COSTS OF ENVIRONMENTAL PROTECTION

LESSON OBJECTIVES

01

Explain sources of economic costs for environmental protection

02

Contrast statutory vs. economic tax incidence

03

Explain impacts of environmental regulation on jobs and innovation

01

SOURCES OF ECONOMIC COSTS

ECONOMIC COSTS OF ENVIRONMENTAL PROTECTION

We just finished a discussion of how to measure benefits.

But as economists, we all know there is no such thing as a free lunch…

So what are the costs?

PLANNING A POLICY THAT CAPS THE POLLUTION OF COAL POWER PLANTS

What associated costs can you think of?

- Cost of cleaning technology
- Cost of cleaner coal inputs
- Cost of abatement (reduced output)
- Cost of monitoring
- etc.

OPPORTUNITY COSTS

In economic terms, the true costs of any activity are the *opportunity costs*—what you give up by doing one thing instead of another

What are the costs of going to Georgia Tech?

Opportunity costs do not match accounting costs

- Often larger than out of pocket costs

HOW CAN WE CLASSIFY THESE COSTS?

We consider 4 types of costs associated with environmental protection:

1. Private compliance costs
2. Government sector costs
3. Social welfare costs
4. Transitional effects

I. PRIVATE COMPLIANCE COSTS

Costs to firms to comply with regulation.

- Capital and infrastructure costs
  - Cost of installing scrubbers
- Changes in input costs
  - Cost of cleaner coal
- Cost of cleaning bad output
  - Cost of capturing emissions
- Time spent on compliance paperwork

I. PRIVATE COMPLIANCE COSTS

Who knows the private compliance costs?

The firms, not the regulators. Cost information is private

To estimate compliance costs, regulators often turn to "engineering cost" approach

Use engineering estimates of cost based on standard technologies and processes

2. GOVERNMENT SECTOR COSTS

Say you impose the new emissions policy. Will firms follow it?

No!

Government must incur cost to administer, monitor, and enforce costly regulations

These resources could be spent on something else (e.g. healthcare or education)

3. SOCIAL WELFARE COSTS

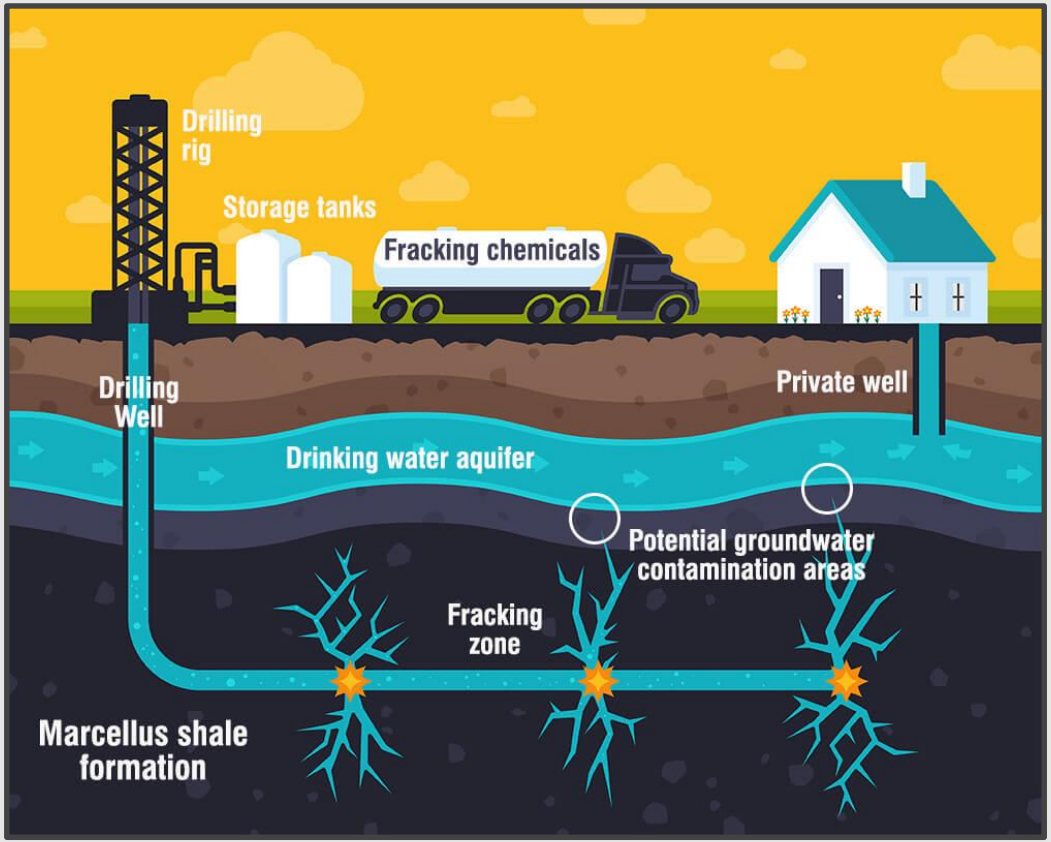
Social welfare changes

Losses in consumer and producer surplus due to increase in price or decrease in output following regulation

3. SOCIAL WELFARE COSTS

Concept:
If regulation increases the price, consumers will buy less of the good and/or substitute away, leading to a decrease in surplus

EXAMPLE: FRACKING



HYDRAULIC FRACTURING BACKGROUND

Concept: Pump high pressure water into shale formations breaking up rocks to release oil and natural gas

Pro: New process lead to increase in cheap oil production in the US

Con: Produces large amount of wastewater with harsh chemicals that can contaminate local drinking water sources (e.g. organic and inorganic chemicals, metals, radioactive materials)

Wastewater is commonly deposited in injection wells or brought to water treatment plants

NEW FRACKING POLICY

Consider a new regulation that requires firms to either pre-treat or recycle wastewater

Private compliance cost of $10/bbl of oil

How can we estimate the total cost of this regulation?

