

US EPA ARCHIVE DOCUMENT

Emissions Trading in Theory and Practice

Meredith Fowlie

Department of Agricultural and Resource Economics,

UC Berkeley

&

The University of California Energy Institute

May 18, 2004

“One of the dangers of ivory tower theorizing is that it is easy to lose sight of the actual set of problems which need to be solved, and the range of potential solutions....

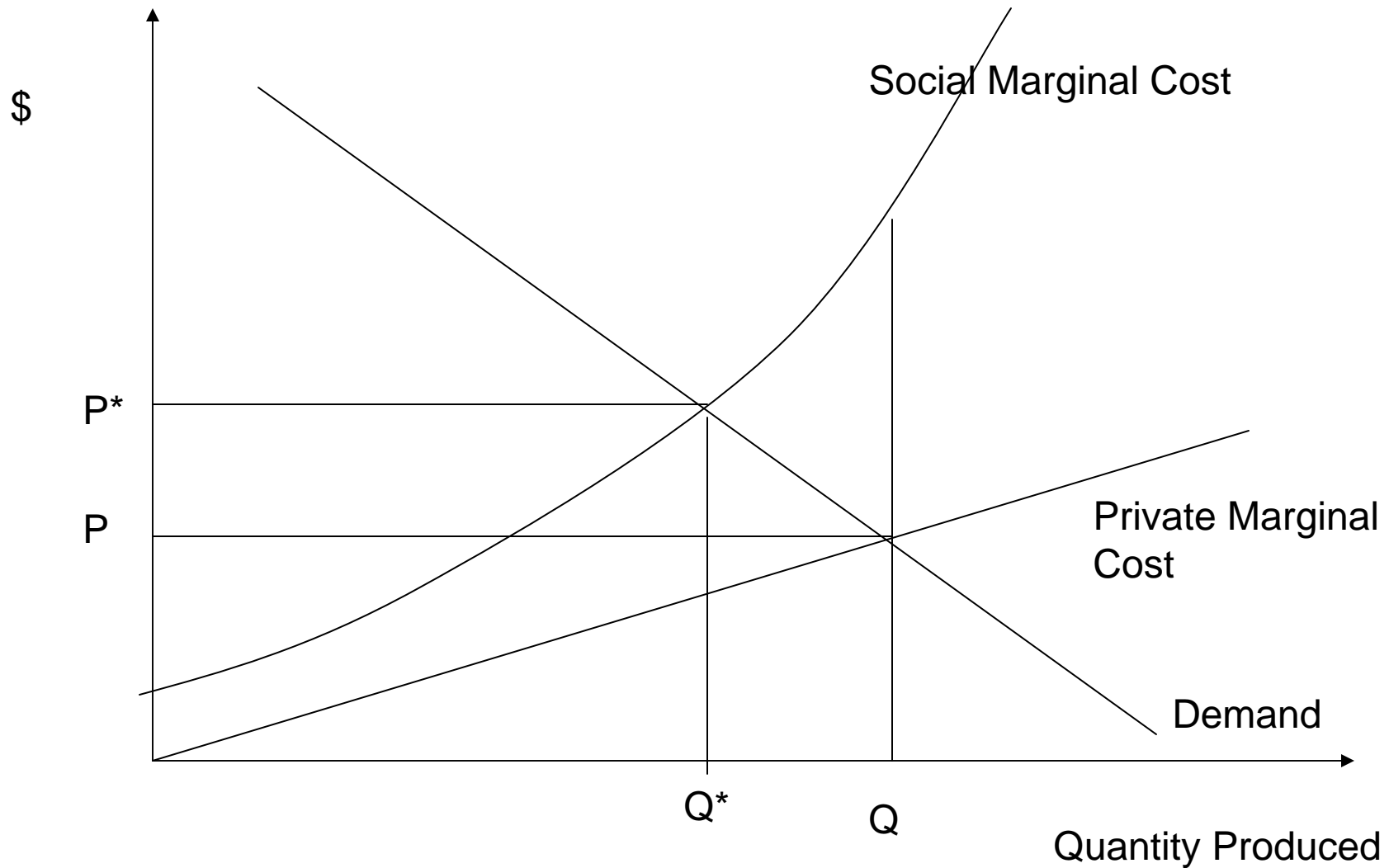
In my view, this loss of sight has become increasingly evident in the theoretical structure underlying environmental economics, which often emphasizes elegance at the expense of realism”

~Robert W. Hahn, 1989

Outline

1. What are the theoretical arguments for emissions trading?
2. What are the assumptions underlying the theory?
3. Survey existing “cap and trade” programs
4. Look at how the theory is playing out in practice.

What is the problem?



