# What We Do and Do Not Know About How Electricity Markets Work:
## implications for energy modeling and policy

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# Outline

- **Energy Policy and Modeling**
  - **traditional goals of modeling**
  - **deregulation and the new paradigm**
- **A generic blueprint of electricity restructuring**
- **Measuring market efficiency**
- **What we do and do not know**

# Energy Policy in the 21st Century

- **Deregulation of supply is a reality**
  - **Utilities aren't investing in new production**
  - **Regulators don't get to firms what kind of production to invest in any more**
    - » **policies setting goals for nuclear, coal, and renewable technologies need to recognize this reality**
- **Policy-makers have two main levers through which to influence energy markets**
  - **Competition policy**
    - » **anti-trust policy, RTOs as regulators**
  - **Environmental policy/ regulation**
    - » **straighten out the ends and the means**

# Modeling Energy Markets

- **Traditional models rely upon cost-based approaches**
  - **Deregulated firms act differently than regulated ones**
  - **example on transmission planning**
  - **example on ethanol in California**
- **Deregulation of energy markets creates a need for two new modeling approaches**
  - **modeling imperfect competition**
    - » **equal emphasis on strategic behavior and costs**
  - **Competitive benchmarking models**
    - » **'backcasting' market performance to measure market efficiency**

# Competitive Benchmark Analysis in Electricity Markets

- **Nature vs. Nurture argument in electricity**
  - **is it market structure or market design??**
- **Estimate perfectly competitive price levels and compare to observed price levels. Accounts for**
  - **fuel costs, shortages, outages, reserves, imports, hydro and must-take production**
- **Produces estimates of margins (p - MC) and Lerner Indices (p-MC)/p**
  - **Borenstein, Bushnell & Wolak (California)**
  - **Mansur (PJM)**
  - **Bushnell & Saravia (New England)**

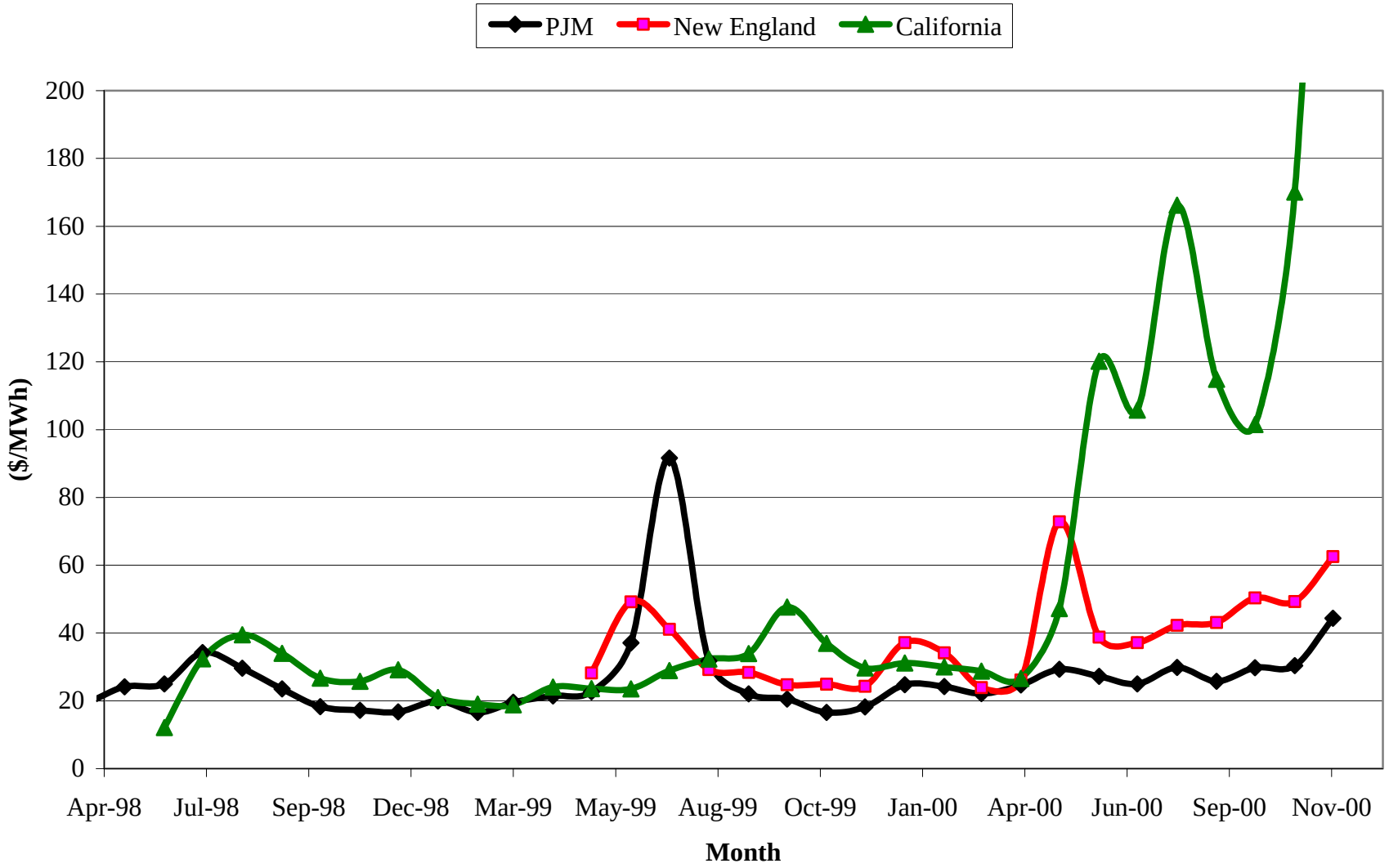
# US Electricity Restructuring: a generic blueprint

