An Economic Theory Masterclass

Part IV: Externalities

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Laissez Faire is Best?

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)

- 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) — older meaning of welfare
- 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 $B''(q) < C''(q)$ ⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀($\bigstar$)
- 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 ($\bigstar$)
- Pigou: Town imposes constant unit pollution Pigouvian tax $\tau = \Delta'(q^*)$
  - FOC is $B'(q^*) = C'(q^*) + \Delta'(q^*) \Rightarrow$ firm chooses optimal pollution q^*
  - If one can guess it, the tax internalizes the externality
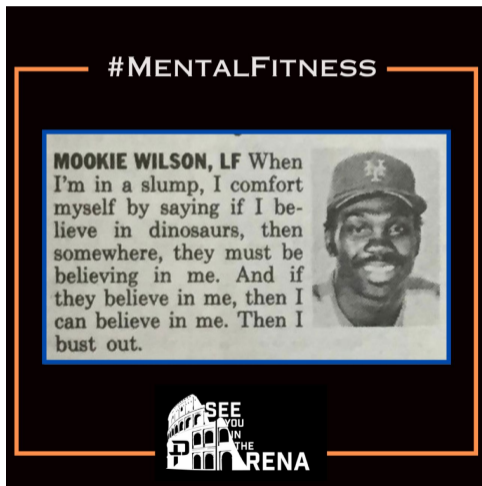 - Tax is assumed socially neutral $\Rightarrow$ causes no additional harm

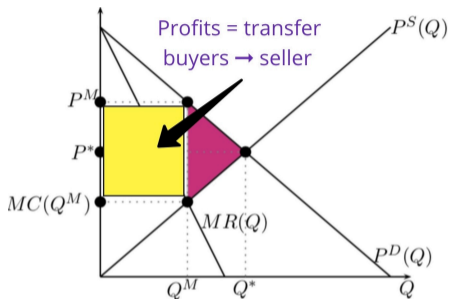# Fines as Stochastic Pigouvian Taxes

- 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

Post Exam Spirit

- Check youtube for Mookie Wilson, Game 6 of the 1986 World Series

#MENTALFITNESS

MOOKIE WILSON, LF When I'm in a slump, I comfort myself by saying if I believe in dinosaurs, then somewhere, they must be believing in me. And if they believe in me, then I can believe in me. Then I bust out.

SEE YOU IN THE ARENA

Rear View Mirror on Market Power and Externalities

- Competitive equilibrium is a Nash eq'm of a game (coming).
- Welfare theorem? What games have Nash efficient equilibria?
- Market power $\Rightarrow$ inefficient welfare loss triangles
- Cournot oligopoly tends to competitive equilibrium as $n \to \infty$
- Externalities $\Rightarrow$ welfare loss triangles (marginal trades are bad)
- Pigou: solve externalities by cleverly pricing damage/benefit
  - Past exam question: What is the optimal vaccination subsidy?

Graphical Analysis of Pigouvian taxes

- Competition: The tax $\tau = \Delta'(q^*)$ just adds to the marginal cost.
- Pigouvian taxes allow firms and individuals to make the final choices
- Those who most need to pollute, do so.
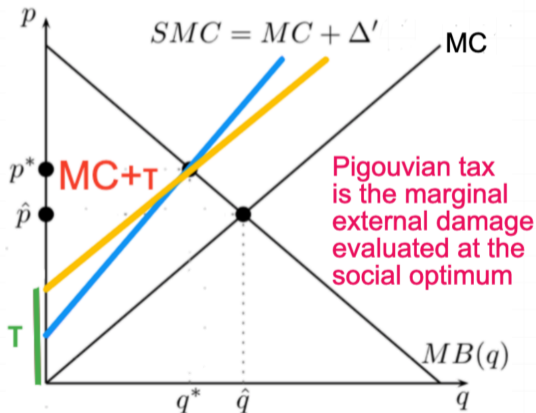
Graphical Analysis of Social Losses of the Externality
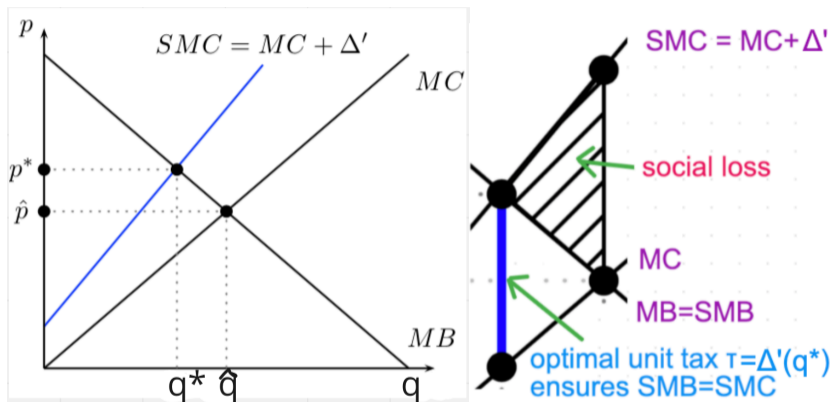
★ Competition: $\tau = \Delta'$ given constant marginal damages
   - this works even if govt. is ignorant of benefit/cost functions
   - This fails if govt. is ignorant of marginal damages (see missing market solution)
- *Thinker: What is the optimal Pigouvian tax with monopoly (so MB < P)?*

