

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
 - ▶ In some European countries, wardrobe is deemed externalities
 - ▶ in some world countries, religious beliefs are externalities
- ▶ Our storyline
 - ▶ Pigou in 1920: clever taxes and subsidies
 - ↪ Coase in 1960: decentralized bargaining
 - ↪ Arrow in 1969: missing markets

Pigou, *The Economics of Welfare* (1920)

Coase, "The Problem of Social Cost" (1960)

Arthur Pigou (1877–1959)



Ronald Coase (1910–2013)



Private Property and the Coase Theorem



Coase's Bovine Example

- ▶ 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.



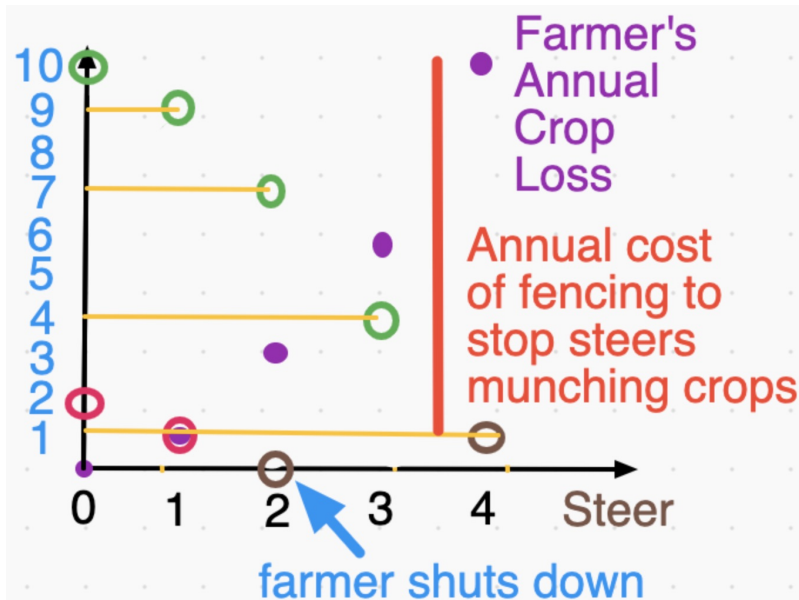
Coase's Bovine Example

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

- ▶ **Legal rule 1:** damaging business must pay for all damages
- ▶ Case 1: value of the crop is \$12 at cost \$10 \Rightarrow net gain \$2.
 - ▶ Rancher has ≥ 1 steer if first steer is worth \geq \$1 to him
 - ▶ Rancher has ≥ 2 steer if second steer is worth \geq \$1 to him
 - ▶ He cannot impose more than \$2 harm on Farmer
- ▶ Case 2: value of the crop is \$20 at cost \$10 \Rightarrow net gain \$10.
 - ▶ Farmer continues to lose crops with each of the first four steers
 - ▶ If 4 steers is privately optimal, he will erect the \$9 fence rather than pay \$10 crop loss
- ▶ Efficiency reigns supreme

Coase' Bovine Example (1960)



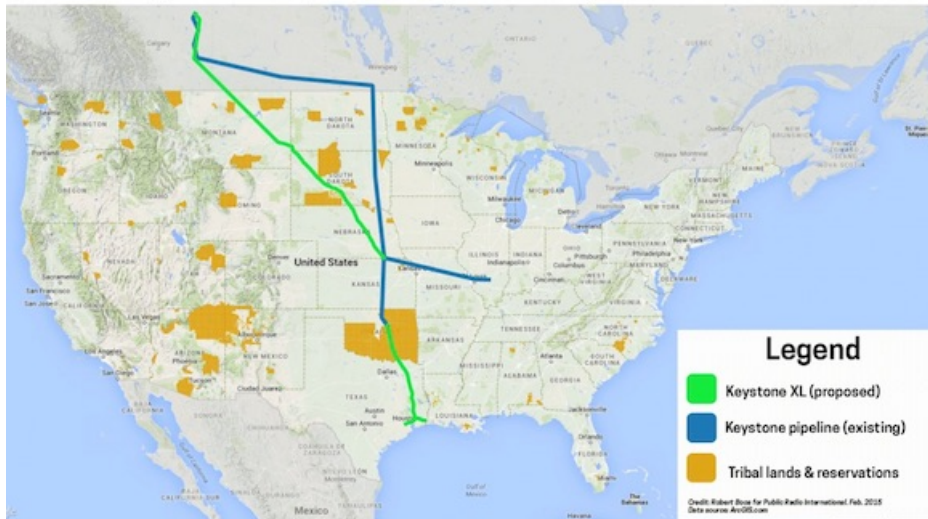
Coase' Bovine Example (1960)

