Chapter 35: Externalities

What not to read

- 35.1: Shows how you can model externalities using the Edgeworth box. Interesting but optional
- 35.2: Not necessary

Today's plan

- Externalities
  - Definition and concept
  - An example
    - Internalizing the externality
    - The Coase theorem
  - The Tragedy of the Commons

Externality

- Definition:
  - A cost or benefit generated by an agent that does not enter the agent's utility/production function.
  - Wikipedia: an **externality** is the cost or benefit that affects a party who did not choose to incur that cost or benefit.
  - Varian: one agent cares directly about another agent's production or consumption.
  - Perloff: an agent's outcome is directly affected by the actions of other agents rather than indirectly through changes in prices.

Externalities

- Crucially, an externality impacts somebody who is not a participant in the activity that produces the external cost or benefit.
- Example: haze
  - Produced by a farmer who gains utility from the activity of plantation/forest burning
  - Enters the utility function of an adjacent bystander who is a not participant to the burning
- An externally-imposed benefit is a positive externality.
- An externally-imposed cost is a negative externality.

Examples of Negative Externalities

- Pollution
  - Air
    - Local: cigarette smoke, haze, vehicle exhaust fumes
    - Global: carbon dioxide, sulfur dioxide
  - Water
    - Local: sewage, chemical
    - Global: thermal
  - Noise
    - Local: aircrafts, trains, trucks, rowdy neighbors
- Congestion
  - Traffic (road vehicles, aircraft)
  - Human (Hong Kong, Singapore, Mecca)

Examples of Positive Externalities

- Positive Production Externalities
  - Beekeepers and fruit/nut plantations
  - First-aid classes for industrial employees
- Positive Consumption Externalities
  - Vaccines
  - Products with network externalities (smartphones, social networking websites)
  - Education
  - Better driving habits
  - Smiles ☺

Externalities and Efficiency

- Externalities may cause Pareto inefficiencies:
  - too many resources are allocated to an activity which causes a negative externality
  - too few resources are allocated to an activity which causes a positive externality.

Two facets of externalities

- Today we will look at two different scenarios where externalities are present.
  - Production ~~and consumption~~ externalities
    - Smokers vs. non-smokers
    - Indonesian plantations vs. Innocent Singaporeans
  - Common property externalities
    - Traffic congestion, fishing in the high seas

Today's plan

- Externalities
  - Definition and concept
  - Production externality example
    - Internalizing the externality
    - The Coase theorem
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Production Externalities

- A steel mill produces steel and water pollution. More pollution lowers the cost of production of steel.
- The pollution adversely affects a nearby fishery.
- Both firms are price-takers.
- p_S is the market price of steel.
- p_F is the market price of fish.

Production Externalities

- $c_S(s, x)$ is the steel firm's cost of producing s units of steel jointly with x units of pollution
- The firm's problem is to maximize

$$\Pi_s(s, x) = p_s s - c_s(s, x)$$

where more x decreases costs and more s increases cost

- By choosing x and s. The first order profit maximizing conditions are:

$$p_s = \frac{\partial c_s(s, x)}{\partial s} \qquad 0 = \frac{\partial c_s(s, x)}{\partial x}$$

Production Externalities

$$p_s = \frac{\partial c_s(s, x)}{\partial s}$$

- states that the steel firm should produce the output level of steel for which price = marginal production cost.

$$0 = \frac{\partial c_s(s, x)}{\partial x}$$

This value is negative

- states that the firm's wants to raise pollution levels until the change it has on cost is zero.

Production Externalities

- E.g. suppose $c_{s(s,x)} = s^2 + (x-4)^2$ and $p_s = 12$. Then

$$\Pi_s(s,x) = 12s - s^2 - (x-4)^2$$

- and the first-order profit-maximization conditions are

$$\frac{\partial \pi_s}{\partial s} = 12 - 2s = 0 \qquad\qquad \frac{\partial \pi_s}{\partial x} = -2(x-4) = 0$$

$$12 = 2s$$

Therefore $\underline{s^* = 6}$ and $\underline{x^* = 4}$

Production Externalities

- The steel firm's maximum profit level is thus

$$\begin{aligned}\Pi_s(s^*, x^*) &= 12s^* - {s^*}^2 - (x^* - 4)^2 \\ &= 12 \times 6 - 6^2 - (4 - 4)^2 \\ &= \$36\end{aligned}$$

Production Externalities

- The cost to the fishery of catching f units of fish when the steel mill emits x units of pollution is $c_F(f,x)$. Given f, $c_F(f,x)$ increases with x; i.e. the steel firm inflicts a negative externality on the fishery.
- The fishery's profit function is

$$\Pi_F(f;x) = p_F f - c_F(f;x)$$

Production Externalities

$$\Pi_F(f;x) = p_F f - c_F(f;x)$$

- The fishery chooses f to maximizes profit. This is done by taking the derivative of the profit function with respect to f.
- The first order condition is:

$$\frac{\partial \pi_F}{\partial F} = p_F - \frac{\partial c_F(f;x)}{\partial f} = 0$$

$$\boxed{\text{P=MC}} \longrightarrow p_F = \frac{\partial c_F(f;x)}{\partial f}$$

Production Externalities

- Why doesn’t the fishery differentiate its profit function with respect to x?
- Because x is not chosen by the fishery. Only the steel mill can produce pollution, and therefore can choose x.

Production Externalities

- Suppose
$$c_F(f;x) = f^2 + xf \text{ and } p_F = 10.$$
- The external cost inflicted on the fishery by the steel firm is xf. Since the fishery has no control over x it must take the steel firm's choice of x as a given. The fishery's profit function is thus
$$\Pi_F(f;x) = 10f - f^2 - xf$$

Production Externalities

$$\Pi_F(f;x) = 10f - f^2 - xf$$

- Given x, the first-order profit-maximization condition is $10 = 2f + x$, or
$$f^* = 5 - 0.5x$$
- We see that the fishery reduces quantity in the presence of more pollution.

