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Introductory Microeconomics ECO/4002Y

Externalities

Outline

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- Topics
  - Positive and negative externalities
  - Taxing Externalities
  - Tradable permits
  - Coase and property rights
  - Extra Slides (more examples – on your own)

Externalities

- Defined as **third party** (or spill-over) **effects** arising from the **production** and/or **consumption** of goods and services for which no appropriate compensation is paid

- Externalities can be positive or negative and can lead to market failure if the pricing mechanism does not take into account the full social costs and benefits of production or consumption

  - Cost benefit analysis says do activity *x* if $B(x) > C(x)$. Here $B(x)$ and $C(x)$ measure ***private*** benefit and cost.
  - Efficiency requires to do activity *x* if $SB(x) > SC(x)$ where $SB(x)$ and $SC(x)$ measure ***social*** benefit and cost.
  - In the absence of externalities private and social benefit and cost are identical

Externalities as public ‘bads’

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- Smoking: causes health hazards to others
- Aeroplane landing and take-off: deafening sound affects nearby residents
- Chemical factory: dumping waste in a nearby river and destroying the fish population and livelihoods of fishermen
- Burning fossil fuel: (oil and coal) our own small contribution to the Greenhouse effect

Some positive externalities

- Externality is not necessarily bad; it can be good too
- Firework: enjoyable for others as well
- Nice front garden: neighbourhood looks good, and other's property price is influenced
- R&D: Benefits of a new drug go far beyond the inventing company
- Education: Skilled workforce benefits the economy

So, what?

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- When such externalities are present, market fails to produce goods and services at the socially optimal level…
  - even when Markets and Society use the same logic!
- Rational society
  - Marginal revenue (social benefit) = Marginal cost (social cost)
- Rational market/firms
  - Marginal revenue (private benefit) = Marginal cost (private cost)

Using Economics

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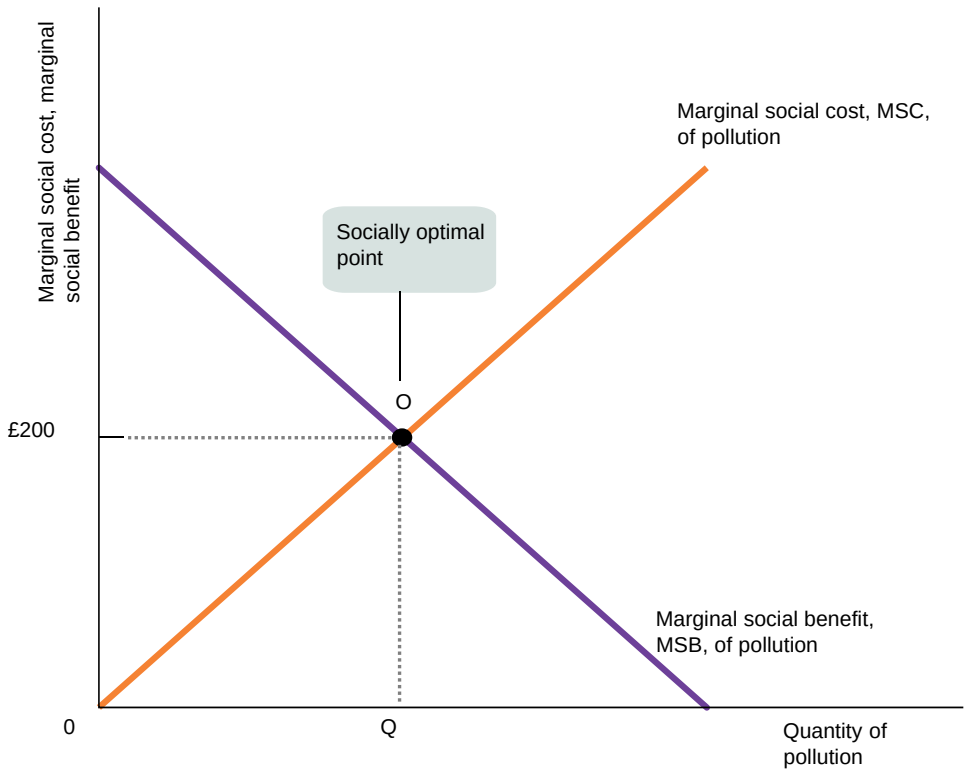
- We distinguish private cost/benefits from social cost/benefits
  - An external cost is an uncompensated cost that an individual or firm imposes on others
  - An external benefit is a benefit that an individual or firm confers on others without receiving compensation

- Bad (or negative) externality:
  - Marginal private cost (MPC)<Marginal social cost (MSC)
  - Pollution: MSC = MPC + external cost due to pollution

- Good (or positive) externality:
  - Marginal private benefit (MPB)<Marginal social benefit (MSB)
  - R&D: MSB = MPB + external benefit from R&D

Socially Optimal Quantity

- The **marginal social cost of pollution** is the additional cost imposed on society as a whole by an additional unit of pollution.
- The **marginal social benefit of pollution** is the additional gain to society as a whole from an additional unit of pollution.
- The **socially optimal quantity of pollution** is the quantity of pollution that society would choose if all the costs and benefits of pollution were fully accounted for.
- If the private costs/benefits differ from the social costs and benefits, the market outcome will be different from the socially optimal outcome.



Economic consequences

- Good externality
  - Market produces too little relative to the social optimum
  - Benefits are not recovered

- Bad externality
  - Market produces too much relative to the social optimum
  - Costs are never paid

- Market fails to achieve social optimum (market failure)

Positive and Negative Externalities

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- Externalities
  - External costs of production
    MSC > MPC
  - External benefits of production
    MSC < MPC
  - External costs of consumption
    MSB < MPB
  - External benefits of consumption
    MSB > MPB

