



CALIFORNIA ISO

California Independent  
System Operator

# Interpreting Evidence for Market Power

*Anjali Sheffrin, Ph.D.*

*Director, Market Analysis, CAISO*

<http://www.caiso.com/surveillance/>

*POWER Conference, Berkeley, CA*

*March 16, 2001*



## Puller Study: Pricing and Firm Conduct in California's Deregulated Electricity Market

- Key Assumptions:
  - Uses EPA generation utilization data and PX MCP for April 1998-December 1999
  - Symmetric firms
  - Game where firms Choose Production Quantity
- Reduced form regression to study utilization rates and 2 Structural equations on firm conducts
- Searching for static or dynamic market power
- Found evidence of static market power consistent with Cournot pricing model



## Puller's Findings : Reduced form regression

- Found utilization rate by firm negatively correlated with share of profitable capacity
- Not significantly related with projected demand or lagged change in market shares (which would have indicated dynamic market power)



## Puller Findings: Structural Equations

$$P(q_{it} + q_{-it}) - c_i(q_{it}) - \lambda_{it} = -\theta_{it} P'_t q_{it} + \mu_t \frac{d\pi^{BR}}{dQ_t}$$

H<sub>1</sub>: No Market Power:

$$\theta_{it} = 0, \quad \mu_t = 0, \quad \lambda_{it} \geq 0$$

H<sub>2</sub>: Static Market Power:

$$\theta_{it} = 1, \quad \mu_t = 0, \quad \lambda_{it} \geq 0$$

H<sub>3</sub>: Dynamic Market Power:

$$\theta_{it} = N, \quad \mu_t \geq 0, \quad \lambda_{it} \geq 0$$

- Supports H<sub>2</sub> ( $\theta = 1$ ); Found no evidence of dynamic market power
- However, full dynamic specification did not support the static results ( $\theta < 1$ )



## Joe Crespo et al:

### Bidding Asymmetries in Multi-Unit Auctions: Bid Function Equilibria in the British Market

- Key Assumptions
  - Detailed Bidding Data
  - Asymmetric Firms: Price Setter and Non-Price Setters
  - Game where Firms Choose Bid Prices
- Regression and Simulation Display Fit to the BFE Hypothesis in UK Market