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

- Pigouvian taxes are "good taxes": they eliminate deadweight losses
- Greg Mankiw: The Pigou Club is supported by top economists
- Taxes are deemed "socialist" in today's nutty world.
- But fees or tolls are prices! Demanding zero prices is socialist.
- Canada has a carbon tax (ending this year). USA does not.

Share of CO₂ emissions covered
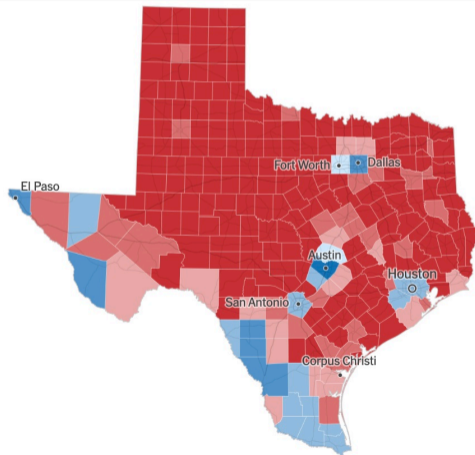by a carbon price, 2020

Our World
in Data

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

World ⌄
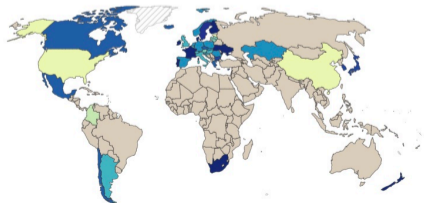
Insight: Urban / Rural Political Divide and Externalities

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

Peter and Paul, Easy Summer 2024 Prelim Question

- Peter & Paul are risk-neutral. Peter's care $x \in [0, q]$ averts a disaster to Paul
- Loss $L \in (0, 2q)$ has probability $q - x$, where $q > 0$
- Care costs Peter x^2.
- If Peter causes the disaster, this is publicly learned with chance $p \in (0, 1)$.
  - (a) What fine $F > 0$ ensures that Peter takes the socially efficient level of care?
  - (b) In law, "treble damages" sets $F = 3L$.
    When is this socially optimal?

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
- Private property therefore aligns incentives of the consumer and controller of an asset, and so ensures efficiency
- "Possession is nine-tenths of the law"

- Coase said that 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 Binary Action 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

$\leftarrow$ famous Canadian Monte Hall

Coasian Analysis for Firm Polluting Lake (Continuous Action)

- 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 $\Rightarrow \exists$ gains from pollution $\downarrow$
  - 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 $\Delta'(0) \Rightarrow \exists$ gains from pollution $\uparrow$
  - Deal making continues as long as $MB(q) > MC(q) + \Delta'(q)$, stopping where $MB(q^*) = MC(q^*) + \Delta'(q^*)$, at the efficient q^*.
- Both analyses assume that the firm transfer payments do not impact homeowners' marginal costs or the firm's marginal pollution benefits
- *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

Theorem (Coase Theorem, 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.*
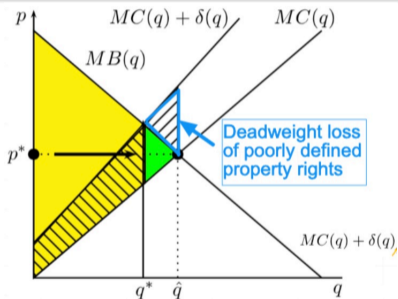
- Case 1: the firm owns the lake: can insist $q = \hat{q}$
  - Pollution $\downarrow$ if $q > q^*$ and green $\leq$ transfer to firm $\leq$ green+NE diagonal lines
- Case 2: homeowners own the lake: can insist $q = 0$
  - Pollution $\uparrow$ if $q < q^*$ and yellow \\\ $\leq$ transfer from firm $\leq$ 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.

