Market-based approaches to environmental policy (pollution control +)

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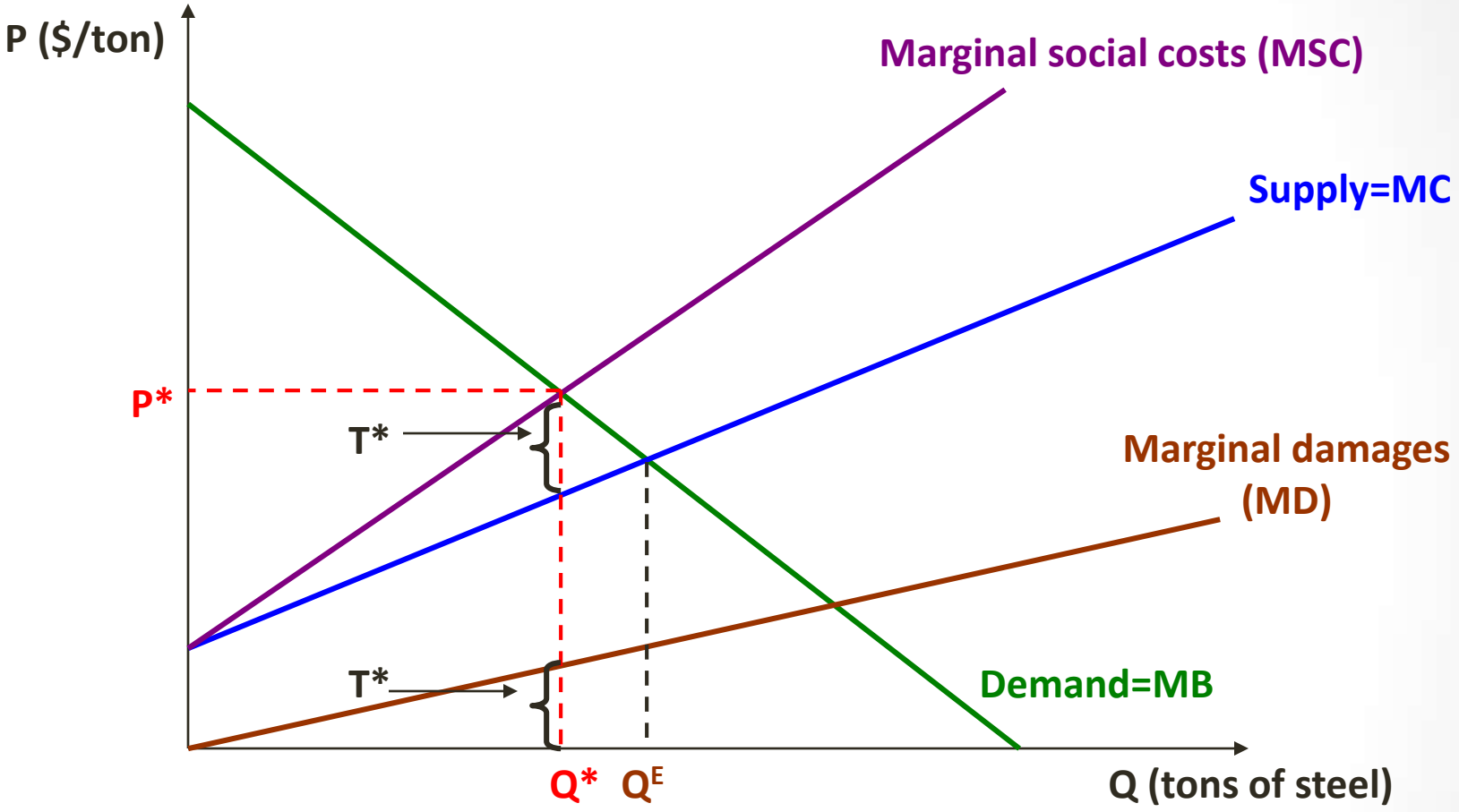
Solutions to externalities

- Liability regime: very important part of the apparatus for correcting externalities.
- Private bargaining (Coase); social norms/institutions (Ostrom)
- Regulation – in economic terms, some are better than others.