Assumptions:
Marginal costs for each well is $\mathrm{MC_i} = 0.5q_i$
Current price of oil is $50/bbl

CONSIDER A SINGLE WELL

Initial quantity:

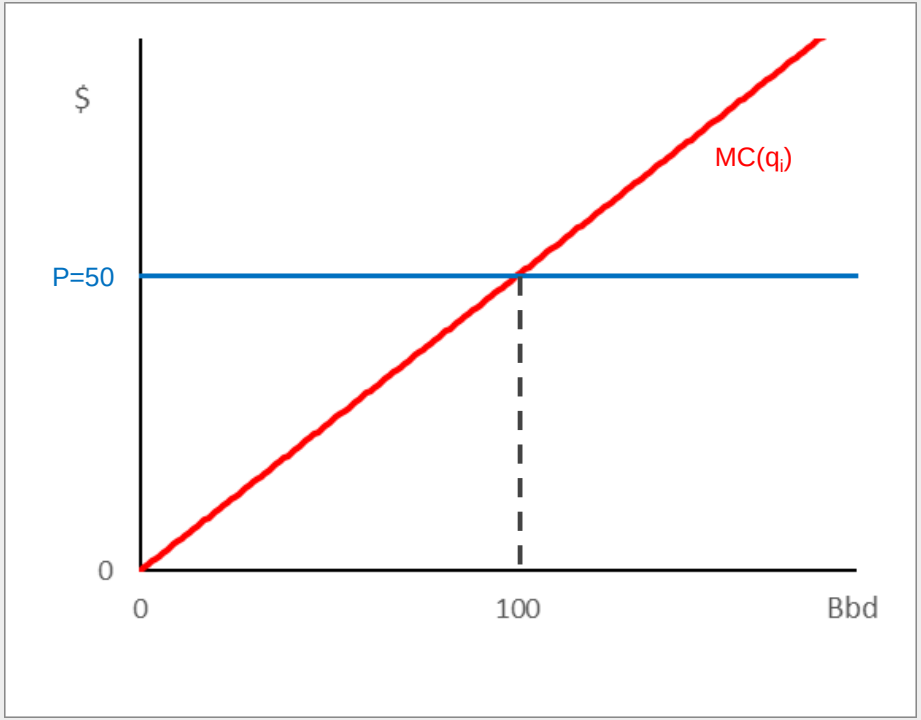
$$\mathrm{MC_i} = 0.5q_i = \$50$$

$$q_i = 100$$

Initial profit:

$$\pi_i = \frac{1}{2} * (50 - 0) * (100)$$

$$= \$2500$$



CONSIDER A SINGLE WELL

New quantity:

$$\mathrm{MC}_i' = 10 + 0.5q_i = \$50$$

$$q_i' = 80$$

New profit:

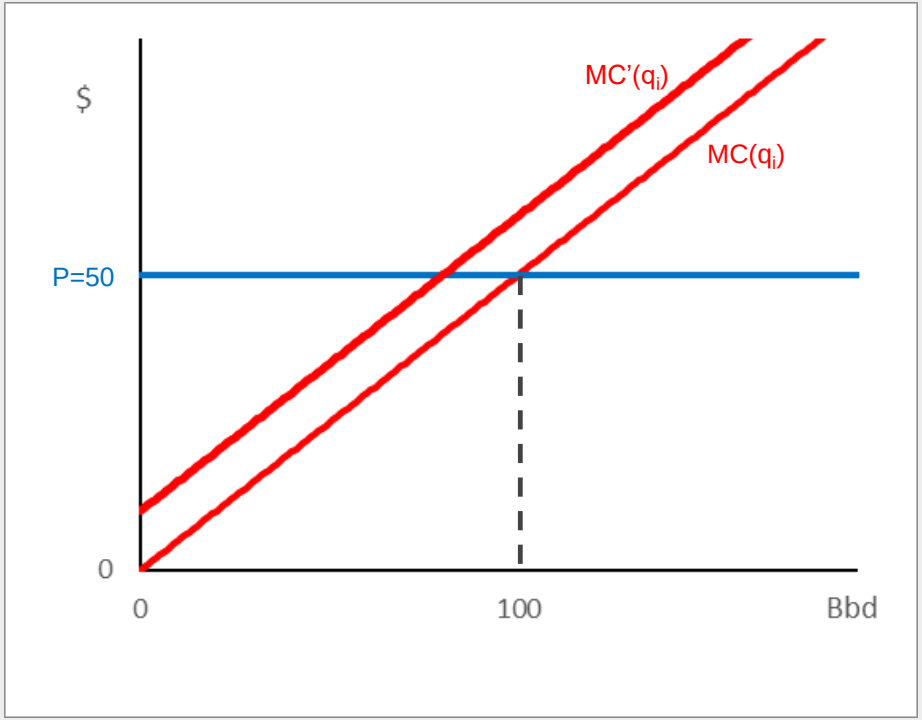
$$\pi_i' = \frac{1}{2} * (50 - 0) * (80)$$

$$= \$1600$$

Cost:

$$\mathrm{TC} = \$2500 - \$1600$$

$$= \$900$$



How does this compare with the size of the tax?