Economic Conceptualization of PollutionExternality

Problem:

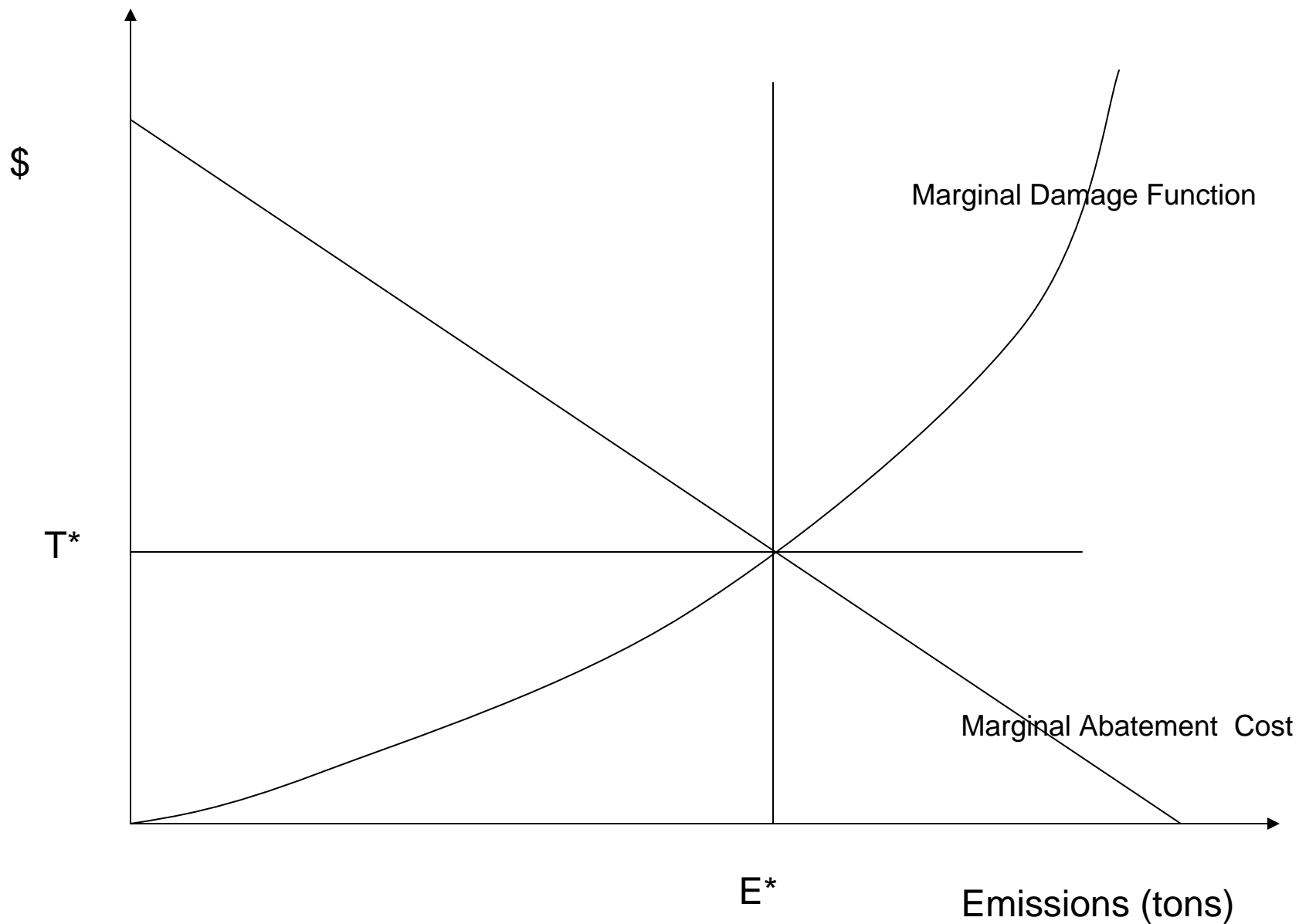
Minimize the total social cost of pollution

$$\begin{array}{rcccl} \text{Total social} & & \text{Total} & & \text{Total} \\ \text{cost of} & & \text{abatement} & + & \text{damage} \\ \text{pollution} & = & \text{cost} & & \text{from pollution} \end{array}$$

Basic principle underlying the solution:

Set abatement costs equal to damages at the margin.