Types of pollution control regulations

- Prescriptive or command-and-control regulation
  - Technology standard – require firms to use a particular pollution abatement technology.
  - Performance standard – impose a ceiling on emissions or the emissions rate.
- Market-based regulation
  - Price instruments – tax negative externalities and subsidize positive externalities.
  - Quantity instruments – establish a total cap on pollution for a group of firms, allocate permits, and allow firms to trade.
  - Information-based approaches – provide information about the environmental damages/benefits of firms' practices and products, let consumers decide how to respond.

"Pigouvian tax" of a negative externality

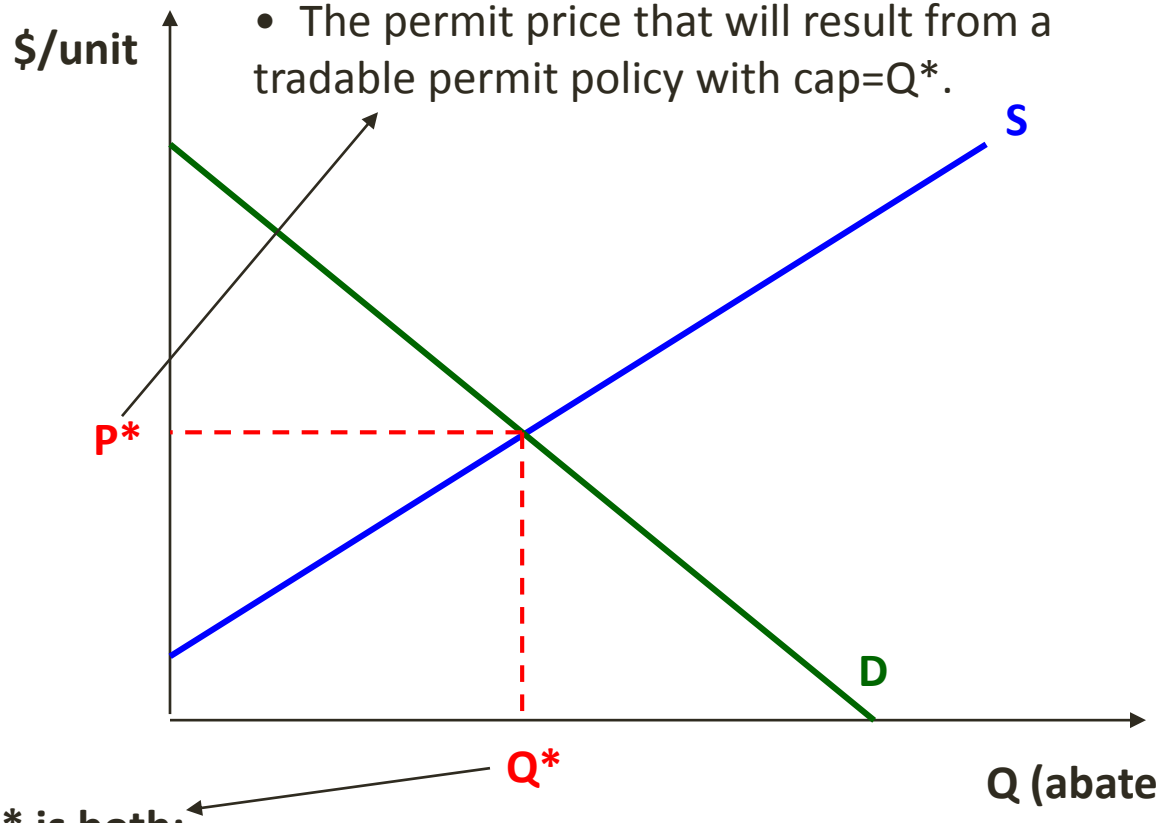


- A tax (T*) equal to marginal damages at the efficient level of production will induce the efficient outcome (Q*).
- Imposing this price on pollution "internalizes the externality".