$$\$10 * 80 = \$800 < \$900 < \$10 * 100 = \$1000$$

CONSIDER THE MARKET

Demand:

$$P = 100 - Q/(20{,}000)$$

Supply:

Assume 10,000 wells

Sum horizontally

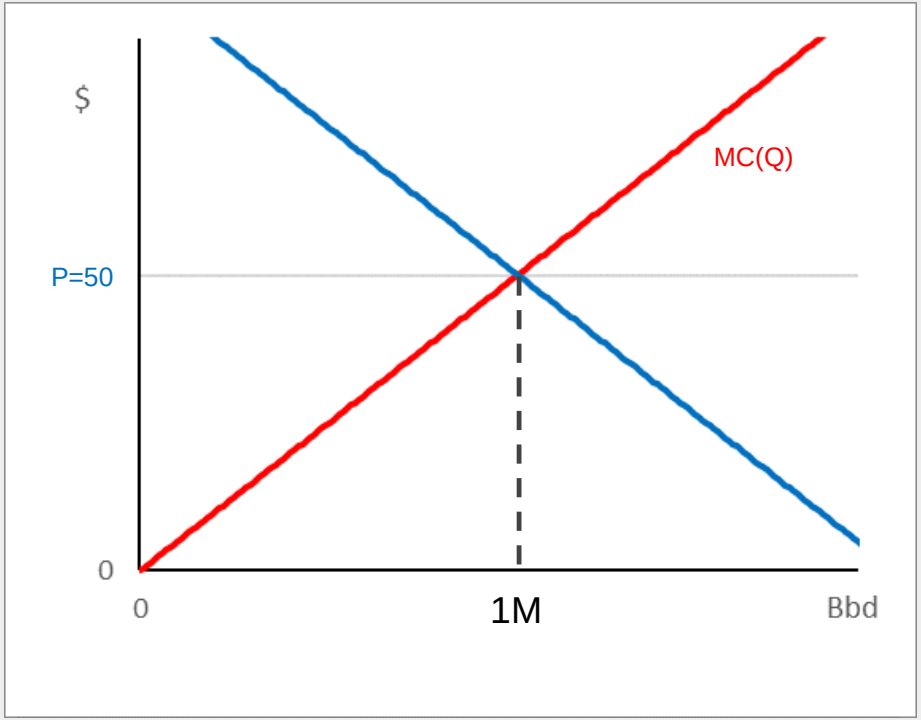
$$q_i = 2MC_i$$

$$10{,}000(2MC_i) = Q$$

$$MC = \frac{Q}{20{,}000}$$

Initial Quantity

$$Q = 1{,}000{,}000$$



CONSIDER THE MARKET

New Equilibrium:

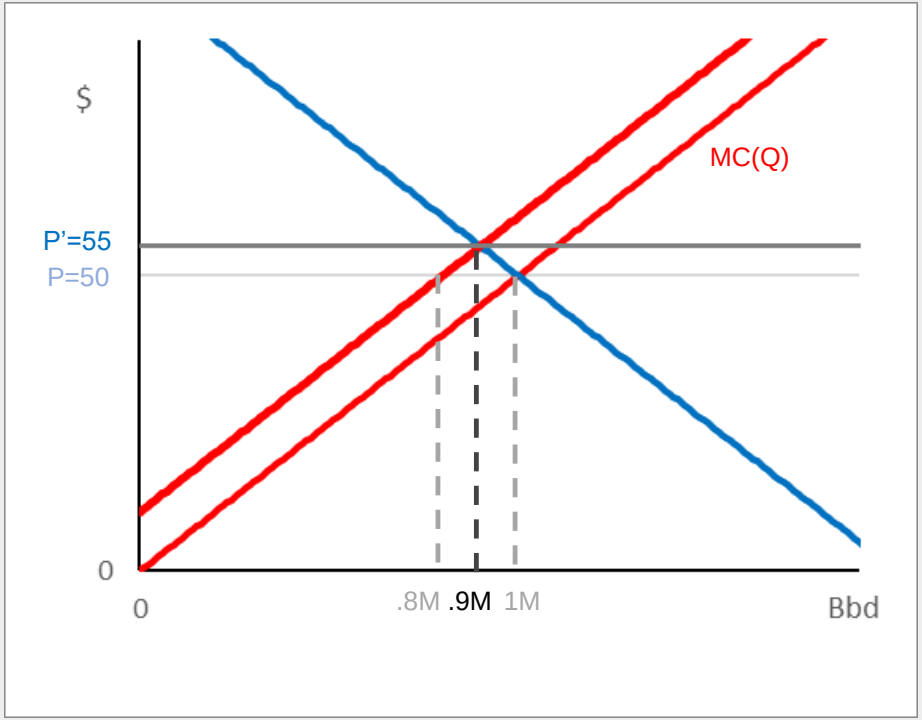
$P' = 55$

$Q' = 0.9M$

Surplus Changes:

