Reading

• **Essential reading**

• **Further reading**
Reading


• Challenging reading


Introduction

• An externality is a link between economic agents that lies outside the price system
  – Pollution from a factory
  – Envy of a neighbor

• Externalities are not under the control of the affected agent
  – Efficiency theorems do not apply
  – Competitive equilibrium unlikely to be efficient

• Externalities are of practical importance
  – Global warming
  – Damage to ozone layer
Externalities Defined

• An *externality* is present whenever some economic agent’s welfare is “directly” affected by the action of another agent in the economy.

• *Production externality*: the externality affects profit.

• *Consumption externality*: the externality affects utility.

• *Positive externality*: raises utility or profit.

• *Negative externality*: reduces utility or profit.
Externalities Defined

- *Pecuniary externality*: an external effect that works through prices
  - An oil price rise affects the profitability of a fishery
- Pecuniary externalities do not create an inefficiency
- With externalities the actions of agents are not independent and not determined solely by prices
  - Strategic interdependence arises
  - This is the source of inefficiency
Market Inefficiency

- Consider two consumers with utility functions

\[ U^1 = x^1 + u_1(z^1) + \nu_1(z^2) \]
\[ U^2 = x^2 + u_2(z^2) + \nu_2(z^1) \]

- Externality arises from consumption of good \( z \)

- Competitive equilibrium has

\[ u_h'(z^h) = 1 \]

- Efficient allocation described by

\[ u_1'(z^1) + \nu_2'(z^1) = 1 \]
\[ u_2'(z^2) + \nu_1'(z^2) = 1 \]
Market Inefficiency

• The externality leads to a divergence of private valuation ($u_h'$) from social valuation ($u_h' + \nu_h'$).

• If the externality is positive $\nu_h' > 0$
  – Marginal utility of each consumer is lower at efficient allocation than at market equilibrium
  – Too little good $z$ is consumed in equilibrium

• If the externality is negative $\nu_h' < 0$
  – Marginal utility of each consumer is higher at efficient allocation than at market equilibrium
  – Too much good $z$ is consumed in equilibrium
Market Inefficiency

- Fig. 7.1 illustrates the argument
- Market outcome has private marginal benefit (PMB) equal to marginal cost (MC)
- Optimum allocation has social marginal benefit (SMB) equal to MC
- Position of SMB relative to PMB depends on external effect

Figure 7.1: Deviation of private from social benefits
Externality Examples

• River pollution
  – Two firms located on a river
  – Upstream firm, \( u \), pollutes the river
  – Reduces output for the downstream firm, \( d \)
  – Both produce the same output and sell at price of 1
  – Technologies are \( F^u(L^u),\ F^d(L^d, L^u) \) where \( L^i \) is labor use of firm \( i \)
  – The profit level of firm \( i \) is \( \pi^i = F^i(\cdot) - wL^i \)
Externality Examples

- Fig. 7.2 shows the allocation of labor between the firms
- As $L^u$ is increased the production function of downstream moves towards horizontal axis
- Profit maximization by the upstream firm implies $L^u^*$
- The downstream firm chooses $L^d^*$
- A small reallocation of labor from $u$ to $d$ has no effect on $\pi^u$ but raises $\pi^d$
- This shows the equilibrium is inefficient

**Figure 7.2:** Equilibrium with river pollution
Externality Examples

• Traffic Jams
  – This example shows the externalities that car drivers impose on each other
  – Assume there are $N$ commuters with a choice of train or car
  – Travel by train takes 40 minutes
  – The travel time by car increases as the number of car users increases
  – Commuters make the choice which minimizes their personal travel time
Externality Examples

- Fig. 7.3 shows the equilibrium choice of commuting mode.
- The travel time by car will equal the travel time by train.
- This has 40% of commuters choosing travel by car.
- The optimumchoose minimizes total travel time.
- This occurs when 20% travel by car.
- The equilibrium has too many commuters choosing to use cars.
- Congestion is a negative externality.