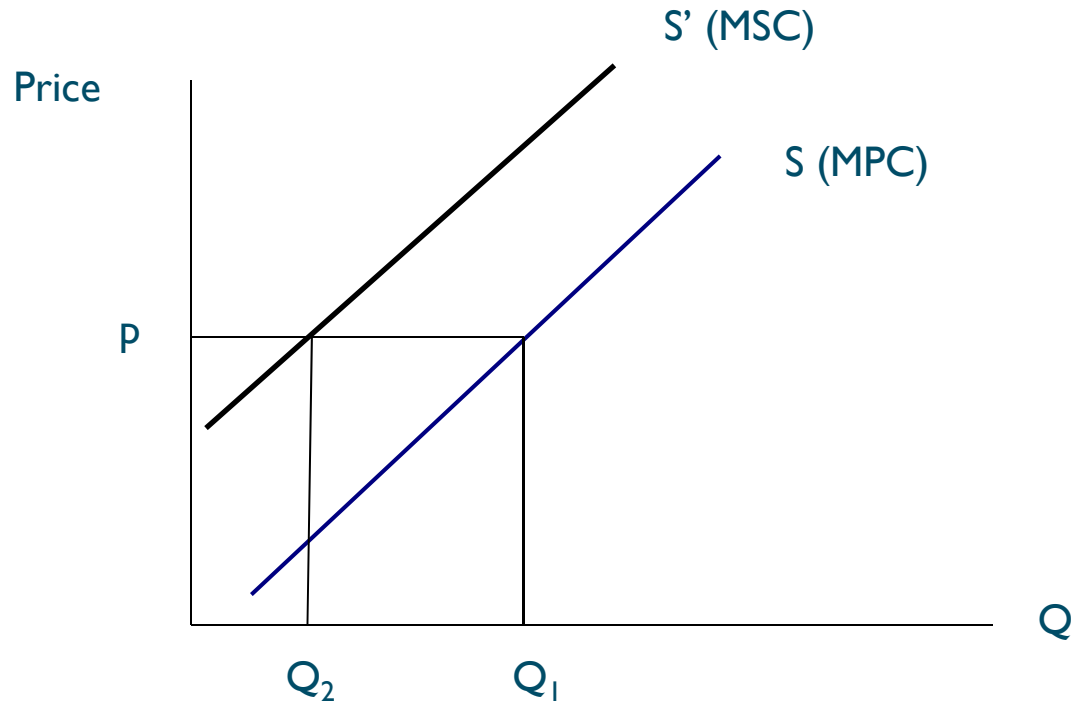
An example

Markets need a little help from their friends

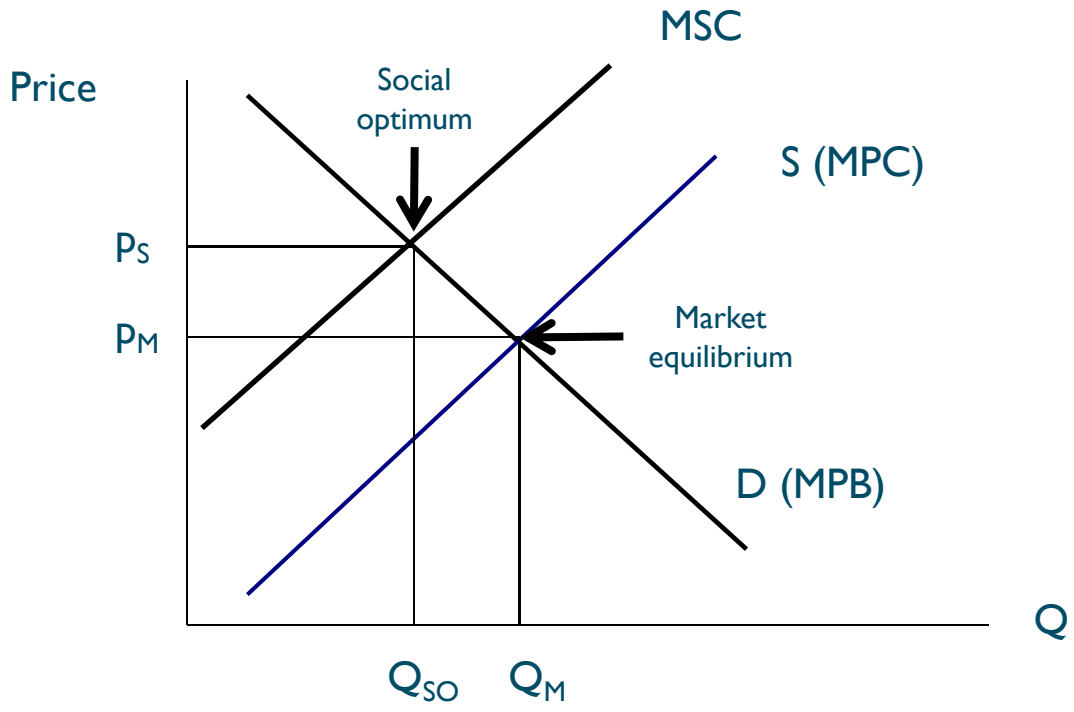
Pollution

- Negative externality
- Benefit side: MPB = MSB (no externality)
- Cost side: MSC > MPC
- Social rational rule: MSB = MSC
- Market rational rule: MPB = MPC
- Market equilibrium does NOT match social optimum
- Market produces too much

The external cost



Market vs. society



Can we make the market work?

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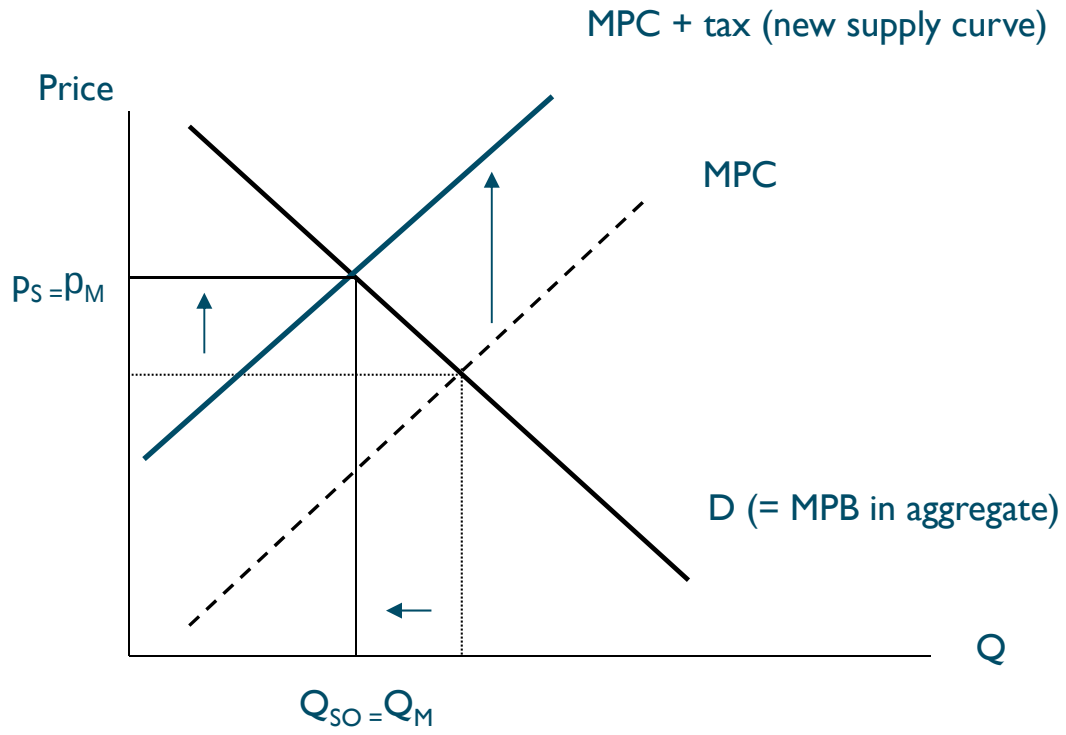
- If polluters internalise the external cost, the market equilibrium will match the social optimum
- How to do that?
- Tax on the polluting product
- Set the tax = Marginal damage to the society
- Taxes make markets work… (food for thoughts)

Social optimum



A Numerical example:

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- Data:
  - Demand Curve: $p = 20 - QD$
  - Supply Curve: $p = Q_S$
- Market equilibrium?
  - $20 - Q_D = Q_S$
  - or $Q_M = 20/2 = 10$, and $p_M = 10$
- Negative externality?
  - External marginal cost = 4
- MSC?
  - Add 4 to the supply curve (the original gets the MPC)
  - $MSC = Q_s + 4$
- Social optimum?
  - $20 - Q_D = Q_S + 4$
  - or $Q_{SO} = 16/2 = 8$ and $p_{SO} = 12$

A problem?