- **Deregulate power production**
  - **in some areas many assets retained by IOUs**
- **Create ISOs responsible for operating grid and maintaining system balance**
  - **ISOs run operating reserve and `imbalance energy' markets**
  - **market-based prices for energy overseen by FERC**
- **Customers can choose their retailers**
  - **but most of the retailers buy power from the same place at the same price**
- **'default' rates frozen for transition period**
  - **mechanism for funding `stranded' investments (i.e. nukes) by locking in `high' retail rates for some period**
  - **transition charge cannot be bypassed by switching retail providers**
- **No serious efforts to implement direct demand-side participation in wholesale markets**

# Important differences between US electricity markets

- **Ownership structure**
  - **eastern markets more concentrated**
  - **more capacity was retained by incumbent utilities in PJM than other markets (roughly 50%)**
  - **sale of capacity usually accompanied by 'buy-back' contracts in the east**
  - **by this measure, California was more 'deregulated'**
- **Market Design**
  - **Eastern markets are more 'centralized' (PJM >>NE>>Cal)**
    - » **history of integrated operations**
  - **Differences in transmission pricing (PJM >>Cal>>NE)**
- **Regulation**
  - **price-caps (California & PJM ) vs. bid-caps (NE, PJM)**
- **Relative capacity?**

## Monthly Average Wholesale Electricity Prices

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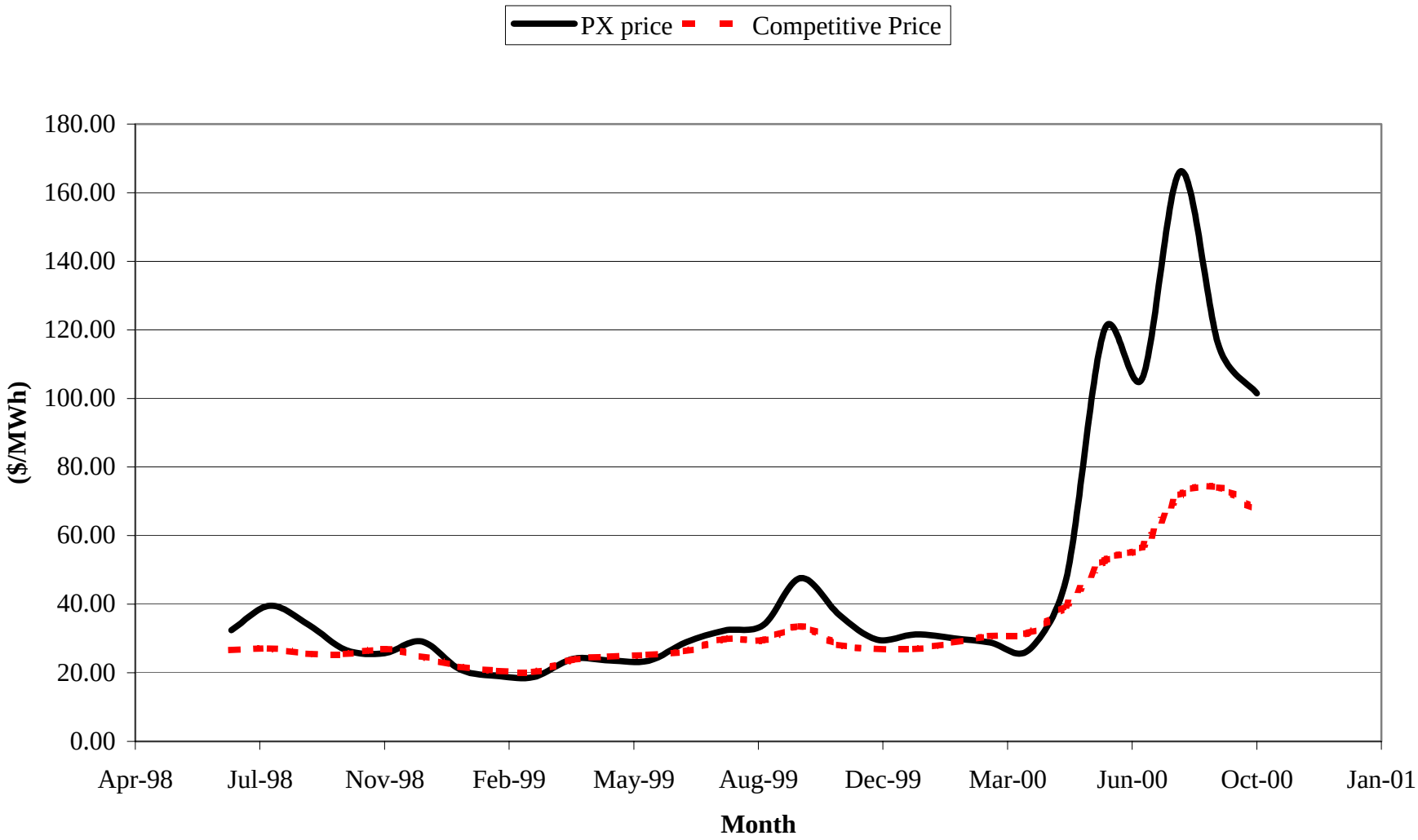
# Market Power

