

An Economic Theory Masterclass

Part IV: Externalities

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Externalities

- ▶ Individuals can be helped or harmed by others in a market.
 - ▶ Example: If demand for sushi is driven up by an influx of Japanese students, lovers then this price impact is optimally managed by the price system.
- ▶ For such *pecuniary externalities*, the price system reallocates gains from trade, but gains exceed the losses.
- ▶ A **technical externality** is an uncompensated negative or positive impact of one person on another, and so can lead to an efficient competitive equilibrium
 - ▶ A honey bee owner who expands helps nearby flower growers
 - ▶ Our technical externality examples will be noise or air pollution
 - ▶ Definition of an externality varies around the world!
 - ▶ In some European countries, wardrobe is deemed externalities
 - ▶ in some world countries, religious beliefs are externalities

The Economics Approach: Pigou (1920) and Coase (1960)

- ▶ Our storyline
 - ▶ Pigou in 1920: clever taxes and subsidies
 - ↪ Coase in 1960: decentralized bargaining
 - ↪ Arrow in 1969: missing markets

Arthur Pigou (1877–1959)



Ronald Coase (1910–2013)



Pigouvian Tax Analysis for Firm Polluting Adjacent Lake

- ▶ *The Economics of Welfare* (1920)
- ▶ A firm pollutes a town lake, harming the 100 adjacent homes.
 - ▶ firm's pollution profits = $B(q) - C(q)$ (revenues minus costs)
 - ▶ external damages on homes' of pollution $\Delta(q)$
 - ▶ Marginal **damage** $\delta(q) = \Delta'(q) > 0$ may vary in pollution q .
- ▶ Private optimum $\hat{q} = \arg \max_q [B(q) - C(q)]$
- ▶ FOC $\Rightarrow B'(\hat{q}) - C'(\hat{q}) = 0$ has unique solution, for:
 - (a) Marginal benefits and costs: $B'(q), C'(q) > 0$
 - (b) Diminishing net returns $B''(q) < C''(q)$ (★)
- ▶ Social optima $q^* \in \arg \max_q [B(q) - C(q) - \Delta(q)]$
 - ▶ FOC $\Rightarrow B'(q^*) - C'(q^*) = \Delta'(q^*) > 0 \Rightarrow q^* < \hat{q}$ by (★)
- ▶ Pigou: Town imposes constant unit pollution tax $\tau = \Delta'(q^*)$
 - ▶ With this **Pigouvian tax**, the FOC is $B'(q^*) = C'(q^*) + \Delta'(q^*)$, and thus the firm chooses the optimal pollution q^* .
 - ▶ **If one can guess it**, the tax **internalizes the externality**
 - ▶ Since the tax is assumed socially neutral, it causes no additional harm

Fines as Stochastic Pigouvian Taxes

Don't be a "Pooper-trator."
Pick up after Your Dog
It's the Law!



**\$250
Fine**

Keep your dog on a leash (no more than
6 feet long) **\$200 Fine**



Bill de Blasio
New York City Mayor

Keep New York City
Clean and Beautiful



Kathryn Garcia
DSHY Commissioner

To report a violation, call 311

Revised 12/16/16 5/16/17



- ▶ Poop & scoop laws, speeding, bad parking \Rightarrow fines, *if caught*
- ▶ Expected fine is the tax for (risk neutral) decision makers
- ▶ A crime punishable by fine means it's legal for a price
- ▶ Some always violate (eg off leash dog), paying the random fee

My Genius Re-Branding Idea: Call it a Pigouvian Fee

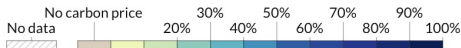
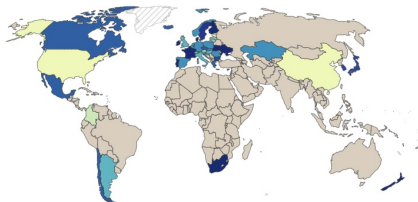
- ▶ Pigouvian taxes are “good taxes”: they reduce welfare losses
- ▶ Greg Mankiw: [The Pigou Club](#) is supported by top economists
- ▶ Taxes are deemed “socialist” in today’s world.
- ▶ But fees or tolls are prices! Demanding zero prices is socialist.
- ▶ Canada has a carbon tax. USA does not.