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Demand		Supply		
Q	p (MB)	Q	p (MPC)	MSC
2	18	2	2	6
4	16	4	4	8
6	14	6	6	10
8	12	8	8	12
10	10	10	10	14
12	8	12	12	16

A problem: markets produce too much

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Demand		Supply		
Q	p (MB)	Q	p (MPC)	MSC
2	18	2	2	6
4	16	4	4	8
6	14	6	6	10
8	12	8	8	12
10	**10**	**10**	**10**	14
12	8	12	12	16

Market

A simple solution: imposing a tax

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Demand		Supply		
Q	p (MB)	Q	p (MPC)	MSC
2	18	2	2	6
4	16	4	4	8
6	14	6	6	10
8	**12**	**8**	8	**12**
10	10	10	10	14
12	8	12	12	16

so

Good Externality

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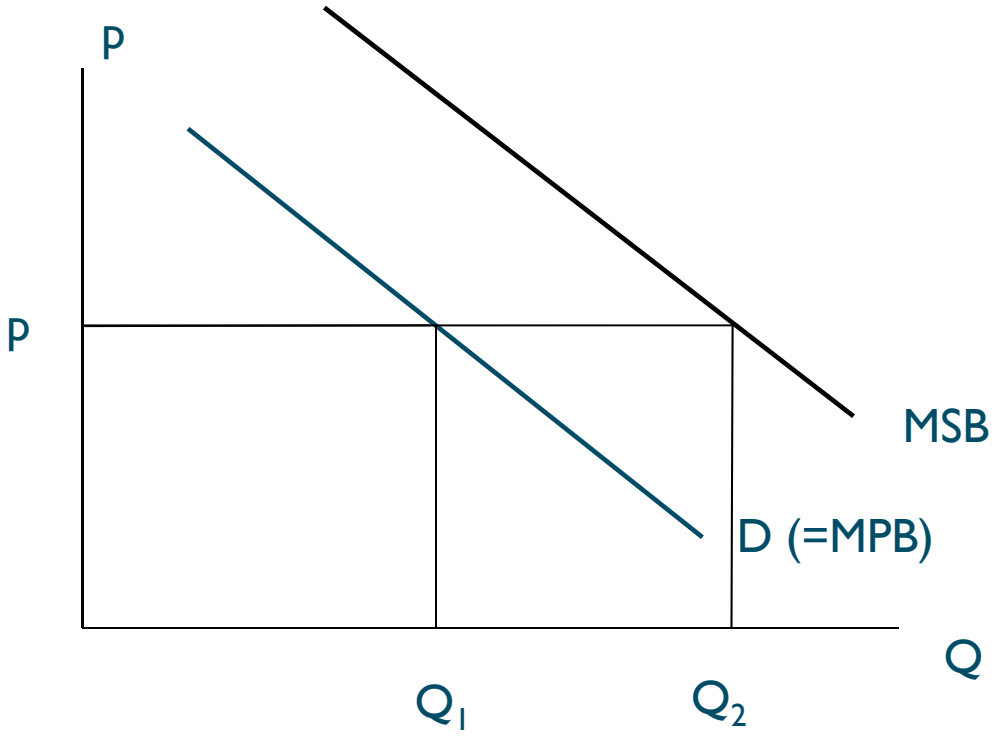
- The market produces too little
  - Cost side: $MSC = MPC$ (no external cost)
  - Benefit side: $MPB < MSB$

