Tradable permits and introduction to instrument choice

Lecture 2

ARE 264

January 20, 2022

Preparing for lecture 3

- bCourses prompt on Coase due before class
- Starred reading is Pizer and Prest, and Coase

Lecture 1 Recap

1. **What is an externality, and how does it cause market failure?**
   - An externality affects costs or utility directly, not through prices
2. **How do we fix problems caused by externalities?**
   - The Pigouvian prescription is to set a tax equal to marginal damages at the optimum, which will restore market efficiency
3. **Are Pigouvian taxes efficient?**
   - Transitions are not Pareto improvements, but outcomes under a Pigouvian tax are Pareto efficient if the tax is at the right level. But it is hard to get the right tax, so the primary appeal of market based instruments is that they require far less information to achieve cost effectiveness than do other interventions.

Outline

1. **What should we know about tradable permits?**
   - A tradable permit system can mimic cost effectiveness of a tax. Efficiency is independent of permit allocation.
2. **What is the Weitzman P vs Q model?**
   - Weitzman's model suggests that the relative slopes of supply and demand determine whether a price or quantity instrument is more efficient when there is uncertainty about costs
3. **What criteria might determine which instrument is best?**
   - Goulder and Parry suggest: Efficiency, Cost effectiveness, Equity/distribution, Robustness to uncertainty, Political feasibility, Political flexibility or robustness, Administrative costs, Enforcement

Quantity instruments

- What are the basic things you think economists should know about tradable permit systems?
  - They are a "market-based instrument" that can mimic cost-effectiveness of a tax
  - Permit allocation determines incidence but not efficiency
  - Fixing quantity allows price volatility

- Pigou (1920) suggested fixing externalities via a tax
- Crocker (1966) and Dales (1968) both suggested that a tradable permit system was an efficient alternative to taxation
- Montgomery (1972) pointed out that the efficiency of a tradable system was irrespective of how the permits were allocated

The cap and trade problem

- The key to a cap and trade (tradable permit) system is that firms can trade the pollution permits
- Write firm *j*'s problem in a permit system (continuing model from Lecture 1):

$$\max_{a_j, x_j, w_j} \pi = Px_j - (c_j(x_j) + g_j(a_j)) + P_w(d_j - w_j)$$

$$\text{s.t. } \underbrace{e_j(x_j) - a_j}_{\text{emissions}} \leq \underbrace{d_j + w_j}_{\text{permits}}$$

- where w_j is net permits purchased; can be negative
- d_j is permits endowed; $d_j + w_j$ is total permits held
- P_w is the market price of permits

The cap and trade problem

$$
\begin{aligned}
\mathcal{L}_j =& Px_j - (c_j(x_j) + g_j(a_j)) + P_w(d_j - w_j) \\
& - \mu_j \left(e_j(x_j) - a_j + (d_j + w_j)\right) \\
\\
=& Px_j - (c_j(x_j) + g_j(a_j)) - P_w w_j \\
& - \mu_j \left(e_j(x_j) - a_j + w_j\right) - \underbrace{(P_w + \mu) d_j}_{\in \mathbb{R}}
\end{aligned}
$$

- Note: d_j enters only as a constant in Lagrangean—therefore, it will not affect any marginal choices (disappears from FOC)
- Endowed permits act purely as lump-sum transfers (unless they are allocated on the basis of behavior)

$\Rightarrow$ Initial allocation does not affect efficiency (caveat is exit/entry)

- Some use this to argue for paying off stakeholders with permits

FOCs:

$$\frac{\partial \mathcal{L}_j}{\partial x_j} : \quad P = c_j' + \mu_j e_j'$$

$$\frac{\partial \mathcal{L}_j}{\partial a_j} : \quad \mu_j = g_j'$$

$$\frac{\partial \mathcal{L}_j}{\partial w_j} : \quad \mu_j = P_w$$

- When $P_w = \phi$, these conditions match planner's first-best
- Cap identical to tax with $P_w = \tau$
- Regardless of P_w, satisfies equimarginal principle:
  - Abate until MC (g_j') equals shadow cost
  - Shadow price equals permit cost $\forall j$

Collective Think Aloud

- What **research questions** might you ask about/around tradable permit systems?