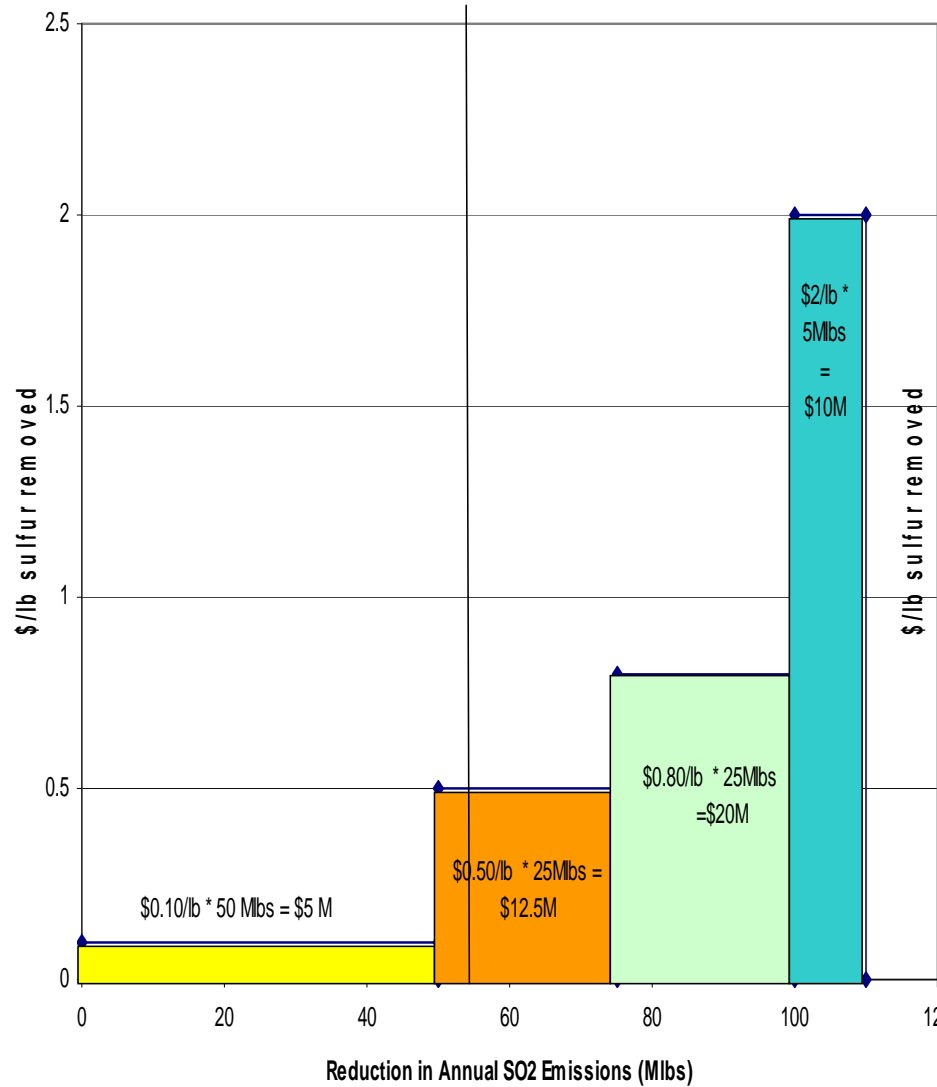
Regulatory Approaches to Addressing the Problem



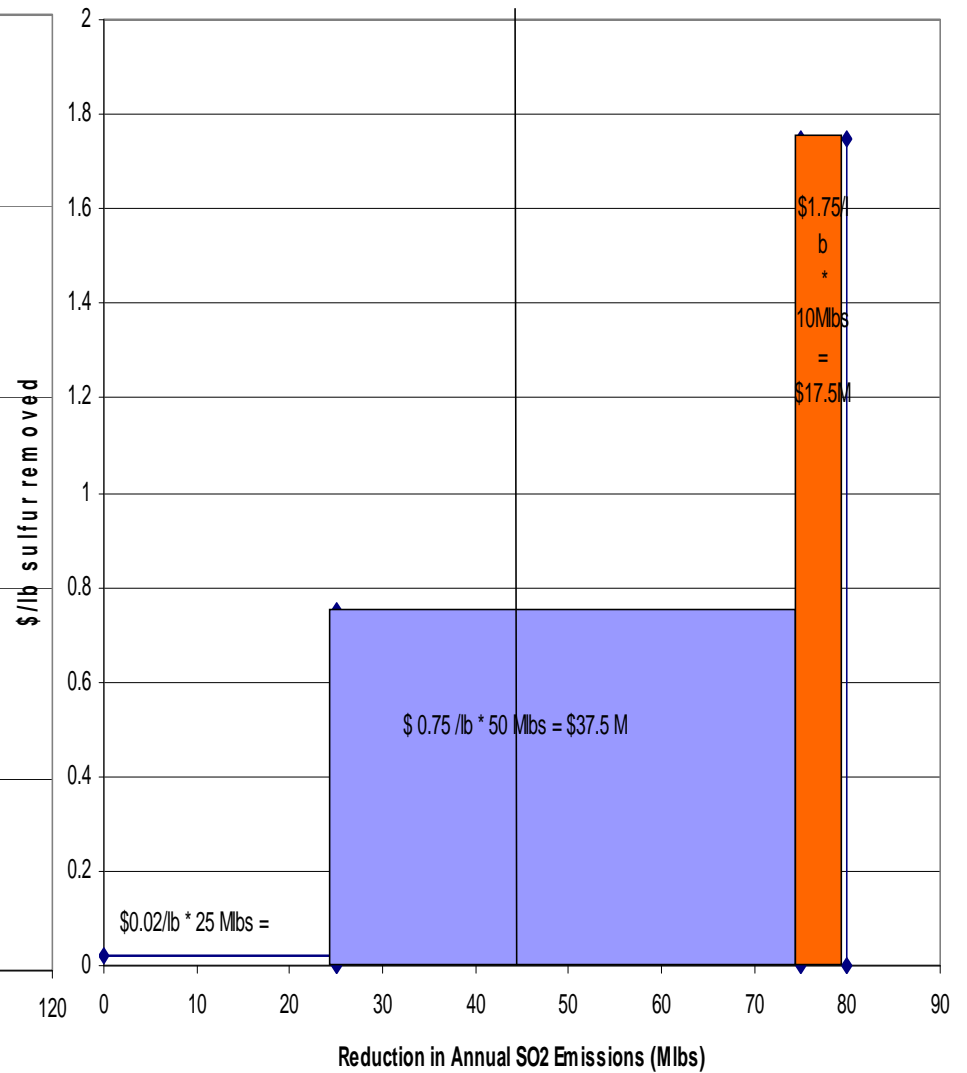
Addressing the Pollution Problem with Quantity Regulation