**Figure 7.3**: Choice of commuting mode.
Externality Examples

• Pecuniary Externality
  – A group of students must choose to be economists or lawyers
  – Income declines when more students make the same choice
  – This is a pecuniary externality since an additional student choosing to be an economist lowers income for all economists
  – Each individual ignores this externality when choosing occupation
Externality Examples

- The income of each occupation is shown in Fig. 7.4.
- The proportion choosing each occupation adjusts until incomes are equal.
- This occurs when percentage $E$ choose to be economists.
- This equilibrium is efficient.
- A reduction in income is a cost for an employee but a benefit for an employer.
- Pecuniary externalities do not cause inefficiency of the market equilibrium.

**Figure 7.4**: Job choice
Externality Examples

• The Rat Race Problem
  – The rat race is a contest for relative position
  – Assume performance is judged in *relative* terms and not *absolute* terms
  – An advantage is gained over rivals only by competing harder than they do
  – If all competitors compete hard the extra efforts cancels out
  – All competitors could gain by making an agreement to reduce effort
Externality Examples

- The rat race is shown in Fig. 7.5
- Making high effort has a cost of $c$
- High effort is a dominant strategy so the Nash equilibrium is \{high, high\}
- The Pareto-efficient outcome is \{low, low\}
- Committing to low effort is a Pareto-improvement

\[\begin{array}{c|cc}
\text{Player 1} & \text{low} & \text{high} \\
\hline
\text{low} & 1/2 & 1 - c \\
\text{high} & 1 - c & 1/2 - c \\
\end{array}\]

\[\begin{array}{c|cc}
\text{Player 2} & \text{low} & \text{high} \\
\hline
\text{low} & 1/2 & 1 - c \\
\text{high} & 0 & 1/2 - c \\
\end{array}\]

Figure 7.5: Rat race
Externality Examples

• The Tragedy of the Commons
  – This example arises from the common right of access to a resource
  – Consider a lake that is used by local fisherman who can earn wage $w$ if they do not fish
  – The fishermen rent boats on a daily basis at cost $c$
  – If $B$ boats are hired each fisherman catches $F(B)$ fish
Externality Examples

- In Fig. 7.6 the equilibrium number of boats solves $F(B^*) - c = w$
- The optimum number solves $F(B^o) - c + BF'(B^o) = w$
- $F'(B^o) < 0$ implies $B^o < B^*$
- In equilibrium there are too many boats
- Each fisherman ignores the negative externality
- The tax can restore efficiency

![Figure 7.6: Tragedy of the Commons](image-url)
Externality Examples

• Bandwagon Effect
  – The bandwagon effect studies how standards are adopted and wrong standards may be sustained
  – The standard example is the typewriter keyboard
  – The Qwerty keyboard was designed to prevent jamming of mechanical keys
  – It is claimed that faster keyboards can be designed
  – Typists are reluctant to switch given their skills
Externality Examples

- Such a *bandwagon* effect is illustrated in Fig. 7.7
- If less than $p^*$ typists use Qwerty the proportion falls to 0 over time
- Inefficiency of Qwerty reflected in $p^* > 0.5$
- There are equilibria at 0, $p^*$, 1
- The inefficient technology dominates if starting point is to the right of $p^*$

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**Figure 7.7**: Equilibrium keyboard choice
Pigouvian Taxation

- Externalities cause inefficiency because of the divergence between social and private benefits (or costs)
- A tax can be used to raise the private marginal cost
  - This assists efficiency with a negative externality
- A subsidy can be used to reduce the private marginal cost
  - This assists efficiency with a positive externality
- Taxes used to combat externalities are called *Pigouvian taxes*
Pigouvian Taxation

• The correction of a negative externality is shown in Fig. 7.8
• Social marginal benefit (\(SMB\)) is below Private marginal benefit (\(PMB\))
• The tax, \(t\), raises Private marginal cost from \(PMC\) to \(PMC'\)
• The quantity consumed falls from \(x^m\) to \(x^o\)
• \(x^o\) is efficient with \(SMB = PMC\)