- Market equilibrium?
  - $MPB = MPC$

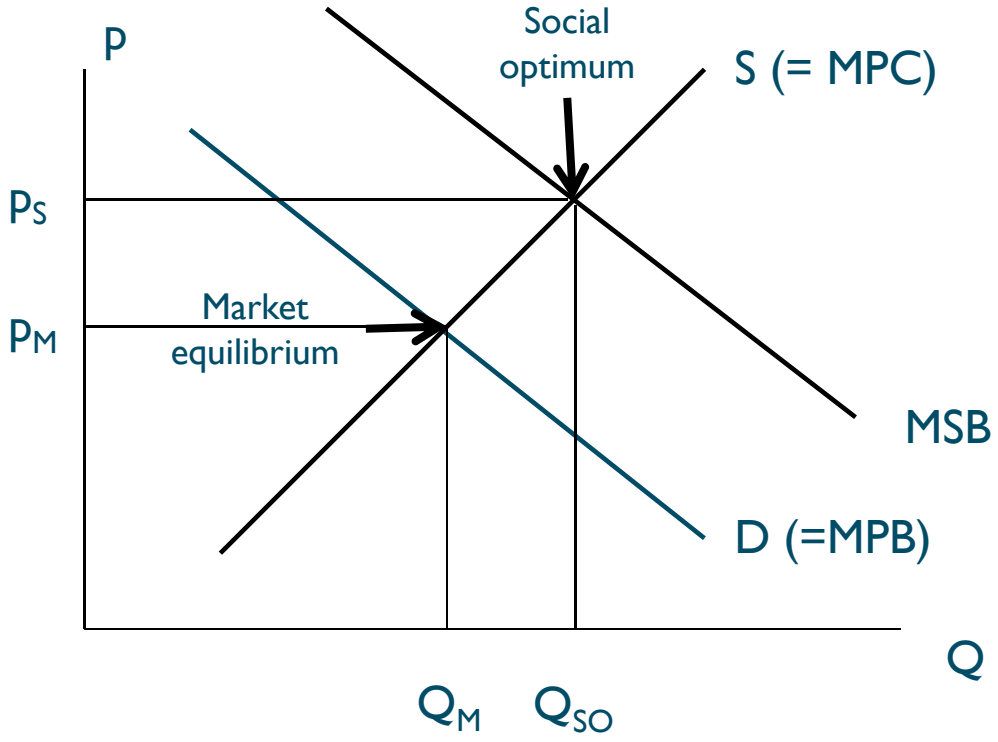
- Social optimum?
  - $MSB = MPC$

- Market equilibrium does not match social optimum
  - $Q_{SO} > Q_M$

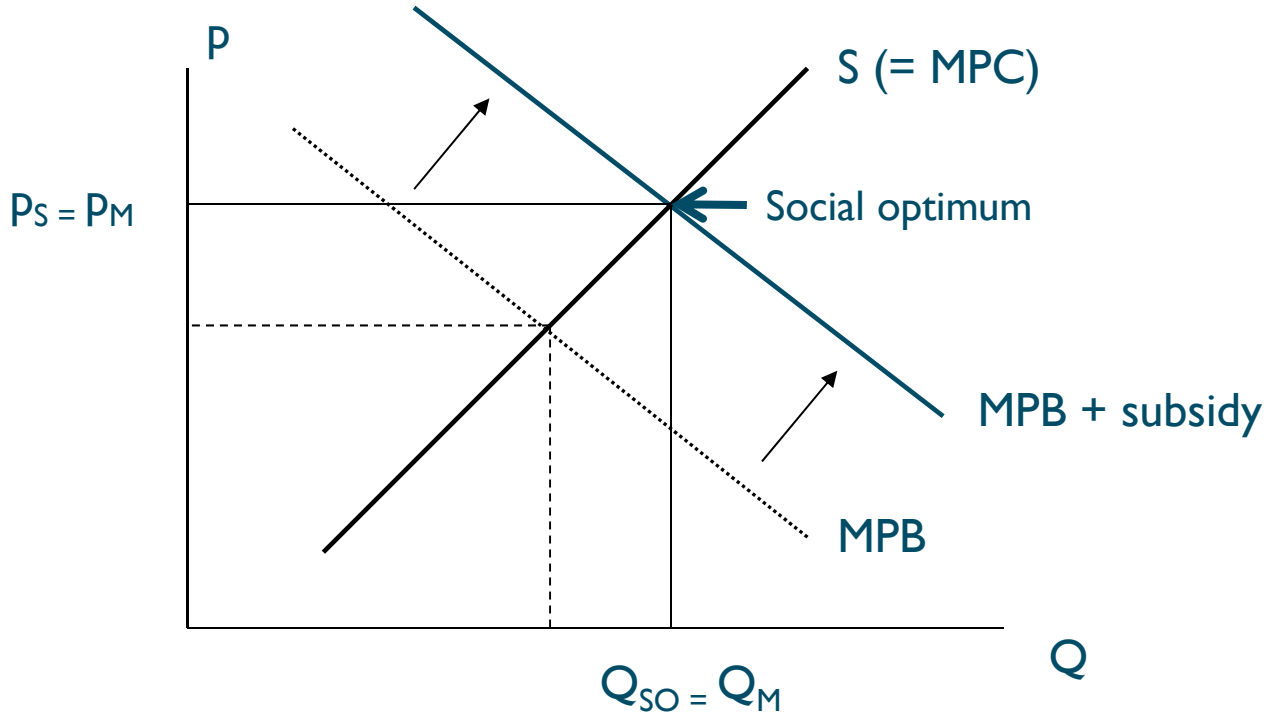
External Benefits



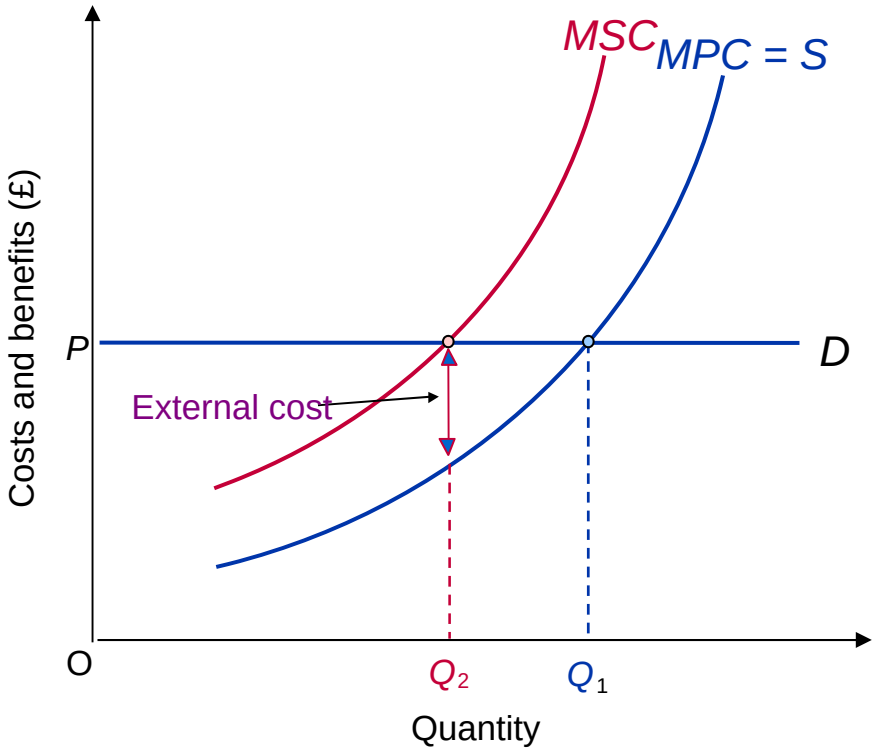
Market produces too little



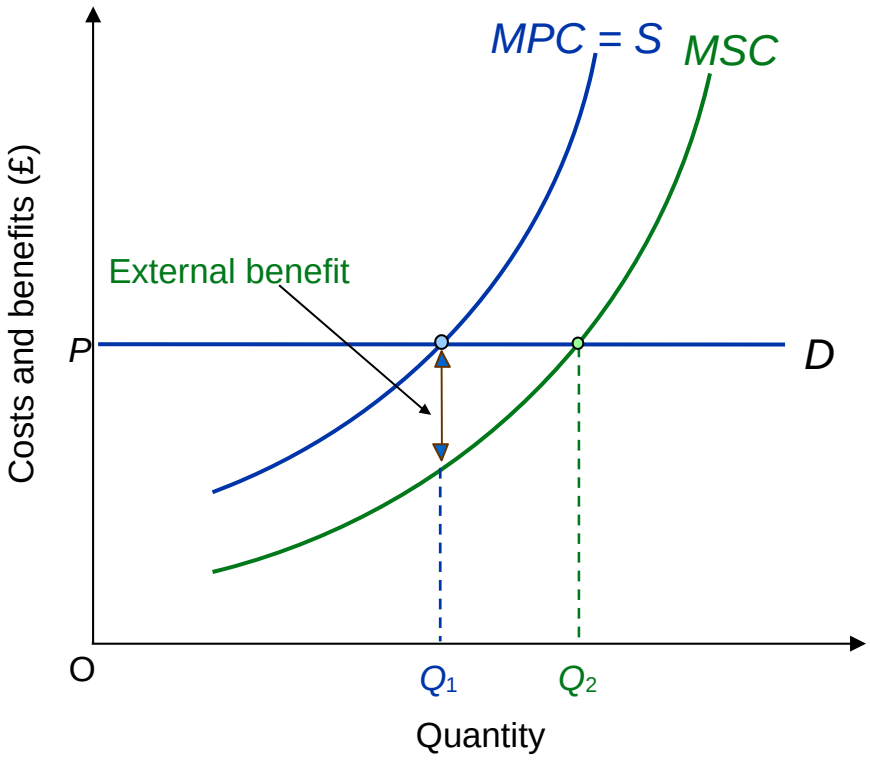
A subsidy



External costs and benefits in production

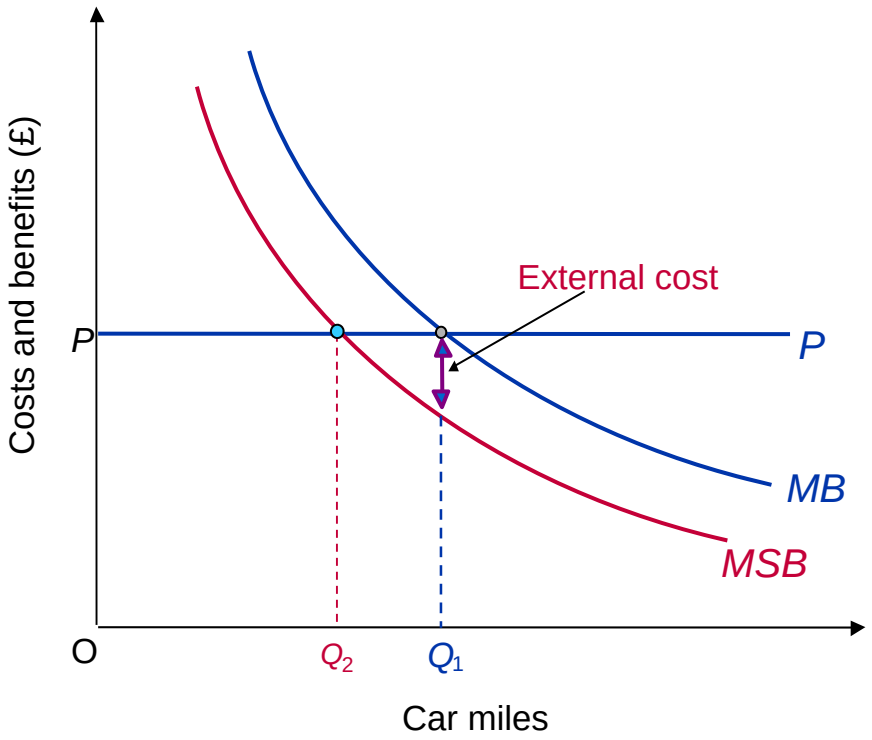


(a) External costs

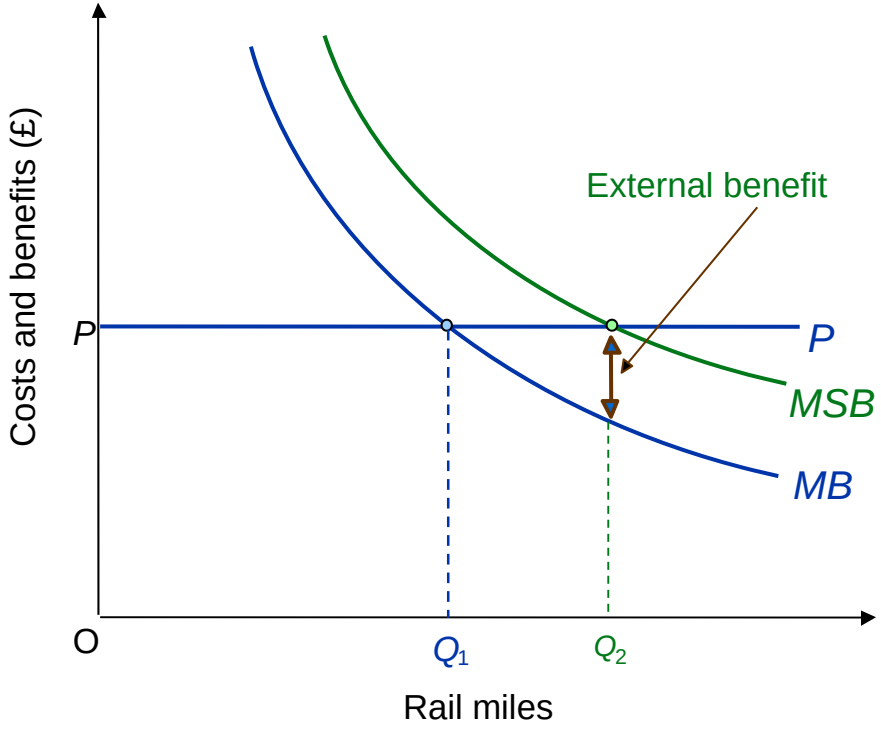


(b) External benefits

External costs and benefits in consumption



(a) External costs



(b) External benefits

Government intervention

- When markets fail, markets need help

- A government should/could…
  - Impose a tax (for bad externalities)
  - Give subsidy (for good externalities)
  - Other regulations and technological restrictions (e.g. MOT every year, emission standard)

- Some solutions are market-based (see Coase)

Public Policies Toward Externalities

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- Two approaches:
- Command-and-control policies regulate behavior directly. Examples:
  - limits on quantity of pollution emitted
  - requirements that firms adopt a particular technology to reduce emissions
- Market-based policies provide incentives so that private decision-makers will choose to solve the problem on their own. Examples:
  - corrective taxes and subsidies
  - tradable pollution permits

Corrective Taxes & Subsidies

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- **Corrective tax:** a tax designed to induce private decision-makers to take account of the social costs that arise from a negative externality
  - Also called Pigouvian taxes after Arthur Pigou (1877-1959).
  - The ideal corrective tax = external cost
  - For activities with positive externalities, ideal corrective subsidy = external benefit
  - Other taxes and subsidies distort incentives and move economy away from the social optimum.
- Corrective taxes & subsidies
  - align private incentives with society's interests
  - make private decision-makers take into account the external costs and benefits of their actions
  - move economy toward a more efficient allocation of resources.

Corrective Taxes vs. Regulations

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- Different firms have different costs of pollution abatement
- Efficient outcome: Firms with the lowest abatement costs reduce pollution the most
- A pollution tax is efficient:
  - Firms with low abatement costs will reduce pollution to reduce their tax burden.
  - Firms with high abatement costs have greater willingness to pay tax.
- In contrast, a regulation requiring all firms to reduce pollution by a specific amount not efficient.

Corrective Taxes vs. Regulations

Corrective taxes are better for the environment:

- The corrective tax gives firms incentive to continue reducing pollution as long as the cost of doing so is less than the tax.
- If a cleaner technology becomes available, the tax gives firms an incentive to adopt it.
- In contrast, firms have no incentive for further reduction beyond the level specified in a regulation.

Tradable Pollution Permits

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- Tradable pollution permits
  - Voluntary transfer of the right to pollute from one firm to another
  - New scarce resource: pollution permits
  - Market to trade permits
  - Firm's willingness to pay
    - Depend on its cost of reducing pollution
  - SO_2 permits traded in the U.S. since 1995.
  - Nitrogen oxide permits traded in the northeastern U.S. since 1999.
  - Carbon emissions permits traded in Europe since January 1, 2005.
  - As of June 2008, Barack Obama and John McCain each propose "cap and trade" systems to reduce greenhouse gas emissions

Tradable Pollution Permits

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- Tradable pollution permits
  - Advantage of free market for pollution permits
  - Initial allocation of pollution permits
    - Doesn't matter
  - Firms - reduce pollution at a low cost
    - Sell whatever permits they get
  - Firms - reduce pollution only at a high cost
    - Buy whatever permits they need
  - Efficient final allocation

Reducing pollution using pollution permits or corrective taxes

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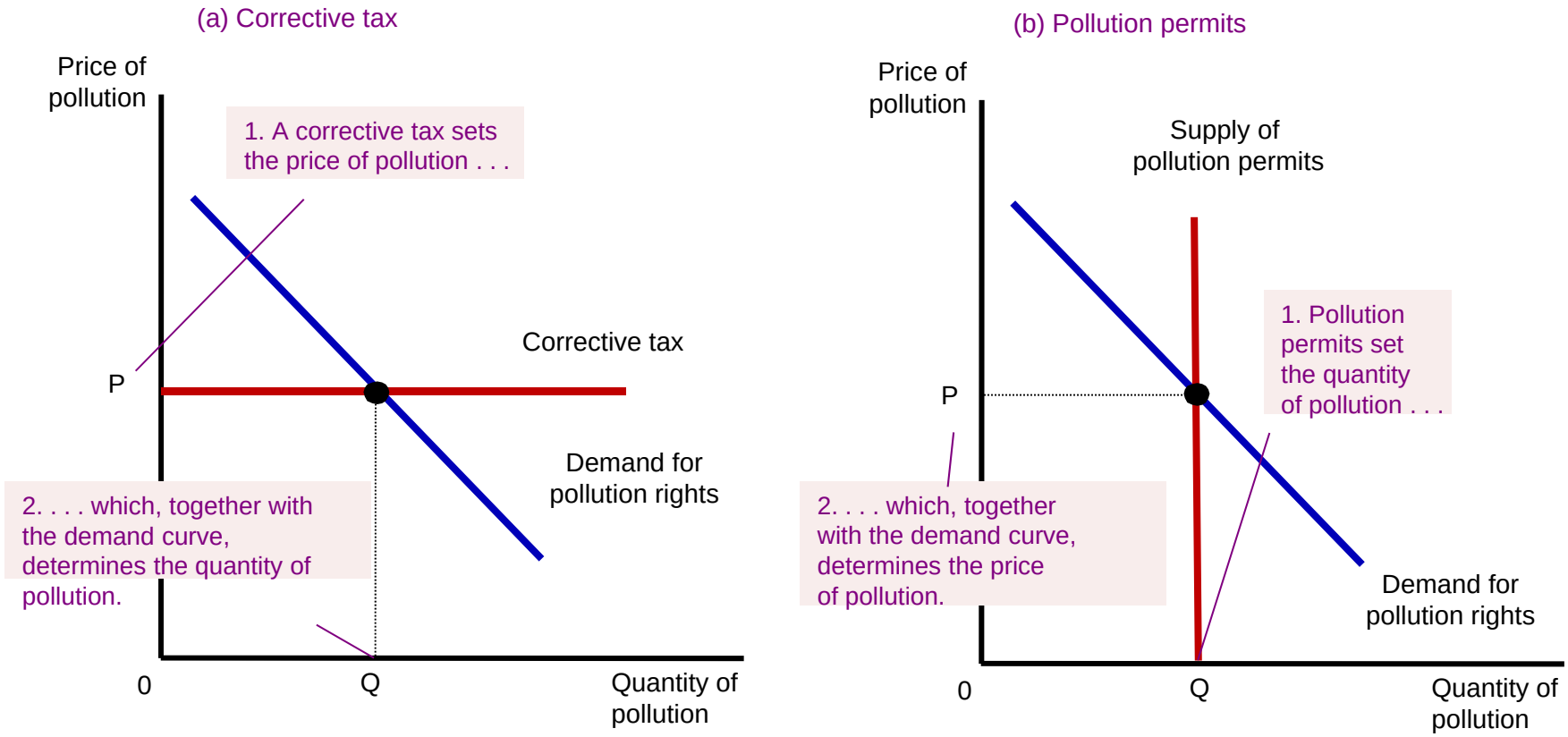
- Firms pay for their pollution
  - Corrective taxes - to the government
  - Pollution permits, - buy permits
- Internalize the externality of pollution

The equivalence of corrective taxes & pollution permits



In panel (a), the EPA sets a price on pollution by levying a corrective tax, and the demand curve determines the quantity of pollution. In panel (b), the EPA limits the quantity of pollution by limiting the number of pollution permits, and the demand curve determines the price of pollution. The price and quantity of pollution are the same in the two cases.

