Lecture Notes 1

Externalities & Public Goods

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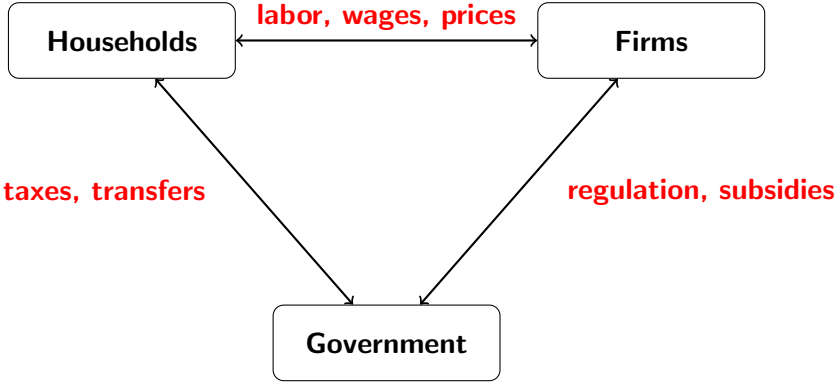
Government as a Player in the Economy

The Economy as a Game

- Think of the economy as a strategic interaction among **households, firms, and the government**.
- Each player makes decisions that affect others:
  - Households: supply labor, consume goods, pay taxes.
  - Firms: hire labor, produce goods, respond to regulation/subsidies.
  - Government: sets taxes, transfers, regulations, and subsidies.

The Economy as a Game



Why Should the Government Intervene?

- Adam Smith's "invisible hand" suggests that individuals pursuing their own interests can generate socially beneficial outcomes.
- However, markets are not always perfectly efficient:
  - **Externalities:** private decisions impose costs or benefits on others (pollution, vaccination).
  - **Public goods:** non-excludable and/or non-rival goods are often underprovided (national defense, clean air).
  - **Information problems:** imperfect information can lead to suboptimal decisions (e.g., credit markets, healthcare).
  - **Market power:** monopolies or oligopolies can distort prices and output.
- Government intervention can help **correct these market failures**, align private incentives with social welfare, and stabilize the economy.

Example: Pollution and Regulation

Setup

- Two identical firms choose emissions e_i independently.
- Total pollution $E = e_1 + e_2$ and social damage

$$D(E) = \frac{d}{2}E^2, \quad d > 0$$

- Firm i's profit $\pi_i(e_i) = ae_i - \frac{1}{2}e_i^2$

Equilibrium:

$$\max_{e_i} \pi_i = ae_i - \frac{1}{2}e_i^2$$

with optimal solution $e_1^* = e_2^* = a$ and total pollution $E = 2a$.

Example: Pollution and Regulation

Social optimum

- The social planner

$$\max_{e_1,e_2} W = \sum_i \left(a e_i - \frac{1}{2} e_i^2 \right) - \frac{d}{2} E^2$$

  with the socially optimal solution

$$e_1^{SO} = e_2^{SO} = \frac{a}{1+2d}$$

- Firms ignore marginal social damage dE, so private emissions exceed e^{SO}.
- Market failure arises from an externality.

Example: Pollution and Regulation

Government: impose per-unit tax t on emissions.

- Firms:

$$max_{e_i} \pi_i = ae_i - \frac{1}{2}e_i^2 - te_i$$

  with a best response under tax $e_i = a - t$.

- Set t so the induced equilibrium equals the social optimum:

$$a - t^* = \frac{a}{1+2d} \quad \Rightarrow \quad \boxed{t^* = \frac{2ad}{1+2d}}$$

- The marginal external damage at e^{SO} is

$$dE^{SO} = d \cdot 2e^{SO} = 2d\frac{a}{1+2d} = t^*$$

  so the tax equals marginal external damage and restores efficiency:

$$e_i(a, t^*) = e^{SO} = \frac{a}{1+2d}$$

Public Finance

Definition

Public finance is the study of the role of the government in the economy.

This study involves answering the four questions of public finance:

1. *When* should the government intervene in the economy?
2. *How* might the government intervene?
3. *What* is the effect of those interventions on economic outcomes?
4. *Why* do governments choose to intervene in the way that they do?