- **Market power is the ability to raise prices above marginal costs**
- **It exists in a lot of industries**
  - **although a lot of commodity markets are perfectly competitive**
- **Unilateral market power is not illegal (in U.S.)**
- **Electricity markets are particularly vulnerable**
  - **lack of storage,**
  - **binding capacity limits,**
  - **lack of price-responsive demand**
- **It does not require near scarcity or collusion to exist**
  - **Lerner Index $(p-mc)/p \sim \theta/(n\varepsilon)$**

# Average California PX price and MC

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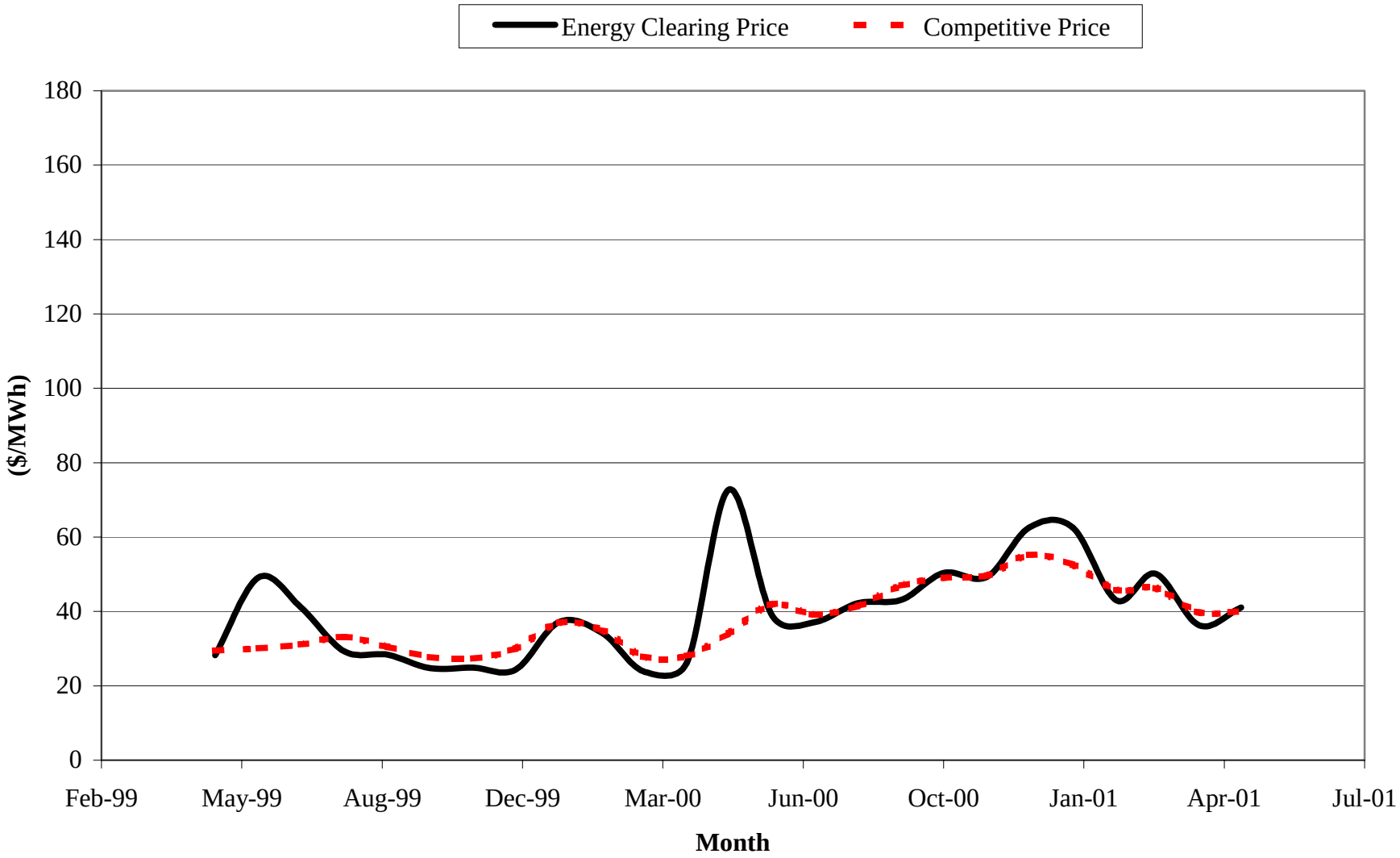
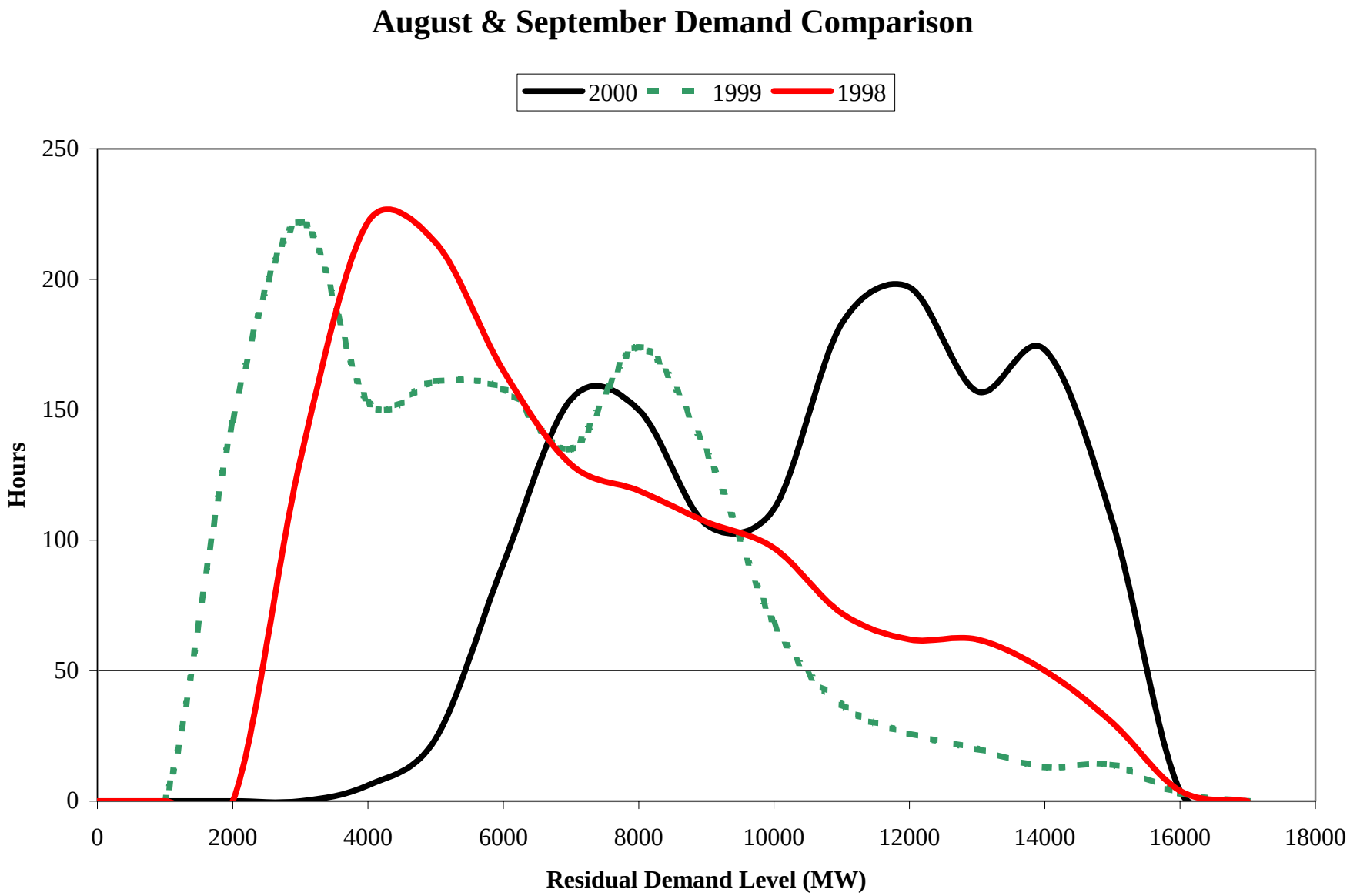
## New England Energy Clearing Price and MC



