximize benefits of wholesale competition
  - Extremely difficult challenge associated with realizing full benefits of wholesale competition
  - Because of initial excess capacity in transmission network in most international markets this issue has not yet arisen

Micro Market Power Mitigation

- Automatic Mitigation Procedure (AMP)
  - Look at individual bids submitted and compare them to a reference price
    - If bids exceeds reference price by some level then proceed to conduct test
  - If bid would impact market price by some pre-set amount
    - Then mitigate bid to reference price, or more typically reference price plus arbitrary adder
      - Can distort market outcomes
- AMP makes it costly for generators to bid low prices
- May reduce price volatility, but may not reduce and may even increase amount of market power exercised

Macro Market Power Mitigation

- Compare 12-month rolling average actual price to 12-month rolling average benchmark price
  - Take rolling average of hourly market prices over entire 12-month period and compare this to average hourly competitive benchmark price over same 12-month period
  - If difference in P(actual) and P(benchmark) exceeds some critical value then automatic regulatory intervention occurs to protect consumers
- Requires no "AMP-like" hour-to-hour regulatory intervention by ISO
  - Can set high or no bid cap or price cap and therefore allow hourly price signals
- Consumers protected from excessive market power
    - Recommended level--$5/MWh difference between 12-month average P(actual) - P(benchmark)
    - This would have not triggered regulatory intervention until June of 2000 in California
- Macro mitigation protects consumers from significant harm by requiring automatic intervention when this harm occurs
  - Micro mitigation may not—paying $4/MWh too much over 4000 hours causes equivalent consumer harm to paying $400/MWh too much over 10 hours

Some Outstanding Issues

- Ex Ante versus Ex Post mitigation
  - Giving money back extremely difficult
  - Ex post can do more careful analysis of amount due
  - Combination of Ex Ante and Ex Post possible
- Regulatory Clarity
  - Market performance indexes
  - Standard measures of market power endorsed by regulatory bodies
- Across-market and across jurisdiction coordination of regulatory oversight
  - Natural gas regulation and electricity regulation
  - Federal and state regulatory policies
- Rules versus Discretion in market and system operation
  - System Operator sets own rules with limited regulator intervention
  - Regulator sets all rules with limited System Operator input