Public Finance

When should the government intervene in the economy?

Two main reasons:

- **Market failures:** problems that cause a market economy to deliver an outcome that does not maximize efficiency.
  1. Externalities
  2. Public goods
  3. Market power, etc.
- **Redistribution:** the shifting of resources from some groups in society to others.

Public Finance

How might the government intervene?

1. Tax or subsidize private sale or purchase.
   - Taxes raise the price for private sales or purchases of goods that are overproduced.
   - Subsidies lower the price for private sales or purchases of goods that are underproduced.
2. Restrict or mandate private sale or purchase.
3. Public provision.
   - Have the government provide the good directly in order to potentially attain the level of consumption that maximizes social welfare.
4. Public financing or private provision.

Public Finance

What is the effect of those interventions on economic outcomes?

Any policy has direct and indirect effects:

1. **Direct effects** are those effects that would be predicted if individuals did not change their behavior in response to the interventions.
2. **Indirect effects** are effects that arise only because individuals change their behavior in response to the interventions.

Public Finance

Why do the governments do what they do?

To answer this questions, we use tools of political economy.

Definition

Political economy is the theory of how the political process produces decisions that affect individuals and the economy.

Competitive Equilibrium

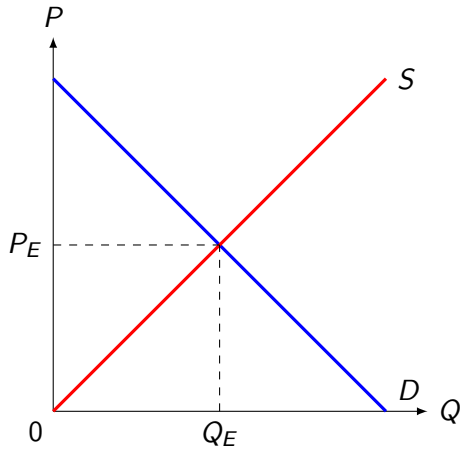
Competitive Equilibrium as a Welfare Benchmark

- In a competitive market, prices coordinate the decisions of consumers and producers.
- At equilibrium:

$$D(P_E) = S(P_E)$$

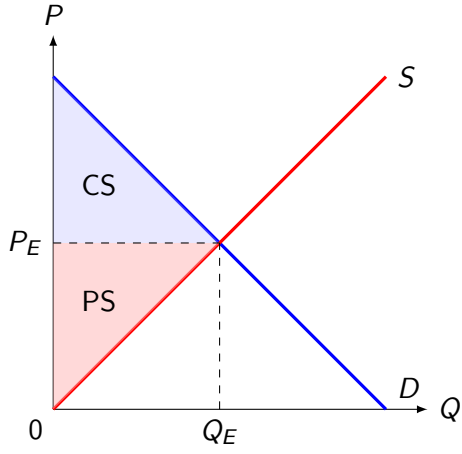
- The equilibrium price P_E equates marginal benefit and marginal cost:

$$MB(Q_E) = MC(Q_E)$$



Social Efficiency

- **Consumer surplus:** the benefit that consumers derive from consuming a good above and beyond what they paid for the good.
- **Producer surplus:** the benefit derived by producers from the sale of a unit above and beyond their cost of producing that unit.
- Total social surplus (efficiency): CS + PS



Competitive Equilibrium Maximizes Social Efficiency

- At the competitive equilibrium (Q_E, P_E), total social surplus is maximized.
- Any deviation from Q_E leads to a loss of total welfare:
  - Producing less: foregone gains to consumers and producers.
  - Producing more: additional units cost more than the benefit they generate.