# Measuring Relative Demand

- **Is California producing higher margins because of `tight' capacity conditions?**
- **How to compare market tightness?**
- ***Residual Demand* - demand net of**
  - **imports**
  - **hydro & nuclear**
  - **very small thermal, renewables, cogeneration**
- ***Residual Capacity* - capacity of large fossil-fired generation within the ISO system**

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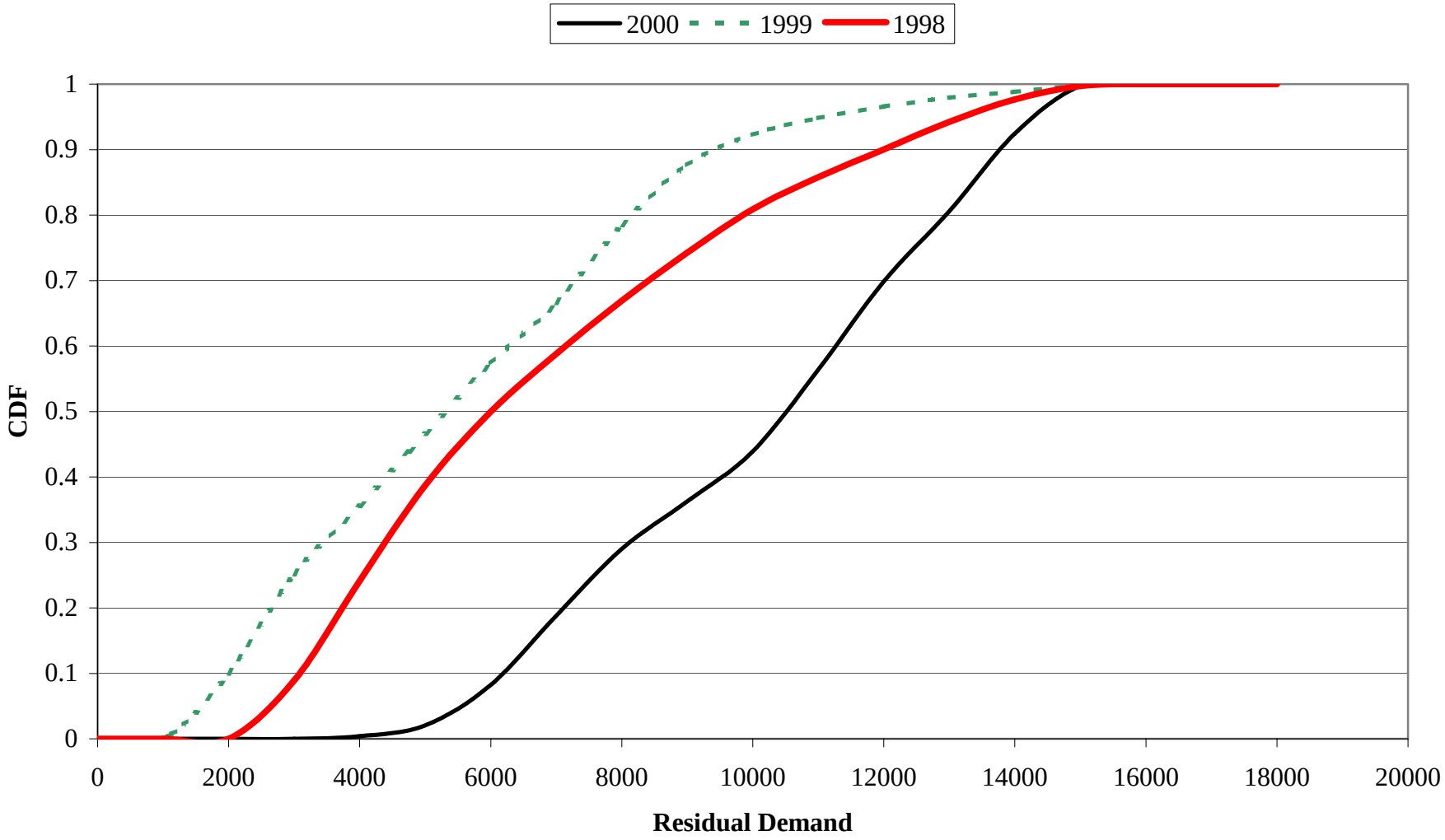
## Cumulative Distributions of Residual Demand
## August & September