Share of CO₂ emissions covered
by a carbon price, 2020

Our World
in Data

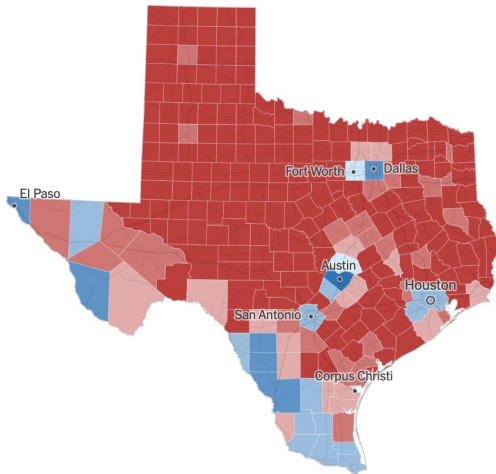
Carbon dioxide emissions are included in this figure if they are covered by a carbon tax or trading system.

World

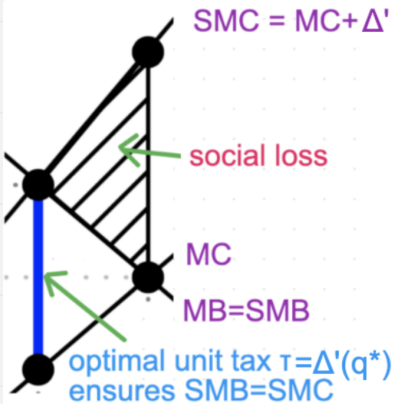
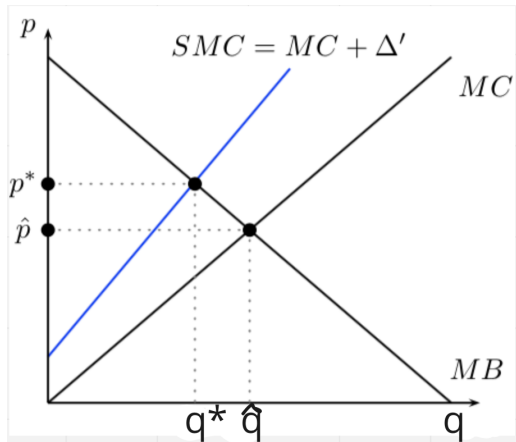


Insight: Urban / Rural Political Divide and Externalities

- ▶ Cities Vote Left and Rural Areas Right around the world
- ▶ Example: 2020 Presidential Election in Texas

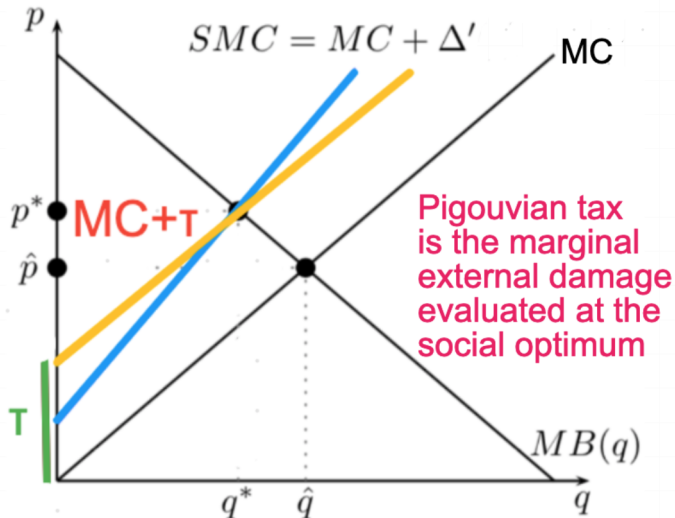


Graphical Analysis of Social Losses of the Externality



Graphical Analysis of Pigouvian taxes

- ▶ The tax $\tau = \Delta'(q^*)$ just adds to the marginal cost.
- ▶ Pigouvian taxes are paternalistic, but allow firms and individuals to make the final choices



Private Property and the Coase Theorem

- ▶ Private property: person consuming a good gets the complete **control rights** (buy/sell/repair/damage/trash)
- ▶ A rental does not confer these rights
- ▶ This aligns incentives and ensures efficiency