Production Externalities

- Recall that the steel firm chose $s^* = 6$ and $x^* = 4$.
- This means the fishery will produce:
$$f^* = 5 - 0.5(4) = 3$$
- The fishery's profit is:
$$\Pi_F = 10 \times 3 - 3^2 - \underbrace{(4 \times 3)}_{\boxed{\text{external cost} = 12}} = \$9$$
- Profits for both firms sum to:
$$\$36 + \$9 = \$45$$

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Production Externalities

- Is \$45 the largest possible total profit that can be achieved?
- Suppose the two firms merge to become one. What is the highest profit this new firm can achieve?
- The profit function becomes

$$\Pi = \Pi_s + \Pi_F$$
$$= [12s - s^2 - (x-4)^2] + [10f - f^2 - xf]$$

Merger and Internalization

$$\Pi = [12s - s^2 - (x-4)^2] + [10f - f^2 - xf]$$

- What choices of s, f and x maximize the new firm's profit?
- The first order conditions are:
  - $\frac{\partial \Pi}{\partial s} = 12 - 2s = 0$
  - $\frac{\partial \Pi}{\partial f} = 10 - 2f - x = 0$
  - $\frac{\partial \pi}{\partial x} = -2(x-4) - f = 0$

The solutions are:

$$s^m = 6$$
$$f^m = 4$$
$$x^m = 2$$

Recall that $x^* = 4$. The merger lowers pollution.
Recall that $f^* = 3$. The merger raises fish production.

Merger and Internalization

- And the merged firm's maximum profit level is

  $\Pi^m(s^m, f^m, x^m)$
  $= 12s^m - (x^m - 4)^2 + 10f^m - f^{m^2} - x^m f^m$
  $= 12 \times 6 - (2 - 4)^2 + 10 \times 4 - 2 \times 4$

  $= \$48$
- Recall that un-merged profits were $45.

Merger and Internalization

- In summary, the merger improves efficiency:
  - The steel firm produced $x^* = 4$ units of pollution. Within the merged firm, pollution production is only $x^m = 2$ units.
  - On its own, the fishery produced $f^* = 3$. Within the merged firm, the fishery produces $f^m = 4$
  - Total profits rise from $45 to $48 with the merger and none of this comes from market power (remember both firms are price takers)
- So the merger has caused both an improvement in efficiency and less pollution. Why?

Merger and Internalization

- The steel firm's profit function is
$$\Pi_s(s, x) = 12s - s^2 - (x - 4)^2$$
- so the marginal cost of producing x units of pollution is $MC_s(x) = 2(x - 4)$
- When unmerged, the steel firm increases pollution until $MC_s(x)$=0, hence $x^* = 4$.
- The merged firm has $MC_m(x) = 2(x - 4) + f$ which is higher than $MC_s(x)$

Merger and Internalization

- The merged firm has a higher marginal cost of pollution because it faces the <u>full cost</u> of pollution:

  $2(x-4) = -f$, rather than $2(x-4) = 0$

- This causes the merged firm to produce less pollution.
- The merger internalizes the externality and induces economic efficiency.

Merger and Internalization

- Notice that $x^m = 2$ not 0. The optimal amount of pollution isn't zero, it is the amount where marginal benefit from pollution (which is a lower cost of producing s) equals marginal cost of pollution (which is a higher cost of producing f)

Merger and Internalization

- How else might internalization be caused so that efficiency can be achieved?

Today's plan

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Coase and Production Externalities

- Coase theorem:

  If

  1. property rights of an externality are clearly defined, and
  2. there are no transaction costs,

  bargaining will lead to an efficient outcome regardless of the initial allocation of property

Coase and Production Externalities

- The Coase Theorem posits that the pollution externality exists because neither the fishery nor the steel mill has been assigned property rights of water pollution (or, ownership of the water)
- Suppose the property right to the water is created and assigned to one of the firms. Does this induce efficiency?

Coase and Production Externalities

- Suppose the fishery owns the water.
- Then it can sell pollution rights, in a competitive market, at $\$p_x$ each.
- The fishery's profit function becomes
$$\Pi_F(f, x) = p_f f - f^2 - xf + p_x x$$
- Given p_f and p_x, how many fish and how many rights does the fishery wish to produce?
- Notice that x is now a choice variable for the fishery.

Coase and Production Externalities

$$\Pi_F(f,x) = p_f f - f^2 - xf + p_x x$$

- The profit-maximum conditions are

$$\frac{\partial \Pi_F}{\partial f} = p_f - 2f - x = 0$$

$$\frac{\partial \Pi_F}{\partial x} = -f + p_x = 0$$

which yields $x_s^* = p_f - 2\mathrm{f}$ (pollution right supply)

$f^* = p_x$ (fish supply)

Coase and Production Externalities

- The steel firm must buy one right for every unit of pollution it emits so its profit function becomes
$$\Pi_s(s,x) = p_s s - s^2 - (x-4)^2 - p_x x$$
- Given p_f and p_x, how much steel does the steel firm want to produce and how many rights does it wish to buy?