Tradable permits also reveal marginal cost of compliance

Is Air Pollution Regulation Too Stringent?*

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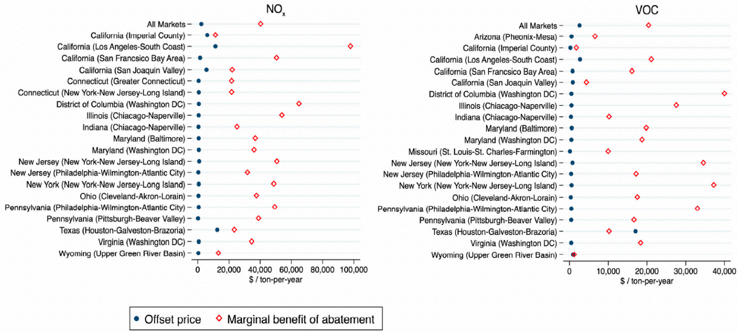
December 2020

Abstract

This paper describes a novel approach to estimating the marginal cost of air pollution regulation, then applies it to assess whether a large set of existing U.S. air pollution regulations have marginal costs exceeding their marginal benefits. The approach utilizes an important yet underexplored provision of the Clean Air Act requiring new or expanding plants to pay incumbents in the same or neighboring counties to reduce their pollution emissions. These "offset" regulations create several hundred decentralized, local markets for pollution that differ by pollutant and location. We describe conditions under which offset transaction prices can be interpreted as measures of the marginal cost of pollution abatement, and we compare estimates of the marginal benefit of abatement from leading air quality models to offset prices. We find that for most regions and pollutants, the marginal benefits of pollution abatement exceed mean offset prices more than ten-fold. In at least one market, however, estimated marginal benefits are below offset prices. Marginal abatement costs are increasing rapidly in real terms. Notably, our revealed preference estimates of marginal abatement costs differ enormously from typical engineering estimates. Some evidence suggests that using price rather than existing quantity regulation in these markets may increase social welfare.

- In theory, agents should set the marginal cost of abatement equal to the permit price $\Rightarrow$ so a permit price reveals marginal cost

Figure 3—Offset Prices and Marginal Benefits of Abatement, Large Individual Markets



Notes: This figure compares offset prices and the marginal benefits of pollution abatement in individual market × pollutants, for a set of large markets with data. Data represents years 2010-2019. The vertical axis lists the state that the data represent, then in parentheses, the market's name. Offset prices are the mean price of pollution offsets per ton for the indicated census region, pollutant, and time period, weighted by transaction amount in tons or by population in offset markets, and annualized using the price ratio between permanent and temporary offset prices. Marginal benefits of abatement are the marginal external cost avoided per ton abated for the indicated market and pollutant. Data on marginal benefits are available for years 2008, 2011, 2014, 2017, and linearly interpolated between years. All currency are in 2017$, deflated using the GDP deflator. Abatement marginal benefits for each market are weighted across counties within a market according to county population in 2010 Census. The Philadelphia-Wilmington-Atlantic City area includes Delaware.

Source: Shapiro and Walker 2020

Gains from trade

- Might want to know if systems deliver large gains as compared to some other alternative regulation
- How would you figure this out?
- What information would you need to know?

Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?
Author(s): Curtis Carlson, Dallas Burtraw, Maureen Cropper and Karen L. Palmer
Source: *Journal of Political Economy*, Vol. 108, No. 6 (December 2000), pp. 1292-1326
Published by: University of Chicago Press
Stable URL: http://www.jstor.org/stable/10.1086/317681
Accessed: 09-03-2016 21:46 UTC

- How do you think they answered this question?

TABLE 2

LONG-RUN (Phase II, Year 2010) COST ESTIMATES (1995 Dollars)

	Total Cost under "Enlightened" Command and Control (Billions) (1)	Total Cost under Efficient Trading (Billions) (2)	Marginal Cost per Ton SO_2 (\$/Ton) (3)	Average Cost per Ton SO_2 (\$/Ton) (4)	Potential Gains from Trade (Billions) (5)
Preferred estimate	1.82	1.04	291	174	.78
1995 technology	2.23	1.51	436	198	.72
1989 prices and 1989 technology	2.67	1.90	560	236	.77
EPA (1990)	...	2.3–5.9	579–760	299–457	...
EPA (1989)	...	2.7–6.2		377–511	...

