

Options for Emissions Market Simulation

UC Market Simulation Group

Market Simulation Modeling

- Goal is to identify potential inefficiencies in the allowance market
 - Risks of strategic behavior (market power)
 - Strategic compliance and its impact on prices
 - Implications of key design elements
 - Auction timing, consignment requirements
 - Banking and borrowing
 - Volatility controls (e.g., allowance reserve, floor price)

Simulation Method Options

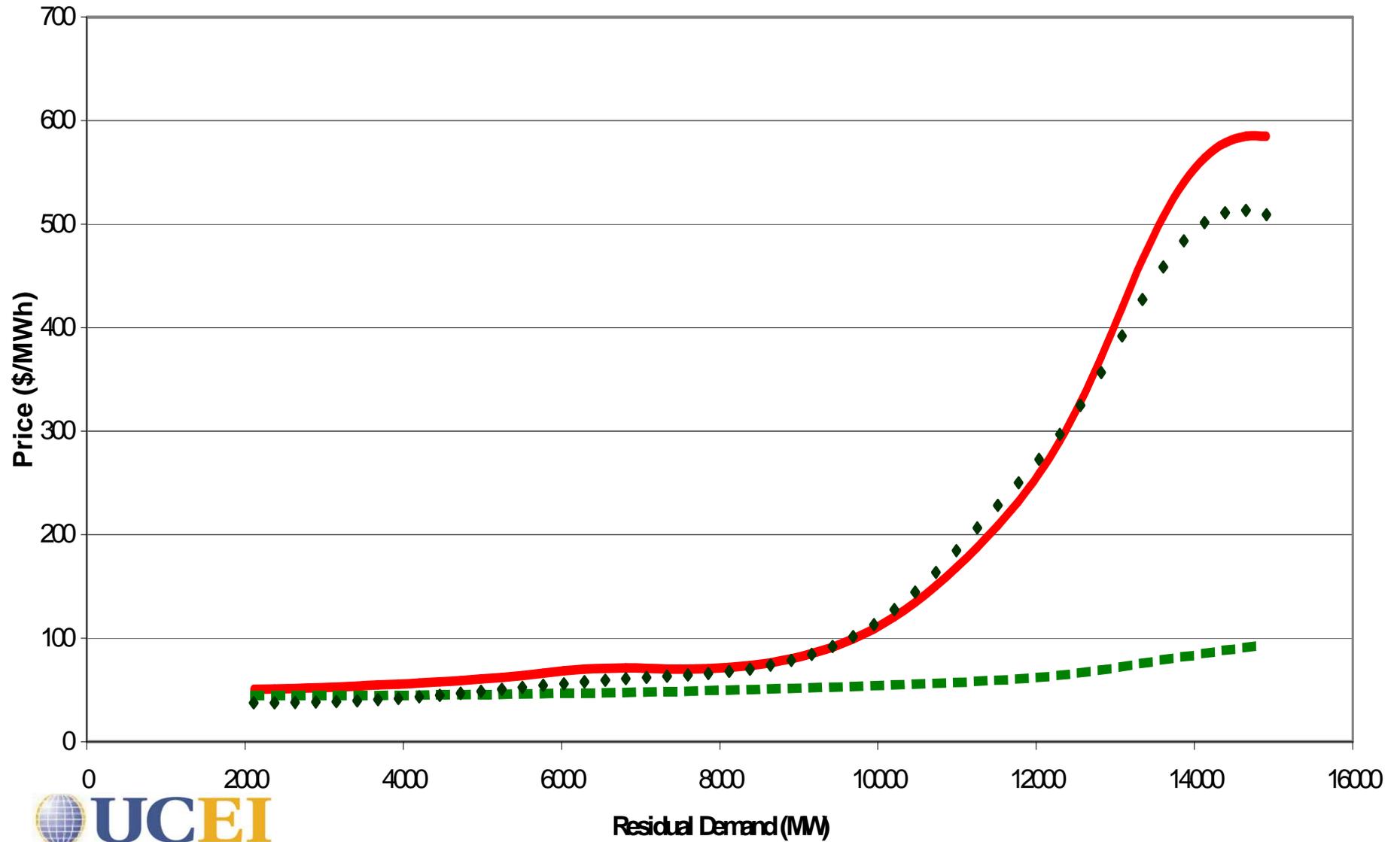
- Equilibrium models
 - Calculates “stable” solution where all parties maximize their objectives given what other parties are doing.
 - Objectives can vary (minimize cost, maximize profit)
 - Strategic behavior can be represented with an oligopoly framework such as the Cournot equilibrium
 - Good for anticipating market power (an equilibrium phenomenon), more challenges for manipulation (an out-of equilibrium case)
- “Agent-based” models
 - Similar to equilibrium models, but equilibria not required, or necessarily reached
 - Simulated parties (agents) repeat interactions with each other following heuristics for strategies and objectives
 - Interpretation of non-equilibrium solutions, multiplicity of solutions
- Experimental models
 - Similar to agent-based, but “agents” are people (e.g., students)
 - Distinguishing incentives and competence of agents vs. outcomes

Can equilibrium models tell us something useful?