Coase and Production Externalities

$$\Pi_s(s,x) = p_s s - s^2 - (x-4)^2 - p_x x$$

- The profit-maximum conditions are

$$\frac{\partial \Pi_s}{\partial s} = p_s - 2s = 0$$

$$\frac{\partial \Pi_s}{\partial x} = -2(x-4) - p_x = 0$$

and these give $s^* = \frac{p_s}{2}$ and $x_d^* = 4 - \frac{p_x}{2}$

(steel supply)

(pollution right demand)

Coase and Production Externalities

$f^* = p_x$ (fish supply)

$s^* = \frac{p_s}{2}$ (steel supply)

$x_s^* = p_f - 2\mathrm{f}$ (pollution right supply)

$x_d^* = 4 - \frac{p_x}{2}$ (pollution right demand)

- Since $p_s = 12, s^* = 6.$

Coase and Production Externalities

- The demand and supply of pollution must equal:

$$p_f - 2f = 4 - \frac{p_x}{2}$$

- From the fish supply equation, we know that $f = p_x$
- Therefore, $p_f - 2p_x = 4 - \frac{p_x}{2}$.
- This solves to $p_x = \frac{2p_f - 8}{3}$

Coase and Production Externalities

- Since $p_f = 10, p_x = \frac{2(10)-8}{3} = 4$
- Therefore, $f^* = 4$,

$$x_s^* = x_d^* = 10 - 2(4) = 2$$

- and from before, $s^* = 6$
- This is the same outcome as we obtained when the firms merged which means we have achieved economic efficiency.
- What about profits?

Coase and Production Externalities

- $\Pi_s(s, x) = p_s s - s^2 - (x-4)^2 - p_x x$
  $= 12(6) - 6^2 - (2-4)^2 - 4(2)$
  $= \$24$
- $\Pi_F(f, x) = p_f f - f^2 - xf + p_x x$
  $= 10(4) - 4^2 - 2(4) + 4(2)$
  $= \$24$

Coase and Production Externalities

- Combined profits are \$48, the same as profits of the merged firm.
- But compared to the unmerged case, where $\Pi_s = \$36$ and $\Pi_f = \$9$, since now both firms make \$24, the steel firm is not happy and the fishery is elated!

Coase and Production Externalities

- Q: Would it matter if the property right to the water had instead been assigned to the steel firm?
- A: Yes and no.
  - The efficient outcome will still be achieved. Coase theorem only says that property rights have to be assigned, it doesn’t matter whom they are assigned to.
  - Profits will be very different. Any firm would prefer to have the property right assigned to them because then they can sell it for additional revenue.

Coase and Production Externalities

- Open question: How do we determine who gets the property right of the externality?
  - Steel firm or fishery?
  - Smokers or non-smokers?
  - Indonesian plantation owners or Singaporeans?

Coase on the Coase Theorem

- The Coase theorem was coined by George Stigler, adapting ideas from a paper by Ronald Coase.
- Here are Coase's thoughts on the Coase theorem (and other things):

  https://www.youtube.com/watch?v=04zFygmeCUA

Coase on the Coase Theorem

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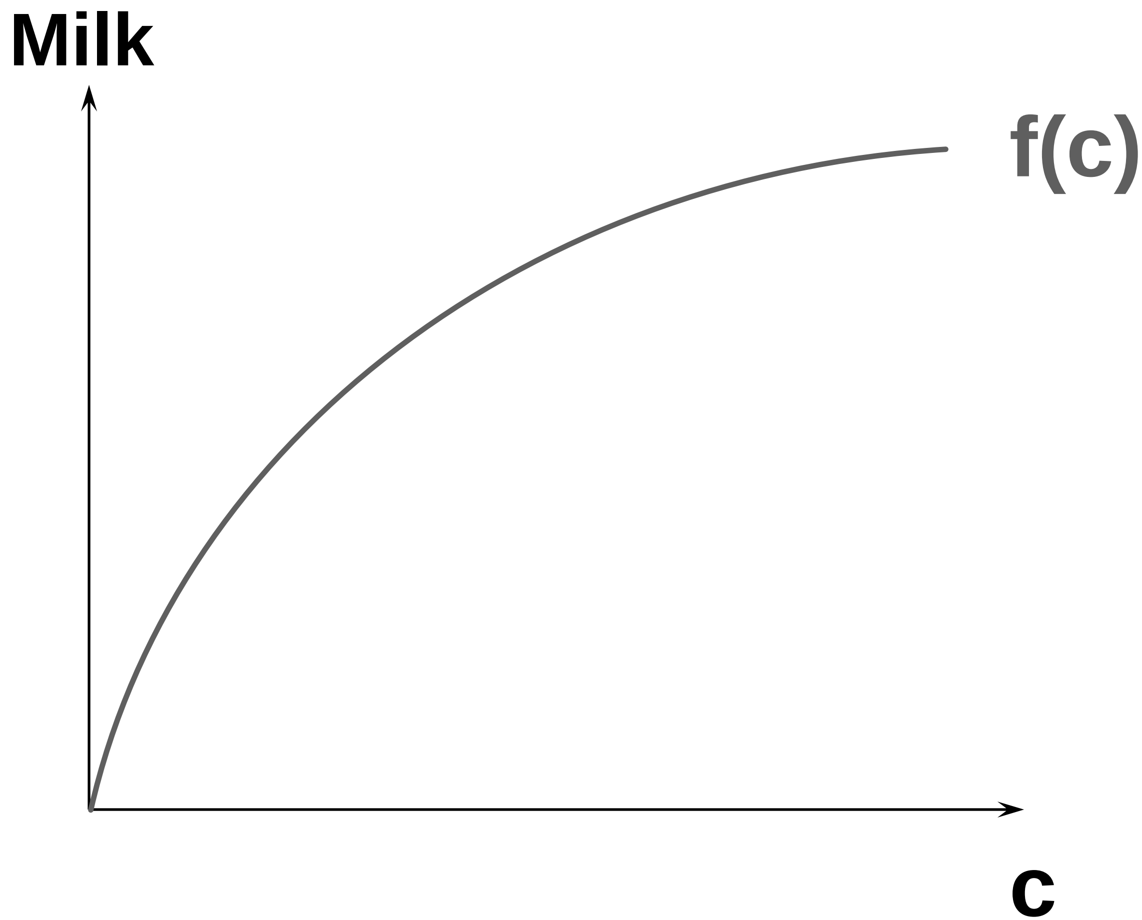
The Tragedy of the Commons

- Consider a grazing area owned "in common" by all members of a village.
- Villagers graze cows on the common.
- When c cows are grazed, total milk production is $f(c)$, where $f' > 0$ and $f'' < 0$
  - function is increasing but at a decreasing rate
- How should the villagers graze their cows so as to maximize their overall income?