Another way to think about this problem…

P* is both:

- The efficient tax; and
- The permit price that will result from a tradable permit policy with cap=Q*.



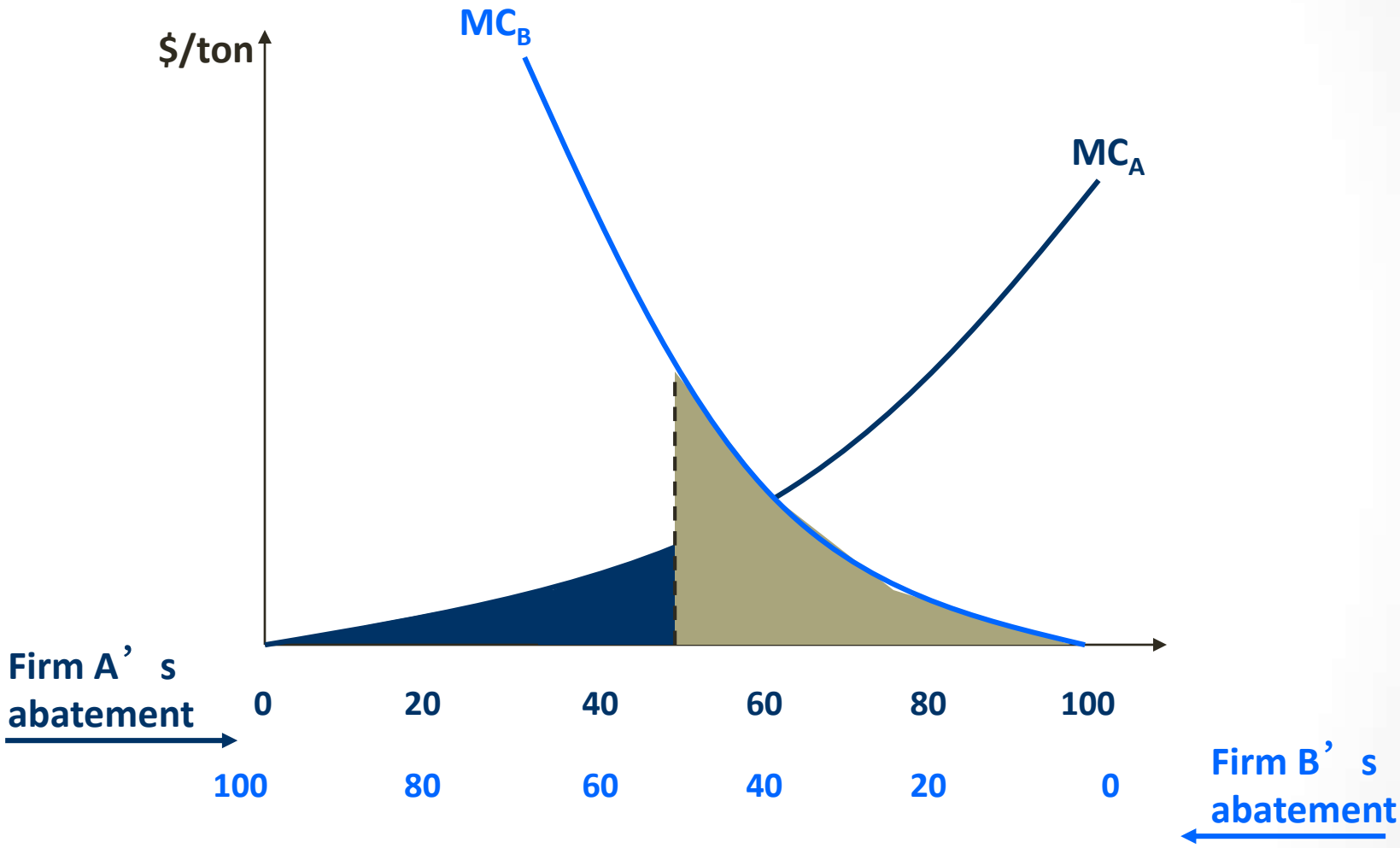
Q* is both:

- The efficient "cap" in a tradable permit policy; and
- The quantity of abatement that results from an efficient tax.