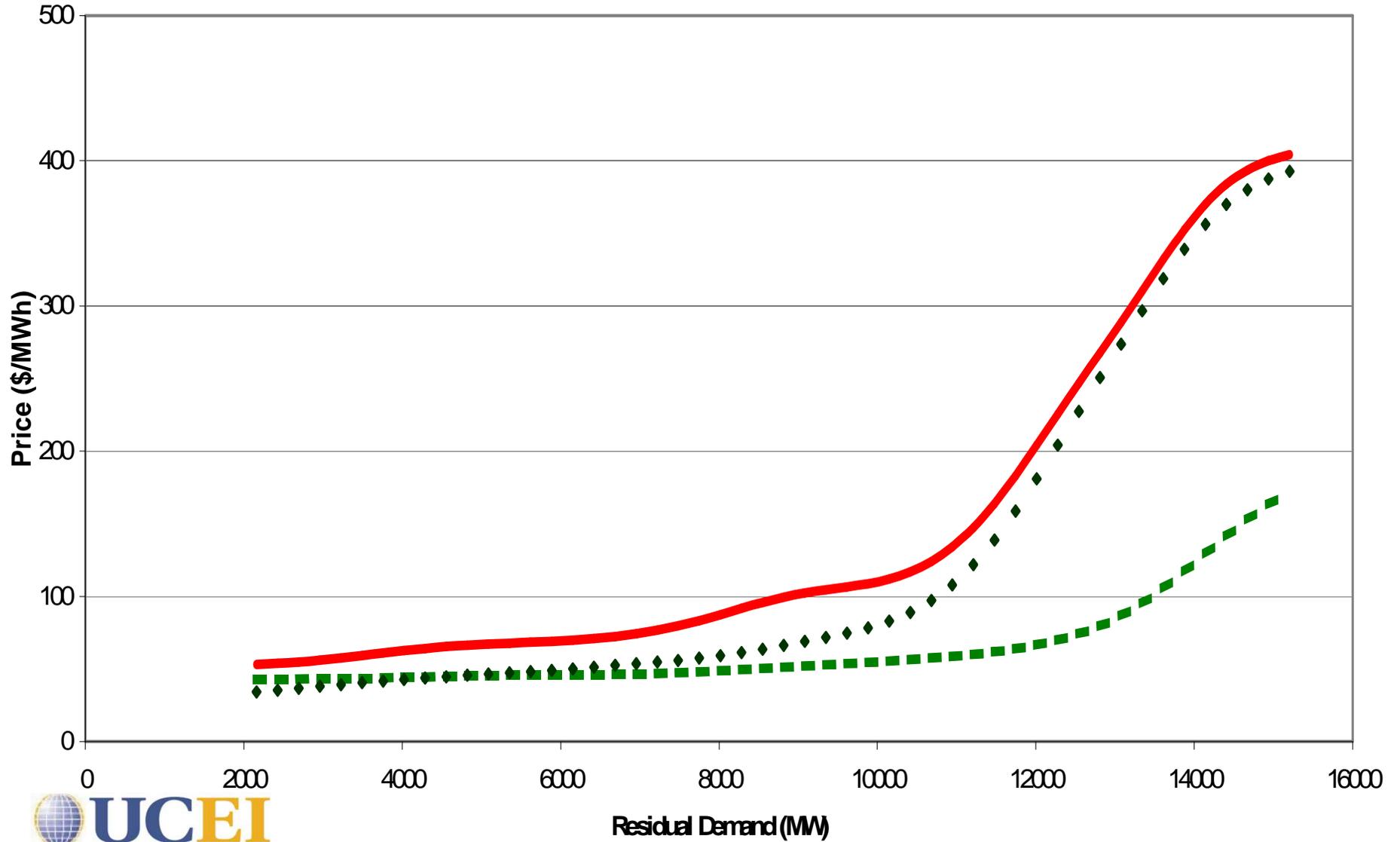
Electricity Restructuring in California

- Borenstein & Bushnell (1999), Borenstein, Bushnell, & Wolak (2002), Bushnell, Mansur, Saravia (2008).
- Establish a baseline of market conditions drawing upon existing market data
 - gas-unit heat rates, outage rates, daily fuel prices, monthly oil & emissions prices
- Simulate counter-factual outcomes assuming
 - Firms set output to maximize profits (*not* minimize costs)
 - Firms' profits can increase (or decrease) with electricity prices
 - Depends upon their net position in the market
 - Firms may be able to influence product prices
 - Not "price-takers"
 - May (or may not) have an incentive to do so
 - Requires modeling firms' assumptions about the responses of other firms

