Chapter 17

Externalities and Public Goods

Externalities and Public Goods

- Some markets have externalities and markets with public goods.
  - These markets are unlikely to allocate resources efficiently.
- **Externality:** The effect that an action of any decision maker has on the well-being of other consumers or producers, beyond the effects transmitted by changes in prices.
- **Public Good:** A good, such as national defense, that has two defining features: first, one person's consumption does not reduces the quantity that can be consumed by any other person (non-rivalry); second, all consumers have access to the good (non-excludability).

More about this in a few days. **Now:** Externalities

Externalities - Examples

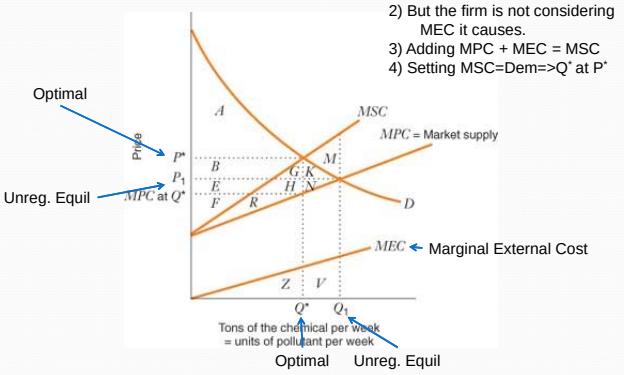
Example	Positive/Negative	Consumption/Production
Vaccination	Positive	Consumption
Bandwagon Effect	Positive	Consumption
Development of laser technology	Positive	Production
Manufacturer Polluting a River	Negative	Production
Highway congestion	Negative	Consumption
Computer Network	Negative	Consumption
Snob Effect	Negative	Consumption

Let's consider a negative externality…

- A perfectly competitive industry where every firm generates one ton of pollutant (pound) per ton of chemical they produce
- The pollutant negatively affects society

Negative Externality

1) If unregulated: Increase Q until Dem=Supply=>Q_1 at P_1
2) But the firm is not considering MEC it causes.
3) Adding MPC + MEC = MSC
4) Setting MSC=Dem=>Q^* at P^*



Negative Externality

Unregulated

	Equilibrium (price=p_1)	Social Optimum (price=p^*)	Difference
Consumer Surplus	A+B+G+K	A	-B-G-K
Private Producer Surplus	~~E+F+R+H+N~~	~~B+E+F+R+H+N~~+G	B+G-N
-Cost of Externality	-R-H-N-G-K-M = Z + V	-R-G-H = Z	M+N+K (external costs savings) = V
Net Social Benefit	A+B+E+F-M	A+B+E+F	M Deadweight Loss
Deadweight Loss	M	Zero	M

What do we do with pollution?

- **Is Zero pollution socially efficient? No…**
  - At Q=0 Mg Benefit> Mg Social Cost
  - Q^* is efficient amount of production and pollution
  - Intuitively, the firm's increase in profits by emitting the first ton of CO_2 are so high, that it would be willing to compensate consumers for the (small) cost of having one single ton of CO_2 in the air.
  - You can extend that argument, until…Q^*, where

    Mg Benefit = Mg Cost of Pollution
    (Firm) (Consumers)

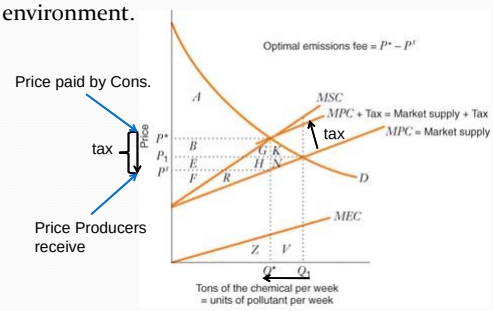
- So far we showed that too much negative ext. is produced, i.e., $Q_1 > Q^*$
- How can we move the equil. Q_1 towards Q^*?
- Two policy instruments:
  - 1) Emission Standards (quota)
  - 2) Emission Fees (taxes)