- ▶ Pigou's struggle was a lack of well-defined property rights:
 - ▶ If the law allows firm to pollute freely, then the homeowners association should cut a deal with them
 - ▶ If the law allows homeowners association to disallow pollution, then the firm should cut a deal with them

A True Explosive Decision Example

- ▶ A potential new driveway into his forest is blocked by bedrock
- ▶ He hires a Vietnam explosives expert to take out the bedrock (short period delay detonators, with 25 milliseconds delays)
- ▶ 0.01% chance: neighbors incur \$2M damage and loss of life
- ▶ A costly sledgehammer approach avoids the explosives



Let's Make a Deal

- ▶ **Legal Rule 1:** homeowners must pay for harm they inflict
 - ▶ If the sledgehammer costs more than the insurance ($\approx \$200 = 0.01\% \times \$2M$), Lones buys the insurance and blasts the bedrock. If not, he chooses sledgehammer.
- ▶ **Legal Rule 2:** homeowners need not pay for harm they inflict.
 - ▶ If the sledgehammer costs more than the insurance, neighbors buy the insurance and Lones blasts the bedrock. Otherwise, neighbors more cheaply pay off Lones to choose sledgehammer
- ▶ **Claim:** Frictionless* bargaining leads to the efficiency, irrespective of property rights — if they are clearly defined



← a famous Canadian

- ▶ We next explore as intensive margin application of this idea. ≡

Coasian Tax Analysis for Firm Polluting Adjacent Lake

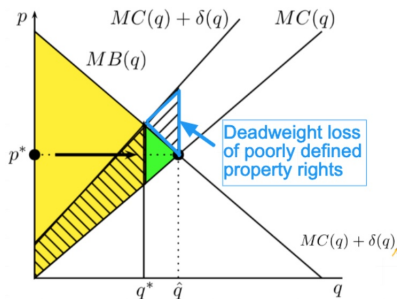
- ▶ If the firm owns the lake, it has the right to demand pollution
 - ▶ But the homeowners' marginal damage at the firm's privately optimal pollution \hat{q} exceeds the (zero) marginal profits
 - ▶ \exists gains from trade! Some pollution abatement occurs
 - ▶ Deal making continues as long as $MB(q) - MC(q) < \Delta'(q)$, stopping when $MB(q^*) - MC(q^*) = \Delta'(q^*)$, at efficient q^* .
- ▶ If homeowners own the lake, they can demand no pollution
 - ▶ But the firm's initial marginal profits $B'(0) - C'(0)$ exceed the homeowners' initial marginal damages $\Delta'(0)$
 - ▶ \exists gains from trade! Some pollution should be agreed to
 - ▶ Deal making continues as long as $MB(q) > MC(q) + \Delta'(q)$, stopping where $MB(q^*) = MC(q^*) + \Delta'(q^*)$, at the efficient q^* .
 - ▶ This assumes that the firm transfer payments do not impact homeowners' marginal costs or the firm's benefits of pollution
- ▶ *Making the biggest pie always creates gains from trade, and the market system or bargaining always lands there.*
- ▶ **Extreme bargaining payoffs: take-it-or-leave-it outcomes**
 - ▶ Nash demand game: any pie split is possible

The Coase Theorem

Theorem (Coase, 1960)

Assume well-defined property rights, negotiation that freely realizes gains from trade, and transfers that do not affect marginal values.

(a) The efficient outcome arises irrespective of property rights.



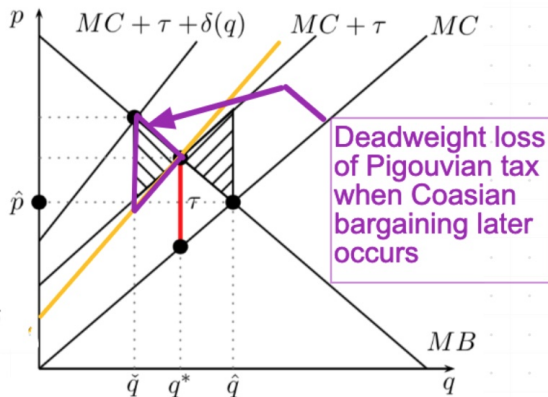
- ▶ Case 1: the firm owns the lake: can insist $q = \hat{q}$
 - ▶ \exists Gains from trade if $q > q^*$
 - ▶ green \leq bargaining transfer to firm \leq green+NE diagonal lines
- ▶ Case 2: homeowners own the lake: can insist $q = 0$
 - ▶ \exists Gains from trade if $q < q^*$
 - ▶ yellow NW diagonal lines \leq transfer from firm \leq yellow

Thinker: Coase's Attack on Pigou

- ▶ The Law of Unintended Consequences (dog treats incentive)

Theorem (Coase, 1960)

... (b) If a Pigouvian tax is imposed in part (a), efficiency is lost.



