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# Predicting Market Power Using the Residual Supply Index

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## Motivation and Objectives

Two sets of metrics to monitor market power

- Measure of Market Power Impact (Price-cost markup. Studies cited above)
- **Indicators of Market Structure :**
  - N-firm concentration or 20% Market Share
  - Traditional HHI
  - Pivotal Supplier Indicator, SMA indicator
  - Residual Supply Index (RSI)

What is the more accurate predictor of market power in electric markets?

- Theoretical analysis and empirical study can provide guidance



## Development of Residual Supply Index

Inadequacy of HHI and n-firm concentration index for electricity markets

HHI index below 2000 can mean significant price-cost markups

1-firm concentration below 20% (market based rate screen) but many firms can bid to inflate prices

Need for indicators which reflects three key factors affecting market outcomes: (1) Demand, (2) Total available supply and (3) Large suppliers' capacity share and contract position



## Pivotal Supplier Indicator

Pivotal Supplier Indicator -- A first attempt to capture the three key factors

A binary variable: whether or not a supplier is pivotal in the market given the hourly supply and demand situation. Or without this supplier, can the residual supply meet the demand?

Significant improvement in predicting market power over traditional indicators

SMA is a form of pivotal supply indicator applied to annual peak condition

Insufficiency of binary variable: ability to exercise market power when pivotal supply index close to but less than pivotal

Extract further information: The RSI index



## Definition of Terms in Residual Supply Index

$$RSI = \frac{\text{Total Supply} - \text{Largest Seller's Supply}}{\text{Total Demand}}$$

**Total Supply = Total in-state supply capacity + Total net import**

1. Total in-state supply Capacity = Thermal capacity [P\_max – outage] + Must\_Take\_mw

*Note: Must\_Take\_mw includes all the other generators, such as hydro, nuclear, and cogeneration. It is measured as:*

*Max [Energy bid in the market, Metered output]*

2. Total net import consists of total net hour-ahead schedule, import through real-time imbalance market, and OOM calls, and measured as: Max [Scheduled, metered]

Total demand = Metered Load + Purchased Ancillary Service

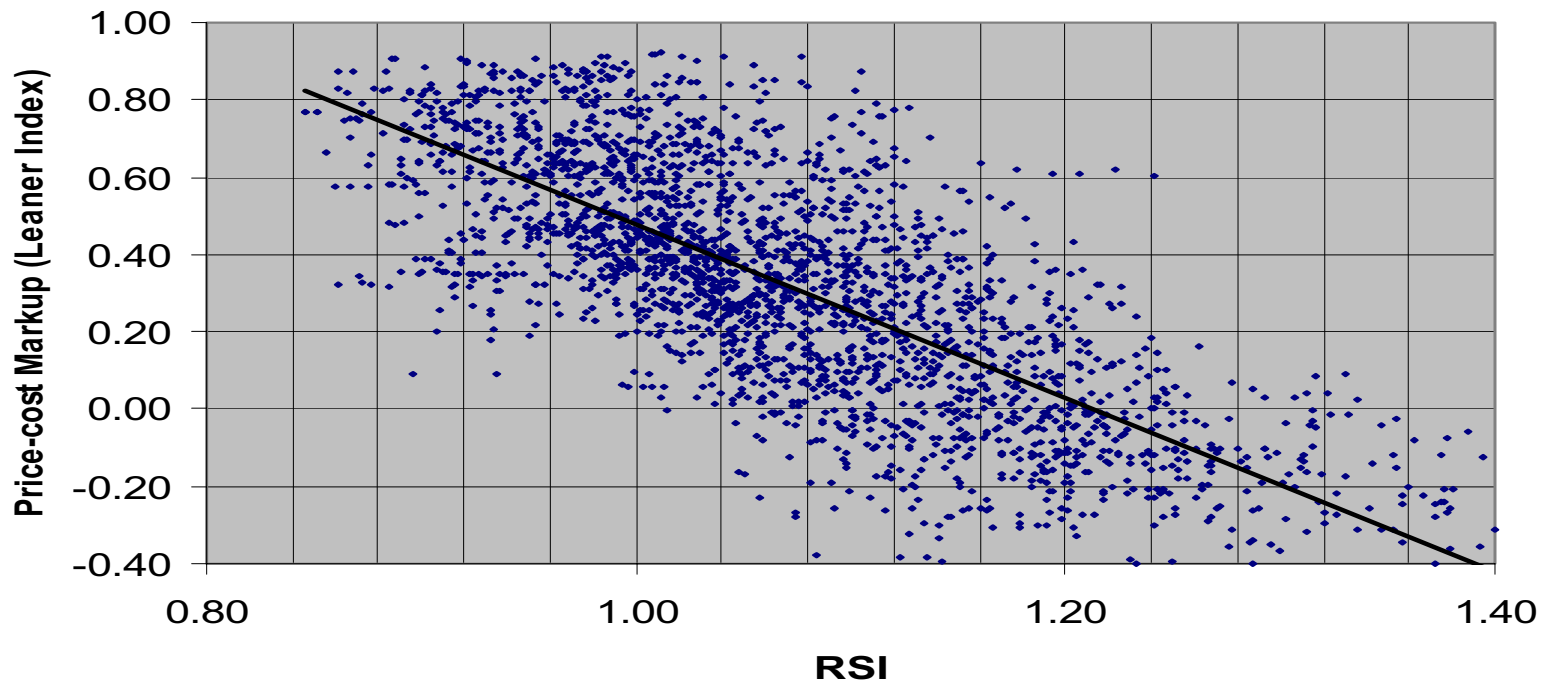
Largest Seller's Supply: Largest Seller's Capacity – It's Contract Obligation to Load