“Internalizing the Externality”

- **Internalizing the externality**: altering incentives so that people take account of the external effects of their actions
- In our example, the $1/gallon tax on sellers makes sellers’ costs = social costs.
- When market participants must pay social costs, market eq’m = social optimum.

  (Imposing the tax on buyers would achieve the same outcome; market ***Q*** would equal optimal ***Q***.)

Private Solutions to Externalities

Ronad Coase –

A famous conjecture by Coase

The Coase theorem:
If private parties can costlessly bargain over the allocation of resources, they can solve the externalities problem on their own.

Property right-based solution

- Ronald Coase got the Nobel prize for a conjecture -- in an influential 1960 article, the economist Ronald Coase pointed out that, in an ideal world, the private sector could indeed deal with all externalities.

- The Coase Theorem: when the parties affected by externalities can negotiate costlessly with one another, an efficient outcome results no matter how the law assigns responsibility for damages.

- According to the Coase theorem, even in the presence of externalities an economy can always reach an efficient solution provided that the transaction costs—the costs to individuals of making a deal—are sufficiently low.

- If affected parties (polluters and pollutees) could bargain at no cost then assigning property right to any one of them will bring down the pollution to the socially optimal level.

Coase conjecture

- Suppose a steel mill pollutes a river causing losses to fishermen downstream.
  - How to align the market outcome with the social optimum, without imposing a tax on the steel mill?

- There are two potential solutions: give property right of the river to
  - (1) the steel mill , or
  - (2) the fishermen

  - If the steel mill gets the property right, it will reduce its pollution and then charge a fee from the fishermen for fishing (Victim pays principle)

  - If the fishermen get the property right, they will charge a fee from the steel mill, which will deter it from polluting too much. (Polluter pays principle)

The Coase solution

- In both cases, Coase argued, the socially desirable outcome is achieved, even if the victim pays principle is adopted

- Critical issue: Distribution of gains varies depending on who gets the property rights (room for lobbying…)

- The same idea is applied to global carbon agreement and emissions trading

Additional slides

Lowering SO2 Emissions

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- Regulate output per firm or let them trade under cap and trade?

Regulating lower SO2 emissions

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- Acme and US Electric run coal-burning power plants. Each emits 40 tons of sulfur dioxide per month,
  total emissions = 80 tons/month.
- Goal: Reduce SO_2 emissions 25%, to 60 tons/month
- Cost of reducing emissions:
  $100/ton for Acme, $200/ton for USE

<u>Policy option 1: Regulation</u>

Every firm must cut its emissions 25% (10 tons).

Your task: Compute the cost to each firm and
total cost of achieving goal using this policy.

Regulating lower SO2 emissions

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- Each firm must reduce emissions by 10 tons.
- Cost of reducing emissions:
  $100/ton for Acme, $200/ton for USE.
- Compute cost of achieving goal with this policy:

Cost to Acme: (10 tons) x ($100/ton) = $1000

Cost to USE: (10 tons) x ($200/ton) = $2000

Total cost of achieving goal = **$3000**

Tradable pollution permits

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- Initially, Acme and USE each emit 40 tons SO_2/month.
- Goal: reduce SO_2 emissions to 60 tons/month total.

<u>Policy option 2: Tradable pollution permits</u>

- Issue 60 permits, each allows one ton SO_2 emissions. Give 30 permits to each firm.
  Establish market for trading permits.
- Each firm may use all its permits to emit 30 tons,
  may emit < 30 tons and sell leftover permits,
  or may purchase extra permits to emit > 30 tons.

Your task: Compute cost of achieving goal if Acme
uses 20 permits and sells 10 to USE for $150 each.

Tradable pollution permits

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- Goal: reduce emissions from 80 to 60 tons
- Cost of reducing emissions:
  $100/ton for Acme, $200/ton for USE.

Compute cost of achieving goal:

Acme

- sells 10 permits to USE for $150 each, gets $1500
- uses 20 permits, emits 20 tons SO_2
- spends $2000 to reduce emissions by 20 tons
- net cost to Acme: $2000 - $1500 = **$500**

continued…

Tradable pollution permits

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- Goal: reduce emissions from 80 to 60 tons
- Cost of reducing emissions:
  $100/ton for Acme, $200/ton for USE.

  <u>USE</u>
  - buys 10 permits from Acme, spends $1500
  - uses these 10 plus original 30 permits, emits 40 tons
  - spends nothing on abatement
  - net cost to USE = **$1500**

  Total cost of achieving goal = $500 + $1500 = **$2000**

  Using tradable permits, goal is achieved at lower total cost and lower cost to each firm than using regulation.

Tradable pollution permits

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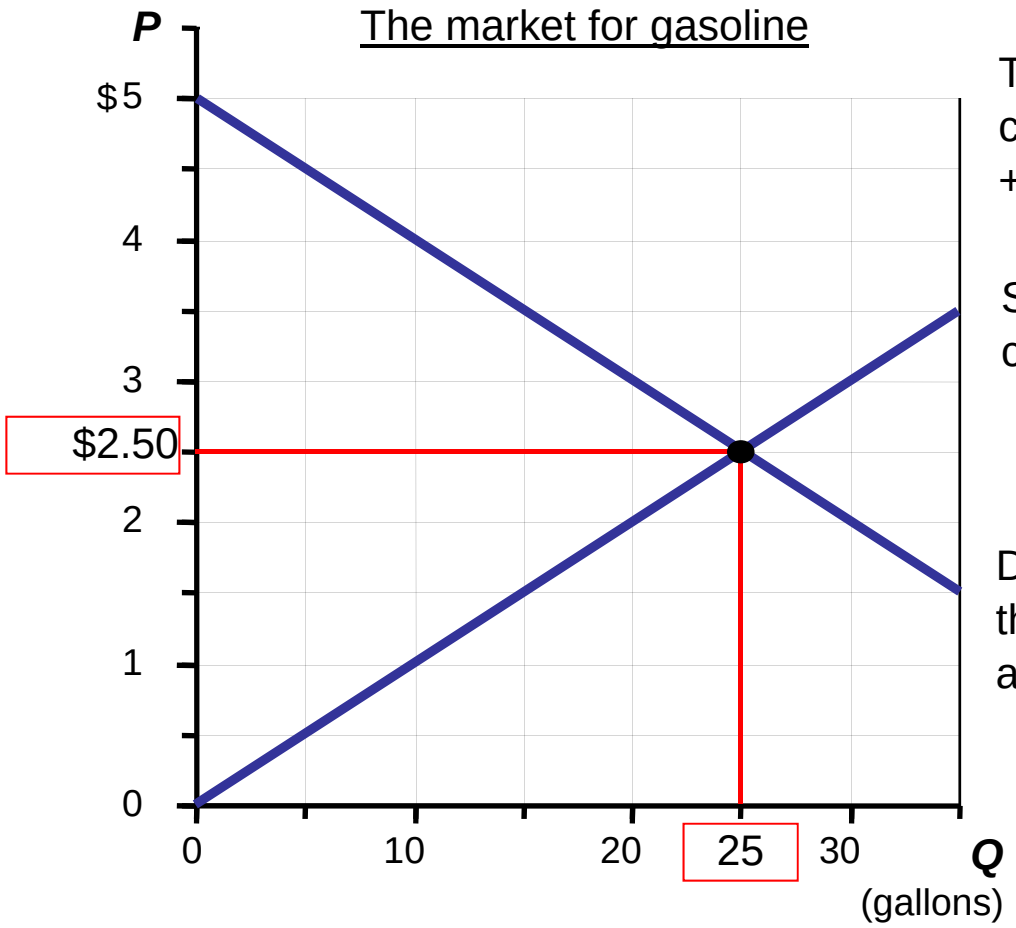
- A tradable pollution permits system reduces pollution at lower cost than regulation.
  - Firms with low cost of reducing pollution sell whatever permits they can.
  - Firms with high cost of reducing pollution buy permits.
- Result: Pollution reduction is concentrated among those firms with lowest costs.