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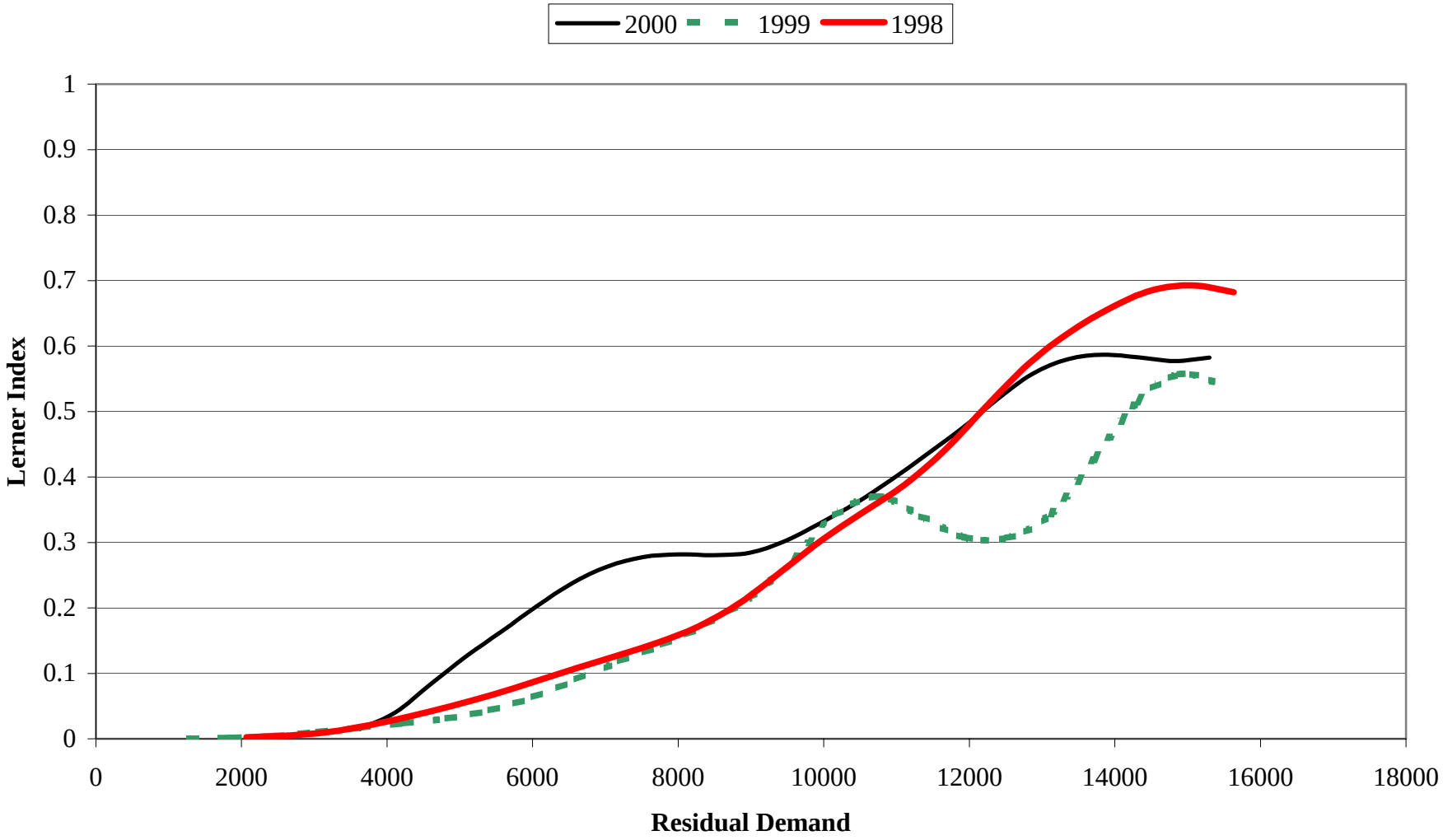
## Kernel Regressions of Lerner Index
## August & September