- What do you notice about this table? Questions?

The Gains from Agricultural Groundwater Trade and the Potential for Market Power: Theory and Application

Ellen M. Bruno, and Richard J. Sexton

This article models and estimates the efficiency gains from using market-based instruments relative to command and control to manage groundwater. A theoretical model of an imperfectly competitive groundwater market is developed to show how the magnitude and distribution of the gains from trade change as market structure varies. Market structure is a key consideration because future groundwater markets will likely feature geographic limitations to trade, large agricultural players, and a legal environment that is conducive to forming cartel-like coalitions. Application of the model to a groundwater-dependent agricultural region in southern California shows the existence of large gains from trade, despite the potential for market power, with benefits up to 36% greater than that under command and control. Distributional impacts, however, can be sizable even for small degrees of market power. Simulations that vary market conditions show that results likely generalize to other groundwater basins.

- Frontier questions often add second element/market distortion
- Here, question how market power impacts efficiency gains from trading

Do tradable permit schemes "work"?

Can Catch Shares Prevent Fisheries Collapse?

Christopher Costello,[1]* Steven D. Gaines,[2] John Lynham[3]†

Recent reports suggest that most of the world's commercial fisheries could collapse within decades. Although poor fisheries governance is often implicated, evaluation of solutions remains rare. Bioeconomic theory and case studies suggest that rights-based catch shares can provide individual incentives for sustainable harvest that is less prone to collapse. To test whether catch-share fishery reforms achieve these hypothetical benefits, we have compiled a global database of fisheries institutions and catch statistics in 11,135 fisheries from 1950 to 2003. Implementation of catch shares halts, and even reverses, the global trend toward widespread collapse. Institutional change has the potential for greatly altering the future of global fisheries.

Although the potentially harmful consequences of mismanaged fisheries were forecast over 50 years ago (*1*, *2*), evidence of global declines has only been seen quite recently. Reports show increasing human impacts (*3*) and global collapses in large predatory fishes (*4*) and other trophic levels (*5*) in all large marine ecosystems (LMEs) (*6*). It is now widely believed that these collapses are primarily the result of the mismanagement of fisheries.

One explanation for the collapse of fish stocks lies in economics: Perhaps it is economically optimal to capture fish stocks now and invest the large windfall revenues in alternative assets, rather than capturing a much smaller harvest on a regular basis. Although this remains a theoretical possibility for extremely slow-growing species

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678 19 SEPTEMBER 2008 VOL 321 SCIENCE www.sciencemag.org

- Tradable permits for resources (water, fisheries) are a conservation/resource management tool
- Reasonable to ask if they are effective

Does independence truly hold?

Distributing Pollution Rights in Cap-and-Trade Programs: Are Outcomes Independent of Allocation?

Meredith Fowlie and Jeffrey M. Perloff

Posted Online December 20, 2013
https://doi.org/10.1162/REST_a_00345

Review of Economics and Statistics
Volume 95 | Issue 5 | December 2013
p.1640-1652

Abstract

Standard economic theory predicts that if property rights to pollute are clearly established, equilibrium outcomes in an efficient emissions permit market will be independent of how the emissions permits are initially distributed. This so-called independence property has important implications for policy design and implementation. Past studies document a strong positive correlation between the initial permit allocation and firm-level emissions, raising concerns that the independence property is failing to hold in real-world settings. We exploit the random assignment of firms to different permit allocation cycles in Southern California's RECLAIM program in order to test the independence of permit allocation and emissions. Our results lend empirical support to the independence hypothesis.