The Tragedy of the Commons



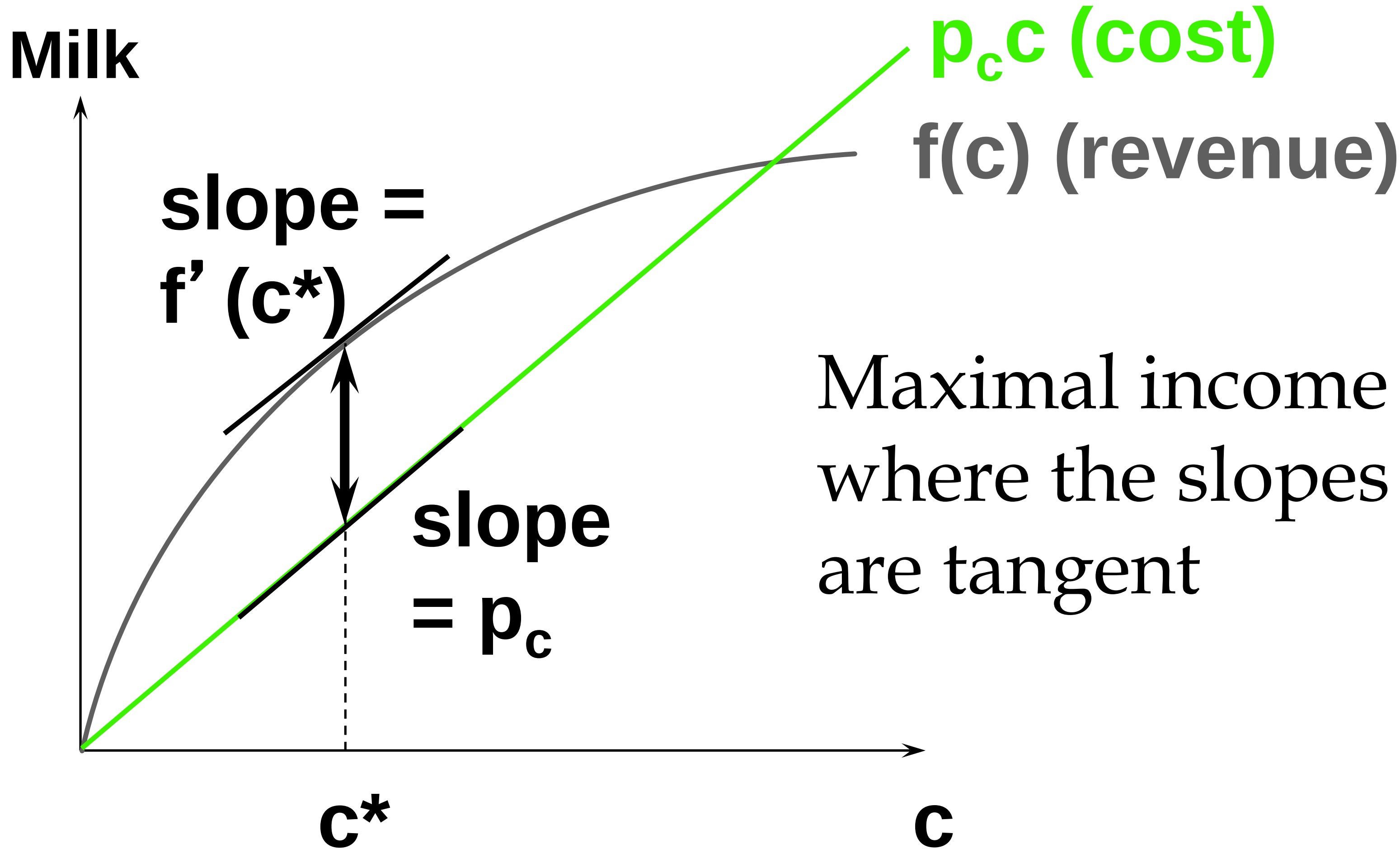
The Tragedy of the Commons

- Make the price of milk \$1 and let the relative cost of grazing a cow be \$$p_c$. Then the profit function for the entire village is
$$\Pi(c) = f(c) - p_c c$$
and the village's problem is to
$$\max_{c \geq 0} \Pi(c) = f(c) - p_c c$$

If the village behaves like a rational individual, then it chooses c such that $f'(c) = p_c$