Both lose

- $5/bbl on 0.9M consumed
- $2.50 on 0.1M no longer consumed



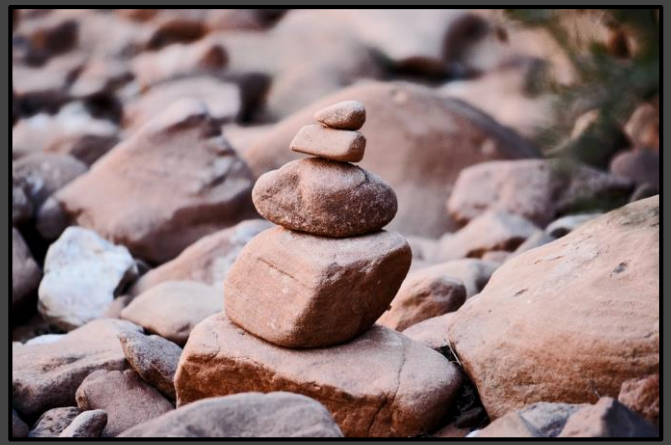
GENERAL EQUILIBRIUM

If the price of product increases, which can spill over into other markets

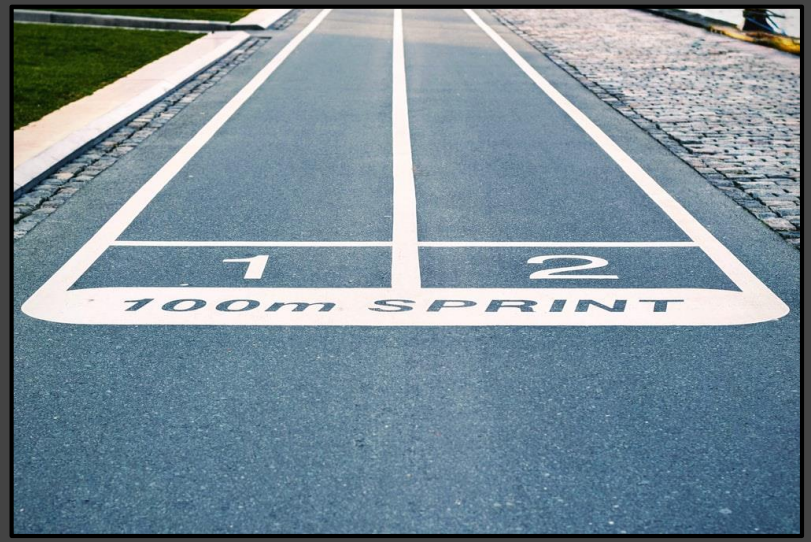
- Consumer substitution
- What about producers?
  - Increase in electricity cost -> increase in cost of producing other goods and services

Different than partial equilibrium, but by how much?

- Often depends on size of regulated industry



COMPETITIVE EFFECTS



What happens in a competitive market if variable costs rise?

- Short-run: firms may shutdown
- Long-run: firms may exit

What happens if regulation increases fixed costs?

- Firms exit
- Harder for firms to enter
- May introduce new inefficiencies

BEFORE WE TALK ABOUT TRANSITIONAL EFFECTS, LET'S TALK ABOUT WHO PAYS THE COSTS OF REGULATION

02

STATUTORY VS. ECONOMIC TAX INCIDENCE

CONSIDER A TAX ON GASOLINE. WHO "PAYS" THE TAX?

IF THE TAX IS ON THE PRODUCER? CONSUMER?

In the previous example, both consumer and producer surplus were reduced by the tax.

But the tax was only imposed on the producer.

ECONOMIC TAX INCIDENCE

The true cost to an individual or group as a result of a tax

STATUTORY TAX INCIDENCE

The individual or group who are required to remit the tax

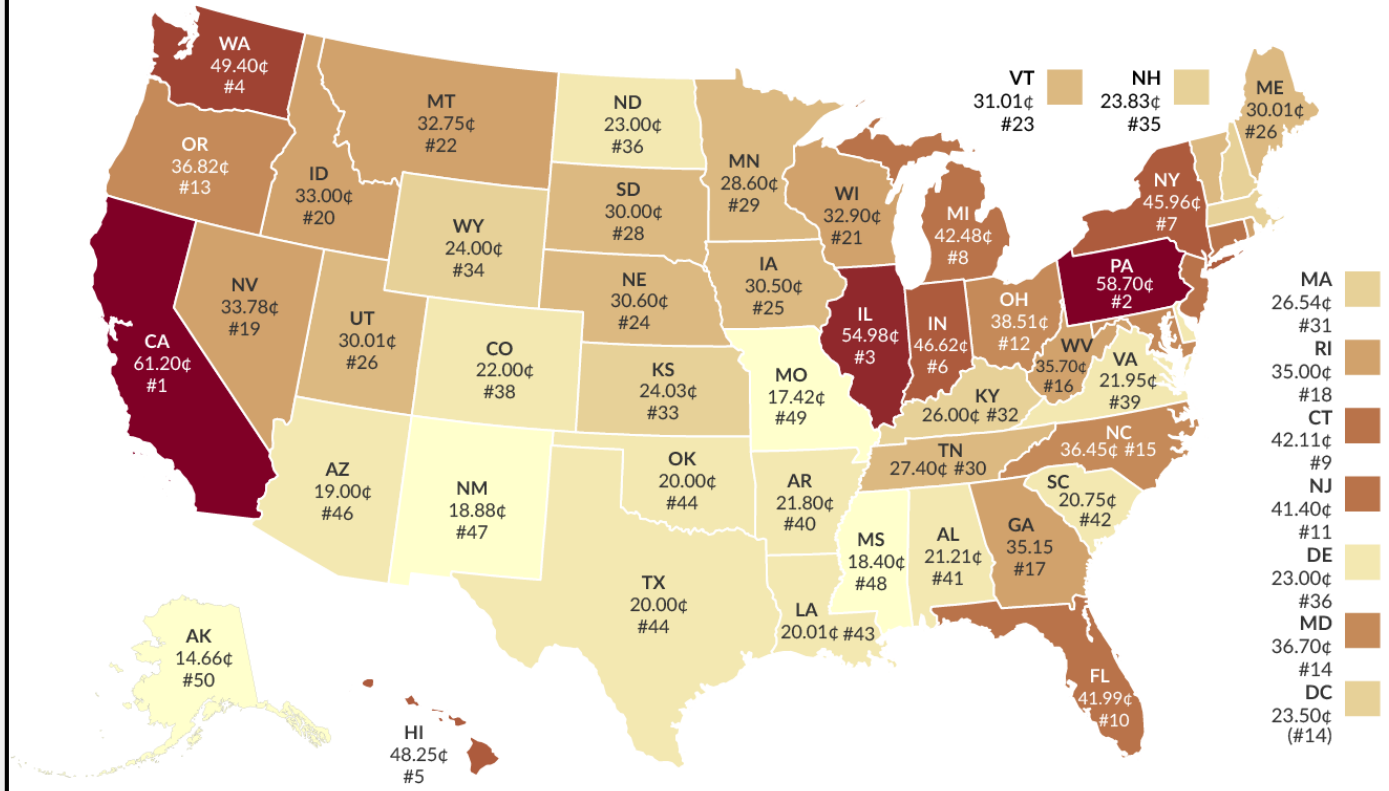
The distinction between statutory and economic tax incidence is important.