## Explanation of Estimation Results

*Significant correlation between the Lerner Index, RSI, and actual system load*

**RSI versus Price-cost Markup  
-Summer Peak Hours, 2000**

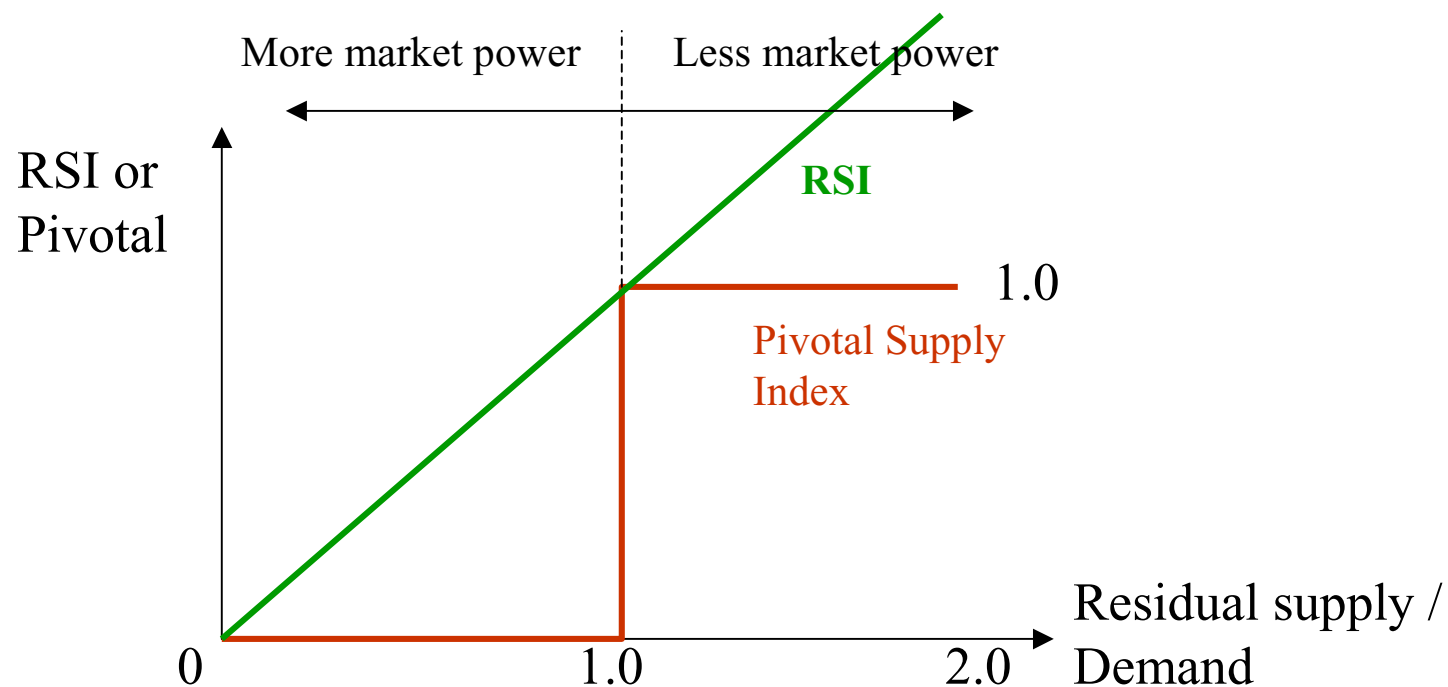




## RSI compared with Pivotal Supplier Index

Pivotal Supplier Index (and SMA) shows whether the residual supply is sufficient to meet market demand (binary index of 0 or 1)