- Existing system of air pollution control regulation has traditionally relied on quantity instruments (NAAQS set by EPA)
- Problem: there is no guarantee that these targets will be achieved at minimum cost.
- The limitations associated with quantity instruments can be illustrated by a simple example.

Plant A: Control Costs per Pound of Sulfur Removed



Plant B: Control Costs per Pound of Sulfur Removed



“Command and Control” Solution
(mandate reductions)

Emissions reduction target: 50% reduction (100 Mlbs)

Plant A

(55 Mlbs reduction)

- Reduce emissions by 55 Mlbs at a cost of \$7.5 M
- Abatement cost on the margin: \$0.50

Plant B

(45 Mlbs reduction)

- Reduce emissions by 45 Mlbs at a cost of \$15.5M
- Abatement cost on the margin: \$0.75

Total cost: \$23 M

“Cap and Trade Solution”

(make mandated reductions transferrable)

Plant A (55 Mlbs permitted)

- Reduce emissions by **75 Mlbs** at a total cost of \$17.5 M
- Use 35 permits to offset its remaining emissions of 35 Mlbs
- Sell 20 permits at \$0.60/lb to earn \$12M
- Total net cost: \$5.5M

Plant B (45 Mlbs permitted)

- Reduce emissions by **25 Mlbs** at a total cost of \$0.5Mlbs
- Purchase 20 permits to offset remaining emissions for \$12M
- Total net cost: \$12.5M

Total Cost of 50% Reduction: \$18M

Advantages of CAT over CAC

- Total abatement costs associated with a given emissions reduction target reduced
- Provides incentives for development and adoption of more efficient abatement technologies
- Addresses the asymmetric information problem
- Constitutes a more politically palatable approach