- ▶ Pigouvian tax τ raises the firm's marginal cost to $MC(q) + \tau$
- ▶ But now Coasian bargaining leads to $\check{q} < q^*$

Coasian Legal Theory is all About Efficiency

- ▶ Coase founded the Chicago school of law and economics, premised on the **social efficiency criterion**
 - ▶ Example: a child runs on a highway and is killed.
 - ▶ What is socially better: kids can run on highways and drivers be vigilant, or drivers have to the right to the highways.
 - ▶ Judges should enforce ex post this efficient outcome.
 - ▶ Judges should enforce the contracts we would have signed had people thought of every possible contingency
- ▶ Why agree to anything inefficient?

Property Rights and Tylenol Murders (Sept/Oct 1982)

▶ Johnson & Johnson got profits from Tylenol and controlled it

5 deaths tied to pills *Fear killer put cyanide in Tylenol*



These pills by Stan Pappas

By Jack Houston
and Jean Latz Griffin

CYANIDE-FILLED capsules of Extra-Strength Tylenol were blamed for the deaths of three persons in suburban Cook County, the critical illness of another, and probably the death of two Du Page County women Thursday.

As the toll rose, the federal Food and Drug Administration warned persons throughout the country against use of the popular pain reliever in capsule form, branding an earlier warning.

And in Du Page County, Dr. James P. Paulsson, director of the health department there, warned against taking any form of Tylenol. "Although only Extra-Strength Tylenol has been indicated, evidence dictates that all forms of Tylenol are possible suspects," he said.

Tylenol, according to one business community expert, is the biggest nonprescription painkiller in the U.S., with approximately \$60 million in sales this year.

THE COOK COUNTY medical examiner's office said the deaths of three persons in Arlington Heights and Elk Grove Village are being treated as homicides because the capsules in bottles of the product they used had apparently been tampered with.

In Du Page County, Deputy Coroner Peter Schumann said one victim was found to have had Tylenol in her home and an inspection of the capsules found four containing cyanide. Cyanide was found late Thursday in five of 18 Extra-Strength Tylenol capsules found in the other victim's purse.

"Apparently a very sophisticated, very malicious person is at large who had to spend a lot of time and a lot of effort to lace these capsules with cyanide," said



Picture photo by Charles O'Connell

Samples taken from Tylenol capsules connected with one of the deaths were analyzed by Cook County doctors. The chunky sample [right] contained cyanide, while the one on the left contained only normal chemicals associated with the product.

Full coverage

- The little red-and-white pills have become a deadly game of cyanide-roulette, officials say. Sec. 2, pg. 3
- Federal officials warn consumers against taking any Tylenol capsule products temporarily. Sec. 2, pg. 2.
- Two suburban firefighters, competing notes, were the first to link Tylenol to the deaths. Sec. 2, pg. 3.
- Cyanide can kill within minutes. A graphic tells of symptoms of the poisoning. Sec. 2, pg. 2.



Village; Adam Jans, 27, of 1802 S. Mitchell Ave., Arlington Heights; his brother, Stanley Jans, 25, of 4181 King

▶ 1991, Johnson & Johnson settled huge lawsuits against it

Coasian vs. Inefficient Privatize Gains & Socialize Losses

- ▶ 2008 Financial Crisis and Bank Insurance (\$500B)
- ▶ 2010 Deepwater Horizon explosion, Gulf of Mexico (\$20B)



- ▶ 2005 Protection of Lawful Commerce in Arms Act (sigh)

Thinker: Coase's 1960 Motivational Bovine Example

- ▶ Coase did not know calculus! All his math was discrete!
- ▶ A Farmer and Rancher have adjacent properties
- ▶ Without fencing, a larger cattle herd increases crop damage
- ▶ Pigou: A smart cattle tax aligns the incentives of Rancher and Farmer, and so decentralizes the social efficient allocation.