Economic incidence is independent of statutory incidence.

PEOPLE OFTEN GET THIS WRONG

How High Are Gas Taxes in Your State?

Total State Taxes and Fees on Gasoline, as of July 2019 (cents per gallon)



Note: These rates do not include the 18.40 cent/gallon federal excise tax rate on gas. The American Petroleum Institute has developed a methodology for determining the average tax rate on a gallon of fuel. Rates may include any of the following: excise taxes, environmental fees, storage tank taxes, other fees or taxes, and general sales taxes. In states where gasoline is subject to the general sales tax, or where the fuel tax is based on

Total State Taxes and Fees on Gasoline

Lower — Higher

EX. GASOLINE TAX

Price of gas is $1.50/gallon without tax

Consider $0.35 tax in Georgia levied on retailers

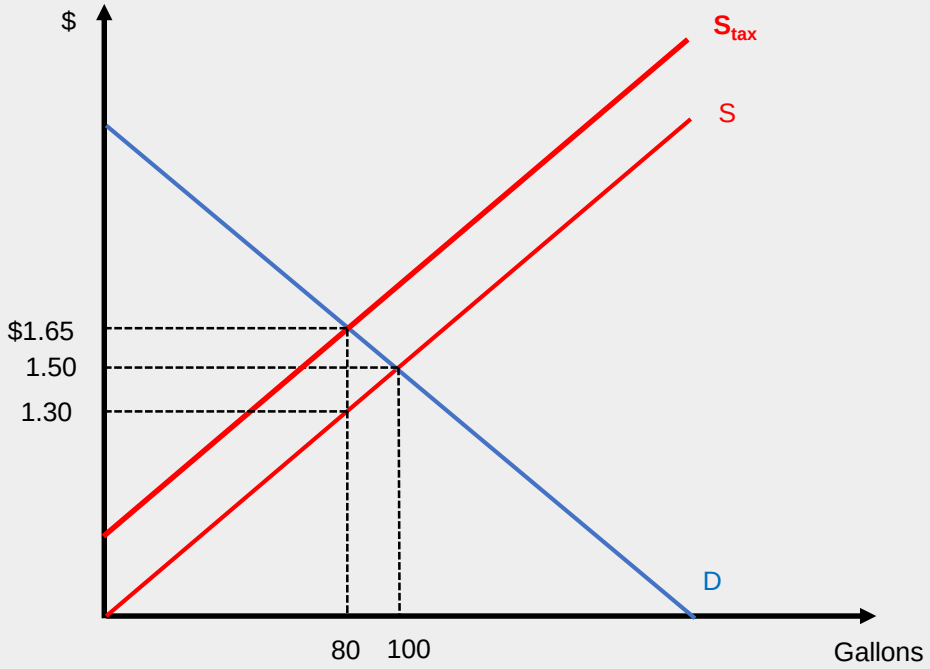
- For every gallon of gas purchased, gas retailer must pay Georgia $0.35

Statutory incidence is on the *retailer*.

Who pays the *true cost* of the tax though?