June 2000



July 2000



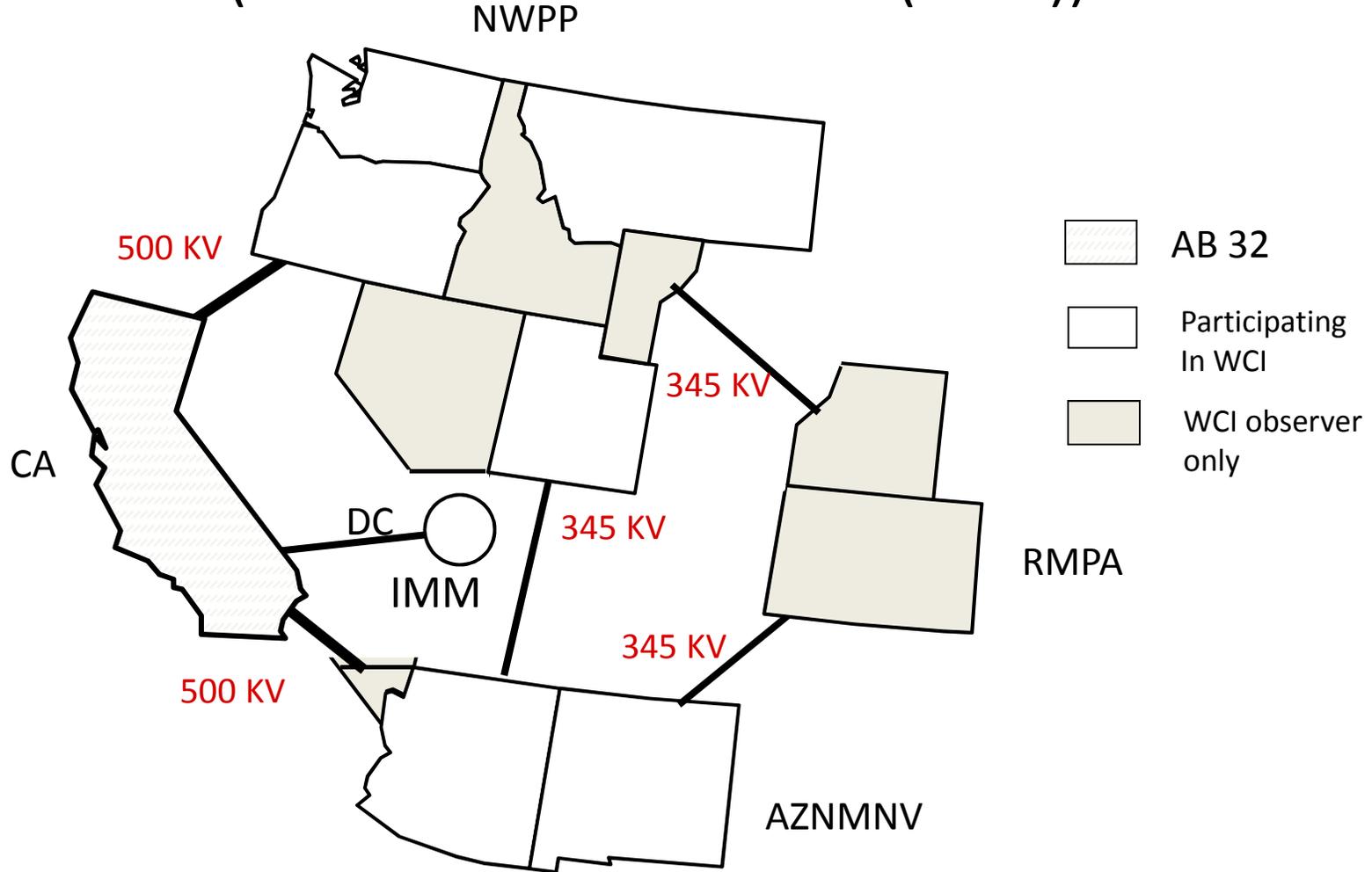
Can equilibrium models tell us something useful?