marginal revenue product from the last cow= marginal cost of grazing it

The Tragedy of the Commons

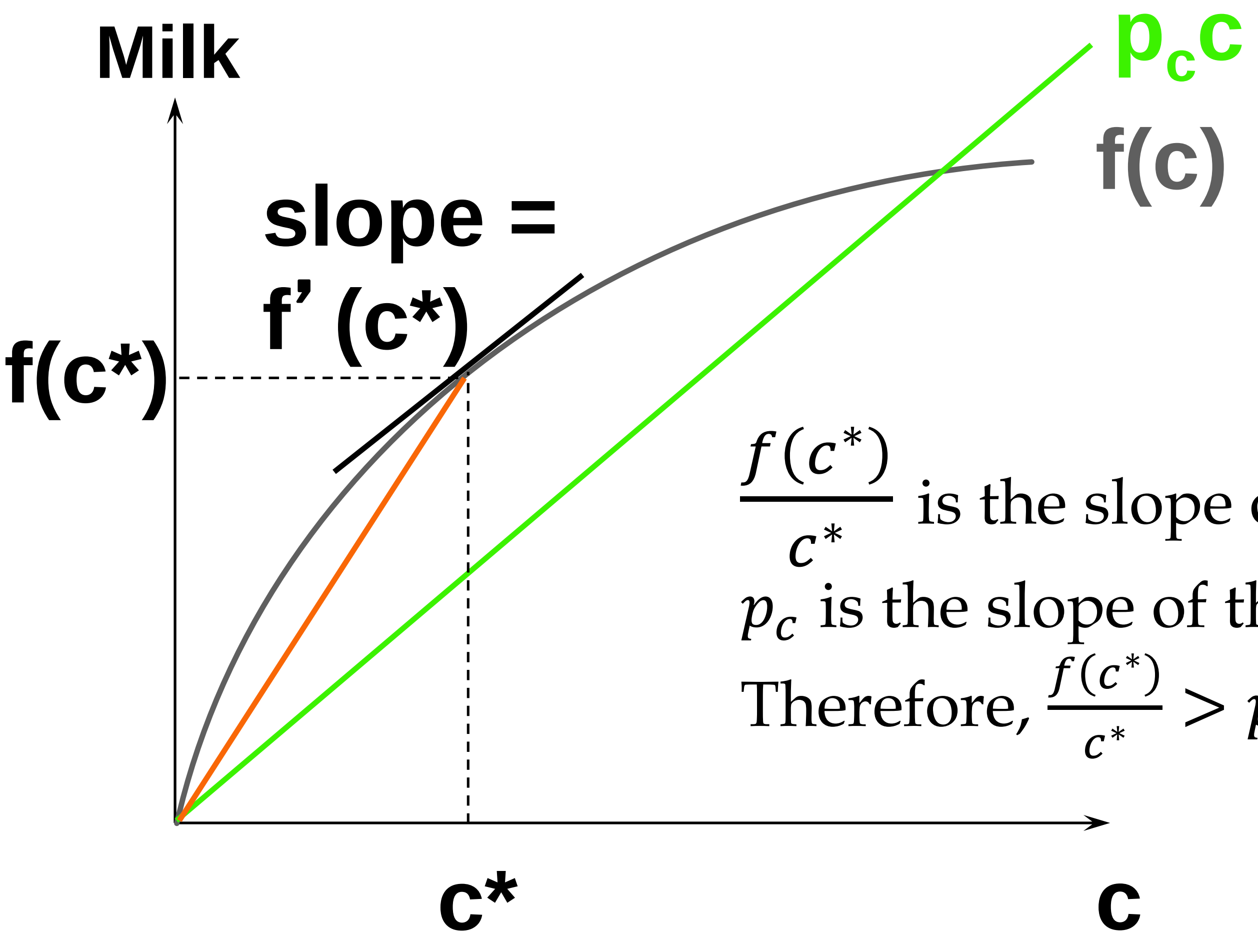


Maximal income where the slopes are tangent

The Tragedy of the Commons

- Suppose instead of the village making the decision collectively, each rational individual in the village decides whether they want to graze a cow.
- If $c = c^* - 1$, and you are deciding if you want to graze a cow or not. If you choose to graze, then
  - The private cost is p_c
  - The private benefit is $\frac{f(c^*)}{c^*}$
  - Every cow is equally productive, so your revenue is the $\frac{total\ revenue}{number\ of\ cows}$