Figure 7.8: Pigouvian taxation
Pigouvian Taxation

• Pigouvian taxation appears a simple solution
  – A tax is paid equal to the marginal damage
  – A subsidy is received equal to marginal benefit
• There are limitations to the argument
  – Taxes may need to be differentiated between consumers, firms, and goods
  – Without sufficient differentiation the externality is only partially corrected
  – Intervention may also be required markets for related goods
• Taxation should be seen as putting a price on the externality
Licenses

• Licenses can control externalities directly
  – Legislate that externalities can only be generated if a license is held
• The optimal quantity of externality is calculated
• Licenses totalling to this quantity are issued
• Trading of licenses ensures they are used by those who obtain the greatest benefit
• Administratively this is simpler than taxation
• But licenses have no information advantage
Licenses

- Licenses and taxes have different outcome with uncertainty
- In Fig. 7.9 $PMC$ can be high ($PMC_H$) or low ($PMC_L$)
- Equating expected cost ($PMC_E$) gives abatement $z^*$
- Achieved by licenses forcing a reduction of $z^*$
- A tax $t^*$ achieves either $z_H$ or $z_L$
- Licenses achieve a certain outcome
- Taxation achieves an outcome that matches abatement cost

Figure 7.9: Uncertain costs
Internalization

- Consider two producers who each causes a positive externality for the other
  - A beekeeper and an orchard
- With no intervention each will ignore externality and produce too little
- If combined into a single firm they will internalize the externality and produce at the efficient level
- But this may cause monopoly
- It may require unwilling partners to cooperate
The Coase Theorem

- The Coase Theorem proposes that economic agents will solve externality problems without intervention.
- The theorem can be stated as follows:
  “In a competitive economy with complete information and zero transaction costs, the allocation of resources will be efficient and invariant with respect to legal rules of entitlement.”
- Legal rules of entitlement (or property rights) determine ownership in the economy.
The Coase Theorem

• Coase sees externalities as arising through the absence of property rights
  – Pollution occurs when there is no right to clean air or clean water
• If there was a property right anyone suffering an externality would be paid compensation
• The compensation is a price for the externality
• Competitive trading will ensure the correct price emerges and efficiency is achieved
The Coase Theorem

• The theorem also asserts that the equilibrium is invariant to assignment of property rights

• Will a firm pollute the atmosphere of a neighboring house?
  – Only if the benefit from doing so exceeds the compensation required by the householder
  – This applies whether the firm has the right to pollute or the householder has the right to clean air

• The final distribution of income will be different

• Equilibrium will be unaffected by the allocation of property rights if there are no income effects
The Coase Theorem

• The practical limitations of the Coase theorem are:
  – The lack of clear property rights
  – Transaction costs in reaching compensation agreements
  – The potential thinness of the market implying bilateral bargaining and potential inefficiency with incomplete information
  – Potential monopoly power

• The Coase theorem suggests a resolution to the externality problem but there are reasons why the market may not function
Nonconvexity

- Convexity ensures economic optimizations have well defined solutions
  - Convexity of preferences implies mixtures preferred
  - Convexity of technology prevents increasing returns
- Externalities are a source of nonconvexity through their effect on technology
- An economy with nonconvexity may not have an equilibrium
- Even if it has an equilibrium it may not be possible for pricing to achieve the efficient equilibrium
Nonconvexity

- Two production functions with a negative externality are shown in Fig. 7.10.
- In the left-hand figure output is driven to zero as the externality increases.
- In right-hand figure output tends to zero.
- Both technologies are nonconvex.
- If offered a price for accepting the externality both technologies would lead to unlimited demand.
- Pigouvian taxation would not work.

Figure 7.10: Nonconvexity
Conclusions

- Externalities are a feature of economic activity.
- The existence of externalities can lead to inefficiency when the conditions of the Coase theorem do not apply.
- Pigouvian taxes can reduce the inefficiency but require excessive differentiation.
- Marketable licenses can also help and have simpler administration.
- But all solutions require the same information for implementation.