- ▶ Legal rule 2: damaging business is not liable for damages
- ▶ We avoid corner solutions with a fence or the farmer quitting
- ▶ Example: Assume 3 steers is privately optimal for the rancher
 - ▶ Then the Farmer is willing to pay up to
 - ▶ \$3 if the herd falls from 3 to 2 steers,
 - ▶ \$5 if the herd falls from 3 to 1 steer
 - ▶ \$6 if the Rancher quits ranching (0 steer)
 - ⇒ Rancher gets the third steer if its marginal value exceeds \$3
 - ⇒ Loss of \$3 payment is part of the marginal cost of third steer
 - ▶ Irrelevant: whether the \$3 is a payment by the Rancher for the third steer (were he liable for crop damage) or money he would have received for not having a third steer (were he not liable)
 - ▶ Herd size is identical whether or not Rancher is liable for losses

Keystone Pipeline

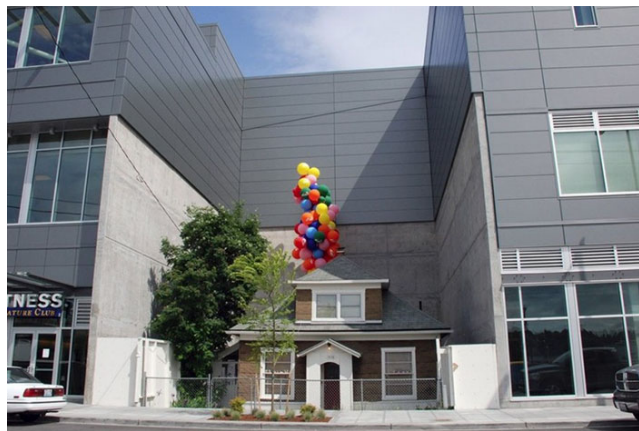
- ▶ Apply Coase Theorem to the Keystone XL pipeline?

Keystone Pipeline in proximity to tribal lands



Eminent Domain (“Supreme Ownership”)

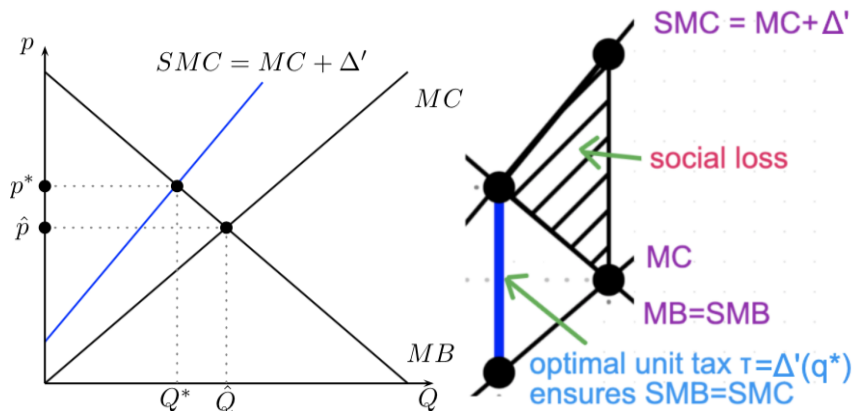
- ▶ Eminent domain takes private property for public use.
- ▶ It removes excessive bargaining power in situations where output is of the form $x_1 x_2 \cdots x_n \Rightarrow$ efficiency enhancing
- ▶ Edith Macefield turned down \$1 million to sell her house in Seattle, Washington \Rightarrow inspired the 2009 movie “Up”