Assumptions behind the theoretical efficiency result

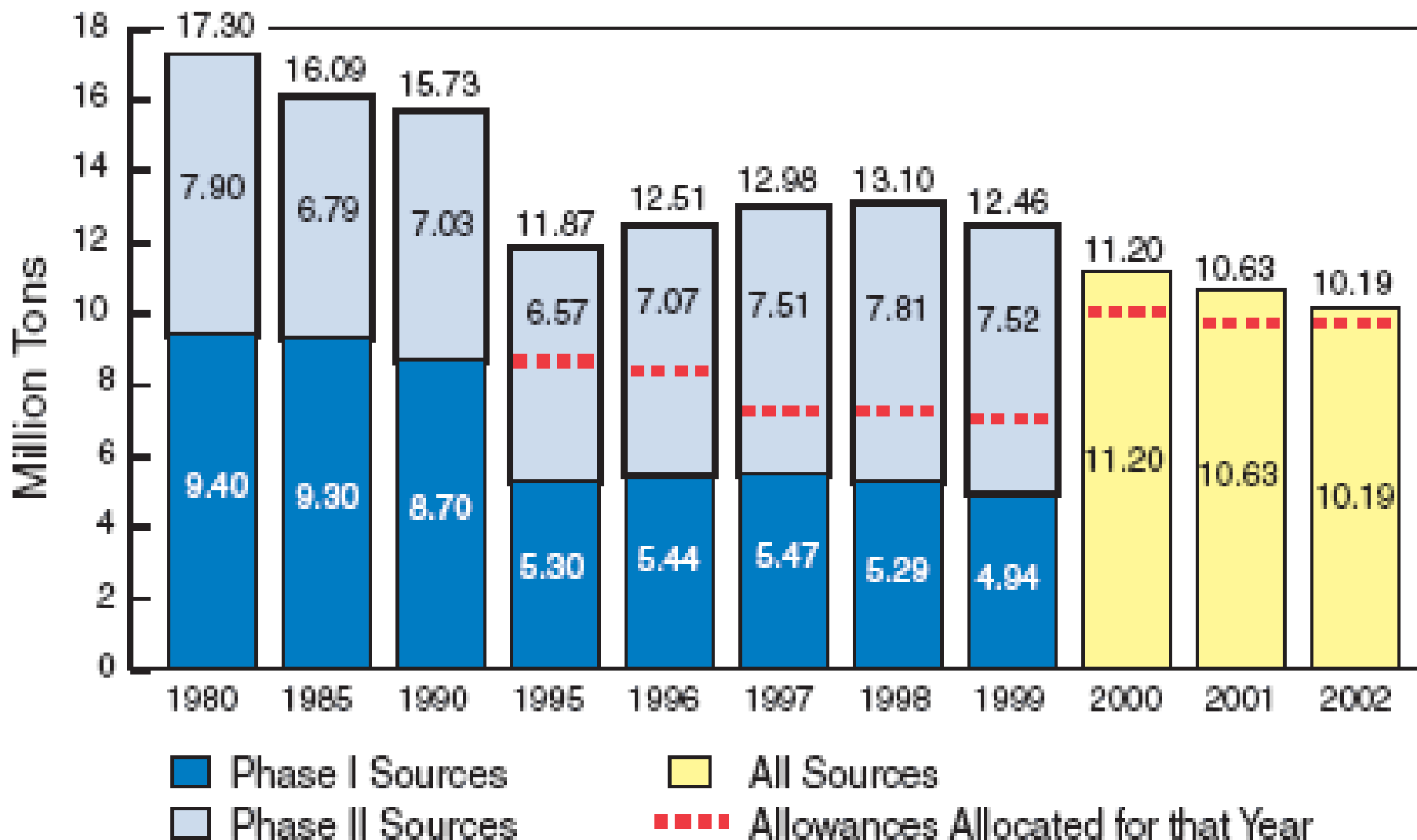
1. Profit maximizing firms
2. Perfectly competitive product markets
3. Perfectly competitive permit markets
4. Zero/Negligible transaction costs
5. Full information
6. Full compliance/enforcement

Major Design Issues

- Setting the Cap
- Defining the market
- Allocating the permits
- Banking rules
- Monitoring and Enforcement

Title IV: The National SO₂ Market

- Created by Title IV of CAAA 1990
- National in scope
- Aims to reduce annual SO₂ emissions to 50% of levels observed in early 1980s
- Phase I : 1995-1999: 261 plants affected
(although an additional 174 plants opted in)
- Phase II : 2000- : all fossil plants > 25 MW