Recap of Welfare Economics

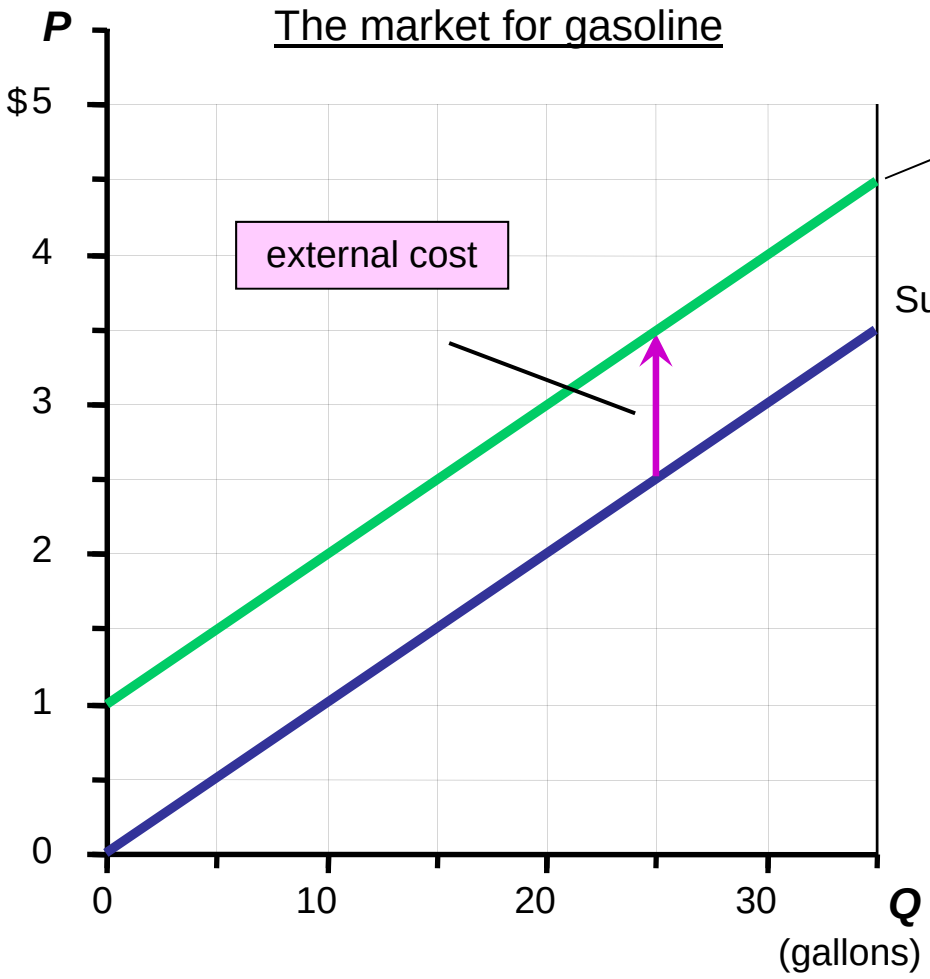


The market eq'm maximizes consumer
+ producer surplus.

Supply curve shows **private cost**, the costs directly incurred by sellers.

Demand curve shows **private value**, the value to buyers (the prices they are willing to pay).

Analysis of a Negative Externality

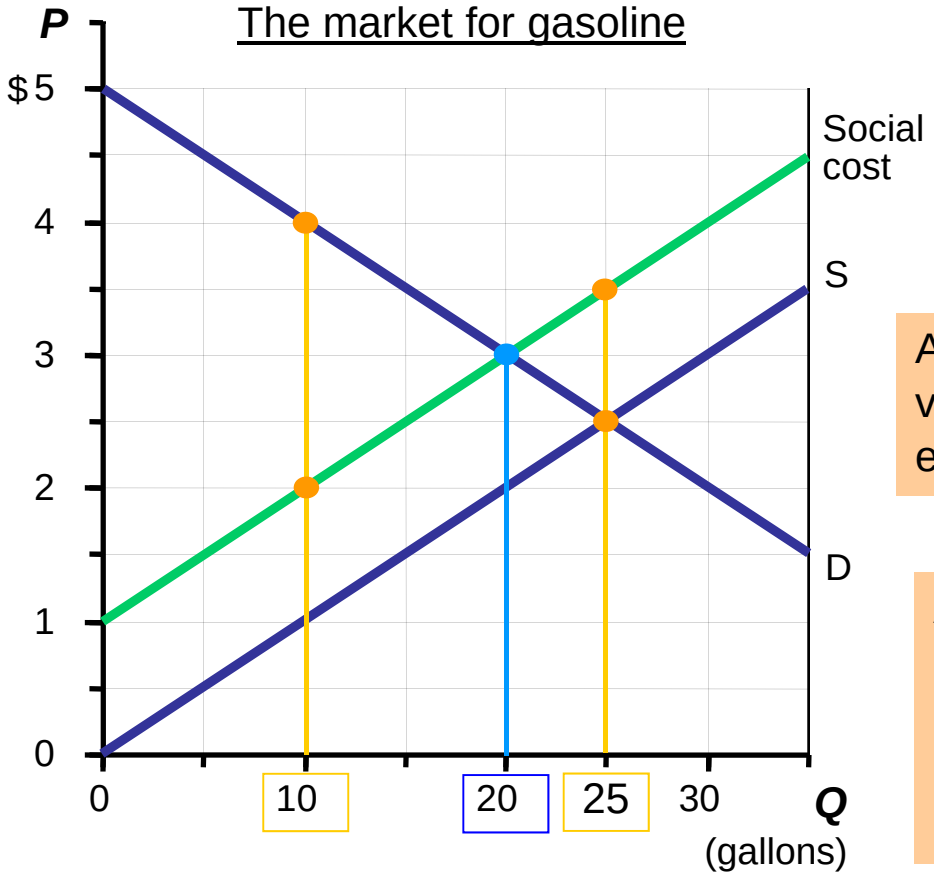


External cost

= value of the negative impact on bystanders

= $1 per gallon (value of harm from smog, greenhouse gases)