Deadweight loss of Pigouvian tax when Coasian bargaining later occurs
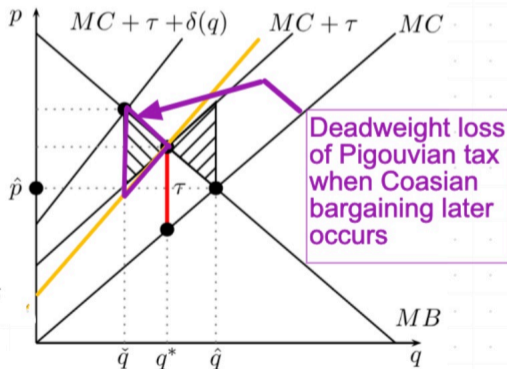
Coasian Legal Theory is all About Efficiency

- 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 the contracts we would have signed had people thought of every possible contingency
  - All rational bargains should be efficient!
    - This "obvious" idea fails with incomplete information (713B?)
    - If not, see Myerson and Satterthwaite (1983)
  - $\Rightarrow$ Judges should enforce ex post this efficient outcome.

Property Rights and Tylenol Murders (Sept/Oct 1982)

- Johnson & Johnson got profits from Tylenol and controlled 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)

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, what is efficient placement of beaches and firms?
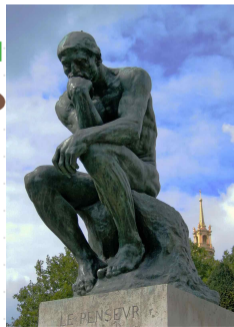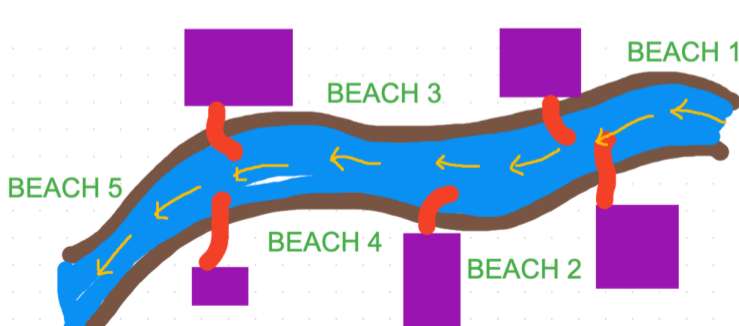
Thinker: Coase's 1960 Motivational Bovine Example

- 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
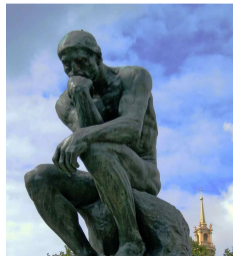
Eminent Domain (When Coasian Bargaining is Too Hard)

- Costless bargaining is a big ask with many bargainers
  - Why? The last hold out has huge power (subgame perfection)
- Eminent domain takes private property for public use.
  - Last holdouts have excessive bargaining power with SPM payoffs
  - E.g. Eminent domain is efficiency enhancing if output is $x_1 x_2 \cdots x_n$
- Example without Eminent domain: Edith Macefield turned down \$1 million to sell her house in Seattle, Washington $\Rightarrow$ inspired the 2009 movie "Up"
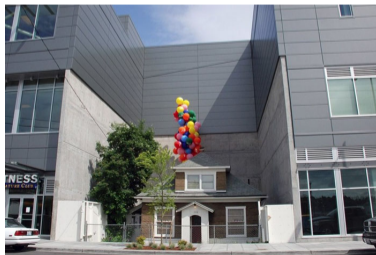
Eminent Domain and the Keystone XL Pipeline

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

Keystone Pipeline in proximity to tribal lands

Legend

- Keystone XL (proposed)
- Keystone pipeline (existing)
- Tribal lands & reservations

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
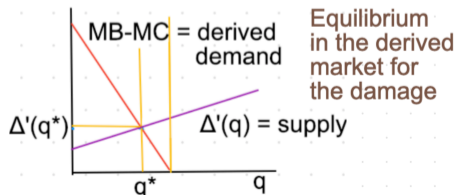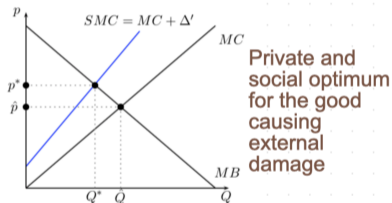
Arrow (1969) Missing Markets

- A missing market is a situation where a competitive market allowing the exchange of a commodity would be Pareto-efficient, but does not exist
- Arrow (1969): "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 $t \lessgtr t^*$, the firm wants to buy $q \gtrless q^*$ permits
    - homeowners' buy permits until the firm has $q \lessgtr q^*$ permits
    - $\exists$ buying/selling pressure toward $t = t^*$
- Permit trade $\Rightarrow$ supply $=$ demand.

Private and social optimum for the good causing external damage

Equilibrium in the derived market for the damage

Arrow's Market Solution is Quite Practical

- *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 Arrovian irrelevance of initial ownership of permits.

Example: World Carbon Markets

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

EU Carbon Permits (EUR) 77.210 -2.540 (-3.19%)

Three Perspectives on Externalities