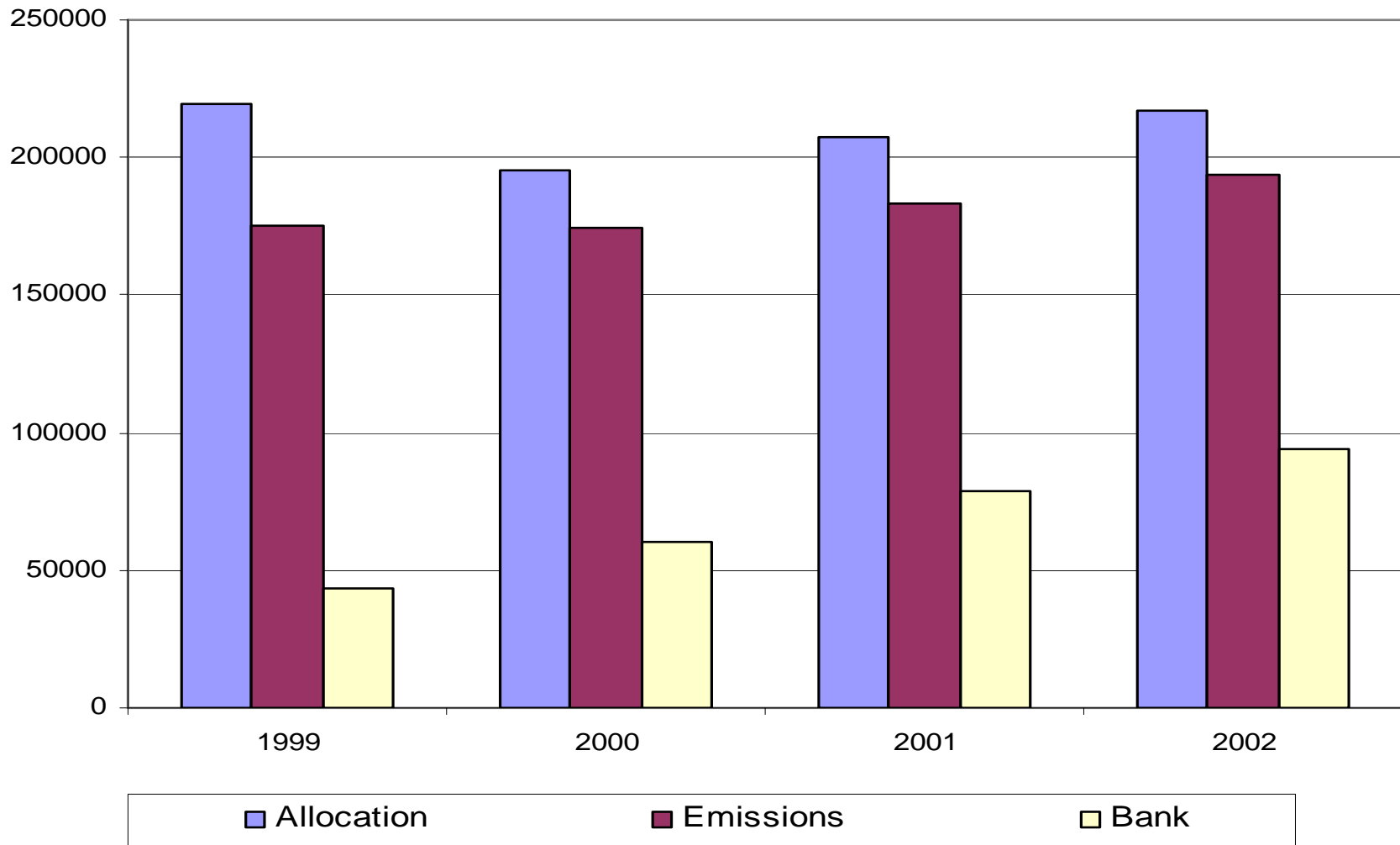


* Taken from <http://www.epa.gov/airtrends/sulfur2.html>

OTC NO_x Budget

- Designed to address ozone problem in the northeast
- Affects 11 states and DC
- Affects 470 power plants and industrial boilers
- Translates to an average emission rate of 0.2 lbs/mmbtu
- Market only operates during ozone season (May –September)
- Restricted banking