EX. GASOLINE TAX

$0.35 tax on retailers



EX. GASOLINE TAX

$0.35 tax on retailers

BEFORE TAX	AFTER TAX	GAINS/LOSSES
Price consumers pay: $1.50	Price consumers pay: $1.65	Consumers lose: $0.15/gallon
Price producers receive: $1.50	Price producers receive: $1.30	Producers lose: $0.20/gallon
Government receives $0	Government receives: $0.35	Government gains: $0.35/gallon

ATTENDANCE ACTIVITY

Price of gas is $1.50/gallon without tax

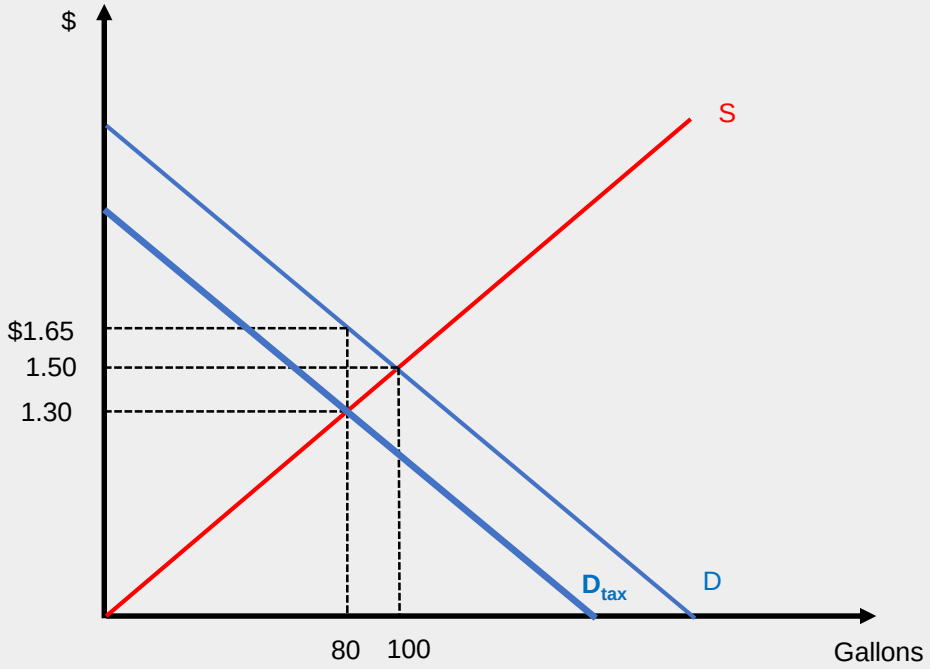
Now consider $0.35 tax in Georgia levied on consumers

- For every gallon of gas purchased, consumer must pay Georgia $0.35

Statutory incidence has changed from *retailer* to *consumer*

What is the gains/losses for consumers, producers, and the government?

ATTENDANCE ACTIVITY $0.35 tax on consumers



ATTENDANCE ACTIVITY

$0.35 tax on consumers

BEFORE TAX	AFTER TAX	GAINS/LOSSES
Price consumers pay: $1.50	Price consumers pay: $1.65	Consumers lose $0.15/gallon
Price producers receive: $1.50	Price producers receive: $1.30	Producers lose $0.20/gallon
Government receives $0	Government receives $0.35	Government gains $0.35/gallon

WHAT HAPPENED TO THE ECONOMIC TAX INCIDENCE WHEN THE STATUTORY INCIDENCE SHIFTED FROM THE RETAILER TO THE CONSUMER?

NOTHING CHANGED!

Economic tax incidence is independent of statutory incidence

WHAT DETERMINES ECONOMIC TAX INCIDENCE?

In fracking example, incidence was split 50/50

In gas example, incidence was split 43/57 with retailers paying more

What determines who bears the cost of a tax?

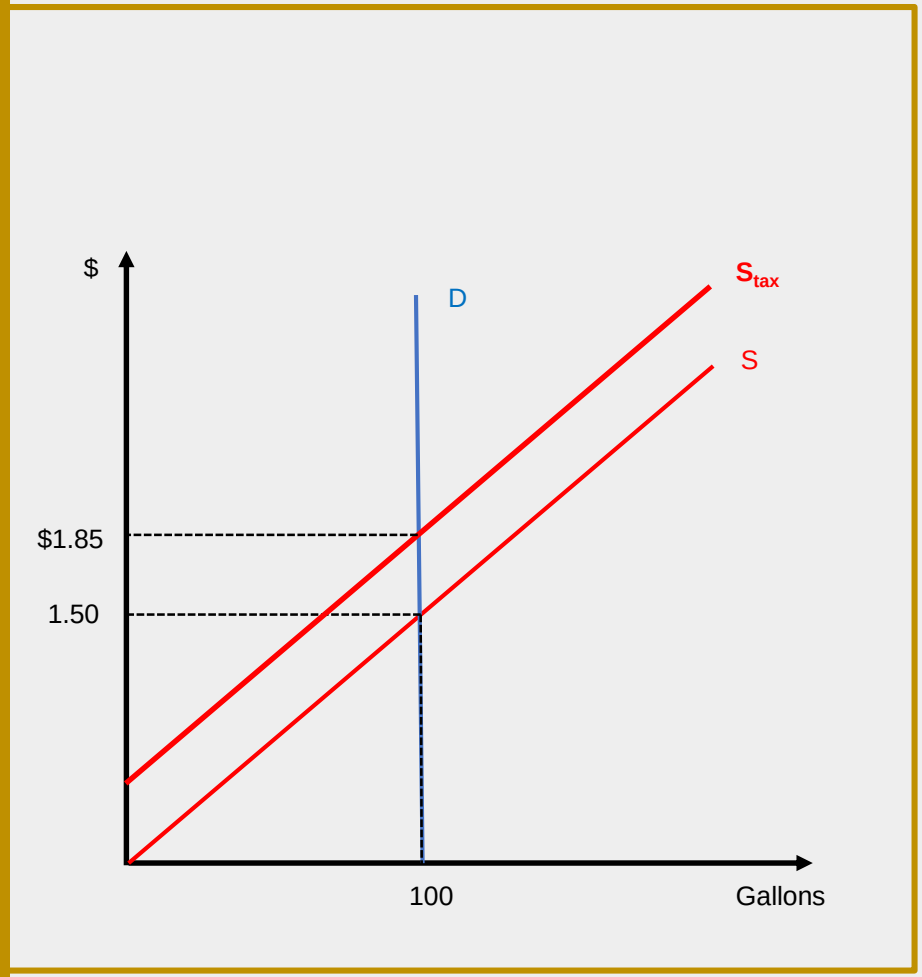
WHAT DETERMINES ECONOMIC TAX INCIDENCE?