First Fundamental Theorem of Welfare Economics

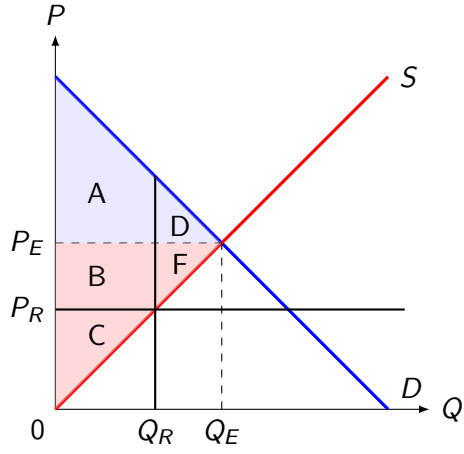
The competitive equilibrium, where supply equals demand, maximizes social efficiency.

Social Inefficiency

- Suppose the government, in an effort to help consumers, restricts the price that firms can charge below the equilibrium price.
- Suppliers react by reducing their quantity produced.
- Consumers face a smaller quantity and a lower price as well.

Social Inefficiency

- Producer surplus is area C. It falls by the area B + F.
- Because of a lower supplied quantity, consumers are worse off by the area D. Because of a lower price, consumer surplus rises by area B.
- Society loses surplus equal to the area D + F. This area is called **deadweight loss**.



When Markets Fail to Maximize Social Welfare

- In a competitive market, prices adjust freely to equate supply and demand.
- However, certain problems can prevent a market economy from achieving the socially optimal outcome $\Rightarrow$ these are called **market failures**:
  - **Externalities**: when the actions of consumers or producers impose costs or benefits on others that are not reflected in market prices.
  - **Public goods**: goods that are non-rival and/or non-excludable, often leading to under-provision in private markets.
  - **Market power**: monopolies or oligopolies can set prices above marginal cost, reducing social surplus.
  - **Information asymmetries**: when buyers or sellers lack full information, leading to inefficient transactions.

Externalities

Whenever the actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefits of doing so.

Negative Production Externalities

Negative Production Externality

When a firm's production reduces the well-being of others who are not compensated by the firm.

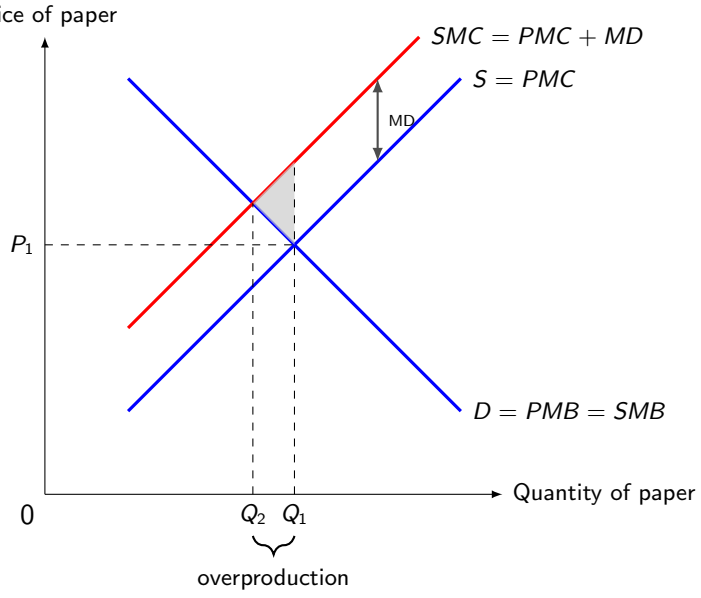
Example: Factory Pollution

- A factory produces paper and releases chemical waste into a nearby river.
- A local fisherman relies on the river to catch fish and sell them to restaurants.
- Because of the chemicals, there are fewer fish in the river, and the fisherman's catches have declined.
- As a result, the fisherman earns less from selling fish, while the factory continues producing paper.

Private vs Social Costs and Benefits

- **Private costs and benefits** are those directly experienced by the producers in the paper market.
  - For example, the factory's costs of producing paper and the revenue it earns from selling it.
- **Social costs and benefits** take into account not only the private costs and benefits, but also any costs associated with the producion of paper that are imposed on others.
  - In our example, the fisherman suffers from lower fish catches due to the factory's chemical waste.
  - These effects on the fisherman are part of the social costs of paper production.
- Comparing private and social costs/benefits helps us understand when production affects others who are not part of the market transaction.