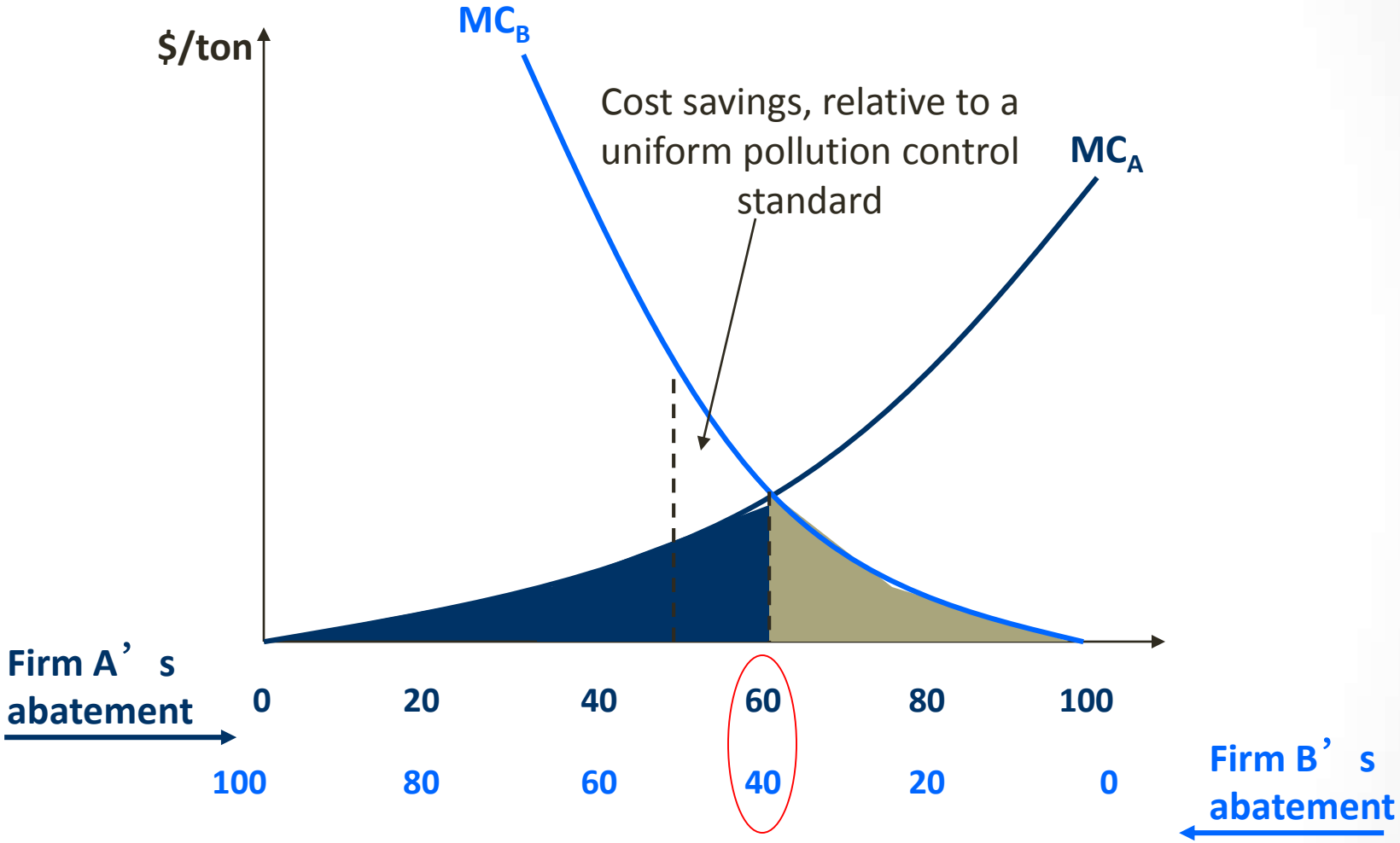
Main advantage of market-based policies

- Market-based solutions to environmental market failures are more ***cost-effective*** than prescriptive approaches (technology standards, performance standards) because:
  - In the short run, they take advantage of differences in costs across regulated firms; and
  - In the long run, they provide incentives for compliance-cost-reducing technological change.