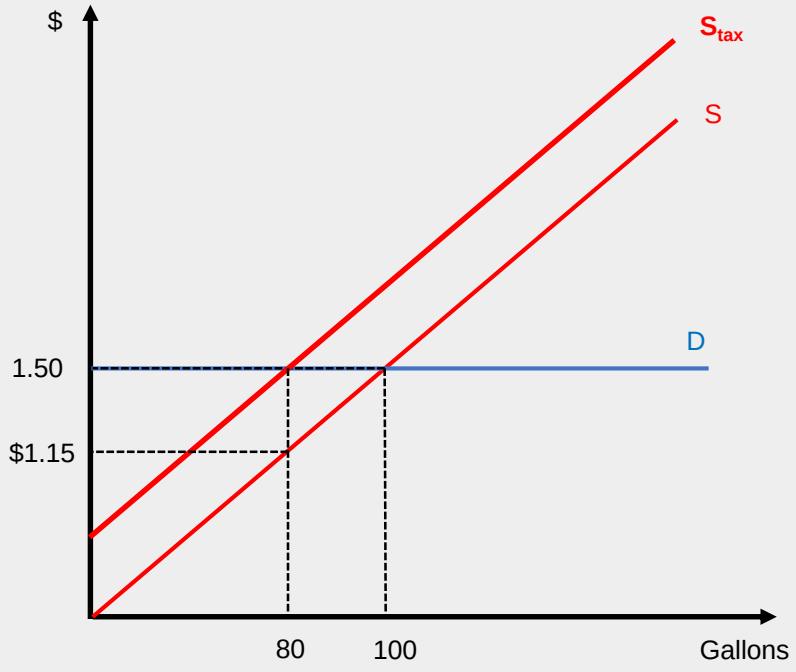
Tax incidence is determined by the responsiveness of supply and demand to changes in price.

This is called the price elasticity of supply and demand

$$\varepsilon_{Supply} = \frac{\%\Delta Q_{Supply}}{\%\Delta P} \qquad \varepsilon_{Demand} = \frac{\%\Delta Q_{Demand}}{\%\Delta P}$$

INELASTIC FACTORS BEAR THE BURDEN





INELASTIC FACTORS BEAR THE BURDEN

ECONOMIC TAX INCIDENCE

We can provide a formula for tax incidence

For suppliers:

$$\frac{\varepsilon_S}{\varepsilon_S - \varepsilon_D}$$

For consumers:

$$\frac{-\varepsilon_D}{\varepsilon_S - \varepsilon_D}$$

Consumers bear full burden if:

- Perfectly inelastic demand (ε_D=0), Perfectly elastic supply (ε_S=∞)

Suppliers bear full burden

- Perfectly elastic demand (ε_D= -∞), Perfectly inelastic supply (ε_S=0)

WHAT DETERMINES ELASTICITIES?

Elasticity of Demand
- Number and closeness of substitutes
- Income share spent on the good

Elasticity of Supply
- Size of firm inventory
- Availability of inputs
- Capacity constraints

ELASTICITIES: SHORT RUN VS. LONG RUN

Which is more elastic: short run or long run?

Generally things are more elastic in the long run.

Demand: Buy more fuel-efficient car

Supply: Open more oil fields

PASSING ENVIRONMENTAL REGULATION TAKES MORE THAN ECONOMIC FEASIBILITY.

MUST ALSO BE POLITICALLY FEASIBLE

AMONG CONSUMERS, WHO BEARS THE BURDEN OF THE TAX?

Politicians (and economists) are often interested in what subgroups bear the tax.

Specifically, they are interested if it weighs heavier on socioeconomically disadvantaged groups

REGRESSIVE TAX SYSTEM

System in which the *lower* the income, the higher percentage of income is paid in taxes

PROGRESSIVE TAX SYSTEM

System in which the *higher* the income, the higher percentage of income is paid in taxes

Electricity tax?

Gasoline tax?

Flood plain restrictions?

Determined by how much of a good is used by each subgroup and their elasticity.

DO YOU THINK ENVIRONMENTAL REGULATION TENDS TO BE PROGRESSIVE OR REGRESSIVE?