Two Main Ways to Reduce Externalities

- 1) **Emission standards** → Set the total pollution at Q^*
- A governmental limit on the amount of pollution that can be emitted. Since MPC and MSC may be difficult to calculate for every firm, the government may set an optimal Q^*, distributed in permits, and allow firms to decide if they really want to pollute or not.
- Tradable emissions standards: low cost firms sell them to high cost firms

  (i.e. cap and trade system)

- 2) **Emission fees (taxes)**
- Tax imposed on pollution the firm releases to the environment.



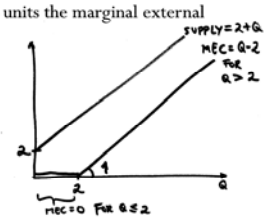
Welfare Analysis: How does the tax affect CS, PS,…?

	Equilibrium (with tax)
Consumer Surplus	A (Above P* and below demand)
Private Producer Surplus	F+~~K~~ (Below p^S and above MPC)
-Cost of Externality	-~~K~~-~~H~~-~~G~~ =Z
Government receipts from emissions tax	B+~~G~~+E+~~H~~ $=(p^* - p^S) \cdot Q^*$ (t)
Net Social Benefit	A+B+E+F

Same net social benefit as in the socially efficient outcome Q^*

Learning by doing 17.2

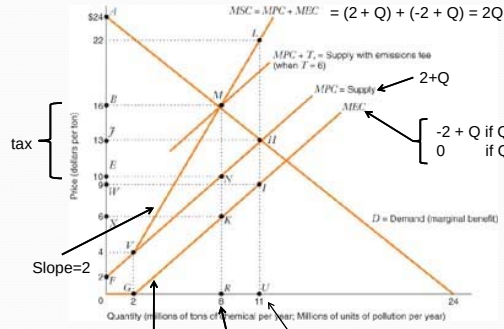
- Inverse Demand Curve: $P^d=24-Q$
- Inverse Supply Curve: MPC=2+Q
- Industry emits one unit of pollutant for each ton of chemical it produces. As long as fewer than 2 million units of pollutant emitted each year, the external cost is zero. But when pollution exceeds 2 million units the marginal external cost is positive.
- MEC: $= \begin{cases} 0, & when\ Q \le 2 \\ -2+Q & when\ Q > 2 \end{cases}$



17.2 (cont.)

- Suppose the government wants to use an emission fee of $T that will induce the market to produce the economically efficient amount of the chemical, Q*.
- Construct a graph and table comparing the equilibria with and without the emission fee.

17.2



$MSC = MPC + MEC$ = (2 + Q) + (-2 + Q) = 2Q for all Q>2

2+Q

-2 + Q if Q>2
0 if Q≤2

tax

=24-Q

Slope=2

Slope=1 Soc. Opt. Unregulated Equilibrium

- a) (Unregulated) Equilibrium

  Dem = Supply

  24-Q = 2+Q → Q= 11

  Price is then p=24-11=$13 } Point H at center of the Figure

- b) Social Optimum

  Dem = Supply + MEC (MSC)

  24-Q = (2+Q) + (-2+Q)

  24-Q = 2Q → Q = 24/3 = 8

  P = 24-8 = $16 } Point M on the Figure

- c) How much must the tax be to move from H to M?
  - From point M, extend a dotted line downwards until you cross N, that is…

Evaluate MPC (supply) at Q=8 units:

MPC = 2 + 8 = $10 ← Height of Point N in the Figure

Q

- Therefore the tax is, the difference between:
  - M (what consumers pay for the good) = $16
  - N (what producers actually receive for the good) = $10, and together reflects the per-unit tax…

T = $16 - $10 = $6

17.2 (cont.)