The Tragedy of the Commons



$\frac{f(c^*)}{c^*}$ is the slope of the orange line

p_c is the slope of the green line

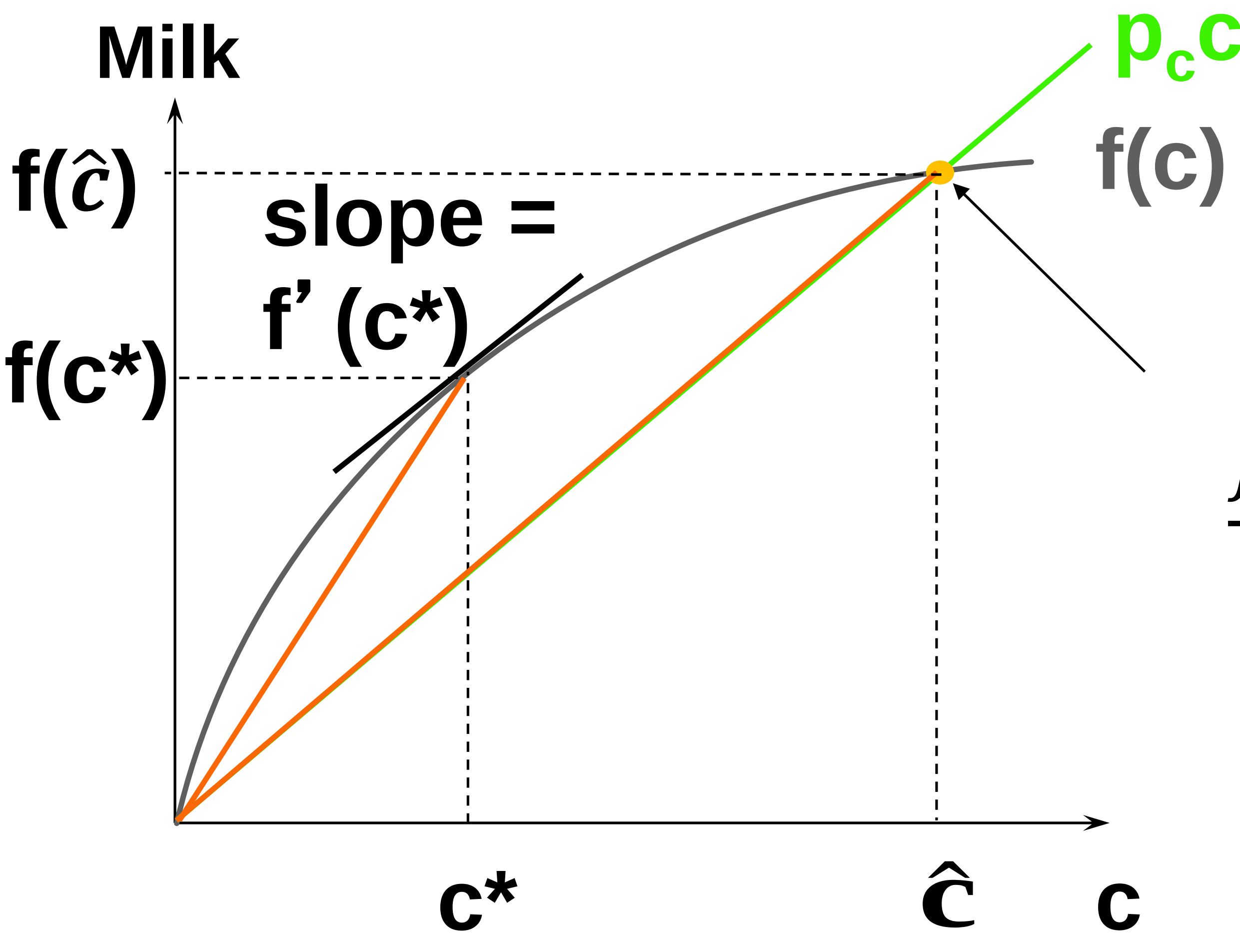
Therefore, $\frac{f(c^*)}{c^*} > p_c$

The Tragedy of the Commons

- Therefore it is profitable for you to graze a cow.
- Entry continues until the economic profit of grazing another cow is zero; that is, until:

$$\frac{f(c^*)}{c^*} = p_c$$

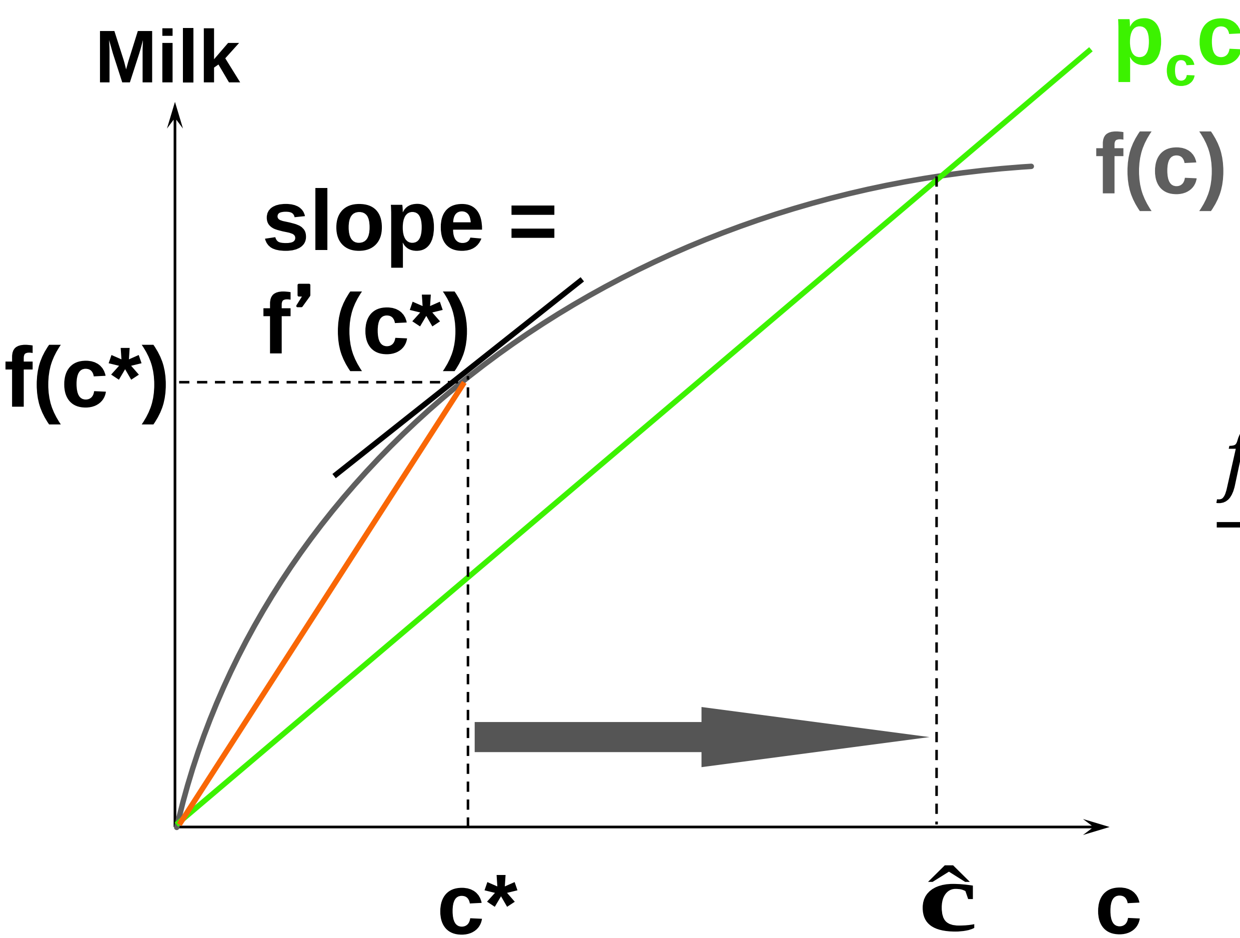
The Tragedy of the Commons



At $\hat{c}$,

$$\frac{f(\hat{c})}{\hat{c}} = p_c$$

The Tragedy of the Commons



$$\frac{f(\hat{c})}{\hat{c}} = p_c$$

The commons are over-grazed, tragically.