HOW TAXES ARE REDISTRIBUTED (SPENT) CAN HELP BALANCE THINGS OUT

The Incidence of U.S. Climate Policy: Alternative Uses of Revenues

TABLE 3
CONSUMER SURPLUS LOSS AS PERCENT OF INCOME, BY DECILE

	Decile										
	1	2	3	4	5	6	7	8	9	10	Avg
Initial CS Loss of CO_2 Pricing	4.42	2.82	2.32	2.05	1.82	1.65	1.51	1.35	1.23	0.91	1.42
Cap-and-Dividend (Taxable)	–4.25	–1.13	–0.44	–0.10	0.01	0.17	0.27	0.38	0.46	0.51	0.23
Cap-and-Dividend (Non-Taxable)	–1.64	–0.44	–0.18	0.00	0.06	0.18	0.23	0.28	0.35	0.41	0.23
Reduce Income Tax	4.15	2.55	1.71	1.44	0.98	0.80	0.46	0.30	–0.18	–0.74	0.23
Reduce Payroll Tax	3.89	2.21	1.37	0.96	0.62	0.38	0.18	–0.04	–0.16	–0.14	0.23
Expansion of EITC	–4.56	–2.14	–1.44	–0.53	0.04	0.33	0.43	0.53	0.58	0.57	0.23

Source: Burtraw et al. (2009)

HOW TAXES ARE REDISTRIBUTED (SPENT) CAN HELP BALANCE THINGS OUT

03

IMPACTS OF ENVIRONMENTAL REGULATION ON JOBS AND INNOVATION

COMING BACK TO TRANSITION EFFECTS...

Environmental regulation can impose a cost as factors reallocate to new equilibrium

The most commonly considered is the effect on jobs.


EPA Rules
DESTROY
GOOD JOBS
EPA Rules Put
EPA Rules
DESTROY
GOOD JOBS
www.umwa.org
UMWA
EPA Rules
VETERAN


GREEN
JOBS

JOB EFFECT

Do you think the effect of environmental regulation on jobs is big or small?

Economists usually find the answer is “not much”

What factors might influence the size of the job effect?

- Ability of firms to move location
- Ability of workers to move to other firms
- Size of effect of regulation
- Time scale

GREENSTONE (2002)

Study effect of Clean Air Act (CAA) on jobs in US counties

Finds that counties unaffected by the Clean Air Act gained 590,000 jobs relative to those affected as a result.

But this is the gross job effect. What about net job effect?

JOB LOSSES

Say a regulation causes a firm to layoff workers.

What happens to those workers? Are they unemployed forever?

Probably not.

Economy is dynamic. Workers can shift between firms.

Net job loss ≠ Gross job loss

LU AND PLESS (WP)

Study effect of environmental regulation on *net* jobs in China

Finds that regulation increases jobs by 5% for dirty firms and 8% for clean firms.

Also finds that regulation increases productivity (we'll talk more about this in a second)

THESE TRANSITION EFFECTS CAN ALSO BE LARGE

Walker (2016)

Study earnings for workers in plants regulated by CAA

Find a 5% decline in average earnings, which takes 5 years to recover

Net effect of 20% loss in pre-regulation earnings

TRANSITION EFFECTS

Little consensus on cost of transition effects

Political feasibility has made job effect the most common concern

Economists would point out the effect is small and often driven by other macroeconomic factors

- Yearly turnover in manufacturing of about 20% of jobs

Economy is dynamic so jobs “lost” are often “gained” elsewhere

EFFECT OF ENVIRONMENTAL REGULATION ON INNOVATION

INITIALLY PROPOSED BY MICHAEL PORTER

HENCE REFERRED TO AS *PORTER HYPOTHESIS*

Environmental regulation should "trigger innovation that may partially or more than fully offset the costs of complying with them" (Porter and van der Linde 1995a, 98)

WEAK VS. STRONG PORTER HYPOTHESIS

Porter hypothesis often split into *weak* and *strong*

Weak PH:

- Partially offset regulatory costs

Strong PH:

- More than offset regulatory costs

PORTER AND VAN DER LINDE (1995)

At Ciba-Geigy's dyestuff plant in New Jersey, the need to meet **new environmental standards** caused the firm to reexamine its wastewater streams. **Two changes in its production process**-replacing iron with a different chemical conversion agent that did not result in the formation of solid iron sludge and process changes that eliminated the release of potentially toxic product into the wastewater stream-**not only boosted yield by 40 percent but also eliminated wastes, resulting in annual cost savings of $740,000** (Dorfman, Muir and Miller, 1992).

PORTER AND VAN DER LINDE (1995)

Similarly, 3M discovered that in producing adhesives in batches that were transferred to storage tanks, one bad batch could spoil the entire contents of a tank. The result was wasted raw materials and high costs of hazardous waste disposal. **3M developed a new technique** to run quality tests more rapidly on new batches. The new technique allowed 3M to reduce hazardous wastes by 10 tons per year at almost no cost, yielding an **annual savings of more than $200,000** (Sheridan, 1992).

These provide anecdotal evidence…

Do you believe them? Strong? Weak?

What empirical evidence exists?

Mixed at best
e.g. Lu and Pless

INDUCED INNOVATION

This idea is akin to *induced innovation* which has a long history in economics.

John Hicks 1932:
"a change in the relative prices of the factors of production is itself a spur to invention, and to invention of a particular kind-directed to economizing the use of a factor which has become relatively expensive."

IMPLICATIONS

What does it mean that environmental regulation “more than” offsets regulatory costs, making firms more competitive?

- Firms are making mistakes before regulation
- Government leads firms in a way to correct mistake

PORTER HYPOTHESIS IN REVIEW

Economists are typically skeptical, especially of *Strong* PH

Economic theory would suggest costs are smaller in long run (reallocation/innovation)

Even if it holds ex post it is hard to predict ex ante

ATTENDANCE ACTIVITY

Minute paper:

Reflect on what we covered this week.
Take a minute to write down what topics covered this week that you feel least comfortable with and what you can do to improve your understanding.

LESSON OBJECTIVES

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Contrast statutory vs. economic tax incidence

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