Unregulated ↓ Socially Optimal ↓

	No Emissions Fee	Emissions Fee of $6 a unit
Consumer Surplus	AJH (60.5 mil)	ABM (32 mil)
Private Producer Surplus	FJH (60.5 mil)	FEN (32 mil)
-Cost of Externality	-VLH=-GUI (-40.5 mil)	-VNM=-GKR (-18 mil)
Gov't Earnings from fee	Zero	ENMB (48 mil)
Net Social Benefit	AMVF-MLH (80.5 mil)	AMVF (94 mil)

- In order to find the values above you have to remember your geometric equations.
  - *Triangle*: .5Base*Height
  - *Square*: Base*Height
- *Example:* consumer surplus in the unregulated equilibrium is AJH .5{(24-13)(11)}=60.5
- Repeat for all other regions of the graph above.

- What is the DWL from an excessive amount of pollution in the unregulated equilibrium?
- DWL is the area of the triangle MNH,

$$= \frac{1}{2}\underbrace{(22-13)}_{\text{Height}}\underbrace{(11-8)}_{\text{Base}} = \frac{27}{2} = 13.5$$

17.2 (cont.)

Tax Revenues ↓

- b) Why is the sum of CS + PPS – MEC+GOVT+DWL the same with or without the fee?
- The figures in the table show that the sum is going to be 94 million both ways because the figure represents the potential net benefit in the market whether or not there is a fee.
- When there is no fee the market performs inefficiently because of the negative externality and there is a DWL>0.
- When there is a fee the market performs efficiently and the entire potential is captured. DWL=0.
- Indeed, $\underbrace{\$80.50 + \$13.50}_{\text{Without Fee}} = \underbrace{\$94}_{\text{With Fee}}$

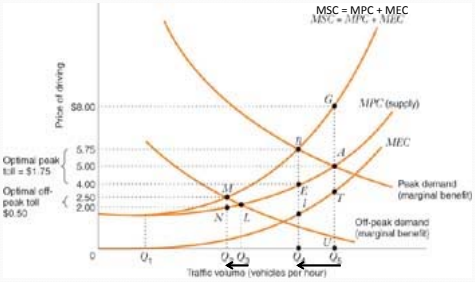
Common Property

- A resource, such as a public park, a highway, or the internet, that anyone can access.

  What's the problem? *Congestion!* → Your car creates a negative externality to other users of the highway. (You impose a MEC)

- On the next graph
- Before Q1= no congestion (MEC = 0 For $Q \leq Q_1$)
- After Q_1, there is congestion (MEC > 0 For $Q > Q_1$)
- Peak: Too much Q_5.....B-E is the toll. It makes each driver internalize the MEC of the congestion he/she causes.
- Off Peak: Too much Q_3.....M-N is the toll

Common Property



Application:

- Congestion pricing in the route Orange County ↔ L.A. County
- There are no toll booths
- Drivers buy a "transponder" (electronic device you stick to the windshield) and prepay money into the account
- Toll prices range from $1.00 to $9.90 ← 4:00 to 5:00 PM, wow!
- Electronic signs at the entrance of the highway inform drivers about the current toll.

This system is now being copied by several countries with few highways: Chile, Brazil, etc.

(Technological Leapfrogging)

Another Application: London Congestion Charge

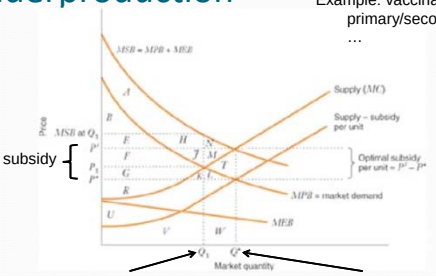
- Drivers must pay around $8 (about $12 US) in order to travel within downtown London (the City and West End) between 7:00 am and 6:30 pm.
- Initial fears, but did it work?
- YES!
  - Number of vehicles decreased by 23%
  - Average speed increased by 21%
- Some neighborhoods outside the charging zone want to now be included within it.
- Similar systems have been implemented in Singapore, Stockholm, Edinburgh and Milan.