Pigouvian Tax Analysis for Firm Polluting Adjacent Lake

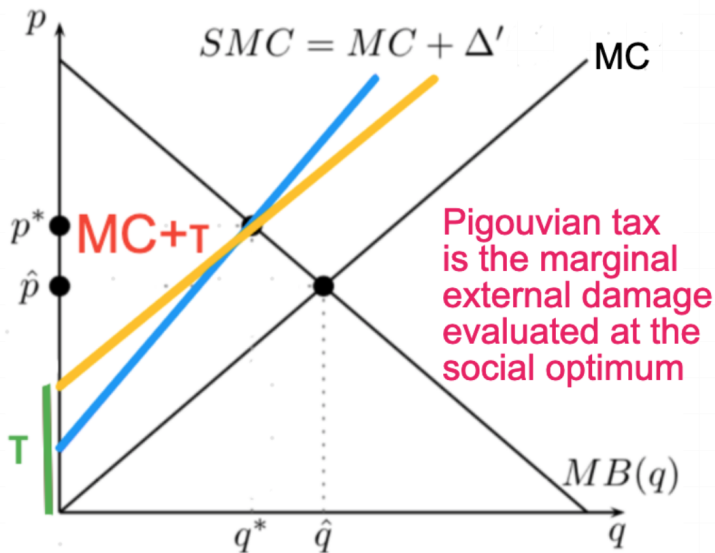
- ▶ A firm pollutes a town lake, harming the 100 adjacent homes.
 - ▶ firm's pollution profits = $B(q) - C(q)$ (revenues minus costs)
 - ▶ external damages on homes' of pollution $\Delta(q)$
 - ▶ Marginal **damage** $\delta(q) = \Delta'(q) > 0$ may vary in pollution q .
- ▶ Private optimum $\hat{q} = \arg \max_q [B(q) - C(q)]$
- ▶ FOC $\Rightarrow B'(q^*) - C'(q^*) = 0$ 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**
 - ▶ Pigouvian taxes are “good taxes”: they reduce welfare losses
 - ▶ Greg Mankiw: **The Pigou Club** is supported by top economists

Graphical Analysis of Social Losses of the Externality



Graphical Analysis of Pigouvian taxes

- ▶ The tax $\tau = \Delta'(q^*)$ just adds to the marginal cost.



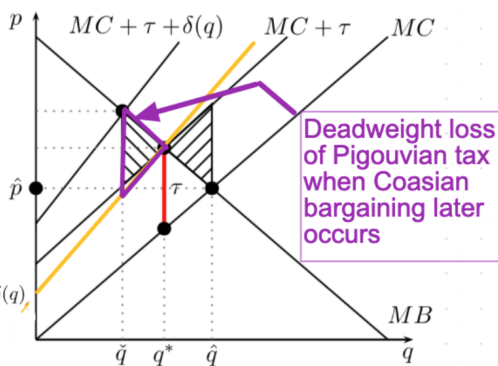
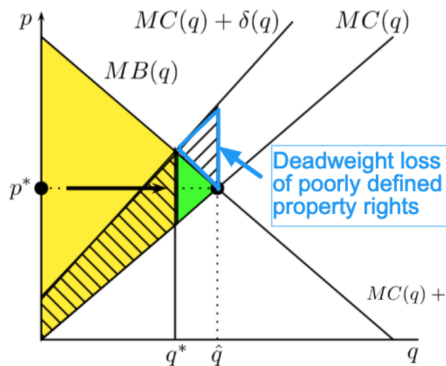
Coase, “The Problem of Social Cost” (1960)

- ▶ 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
- ▶ 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.
- ▶ Why would we agree to anything inefficient?
- ▶ Example: reclining airline seats!

Coasian Tax Analysis for Firm Polluting Adjacent Lake

- ▶ 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
- ▶ 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^* .

The "Coase Theorem"



The “Coase Theorem”

Theorem (Coase, 1960)

Assume well-defined property rights, negotiation that freely realize all gains from trade, and transfers that do not affect marginal values. Then the efficient outcome arises irrespective of property rights. And if a Pigouvian tax is imposed, efficiency is lost.

- ▶ Proof: Green area \leq transfer \leq green + NW diagonal lines
- ▶ The firm's new marginal cost is $MC(q) + \tau$
- ▶ Too many doctors kill the patient (imposing a Pigouvian tax in a world where Coasian bargaining is possible is harmful)

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."

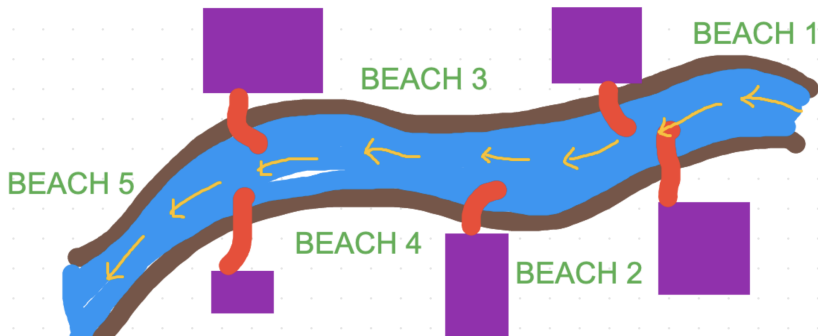
Coasian Reasoning in a Spatial Model

- ▶ Think about Coasian bargaining by polluting jello* firms and private beaches along a flowing river, producing red algae
- ▶ gelatin requires boiling bones and hides of cows and pigs