The Tragedy of the Commons

- The reason for the tragedy is that when a villager adds one more cow his income rises (by $\frac{f(c)}{c} - p_c$) but every other villager's income falls.
- This is because $f'(c) < p_c$ when $c > c^*$ which means total income of the village is shrinking
- The villager who adds the extra cow takes no account of the cost inflicted upon the rest of the village.

The Tragedy of the Commons

- At $c >$ … revenue an in… ual receives, $\frac{f(c)}{c}$ is grea… n the co… has to pay, but it is not greate… n th… tal cost inflicted on society,

$$- \ldots c$$

…te cost

Social c… crease in revenue to all farmers from additional cow

The Tragedy of the Commons

- Modern-day “tragedies of the commons” include
  - over-fishing the high seas
  - over-logging forests on public lands
  - over-intensive use of public parks; e.g. Yellowstone.
  - urban traffic congestion.

The Tragedy of the Commons

- Property rights could solve this problem.
  - If everything that people care about is owned by someone who can control its use and, in particular exclude others from overusing it, then there are by definition no externalities.
- How else could we solve this problem?

The Tragedy of the Commons

- Merger:
  - If the whole village acted collectively, they would internalize the externality and there would be no overgrazing.

The Tragedy of the Commons

- Taxation:
  - If we taxed each individual the amount equal to the decrease in returns he imposes on the farmers, $\cancel{f'(c)}$, then he is forced to take into account the social cost of his actions and there will be no overgrazing.
  - In general, taxing every agent the cost of the externality he imposes on others causes him to internalize it.
  - This leads to an efficient allocation.

The Tragedy of the Commons

- A quantity limit:
  - If we know what the optimal quantity is, we could cap production at that level and not let anyone produce beyond that.

The Tragedy of the Commons

- Cap-and-trade:
  - Suppose firms value pollution differently. To some firms, pollution reduces production costs by a lot, to other firms, pollution reduces production costs by very little.
  - Without regulation, all firms pollute until pollution no longer reduces their costs

The Tragedy of the Commons

- Cap-and-trade:
  - The government wants to set pollution at X units which is less than the current level of pollution. What is the most efficient way to reduce pollution?
    - We want those who value pollution the least to give it up first.
  - We could gather information on the various costs of pollution and dictate who abates but that would be an expensive and involved process.

The Tragedy of the Commons

- Cap-and-trade:
  - Suppose there are two firms.
  - To Firm A, one unit of pollution lowers production costs by $200.
  - To Firm B, one unit of pollution lowers production costs by $300.
  - Firm B values pollution more than Firm A
  - The government has set the cap at two units of pollution. If it lets the firms to produce one unit of pollution each, pollution will lower production costs by $500.

The Tragedy of the Commons

- Cap-and-trade:
  - If the government gives each firm a permit to emit one unit of pollution, Firm B will want to sell that permit to Firm A.
  - Firm A values the permit at $200 while Firm B values it at $300.
  - Once they agree on a price (somewhere between $200 and $300), they will trade the permit from B to A.
  - Now pollution has lowered production costs by $600 and the same pollution target is met.

The Tragedy of the Commons

- The government <u>caps</u> pollution and the firms <u>trade</u> the permits.
- Examples:
  - European Union cap-and-trade for carbon emissions
  - California cap-and-trade for carbon emissions
- If you're interested in environmental issues, cap-and-trade is a big topic right now!

Summary

- Externalities are goods that are not accounted for by regular markets.
- There are market-based solutions to the problem of externalities
- Question: Haze is an externality. How can we solve it?

Problem Set Hint

- Here you saw examples of production externalities. In your problem set, you will work through a few consumption externalities.
- They are somewhat different from what you see here.
- The key to solving externality problems is to identify what the external cost is:
  - When a car adds itself to a congested highway, how much does it slow everyone else down by?

Chapter 37:
Public Goods
(Sections 37.1 - 37.4)

Public Goods

- Definition and concept
- When to provide a public good
- The free-rider problem
- How much of a public good to provide

Definition

- A public good is a good that is:
  - Non-excludible: once produced, it is impossible to exclude someone from consuming it
  - Non-rivalrous: one person’s consumption of the good doesn’t diminish another person’s consumption of the good

Public Goods

	Excludable	Non-excludable
Rivalrous	**Private goods** (food, clothing, books)	**Common goods** (fish stocks, public highways when congested)
Non-rivalrous	**Club goods** (golf courses, cinemas)	**Public goods** (air, national defense, public highways when not congested)

- Non-rivalrous can mean indivisible or very large/abundant
  - National defense is indivisible
  - A golf course is very large/abundant

Public Goods

- Definition and concept
- When to provide a public good
- The free-rider problem
- How much of a public good to provide

When to provide a public good

- Section 37.1 is extensive, and I do not have time to present the whole derivation here. You need to read it, but just grasp the general concept. Do not get bogged down with the details.
    - Second paragraph on pg. 717 until end of section on pg. 718 is less important.
- What these slides will cover is a simpler discussion of the ideas. If we have time, we may come back to the full derivation in Week 13

When to provide a public good

- Suppose there are two individuals, Chandler and Joey.
  - Joey owns a jewelry store.
  - Chandler owns a television store.
  - Both stores are side-by-side
- They are both interested in getting a security guard which is a public good.
  - The security guard will make the entire area safer. He is non-excludible.
  - The security he provides is non-rivalrous.

When to provide a public good

- The cost of a security guard is c
- The value of security to Joey is r_j
- The value of security to Chandler is r_t

When to provide a public good

- Suppose $r_j > c$ and $r_t < c$
- Then Joey gets the security
  - Joey has a payoff of $r_j - c$
  - Chandler free-rides with a payoff of r_t
- Suppose $r_j < c$ and $r_t > c$
  - Chandler gets a guard and Joey free-rides.