Positive externalities

- Activities that create positive benefits for firms or individuals who didn't pay for the good or service.
- You only take into account your private marginal benefits (e.g., vaccine), but ignore the marginal external benefits that your action cause on other individuals.
  - *Examples*: education, health care, research and development (unpatented).

Positive Externalities: Underproduction

Example: vaccination, primary/secondary education, …



Unregulated MPB = MC

Demand Supply

Optimal MSB = MC

MPB + MEB

Unregulated, Q_1 Q^*

	Equilibrium	Social Optimum	Difference
Private Consumer Surplus	B+E+F	B+E+F+G+K+L	G+K+L
Producer Surplus	G+R	F+G+R+J+M	F+J+M
Benefit from Externality	A+H+J = U+V	A+H+J+M+N+T = U+V+W	M+N+T = W
Gov't Cost of Implementing the Subsidy	Zero	-F-G-J-K-L-M-T	-F-G-J-K-L-M-T
Net Social Benefits	A+B+E+F+G+H +J+R	A+B+E+F+G+H +J+M+N+R	M+N

Deadweight Loss in Welfare if $Q = Q_1$

This is not from the LD exercise in your textbook.

Exercise about Positive Externalities – Ex. 17-11

- Amityville has a competitive chocolate industry with (inverse) supply curve $P^S = 440 + Q$.
- While the market demand for chocolate is $P^d = 1200 - Q$, there are external benefits that the citizens of Amityville derive from having a chocolate odor wafting through the town.
- The marginal external benefit is MEB = 6 – 0.05Q.

1. Without government intervention, what would be the equilibrium amount of chocolate produced?

   Equil. occurs at Dem = Supply → $1200 - Q = 440 + Q$

   $Q = 380$ units

2. What is the socially optimum amount of chocolate production?

   Social Opt. occurs at $p^d + MEB = p^S$ (we take pos. ext. into account)…(1200-Q) + (6-0.05Q) = 440 +Q…

Clearly $Q_{equil} < Q_{soc.optimum}$ → Q* = 400 units

380 < 400

Exercise about Positive Externalities – Ex. 17-11

- 1. If the government of Amityville used a subsidy of $S per unit to encourage the optimal amount of chocolate production, what level should that subsidy be?

With a subsidy of $S, equilibrium occurs at

$P^d + S = P^S$

$(1200-Q) + S = 440 + Q$

And in order to have the socially optimal Q = 400 (part b),

we then need…

$(1200 – 400) + S = 440 + 400$

Which implies that S must be (i.e. solving for S)

S = $40.

Property rights

- So far we have shown that, in the presence of externalities, the government might try to restore efficiency by imposing taxes (emission fees), subsidies or quotas.
- An alternative, however, is to simply assign property rights of the resource to the agents (either firms or individuals), and allow them to bargain how many units of the externality (e.g., pollution) they are willing to bear.

Property Rights

- Property Rights: The exclusive control over the use of an asset or resource.
- Why don't we not assign property rights over the resource (e.g., lake) and allow firms to bargain?
- Coase Theorem: Regardless of how property rights are assigned with an externality, the allocation of resources will be efficient when the parties can costlessly bargain with each other.
- Example: Fishery vs. Steel Firm (who owns the river)

What if the fishery owns the river?

What if the steel firm owns the river?

Either way, Q^* is produced!!!

Criticisms of Coase Theorem:

- All parties involved in the negotiation must be perfectly informed about each other's benefits and costs from the externality, e.g., pollution.
- Negotiation costs can be substantial if many firms and consumers are involved … why not set a quota or a tax then?