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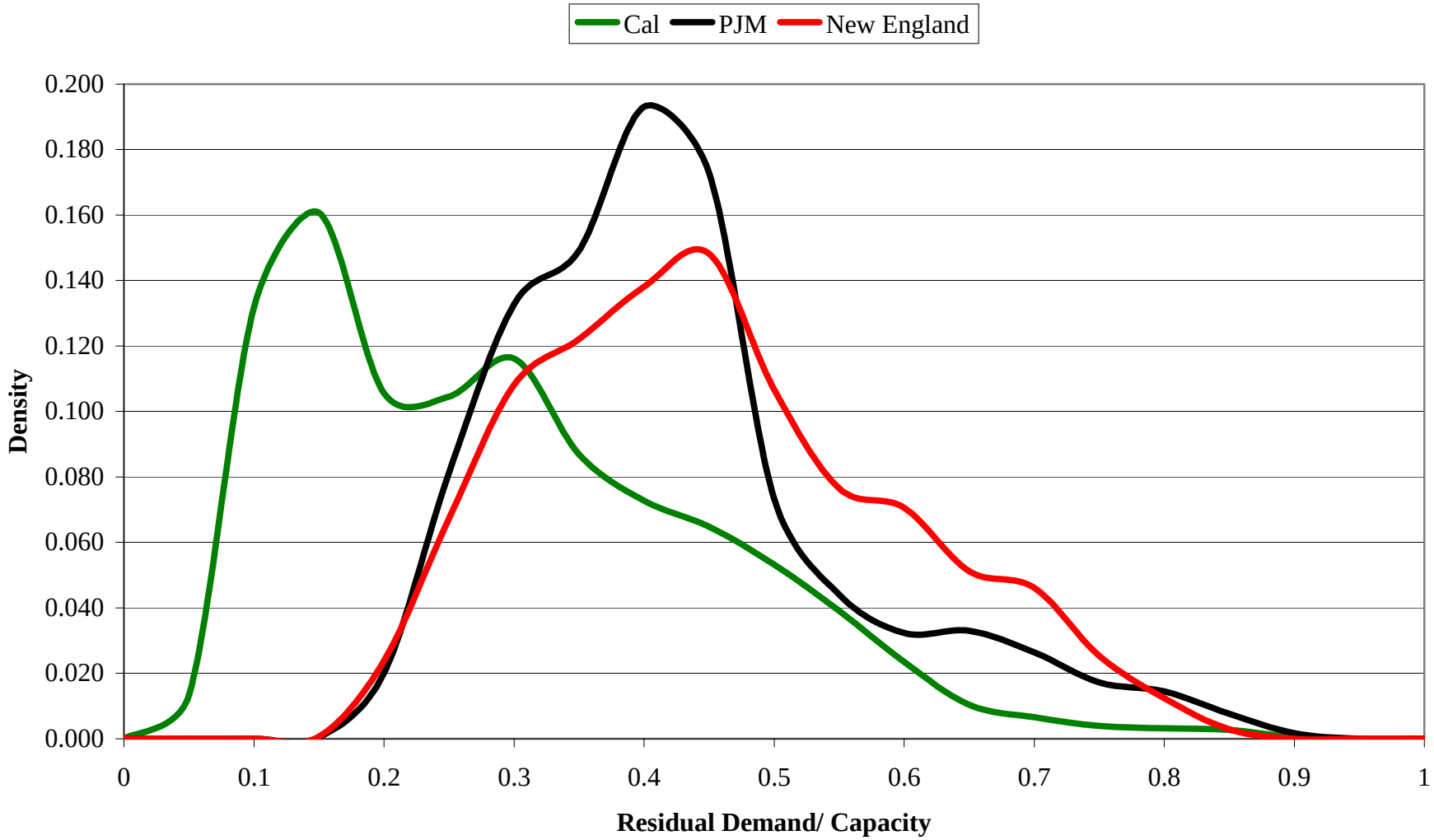
## Relative Residual Demand
## May - December 99