RSI shows additional information of what the ratio of residual supply relative to demand is





## Economic Rationale for RSI

Based on oligopoly pricing models (such as Green and Newberry, 1992)

$$P_i - MC_i = Q_i / ((dS_r(p)/dp - dD(p)/dp));$$

$P_i$ : bid price for  $Q_i$  units of supply

$MC_i$ : marginal cost for  $Q_i$  units of supply

$D(p)$ : total demand at the price of  $p$

$S_r$ : supply from all suppliers other than firm  $i$  (residual supply)

- $Q_i$  has a positive effect on price-cost markup
- Residual Supply elasticity has a negative effect on markup
- Demand elasticity has a negative effect on markup

Empirically, RSI and load are used to predict price-cost markup (demand elasticity is negligible currently, and can be incorporated later)



## Illustration of RSI Computation for Entire Market in the Peak Hour

### 2000-2002

Year	Demand	Total Supply			Total Supply*	Largest Supplier Capacity**	RSI Index
	(MW)	Musttake (MW)	Thermal Capacity (MW)	Imported Energy (MW)	(MW)	(MW)	
2,000	50,421	23,995	17,798	2,386	47,443	4,002	<b>0.86</b>
2,001	45,197	21,674	19,186	2,309	47,155	3,683	<b>0.96</b>
2,002	48,070	21,019	20,036	7,353	49,474	4,424	<b>0.94</b>

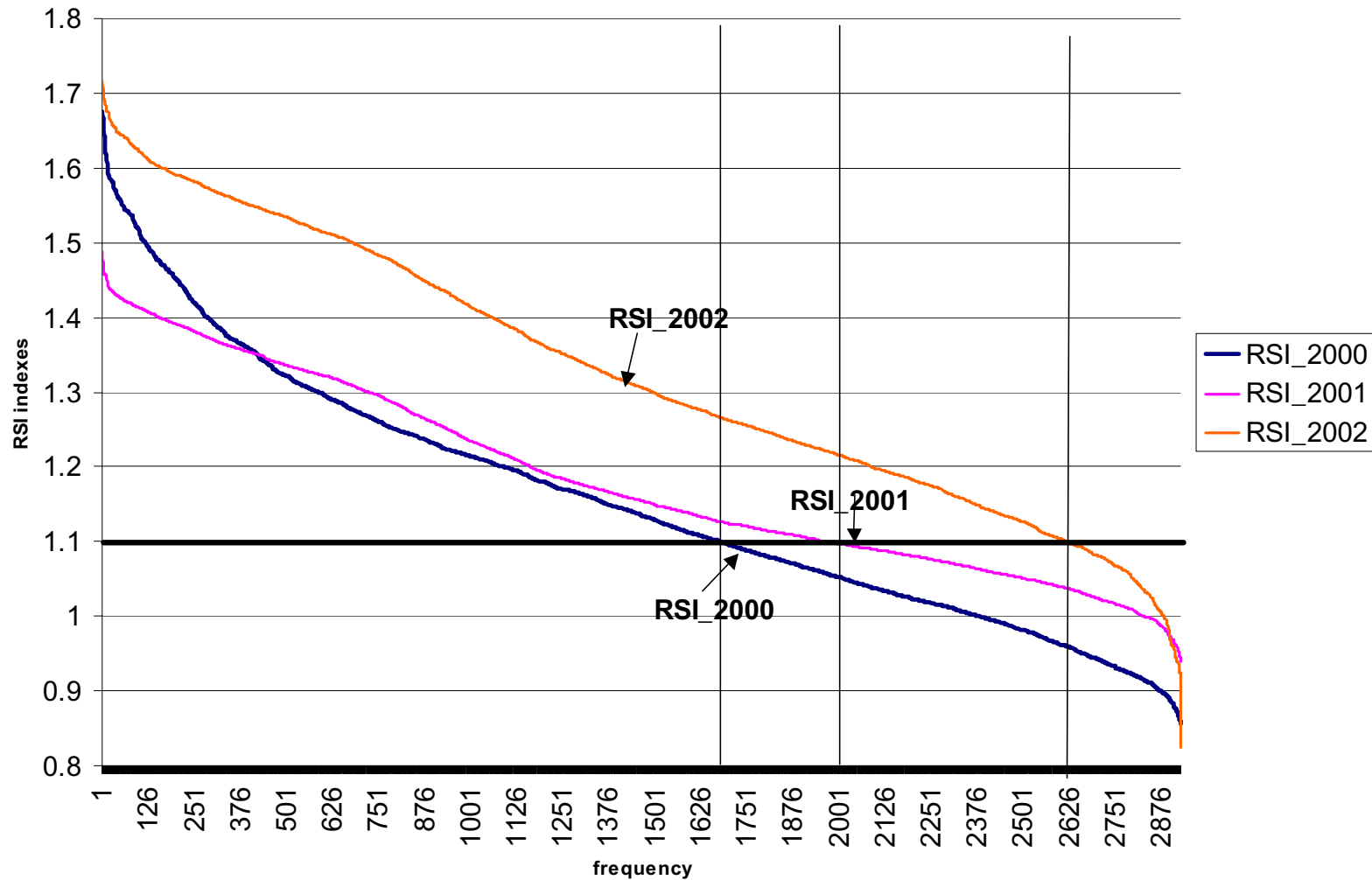
\* Total supply is slightly higher than the sum of musttake, thermal capacity, and imported energy because we also account for loss adjustment.