Public Goods

- National Defense
- Clean Air

Examples

- Two Features of a Public Good:

They must satisfy two properties

1. Non-Rival: When consumption of a good by one person does not reduce the quantity that can be consumed by others.
   - National Defense (yes)
   - Highway (not so much)
   - Clothing or an apple (not at all)

Public Goods

2. Non-Exclusive: A good that, once produced, is accessible to all consumers; no one can be excluded from consuming such a good after it is produced.
   (or his exclusion is extremely expensive)

- National Defense (yes)
- Clean air (yes)
- Highway (not so much)

Easy to exclude if you didn't pay the toll

Public Goods, putting the two properties together…

	Rival	Non-Rival
Excludable	Clothing/Food (Private Goods)	Pay-TV Channels (Club Goods)
Non-Excludable	Hunting (Common Pool Resources)	National Defense/Clean Air (Public Goods)

Learning-by-Doing17.4

Example of Public Goods

- P_1=100-Q Individual 1
- P_2=200-Q Individual 2
- a) If MC =240 Efficient amount of Q?

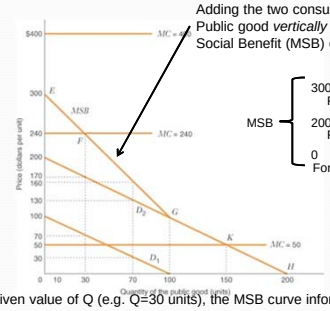
This gives us MSB

- Start by adding the equations vertically
- MSB= P_1+P_2= (100-Q) + (200-Q) = 300-2Q

$$MSB = \begin{pmatrix} 300-2Q \text{ for } Q \le 100 \\ 200-Q \text{ for } \sout{Q>100} \\ 0 \qquad\qquad Q>200 \end{pmatrix} {}^{Q \in (100,\,200]}$$

Let's see its figure…

Finding MSB



Adding the two consumers' demand for the Public good *vertically* we obtain the Marginal Social Benefit (MSB) of the public good

MSB
- 300 – 2Q for Q≤ 100 From point E to G
- 200 – Q for Q ∈ (100,200] From point G to H
- 0 for Q > 200 For all units beyond point H

Intuitively, for a given value of Q (e.g. Q=30 units), the MSB curve informs us about the total benefit that all consumers benefitting from the public good obtain.

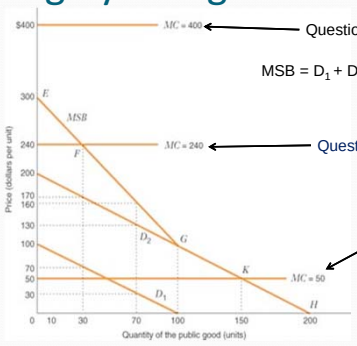
After finding MSB, we are now ready to find the optimal production of the public good by setting **MSB = MC**

- Set MSB=MC
  300-2Q=240
  60=2Q
  Q=30 (Point F in Figure)
- b) What if MC=50?
  MSB=MC
  200-Q=50
  150=Q
  Q=150 (Point K)

c) And what if MC=400?
300-2Q=400
2Q=**-100**
Q=-50?

- When MC=400, the marginal social benefit of this public good is not high enough for any of it to be provided so the optimal amount is Q=0.

Learning by doing 17.4



Free Rider

- A consumer who doesn't pay for a non-excludable good, expecting that others pay.
- Ex. PBS (100 Million viewers, only 4 million contributors)
- National Public Radio (22 million listeners, only 3 million contributors)

- Additional Examples about public goods and externalities that can be worked out:
  - Exercises from the textbook 17.1, 17.6, 17.16
  - (See also handout of the review session)

Future courses where you will be using Intermediate Micro…

- If you like the models about firm competition…
  - Take the course on ***Industrial Organization*** (EconS 425)
- If you like strategy and games…
  - Take the course on ***Strategy and Game Theory*** (EconS 424)
- If you like externalities and environmental policy...
  - Take ***Environmental Economics*** (EconS 330)