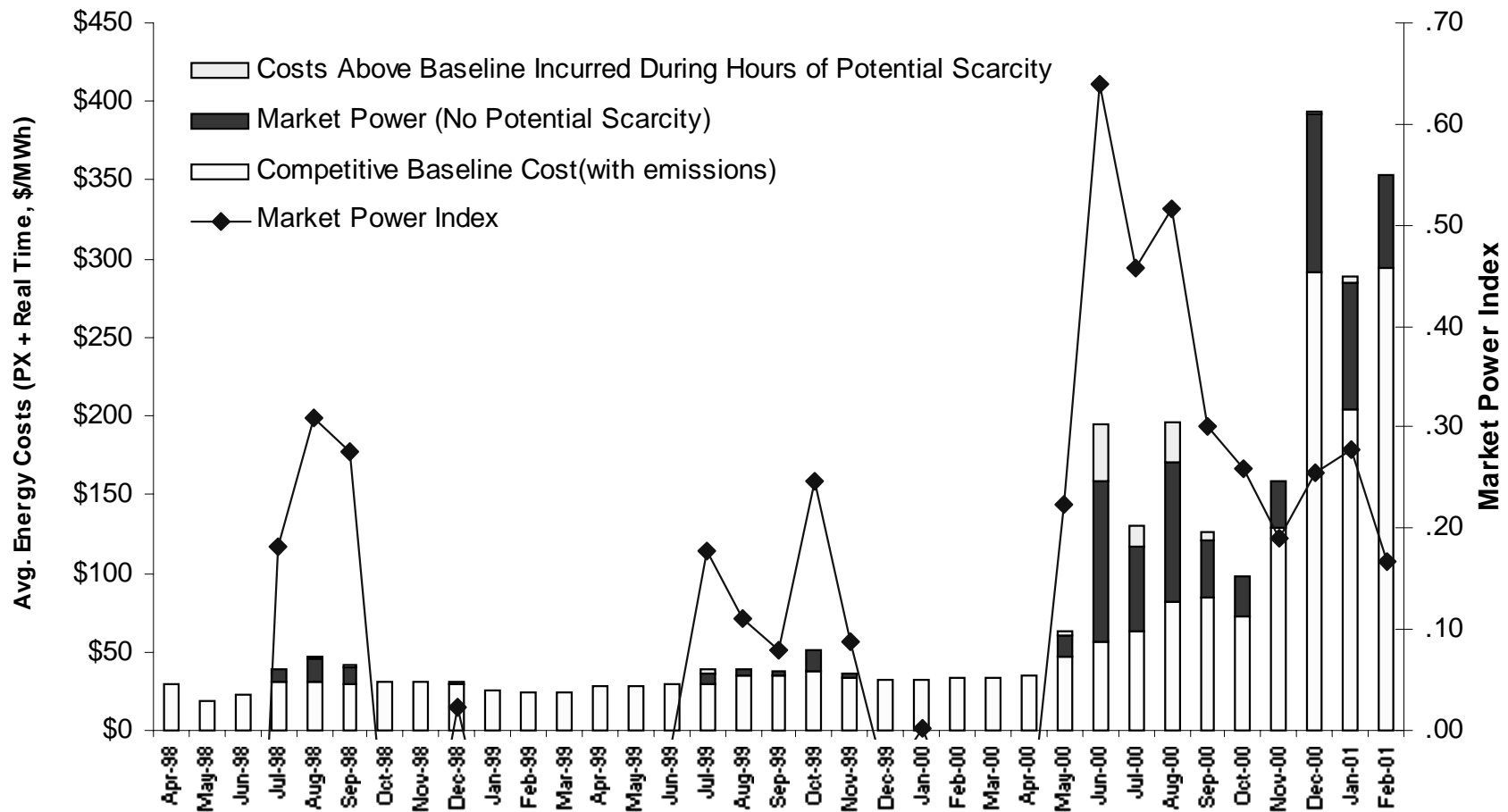
CALIFORNIA ISO

California Independent  
System Operator

# Do These Models Explain the California Experience?



## Significant Market Power Experienced in Calif. Electricity Markets Totaling Approx \$5.5 Billion From May 2000 – Feb 2001 (Accounts for emissions and scarcity hours which includes 10% system reserves)





CALIFORNIA ISO

California Independent  
System Operator

# Empirical Market Experience: CA ISO Study

- Objective:
  - Identify individual firms engaging in market power activity
  - Analyze how each firms' actions set market clearing prices
- Utilized full bidding data in CA ISO real time for each hour between May and Nov 2000
- Defined and categorized bidding patterns and identified withholding (economic or physical)
- Calculated bid-cost mark-up and monopoly rent
- Preliminary checks against key predictions of supply function equilibrium



# CAISO Findings

- Economic withholding is the dominant bidding pattern used by the five large non-UDC generators (two above 80% and two above 70% times).
- Pure physical withholding less than 10% of the time.
- Bid curves were typically increasing step functions. Some very fine steps to approximate upward line segment.
- A few firms bid at or close to the MCP.
- Bid-cost mark-up (Leaner Index) above 50%. (More than \$100 on peak, June to Sept.)
- Approximately \$5.5 billion monopoly rents extracted from May 2000 to Feb 2001.
- Confirmed key predictions of Supply Function Equilibrium
  - Mark-up positively correlated with output quantity
  - Mark-up negatively correlated with residual demand elasticity



# Do We Have the Right Model?

	<b>Puller</b>	<b>BFE</b>	<b>SFE</b>	<b>Empirical Evidence</b>
<b>Symmetry</b>	Yes	No	Both Types	Both Types
<b>Choice Variable</b>	Quantity	Price	Price	Price and quantity
<b>Mark-up</b>	High (Cournot)	Low	Med	Med to High
<b>Other Features</b>	Dynamic Game	Only one price setter, other large firms bid MC (Inconsistent with CA obs)	Not fully tested in terms of econometrics implications	Multi-settlements complicates research