OTC NOx Budget Phase II



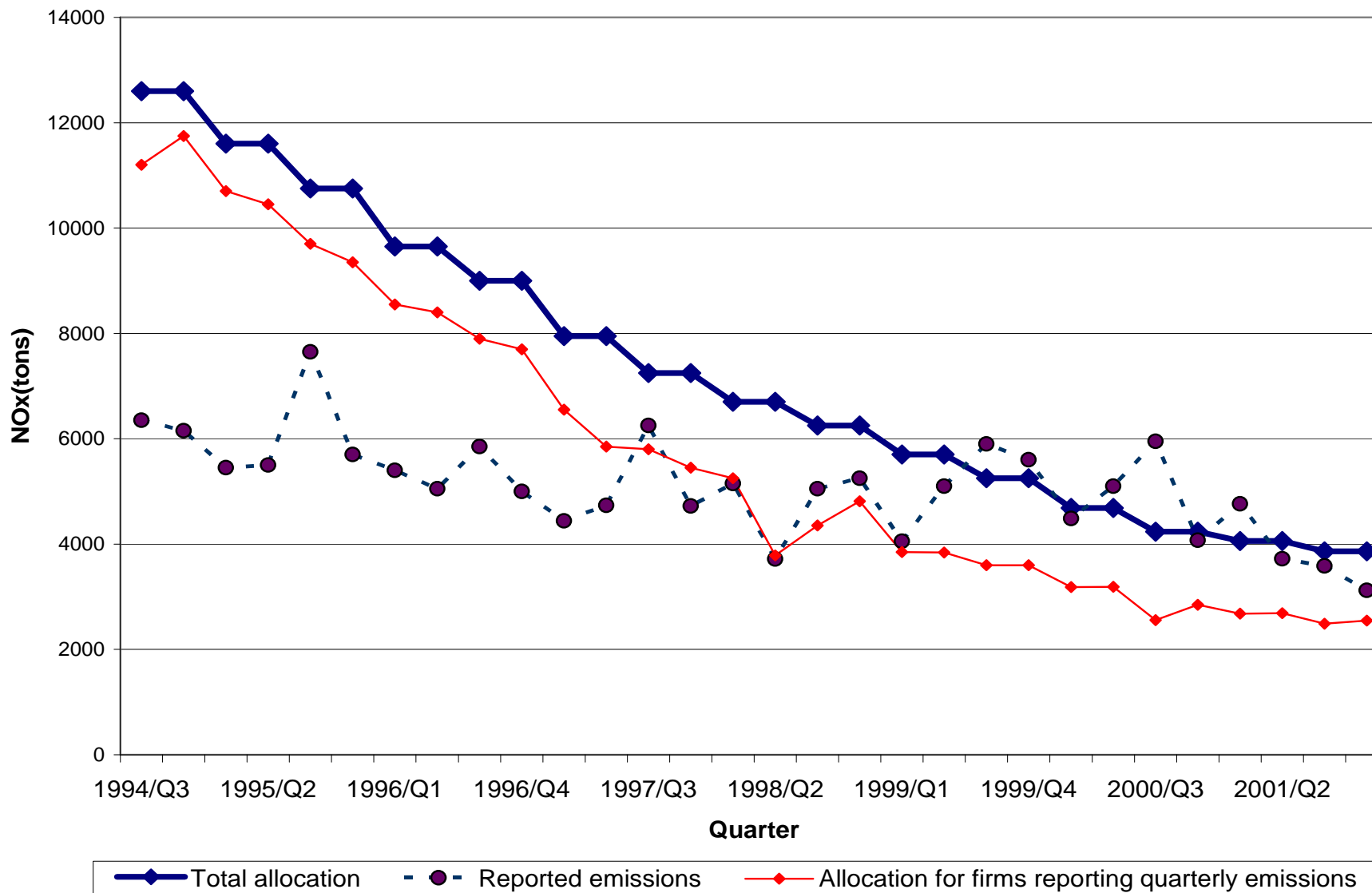
NOx SIP Call

- Issued by EPA in 1998: 22 states and DC
- Each state assigned a “NOx budget”
- Average emissions rate: 0.15 lbs/mmbtu
- States strongly encouraged by EPA to adopt CAT approach
- EGUs > 25MW & NGUs > 250 mmbtu affected
- 8 states + DC start complying May 1, 2003
- 11 states join them in 2 weeks!

RECLAIM

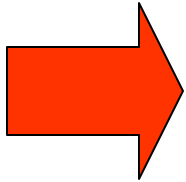
- Introduced by the South Coast Air Quality Management District in 1994
- Program runs 1994-2010
- Total allocation reduced by 75% by 2003
- 390 “major sources” affected (>4 tons/a)
- Over 120 different industries affected
- Trading rules distinguish between inland and coastal zones

RECLAIM: 1994-2001



Outline

- What are the theoretical arguments for emissions trading?
- What are the assumptions underlying the theory?
- Survey existing “cap and trade” programs



Look at how the theory is playing out in practice.