Negative Production Externality



Negative Production Externality

Overproduction

- Social efficiency is defined relative to the social marginal benefit and social marginal cost curves.
- The factory bases its decisions on the private marginal cost, ignoring the external harm (marginal damage, MD), so that $SMC = PMC + MD$.
- The social curves intersect at the efficient quantity Q_2.
- In the private market, equilibrium occurs at Q_1, where demand intersects PMC.
- The supply curve therefore **understates the true cost** of producing Q_1, leading to **overproduction** since $Q_1 > Q_2$.
- Moving away from the socially optimal quantity Q_2 creates a **deadweight loss**: units between Q_2 and Q_1 are produced and consumed even though their **social cost exceeds their social benefit**.

Negative Consumption Externality

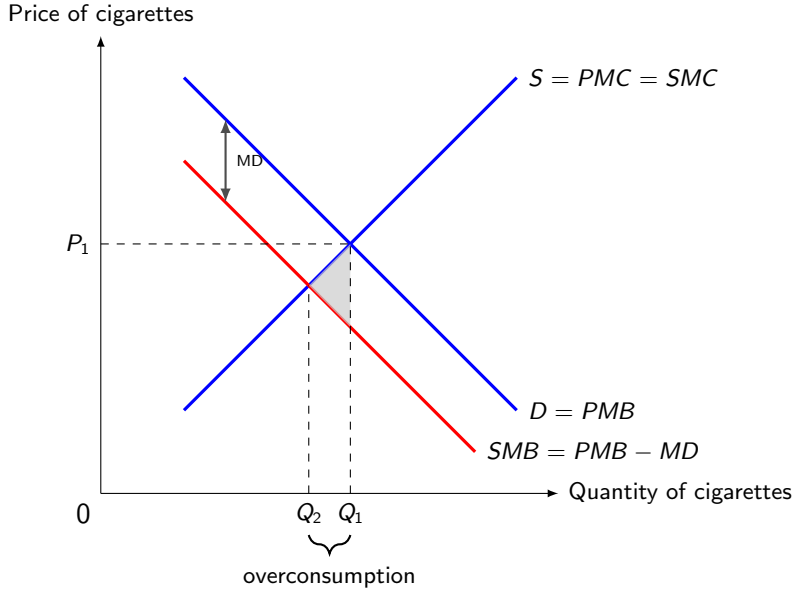
Negative Consumption Externality

When an individual's consumption reduces the well-being of others who are not compensated by the individual.

Example: Second-Hand Smoke

- Consider the case of a restaurant that allows smoking.
- The consumption of cigarettes by smokers may have a negative effect on the enjoyment of a restaurant meal of non-smokers.
- Yet, the smokers do not in any way pay for this negative effect on non-smokers.

Negative Consumption Externality



Negative Consumption Externality

Overconsumption

- With a negative consumption externality, individuals base their decisions on the private marginal benefit, ignoring the external harm their consumption imposes on others. Thus, the true social marginal benefit is lower: $SMB = PMB - MD$.
- The social curves intersect at the efficient consumption level Q_2.
- In the private market, equilibrium occurs at Q_1, where demand reflects PMB rather than SMB.
- The private demand curve therefore **overstates the true benefit** of consuming Q_1, leading to **overconsumption**, since $Q_1 > Q_2$.
- Moving away from the socially optimal quantity Q_2 creates a **deadweight loss**: units between Q_2 and Q_1 are consumed even though their **social benefit is lower than their social cost**.