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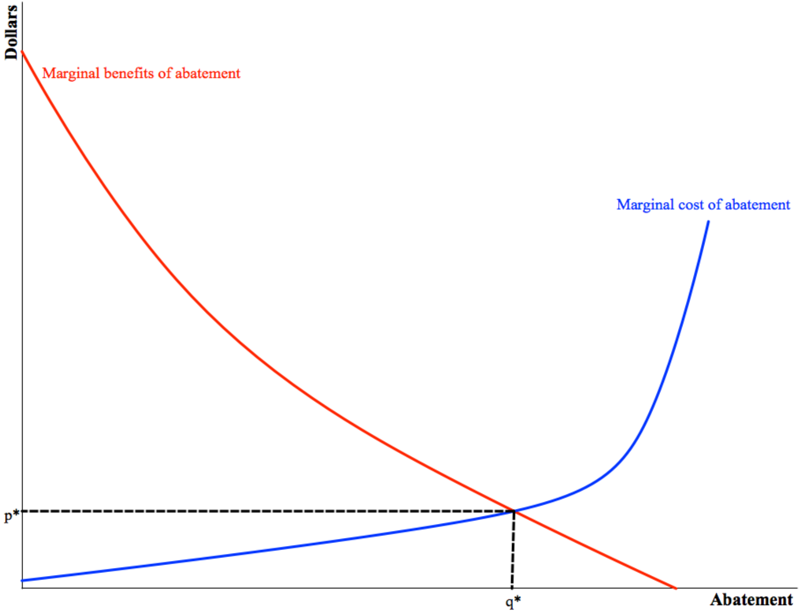
Uncertainty

- Under perfect certainty, we know final allocation as determined by policy
- In reality, costs and benefits and other factors uncertain
- Different policies create different uncertainties
  - Tax fixes price of abatement
  - Tradable permits fix quantity of emissions
  - Other policies fix neither perfectly
- Hybrid systems blur the distinctions (e.g., Pizer 2002)
- Weitzman (1974) shows that such uncertainty implies a difference in the (expected) efficiency of taxes versus permits

Prices versus quantities

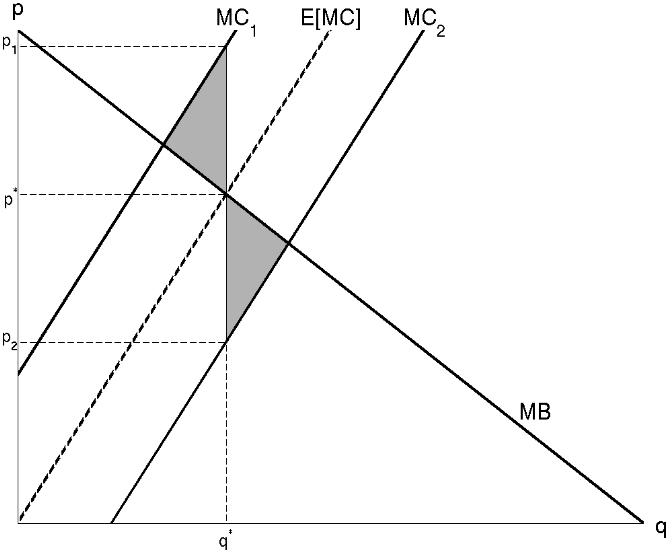
- Under certainty, setting price and setting quantity are the same
- But, if uncertain about costs or benefits, then are they equivalent?

- Credit: graphs from Wolfram Schlenker

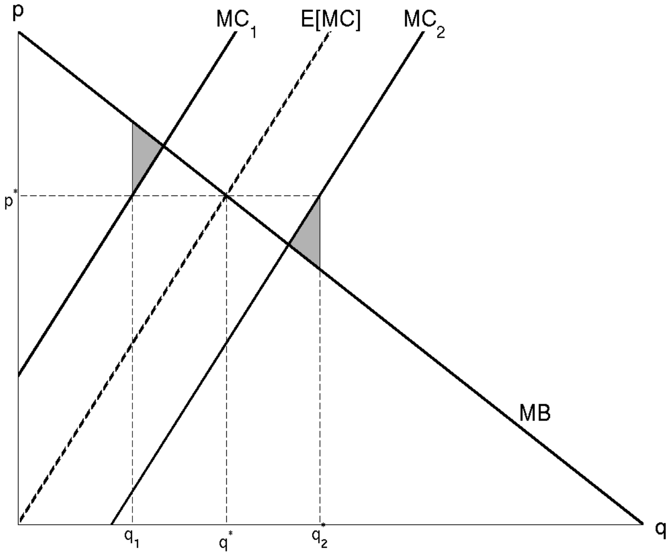

Dollars
Marginal benefits of abatement
Marginal cost of abatement
p*
q*
Abatement

- Weitzman (1974) setup assumes firms comply with policy such that markets always end up on the MC curve, not the MB curve
- Question: does setting price or quantity lead to greater DWL from uncertainty?