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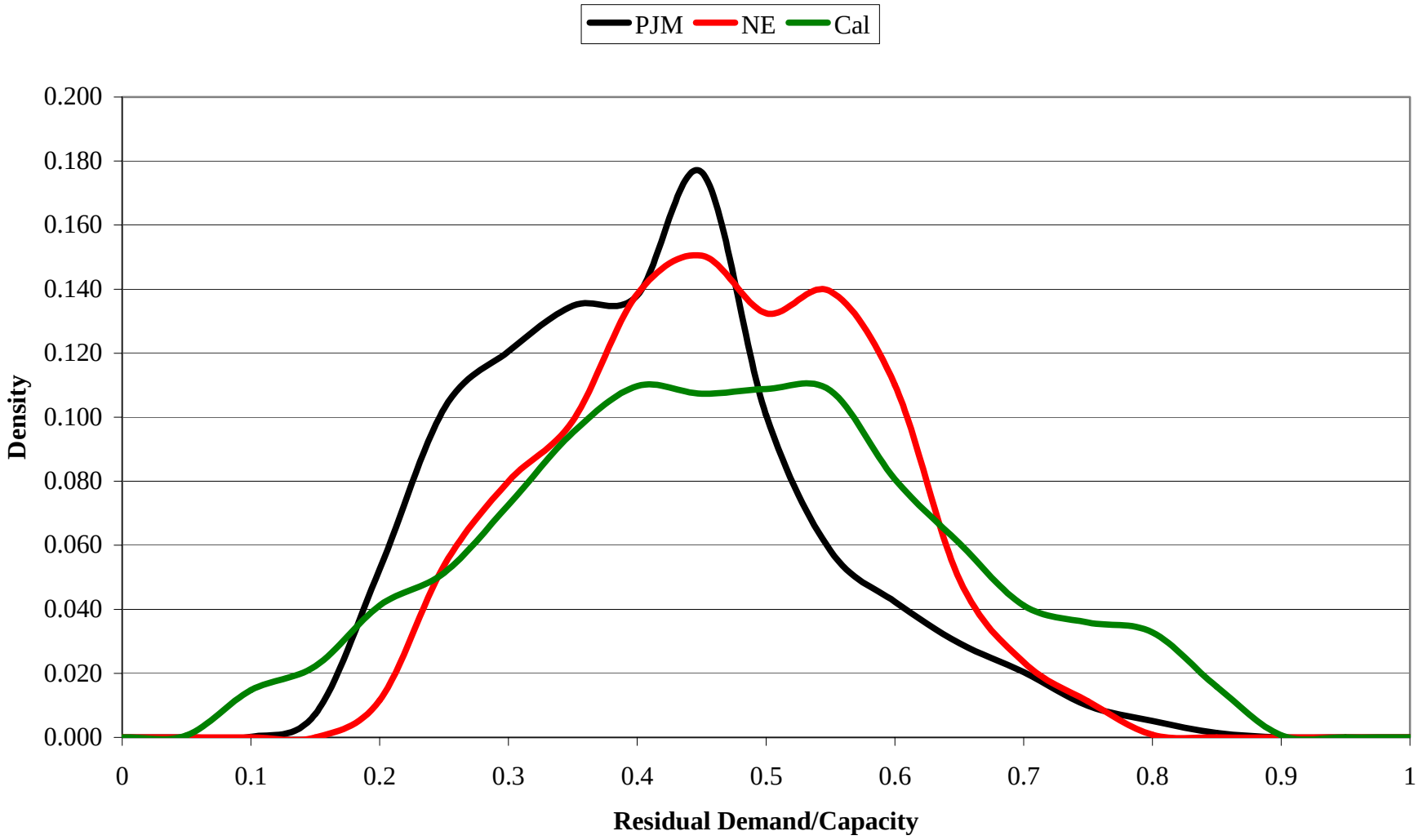
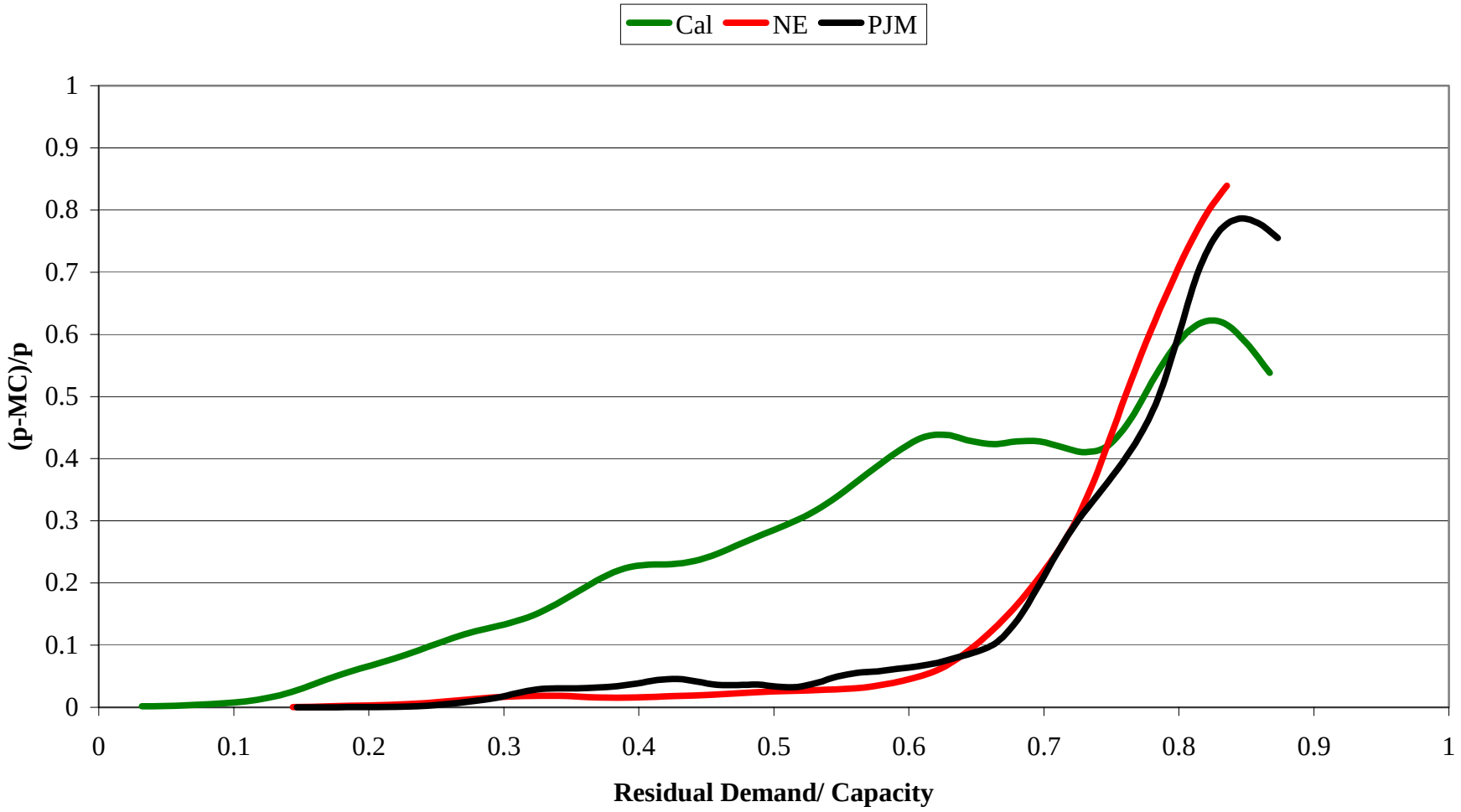
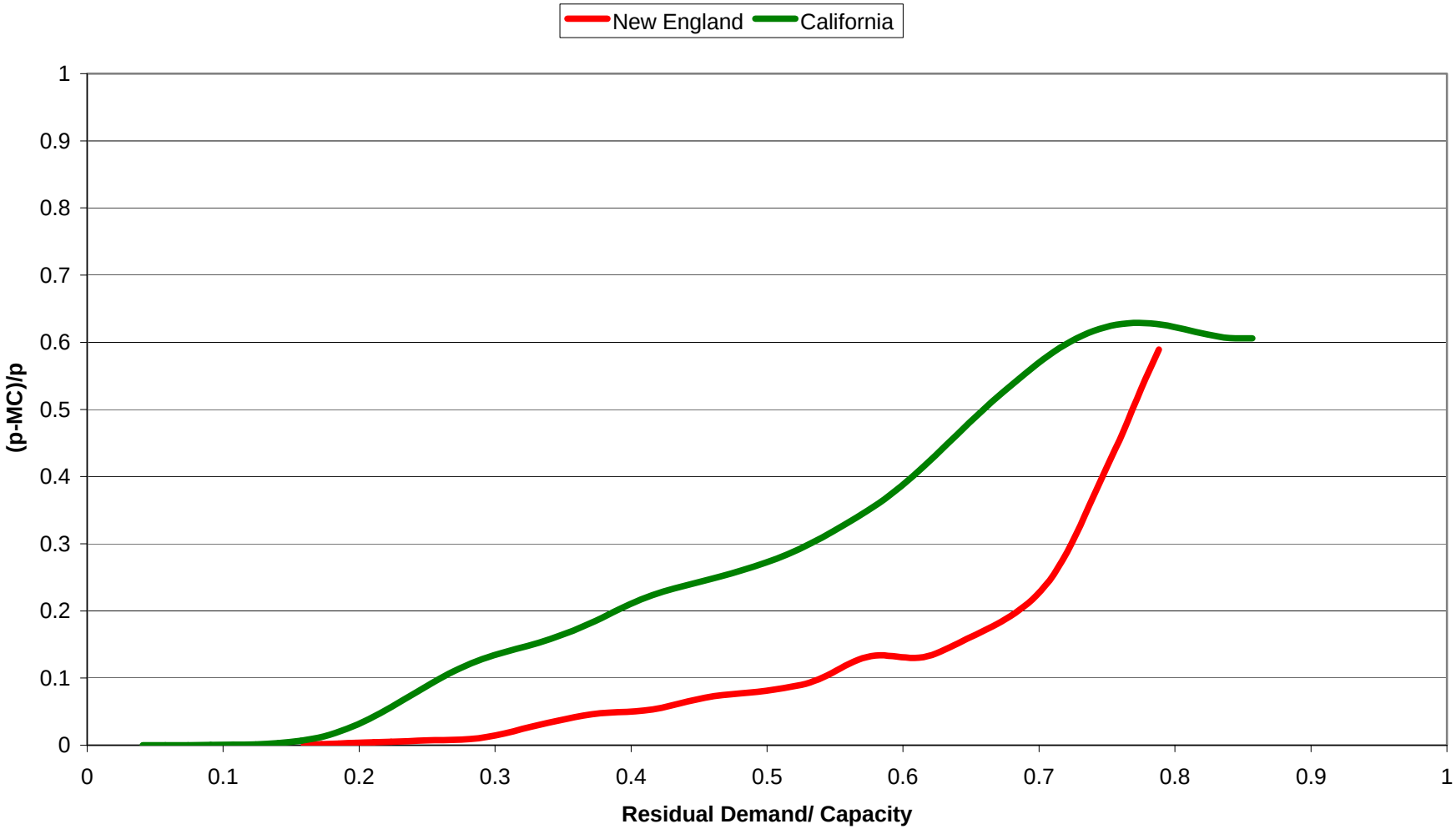


**Kernel Regression of**
**Lerner Index vs. Capacity Ratio**
**May - December 1999**



# Kernel Regressions of Lerner Index vs. Capacity Ration (May - October 2000)

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# What we do know

- **Electricity markets are vulnerable to market power**
  - **collusion not necessary to create large transfers**
- **Eastern markets have experienced less market power than California**
  - **at least when markets are not highly capacity constrained**
- **The higher market power in California does not appear to be due to `tighter' markets**
  - **the *dollar* consequences of that market power are**
- **Transmission pricing methods do not explain these differences**
  - **New England (1 zone) and PJM (4000 zones) perform comparably, California (23 zones) does worse**

# What We Don't Know

- **Why did the eastern markets do better?**
  - **Mix of generation technologies?**
  - **More vertical integration & buy-back contracts?**
  - **Tougher market power mitigation measures?**
  - **Market design?**
- **How have the markets performed according to other standards?**
  - **Costs of transmission congestion?**
  - **Efficiency of operations (& reserves)?**
  - **Environmental consequences?**
  - **Investment environment?**
- **What's the best market standard?**
- **Is restructuring a good idea?**