Pollution abatement by 2 firms



Cost-effective abatement by 2 firms

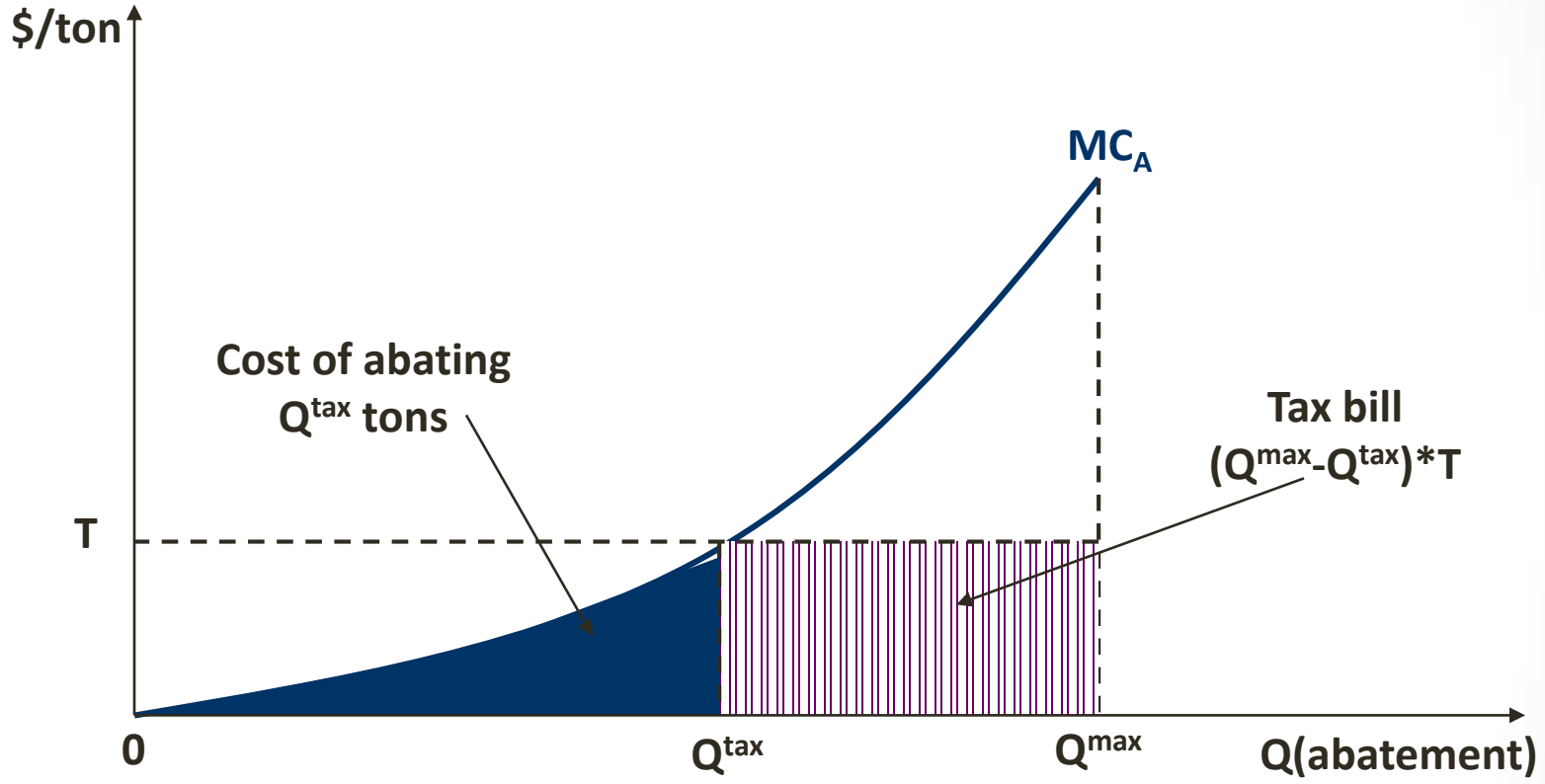


- **The cost-effective allocation of pollution control across firms equates their marginal abatement costs.**

Cost-effectiveness of alternative policy instruments

- Technology standard
  - Not cost-effective because:
    - Different firms have different "adoption" costs
    - Do not minimize costs even for individual polluters
- Performance standard
  - Uniform standard is not cost-effective.
  - Firm-specific standard can be, but only if regulators know firms' marginal cost curves.
- What about market-based approaches?

Abatement output with a tax



- A firm will abate to the point at which its marginal abatement cost is equal to the tax (the "price" of pollution).
- In doing so, it minimizes its total compliance costs.

Summing up how cap-and-trade works

- Firms buy/sell allowances until the marginal costs of abatement are equal across all firms (so the tradable pollution permit policy is cost-effective, like the tax).
- The equilibrium allocation of permits across firms is independent of the initial allocation.
  - True as long as there is no market power in the permit market.
- Unlike the tax, to attain $Q^{standard}$, regulator does not need to know firms' MC.

Promoting technological change

- In the long run, abatement technology is not fixed.
- Firms can lower their abatement costs by developing and/or adopting new technologies.
- Market-based policies provide greater incentives for technological change than command-and-control policies.