Violating the assumption of profit maximizing firms in the National SO₂ Program

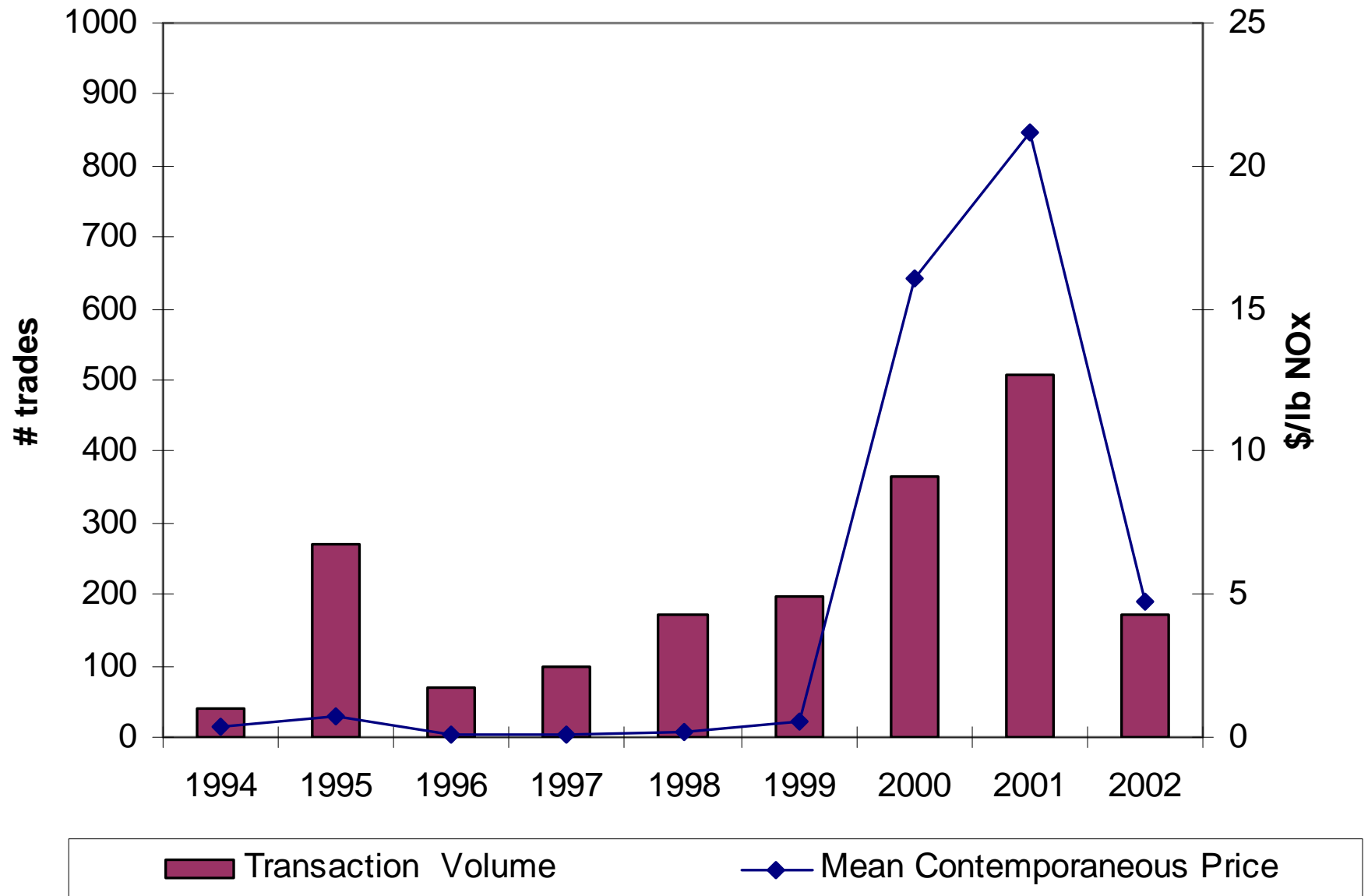
- Most generators addressed under Title IV are subject to PUC “rate-of-return” regulation.
- Uncertainty about PUC regulation of cost recovery inspires caution towards permit market (Arimura(2002);Bailey(1996); Burtraw(1996) Winebrake et al(1995))
- Rate-of-return regulation/rate hearings procedure favors capital-intensive abatement technology (Averch and Johnson(1962); Cronshaw and Kruse (1996), Coggins and Smith(1993), Bohi and Burtraw(1992))
- Some governments in states with high sulfur coal reserves passed legislation to promote high sulfur coal (Ellerman and Montero(1998) ; Rose (1997);Winebrake et al (1995))

Violating the assumption of perfectly competitive product markets in RECLAIM

(Kolstad and Wolak, 2003)

- RTC permits could significantly increase production costs for generators in SCAQMD.
- Kolstad and Wolak (2003) offer evidence in support of their hypothesis that electricity generating companies with some of their plants located in SCAQMD paid statistically significantly higher prices for NO_x permits as compared to other participants in the permit market in 2000/2001 in order to enhance their ability to exercise market power in the electricity market.
- “These results underscore the importance of coordinating the design of environmental markets with the design of affected product markets”

RECLAIM Prices



Violating the assumption of perfectly competitive product markets in PJM

Mansur (2004)

- Mansur(2004) estimates the environmental implications of production inefficiencies attributed to market power in the Pennsylvania, New Jersey, Maryland (PJM) restructured wholesale market.
- Short run changes in air pollution resulting from the exercise of market power will depend on how the emission rates of the technologies that dominant firms withhold compare with the emission rates of the technologies that are substituted to meet demand.
- “Policy makers developing incentive based environmental regulation should consider the consequences of firms exercising market power in product markets.”
- When strategic firms are relatively dirty (clean), permit prices will be lower (higher) as compared with the competitive case

Assessing the independence of emissions and initial allocation in RECLAIM

(Fowlie and Perloff, 2004)

- Theory predicts that if property rights to pollute are clearly established and emissions markets nearly eliminate transaction costs, firm level emissions will be independent of the initial permit allocation.
- We find evidence that initial allocations are a statistically significant determinant of emissions.
- We find no evidence that this relationship is stronger among smaller firms
- We find some evidence that this relationship is stronger among firms with no prior experience with emissions trading.

Assessing banking behavior

(Ellerman and Montero, 2002)

- During phase I of the SO₂ program, 30% of the allowances were banked.
- Ellerman and Montero(2002) build an economic model of permit banking and use it to assess whether observed banking practises were efficient.
- Authors conclude that in aggregate, generators made reasonably efficient decisions, given their assumptions.

Conclusions

- A strong theoretical case can be made for preferring CAT over more prescriptive approaches to achieving emissions reduction targets.
- Experience indicates that CAT implementation faces some technical and administrative challenges.
- Even allowing for imperfect implementation, CAT appears to have reduced aggregate abatement costs.