Analysis of a Negative Externality

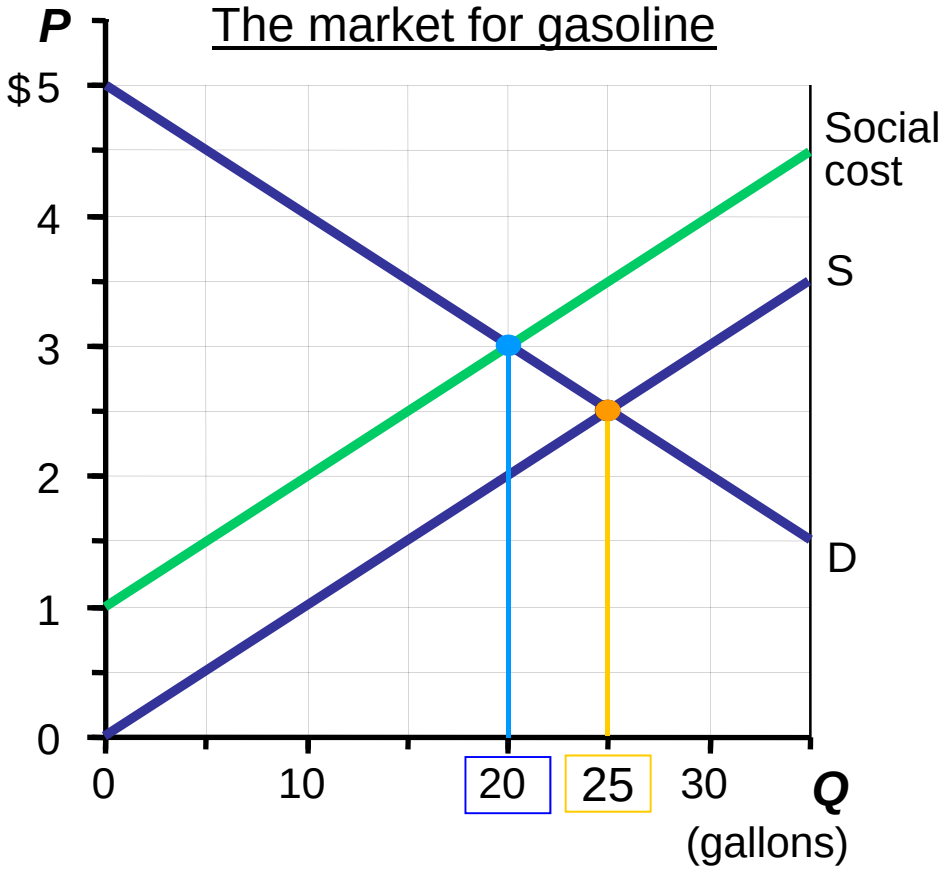


The socially optimal quantity is 20 gallons.

At any ***Q*** < 20, value of additional gas exceeds social cost.

At any ***Q*** > 20, social cost of the last gallon is greater than its value to society.

Analysis of a Negative Externality



Market eq'm
(***Q*** = 25)
is greater than
social optimum
(***Q*** = 20).

One solution:
tax sellers
$1/gallon,
would shift
S curve up $1.

Property Rights

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- The Coase Theorem shows that market efficiency will result if there are clearly defined property rights and negotiation is costless.

- The next few examples (from your textbook) describe outcomes and costs when a confectioner makes a noise (to make candy) but it harms the next door doctor who needs quite to examine patients

Example 16.1

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- Suppose the benefit to the confectioner of continuing to make noise is 40, while the cost of the noise to the doctor is 60. If the confectioner's only alternative to making the noise is to produce nothing?

TABLE 16.1
Outcome and Payoff Summary for Example 16.1

		Net benefit		
Legal regime	**Outcome**	**Doctor**	**Confectioner**	**Total**
Liable	Confectioner shuts down to avoid liability payment	60	0	60
Not liable	Doctor pays confectioner P to shut down, $40 \leq P \leq 60$	$60 - P$	P	60

The gain to the confectioner from operating is 40. The loss to the doctor from the noise is 60. The efficient outcome is for the confectioner to shut down, and this happens under both legal regimes.

Example 16.2

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- Suppose the benefit to the confectioner of continuing to make noise is 60, while the cost of the noise to the doctor is 40. If the confectioner's only alternative to making the noise is to produce nothing?

TABLE 16.2
Outcome and Payoff Summary for Example 16.2

		Net benefit		
Legal regime	**Outcome**	**Doctor**	**Confectioner**	**Total**
Liable	Confectioner stays open and pays doctor 40	40	20	60
Not liable	Confectioner stays open; doctor shuts down	0	60	60

The gain to the confectioner from operating is 60. The loss to the doctor from the confectioner's noise is 40. The efficient outcome is for the confectioner to continue operating, and this happens under both legal regimes.

Example 16.3

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- Suppose the benefit to the confectioner of continuing to make noise is 40, while the cost of the noise to the doctor is 60.
- The confectioner can buy a soundproofing device that will completely eliminate the noise. The cost of the device is 20.

TABLE 16.3
Outcome and Payoff Summary for Example 16.3

		Net benefit		
Legal regime	**Outcome**	**Doctor**	**Confectioner**	**Total**
Liable	Confectioner installs soundproofing at own expense	60	20	80
Not liable	Doctor pays confectioner P to install soundproofing, $20 \leq P \leq 60$	$60 - P$	$20 + P$	80

The gain to the confectioner from operating without soundproofing is 40. Soundproofing costs 20. The loss to the doctor from the confectioner's noise is 60. The efficient outcome is for the confectioner to install soundproofing and to continue operating, and this happens under both legal regimes.

Example 16.4

- Suppose the benefit to the confectioner of continuing to make noise is 40, while the cost of the noise to the doctor is 60.
- The confectioner can buy a soundproofing device that will completely eliminate the noise. The cost of the device is 20.
- The doctor can move his examination room and eliminate the noise at cost of 18.

TABLE 16.4
Outcome and Payoff Summary for Example 16.4

		Net benefit		
Legal regime	**Outcome**	**Doctor**	**Confectioner**	**Total**
Liable	Confectioner pays doctor P to rearrange his office, $18 \leq P \leq 20$	$42 + P$	$40 - P$	82
Not liable	Doctor rearranges his office at his own expense	42	40	82

The gain to the confectioner from operating without soundproofing is 40. Soundproofing costs 20. The loss to the doctor from the confectioner's noise is 60. The doctor can rearrange his office to eliminate the noise problem at a cost of 18. The efficient outcome is for the doctor to rearrange his office, and this happens under both legal regimes.

Example 16.5

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- Suppose the benefit to the confectioner of continuing to make noise is 60, while the cost of the noise to the doctor is 40.
- Confectioner has access to soundproofing that eliminates the noise and costs 20.
- The cost of negotiating an agreement is 25.

TABLE 16.5
Outcome and Payoff Summary for Example 16.5

		Net benefit		
Legal regime	**Outcome**	**Doctor**	**Confectioner**	**Total**
Liable	Confectioner installs soundproofing at his own expense	40	40	80
Not liable	Confectioner does not install soundproofing; doctor shuts down	0	60	60

The gain to the confectioner from operating without soundproofing is 60. Soundproofing costs 20. The loss to the doctor from the confectioner's noise is 40. The cost of negotiating a private agreement is 25. The efficient outcome is for the confectioner to install soundproofing, but this happens only when he is made liable for noise damage.

Example 16.6

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- Suppose the benefit to the confectioner of continuing to make noise is 60, while the cost of the noise to the doctor is 40.
- Doctor has option of avoiding the noise by rearranging his option at cost 18.
- The cost of negotiating an agreement is 25.

TABLE 16.6
Outcome and Payoff Summary for Example 16.6

		Net benefit		
Legal regime	**Outcome**	**Doctor**	**Confectioner**	**Total**
Liable	Confectioner operates and pays doctor 40 for noise damage	40	20	60
Not liable	Doctor rearranges his office at his own expense	22	60	82

The gain to the confectioner from operating is 60. The loss to the doctor from the confectioner's noise is 40. The doctor can escape the noise by rearranging his office at a cost of 18. The cost of negotiating a private agreement is 25. The efficient outcome is for the doctor to rearrange his office, but this happens only when the confectioner is not liable for noise damage.