The non-uniform mixing problem and pollution "hotspots"

- With market-based approaches, emissions vary across firms (low-abatement-cost firms will emit less than high-cost firms).
- If the marginal damages from emissions are the same across firms (i.e., the pollutant is "uniformly mixed"), this is fine.
- If not, then taxes and trading can create pollution "hot spots". If high-damage firms also have high abatement costs, messes up efficiency; not just cost-effectiveness.
- Solutions:
  - Trading ratios
  - Taxes tied to marginal damages

Trading ratios example

- Upper Ohio River Basin combined sewer overflows (CSOs).
  - 70 municipal sewerage systems receive runoff during rainfall
  - When flow exceeds capacity, raw sewage is discharged to waterways.
  - Damages from: bacteria, BOD, TSS
  - Marginal damages from emissions depend on:
    - Flow and other hydrological characteristics of receiving water
    - Exposed population, etc.

Trading ratios for Upper Ohio CSOs

TABLE 3

TRADING RATIOS AS THE RATIO OF THE EXPECTED VALUE OF DAMAGE COEFFICIENTS WEIGHTED BY THE NUMBER OF AFFECTED HOUSEHOLDS

	Source *j*: Source of Pollution Offsets							
Regulated Source *i*	1	2	3	4	5	6	7	8
1 Clairton	1.00	0.25	2.64	0.62	2.80	35.24	0.45	0.72
2 Greensburg	3.99	1.00	10.53	2.46	11.17	140.78	1.81	2.86
3 McKeesport	0.38	0.09	1.00	0.23	1.06	13.37	0.17	0.27
4 Morgantown	1.62	0.41	4.28	1.00	4.54	57.22	0.73	1.16
5 Pittsburgh	0.36	0.09	0.94	0.22	1.00	12.60	0.16	0.26
6 Steubenville	0.03	0.01	0.07	0.02	0.08	1.00	0.01	0.02
7 Uniontown	2.21	0.55	5.82	1.36	6.18	77.85	1.00	1.58
8 Youngstown	1.40	0.35	3.68	0.86	3.90	49.19	0.63	1.00