\*\* Largest suppliers (not the same) on peak hour did not have any contract cover.



# RSI Calculations for All Hours

## Duration Curve for Three Years June-September, 2000-2002





## Application 1: Simple Screening Rule for Market Competitiveness using RSI

We propose an RSI screen ( numbers are for discussion  
purpose only)

*RSI must not be less than 110% for more more than  
5% of the hours in a year (about 438 hours); or  
RSI must be more than 110% for 95% of the hours  
in a year*

Features of the RSI Screen Test

Rather than the peak hour, RSI index is computed  
for all hours in a year



## **Application 2: Using RSI screen for market-based rate screening -- Individual supplier's market power**

FERC has used HHI to determine market based rate authority

Recently, FERC proposed Supply Margin Assessment (SMA) screen

*If a Supply is pivotal during the annual peak hours, the supply does not pass the SMA screen test*

Similar to the RSI index

Weakness of SMA

- Overly restrictive and disqualifies a supplier for a single hour(peak hour)

- Does not account for operating reserve margin requirement

- Ignores the net buyer or seller position of a supplier and the possible collusion between suppliers



## **Advantages of Using the RSI Screening Test**

Allows for some hours where the threshold are exceeded to leave room for price fluctuation to reflect market situation, signal for conservation and new investment

Higher threshold of 110% accounts for possible collusion

Nets out capacity contracted to load under long-term fixed prices

Allows distinction between net buyers and net sellers in the markets

Threshold can be adjusted based on actual market experience



## Application 2: Using RSI screen to assess individual supplier's market power

An Illustration of a RSI Screen Test: % hours less than 110%

	Year 2000		With 5,050 MW additional capacity	
	% of Hours	RSI Screen	% of Hours	RSI Screen
Supplier 1	19.5%	Fail	4.3%	Pass
Supplier 2	20.8%	Fail	4.6%	Pass
Supplier 3	21.9%	Fail	5.2%	Fail
Supplier 4	22.6%	Fail	5.5%	Fail
Supplier 5	23.3%	Fail	5.9%	Fail



## Other Applications of RSI

- Using RSI to evaluate new transmission investment
  - Compare market power impact with and without transmission upgrade based on RSI simulation
- Capacity reserve required for competitive market
  - Using RSI simulation to evaluate system with different reserve level



## Summary and Future Work

The RSI Index is a simple and effective tool in monitoring market power

High accuracy in predicting market power and many applications

The RSI index has its limitations:

- No explicit consideration for the congestions within the area where RSIs are computed

Encourage more investigation on the relationship between the RSI indexes and price-cost markup in other spot markets and forward markets