When to provide a public good

- Suppose $r_j < c$ and $r_t < c$, but $r_j + r_t > c$
  - Then individually, neither will get the security guard, but if they coordinate, they could make themselves better off.
- So the public good should be provided as long as $r_j + r_t > c$

Public Goods

- Definition and concept
- When to provide a public good
- The free-rider problem
- How much of a public good to provide

The free-rider problem

- Suppose $r_J = 8$, $r_t = 8$ and $c = 10$.
- If the stores decide independently whether to hire a guard, then:

		Chandler	
		Hire	Do Not Hire
Joey	Hire	-2, -2	-2, 8
	Do Not Hire	8, -2	0, 0

- The Nash equilibrium is {Joey: Do Not Hire; Chandler: Do Not Hire}
- Because each tries to free-ride on the other, they don't do what is best for the collective.

The free-rider problem

- How do we overcome the free-rider problem?
- If Joey and Chandler can make “side payments” to each other, then we can get to a Pareto improving outcome.
- If Joey hires the guard and Chandler makes him a “side payment” then both agents are better off than in the Nash equilibrium outcome.

The free-rider problem

- Let’s say the “side payment” is $2:

		Chandler	
		Hire	Do Not Hire
Joey	Hire	-2, -2	0 , 6
	Do Not Hire	8, -2	0, 0

The free-rider problem

- Allowing “side-payments” makes possible supply of a public good when no individual will supply the good unilaterally.
- However, “side-payments” could fail:
  - If voluntary, one has the incentive to under-report the valuation of the good to pay less.
  - This would lead to an under-provision of the good.

Public Goods

- Definition and concept
- When to provide a public good
- The free-rider problem
- How much of a public good to provide

How much of a public good to provide

- We've discussed when a public good should be produced and the problem of free riding that may cause the good not to be produced.
- Now we look at how much of a public good society should produce.
- Examples:
  - How much public defense should we have?
  - How big should Gardens by the Bay be?
  - How much should society spend on medical research?

How much of a public good to provide

- Consider the following:
  - $c(G)$ is the cost of providing G units of a public good.
  - There are two individuals, A and B with endowments ω_A and ω_B.
  - They can consume G or a private good, X_A and X_B.
  - Set price of X, $p_X = 1$
  - Budget allocations must satisfy $X_A + X_B + c(G) = \omega_A + \omega_B$

How much of a public good to provide

- MRS_A and MRS_B are the marginal rates of substitution between the private good and public good.

$$MRS_A = \frac{MU_G}{MU_{X_A}}, MRS_B = \frac{MU_G}{MU_{X_B}}$$

- The Pareto efficient allocation is given by

$$MRS_A + MRS_B = MC(G)$$

Where $MC(G)$ is the marginal cost of G

How much of a public good to provide

- Recall in a competitive equilibrium:

$$MRS_A = MRS_B = MC(G)$$

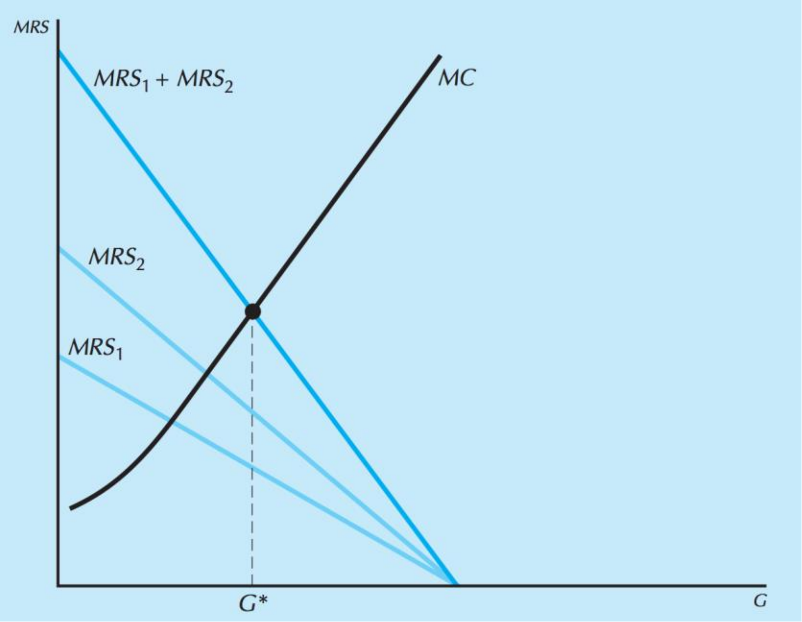
since $p_x = 1$

- Why $MRS_A + MRS_B = MC(G)$
  - Because G is non-rivalrous, one extra unit of G is fully consumed by A and B.
  - You have to think of A & B as if they were one person because they can both simultaneously consume the same good.

How much of a public good to provide

- MRS is how much X an agent is willing to give up to gain more G.
- In other words, it is how much value an agent places on one unit of G measured in units of X
- The value each agent places on G must sum up to the value of G
- In terms of the earlier example with Joey and Chandler, $r_j + r_t = c$

How much of a public good to provide



- If $MRS_A + MRS_B > MC(G)$, reduce G
- If $MRS_A + MRS_B < MC(G)$, increase G

How much of a public good to provide

- How do we figure out what $MRS_A + MRS_B$ is?
- This is a difficult question.
- If agents think the government wants to elicit their MRS so they can charge them for public goods accordingly, then agents will under-report their MRS.

How much of a public good to provide

- Merging will internalize the externality.
  - If the two stores merge, they no longer have a problem of under-provision of security guards.
- Technology makes it easier to track MRS.
  - GPS tracking means it is easy to figure out agents value of public roads by tracking how much they use it.