Source: Farrow et al. (2005), "Pollution Trading in Water Quality Limited Areas: Use of Benefits Assessment and Cost-Effective Trading Ratios," *Land Economics* 81(2), p. 201.

Monitoring and enforcement

- Abatement costs are the largest share of costs for pollution control policies.
- Administrative costs (especially monitoring and enforcement) are the second-largest share of costs.
  - Tend to be small relative to abatement costs for regulations targeting industries.
  - May be very large for regulations targeting individuals.
- CAC approaches may be less costly to monitor and enforce than market-based policies, though not universally.

Are prescriptive regulations ever preferable?

- When "hot spot" problems are severe (highly non-uniformly mixed pollutants).
  - E.g., toxic waste
- When a single control technology is highly effective, and abatement costs extremely similar across firms.
  - E.g., double-hulled oil tankers
- If the number of regulated entities is very high.
  - E.g., emissions from automobiles, home heating systems, …

Examples of market-based environmental policies

- Carbon taxes (British Columbia)
- Cap-and-trade – air pollution: CO2 in the EU, CA, …; SO2 and NOx in the U.S.
- Unit charges for municipal solid waste (pay-as-you-throw) – 7,000+ U.S. communities
- Individual tradable fishing quotas – New Zealand, U.S. (Gulf red snapper, Pacific halibut, …)
- Water quality trading (Minnesota River P trading, Chesapeake Bay N/P markets, …)
- Wetlands mitigation banking
- Tradable development rights

Air pollution trading example: U.S. SO_2 trading (1990-2008)

- Efficiency: benefits~$3,300/ton SO_2; costs: ~$270/ton.
- Cost-effectiveness: cap-and-trade saved ~$1.8 billion/year in comparison to a counterfactual technology standard.
- Long-run technological change: seems to have boosted firms' propensity to adopt lower-cost abatement technologies; also some evidence from patent data on innovation.
- Compliance/enforcement:
  - costs of monitoring emissions roughly two orders of magnitude less than costs of abatement.
  - very high rates of compliance (100%?)
  - Fines of $2,000/ton for noncompliance (>>permit prices)