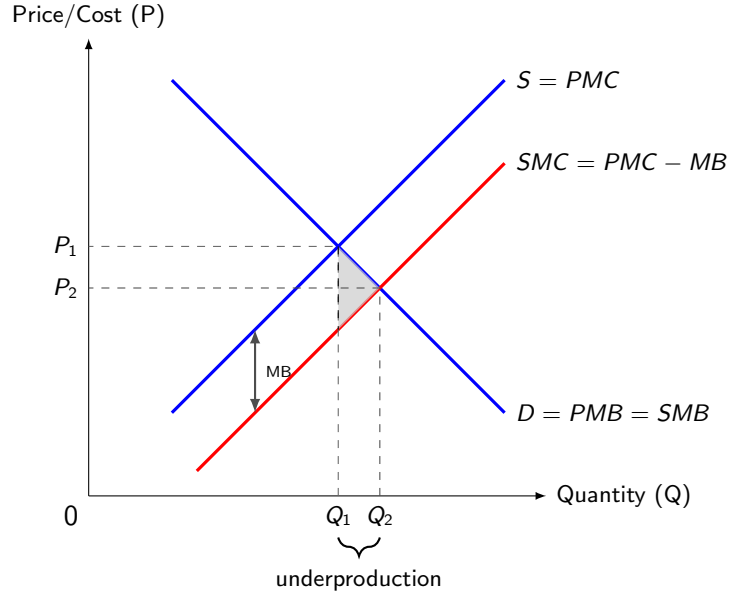
Positive Externalities

Not all externalities are bad!

Positive Externalities

- **Positive production externality:** when a firm's production increases the well-being of others but the firm is not compensated by those others.
- **Positive consumption externality:** when an individual's consumption increases the well-being of others, but the individual is not compensated by those others.

Positive Production Externality

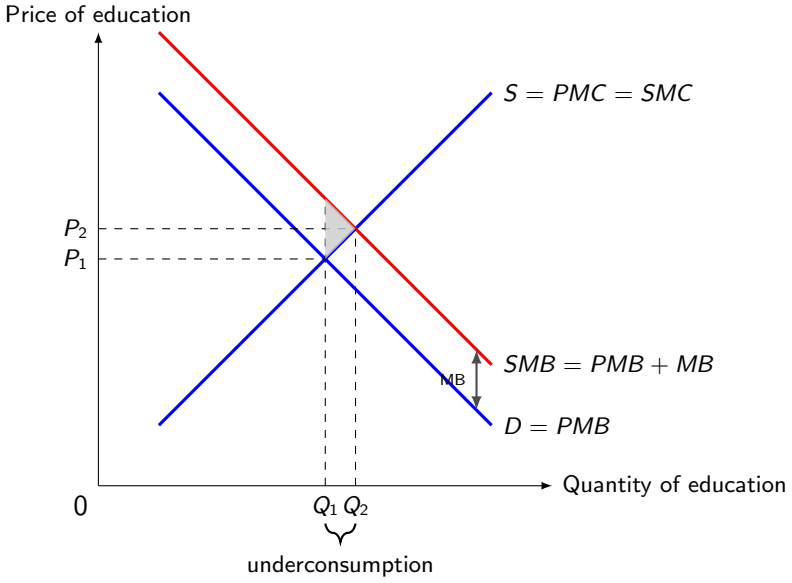


Positive Production Externality

Underproduction

- With a positive production externality, a firm's production generates external benefits for others that the firm does not take into account.
- As a result, the firm bases its decision on the private marginal cost, ignoring that the social marginal cost is actually lower: $SMC = PMC - MB$.
- The market equilibrium occurs at Q_1, where demand intersects the private supply curve.
- The socially efficient outcome is at Q_2, where demand intersects the lower social marginal cost curve.
- Because PMC **overstates the true cost** of production, the market produces too little: this is **underproduction**, since $Q_1 < Q_2$.
- The difference between Q_1 and Q_2 creates a **deadweight loss**: units between Q_1 and Q_2 are not produced even though their **social benefit exceeds their social cost**.

Positive Consumption Externality



Positive Consumption Externality

Underconsumption

- With a positive consumption externality, individuals base their consumption decisions on the private marginal benefit, ignoring the benefit their consumption provides to others.
- The true social marginal benefit is higher: $SMB = PMB + MB$.
- The socially efficient outcome occurs at Q_2, where demand intersects the social marginal benefit curve.
- The private market equilibrium occurs at Q_1, where demand intersects the supply curve.
- The private PMB curve **understates the true benefit** of consuming Q_1, leading to **underconsumption**, since $Q_1 < Q_2$.
- The shaded triangle in the graph represents the **deadweight loss**: units between Q_1 and Q_2 are not consumed even though their social benefit exceeds their social cost.