Coasian Reasoning in a Spatial Model

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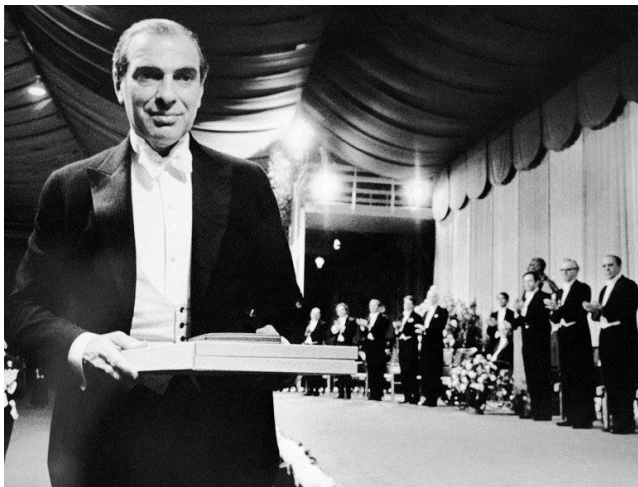
Arrow (1969) Missing Markets

- ▶ 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.

**THE YOUNGEST
WINNER EVER
IN THIS YOUNGEST
NOBEL CATEGORY
WAS 51-YEAR-OLD
KENNETH ARROW**

Arrow (1969) Missing Markets

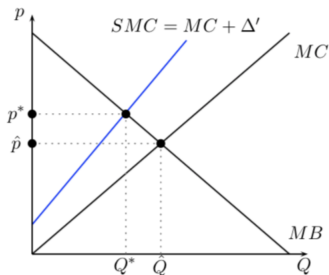
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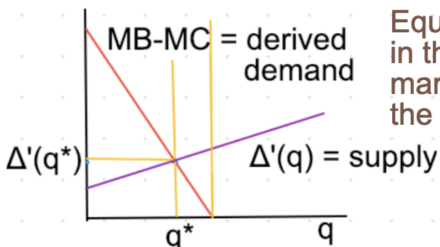
Equilibrium in the Pollution Market

- ▶ Endow firm OR homeowners with rights to the lake pollution
- ▶ Create a market for trading these permits.
- ▶ **Claim: the pollution permits will trade at a price $t^* = \delta(q^*)$.**
 - ▶ At any price $t < t^*$, the firm buys $> q^*$ permits, and the homeowners damage $> MB(q^*) - MC(q^*) = \delta(q^*) = t^*$
 - ▶ But then buying permits is profitable, contradiction.
 - ▶ At any price $t > t^*$, the firm buys $< q^*$ permits, and the damage to the firm $< MB(q^*) - MC(q^*) = \delta(q^*) = t^*$
 - ▶ But then selling permits is profitable, contradiction.
- ▶ The market converts the inefficient technical externality into an efficient pecuniary externality
- ▶ Arrow's market solution works
 - ▶ With many market participants, and not just two parties.
 - ▶ When the firm's profits or homeowners losses are uncertain, and the market must aggregate information (rational expectations equilibrium, later on)
 - ▶ This actually works for carbon trading.
 - ▶ **The major problem is the initial allocation of carbon permits. Typically, they are "grandfathered" in.**

Graphical Analysis of the Pollution Market Equilibrium



Private and social optimum for the good causing external damage



Equilibrium in the derived market for the damage

- ▶ As in the Coase Theorem, the ownership of permits initially is irrelevant: We must trade to the crossing of supply & demand.

Example: World Carbon Markets

CALIFORNIA CARBON DASHBOARD

CARBON PRICE

\$/Tonne CO₂e



5-day moving average price and volume of California Carbon Allowance Futures over time from [ICE End of Day Reports](#). Daily trading volume units are 1000 allowance futures. [Download data](#).

Nudges

- ▶ Even though Pigouvian taxes sound paternalistic, they still allow those who want a good to buy it.
 - ▶ Governments are often more paternalistic
 - ▶ Nanny state Pigouvian taxes fix irrational agents
- ⇒ Richard Thaler, Nobel Prize, 2017

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2017



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Richard H. Thaler