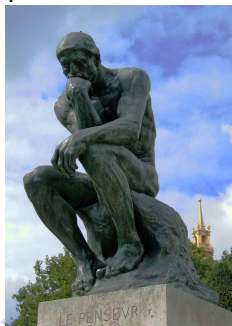


Coase: Efficiency Emerges Even with an Intensive Margin

assume that the annual cost of fencing the farmer's property is \$9 and that the price of the crop is \$1 per ton. Also, I assume that the relation between the number of cattle in the herd and the annual crop loss is as follows:

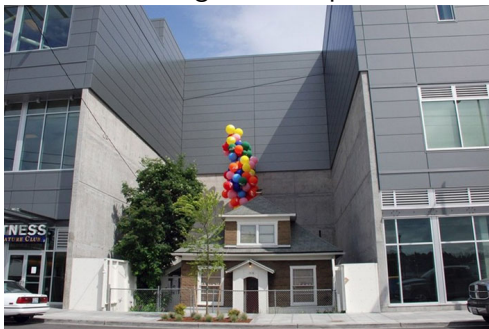
Number in Herd (Steers)	Annual Crop Loss (Tons)	Crop Loss per Additional Steer (Tons)
1	1	1
2	3	2
3	6	3
4	10	4

- ▶ Consider two cases: The damaging business...
 - ▶ **Legal rule 1:** ... must pay for all damages
 - ▶ **Legal rule 2:** ... is not liable for damages
- ▶ Depending on who has the rights, solve for
 - ▶ the efficient outcome
 - ▶ range of transfers



Eminent Domain (When Coasian Bargaining is Too Hard)

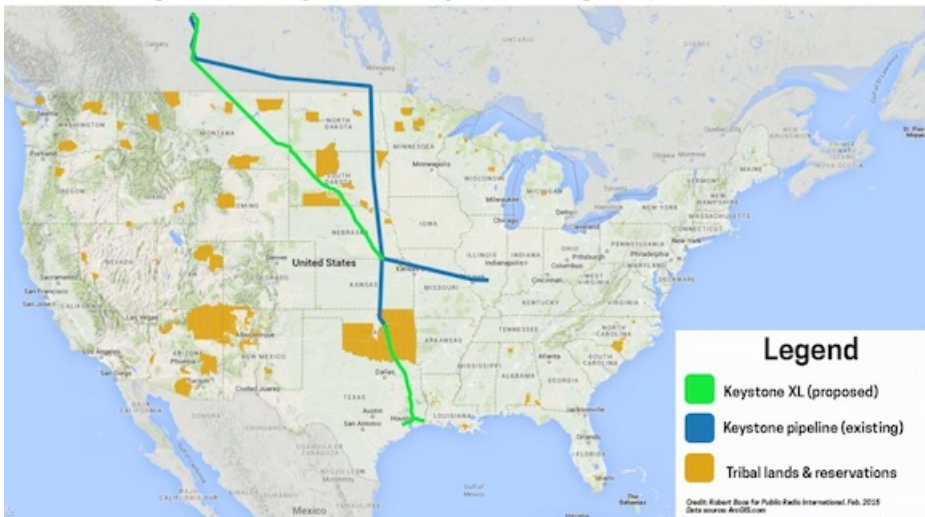
- ▶ Costless bargaining is a big ask with many bargainers
 - ▶ Why? The last hold out has huge power (subgame perfection)
- ▶ The solution is to use the actual social planner.
- ▶ Eminent domain takes private property for public use.
- ▶ It removes excessive bargaining power in situations where output is of the form $x_1 x_2 \cdots x_n \Rightarrow$ efficiency enhancing
 - ▶ SPM and so nonadditive payoffs necessitate eminent domain
- ▶ Example: Edith Macefield turned down \$1 million to sell her house in Seattle, Washington \Rightarrow inspired the 2009 movie “Up”



Eminent Domain and the Keystone XL Pipeline

- ▶ Pipeline would go under Lake Oahe (ND), near Sioux tribe reservation

Keystone Pipeline in proximity to tribal lands



Nobel Prize (1991)