Translating to emissions markets

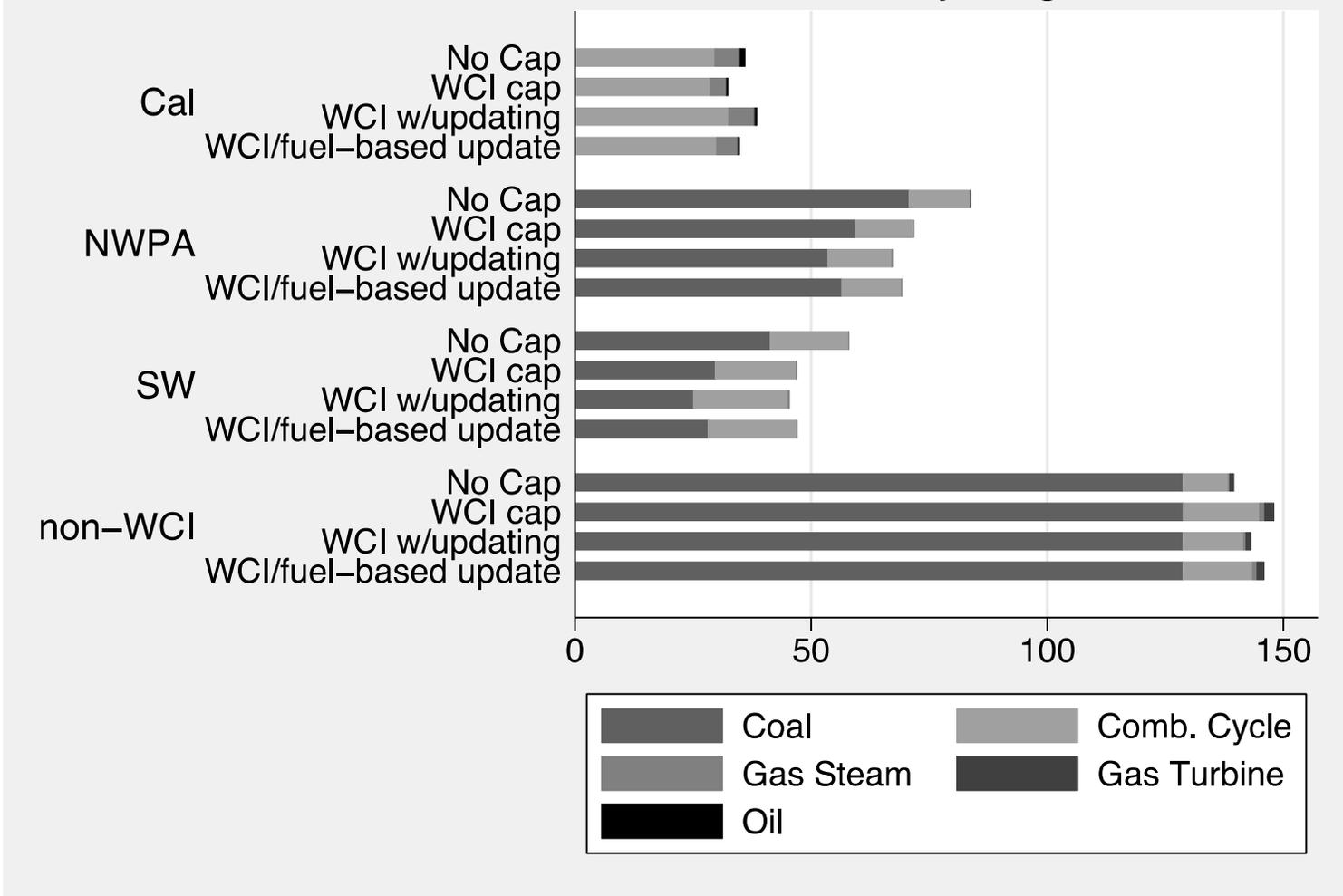
- Establish a baseline of market conditions drawing upon existing market data
 - gas-unit heat rates, outage rates, daily fuel prices, monthly oil & emissions prices
- Simulate counter-factual outcomes assuming
 - Emissions are capped
 - Represent these measurements with as much detail as possible
 - Imports of products (electricity, gasoline)
 - Firms' profits can decrease (or increase) with emissions prices
 - Firms may be able to influence allowance price
 - Not “price-takers”
 - May (or may not) have an incentive to do so
 - Requires modeling firms' assumptions about the responses of other firms

Emissions Markets in the West

(from Bushnell and Chen (2009))



CO2 Emissions by Region and Fuel



Data needs for all approaches

- Reasonable representation of key market elements, that can also fit into a model framework
 - Timing, compliance periods, market format, market rules (such as holding limits), location of sources, etc.
- Market and cost data on key industries and industries
 - Demand elasticities, production costs, input costs, import elasticities
- Compliance costs (e.g., abatement options and costs)
 - Assumptions on offset markets, other inputs (oil, gas)
- Assumptions about future market conditions

Modeling Challenges

- Limiting costs of modeling assumptions and abstractions
 - Representing uncertainty of conditions
- Dynamic considerations
 - Cycles of compliance periods
 - Timing of emissions true-ups relative to clearing of product markets
- Drawing boundaries
 - Across geography, across industries
- Future market conditions
 - Entry of new renewable generation, biofuels, demand growth, etc.

Market Considerations

- Market structure and incentives
- Holding limits
- Timing of compliance
- Strategic compliance behaviors
- Auction design and secondary markets
- Volatility control mechanisms