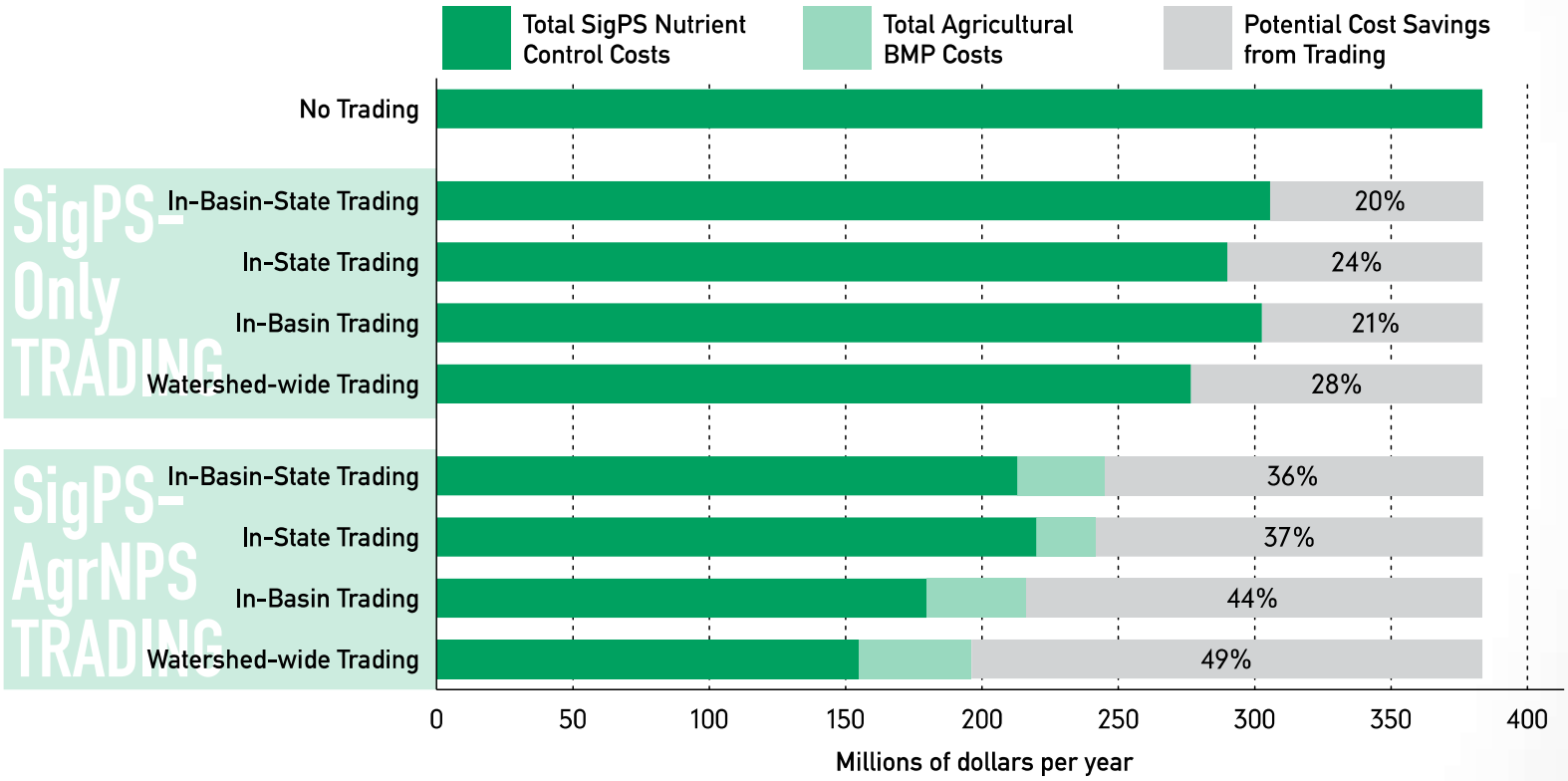
Markets for water pollution?

- In most cases, very “thin” markets.
- Non-uniform mixing : “Fixable” with trading ratios, but reduces cost-effectiveness advantage over CAC policies.
- Regulatory barriers
  - Non-point source pollution is unregulated, and also usually the least-cost abatement (and, increasingly, the only remaining significant pollution source).
- Where NPS are included in trading programs, hard to evaluate, monitor impacts of pollution control techniques – how to develop “tradable commodity” for a market?

Chesapeake Bay: potential gains from trade

Figure 9-3

Costs of Achieving SigPS Load Reduction Targets and Potential Cost Savings from Alternative Trading Scenarios



Source: Van Houtven, GT, et al. 2012. *Nutrient credit trading for the Chesapeake Bay: an economic study*. RTI International, Research Triangle Park, NC, p. 43.

Summing up market-based environmental policy

- Market-based approaches have the potential to significantly decrease the costs (short- and long-run) of attaining a given level of environmental quality.
- Many examples, in practice, in which this potential has been realized.
- Many other applications on the "frontier" (and likely many others in the future), for which outcomes are less clear.
- As markets move to new environmental problems, face new challenges
  - For non-uniform damages, markets need constraints.
  - Design of those constraints requires inputs from natural/physical sciences