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1991



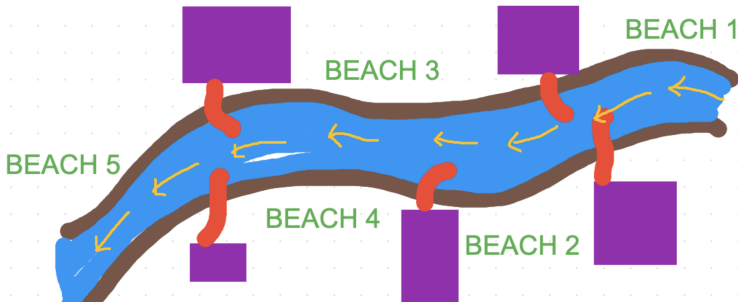
Photo from the Nobel Foundation archive.

Ronald H. Coase

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1991 was awarded to Ronald H. Coase "for his discovery and clarification of the significance of transaction costs and property rights for the institutional structure and functioning of the economy."

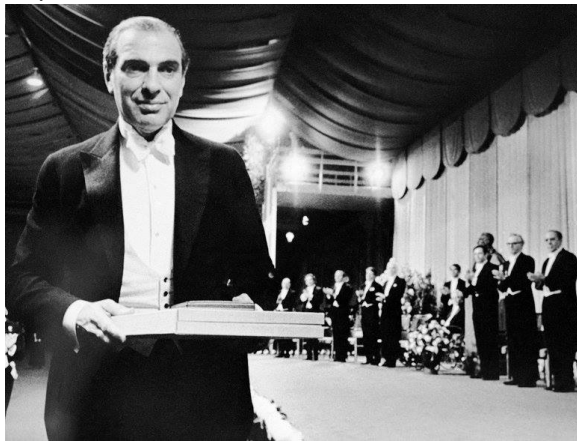
Graphical Thinker: Coasian Reasoning in a Spatial Model

- ▶ Gelatin requires boiling bones and hides of cows and pigs 🤔
- ▶ Think about Coasian bargaining by polluting jello* firms and private beaches along a flowing river, producing red algae
- ▶ Intuitively, which beaches might be shut, or firms deterred?



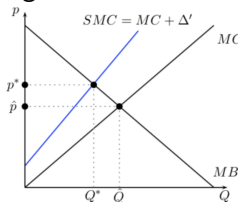
Arrow (1969) Missing Markets

- ▶ A missing market is a situation in microeconomics where a competitive market allowing the exchange of a commodity would be Pareto-efficient, but no such market exists.
- ▶ Arrow (1969) is a chatty spitballing paper with a novel idea: “The problem of externalities is thus a special case of a more general phenomenon, the failure of markets to exist.”

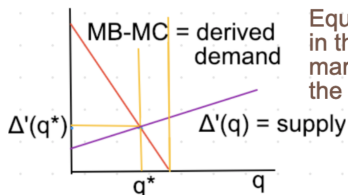


Pollution Permits as a Derived Market

- ▶ Endow firm with rights to the lake pollution \hat{q} (cap and trade)
- ▶ In a market, the pollution permits trade at a price $t^* = \delta(q^*)$.
 - ▶ At prices $t \leq t^*$,
 - ▶ the firm wants to buy $q \geq q^*$ permits
 - ▶ homeowners' buy permits until the firm has $q \leq q^*$ permits
 - ▶ There is respectively buying/selling pressure toward $t = t^*$
- ▶ Permit trade brings us to the crossing of supply and demand.
- ▶ My take:



Private and social optimum for the good causing external damage



Equilibrium in the derived market for the damage

Arrow's Market Solution

- ▶ *The market converts the inefficient technical externality into an efficient pecuniary externality (multimarket equilibrium)*
- ▶ Arrow's market solution works
 - ▶ With many market participants, and not just two parties.
 - ▶ With uncertain firm profits or homeowners losses, the price aggregates information (rational expectations equilibrium)
 - ▶ **A major problem is the initial allocation**
 - ▶ Are they "*grandfathered*" in?
 - ▶ Coasian irrelevance of property rights assignment translates into an Arrowian irrelevance of initial ownership of permits.

Example: World Carbon Markets

▶ emissions-trading systems or cap-and-trade programs