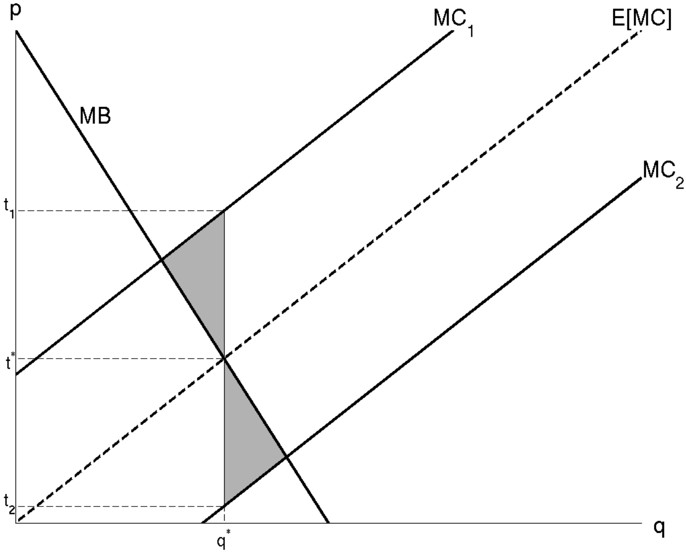
Quantity regulation; steep MC



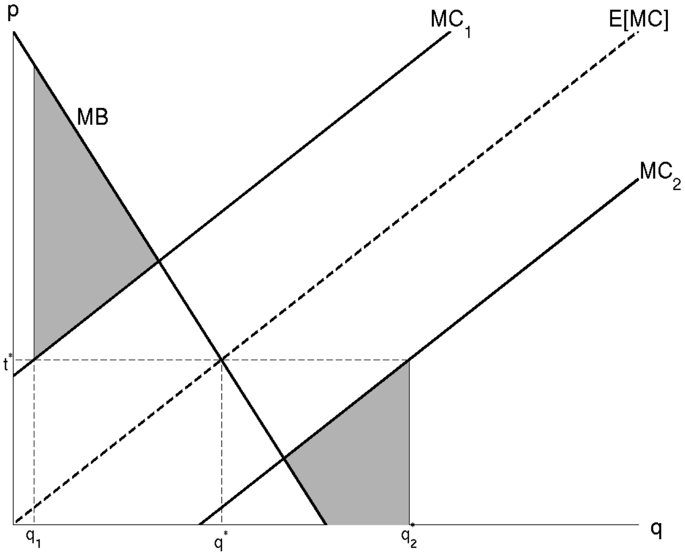
Price instrument (tax); steep MC



Quantity regulation; flat MC



Price instrument (tax); flat MC



- Assumes that market locates on MC curve, bc producers comply with law
- Steepness of MC relative to MB determines whether price or quantity instrument creates more DWL
- Shifting MB curve affects DWL, but in same way for either policy

- The Weitzman model is one-period, but of course you learn about the cost curve when you put a policy in place
  - Pizer and Prest (2019) discuss policy updating and learning

- Most caps have a ceiling and some have a floor, so that they start to act like a tax
  - Pizer (2012) discuss hybrid forms that have price floors and ceilings

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Most policies are not a Pigouvian tax or tradable permits

Tax fuels (inputs)

Subsidize clean products

CAFE
Corporate Average Fuel Economy

Regulate energy efficiency

What policies are used to deal with environmental externalities?

1. Pigouvian tax (price instrument)
2. Tradable emissions permits (quantity instrument)
3. Subsidies for emissions reductions
4. Performance standards
5. Technology mandates
6. Technology (R and D) subsidies

Note: see Goulder and Parry (2008) for related material that reviews instrument choice

Collective Think Aloud

- How might we decide between alternative policies?
- What criteria did you come up with?

Criteria: how might we choose between alternatives?

1. Efficiency
2. Cost effectiveness
3. Equity/distribution
4. Robustness to uncertainty
5. Political feasibility
6. Political flexibility or robustness
7. Administrative costs
8. Enforcement

- Volumes have been written about the merits of price versus quantity instruments for carbon

- How would you evaluate the difference, and do you think it matters?

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