Example

Suppose that demand for a product is $Q = 1200 - 4P$ and supply $Q = -240 + 2P$. Furthermore, suppose that the marginal external damage of this product is \$12 per unit. How many more units of this product will the free market produce than is socially optimal? Calculate the deadweight loss associated with the externality.

From Problem to Solution

Externalities cause inefficiency...

...but there are ways to correct them!

- Taxes, subsidies, regulation, or market-based solutions can restore efficiency.

Private-Sector Solutions to Negative Externalities

- Assume the fishermen owned the river.
- They would march up to the paper plant and demand an end to the dumping that was hurting their livelihood.
- Suppose there is no pollution-control technology to reduce the damage.
- To end dumping, it means shutting down the plant.
- The paper plant owner might propose a compromise:
  - He would pay the fishermen *MD* for each unit of paper produced, so that they were fully compensated for the damage to their fishing grounds.
- This type of resolution is called **internalizing the externality**.

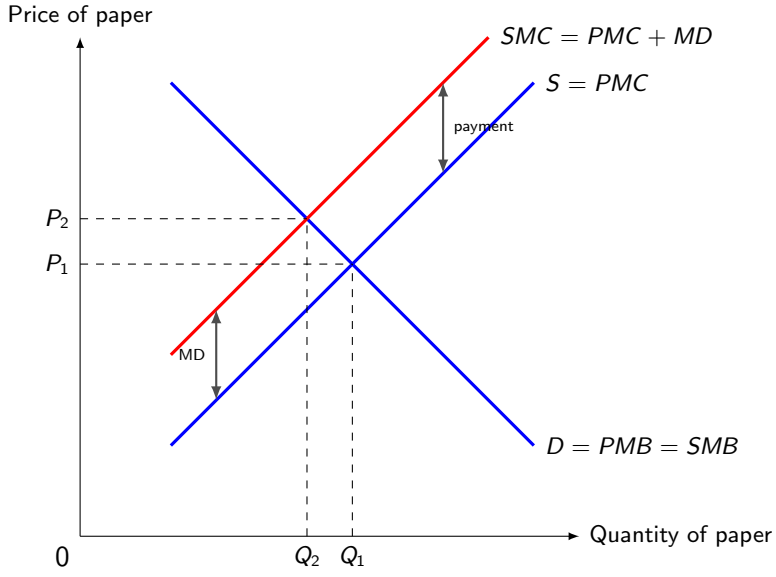
Internalizing the Externality

Internalizing the Externality

When either private negotiations or government actions lead the price to the party to reflect fully the external costs or benefits of that party's actions.

- Fishermen have property rights to the river.
- They have used the market to obtain compensation from the paper plant for its pollution.
- They have implicitly created a market for pollution by pricing the bad behavior of the paper plant.

Negative Production Externality



Coase Theorem I

Coase Theorem (Part I)

When there are well-defined property rights and costless bargaining, then negotiations between the party creating the externality and the party affected by the externality can bring about the socially optimal market quantity.

- Externalities do not necessarily create market failures because negotiations between the parties can lead to offending producers (or consumers) to internalize the externality, or account for the external effects in their production (or consumption).

Coase Theorem I

- There is a very particular and limited role for the government in dealing with externalities: **establishing property rights**.
- The fundamental limitation to implementing private-sector solutions to externalities is poorly established property rights.
- If the government can establish and enforce those property rights, then the private market will do the rest.

Coase Theorem II

Coase Theorem (Part II)

The efficient solution to an externality does not depend on which party is assigned the property rights, so long as someone is assigned those rights.

Problems with Coasian Solutions

In practice, the Coase theorem is unlikely to solve many types of externalities that cause market failures.

1. The **assignment** problem
   - Assigning blame and assigning damage.
2. The **holdout** problem
   - Shared ownership of property rights gives each owner power over all the others.
3. The **free rider** problem
   - When an investment has a personal cost but a common benefit, individuals will underinvest.
4. **Transaction costs and negotiating** problems
   - It is hard to negotiate when there are large numbers of individuals on one or both sides of the negotiation.

Public-Sector Solutions For Externalities

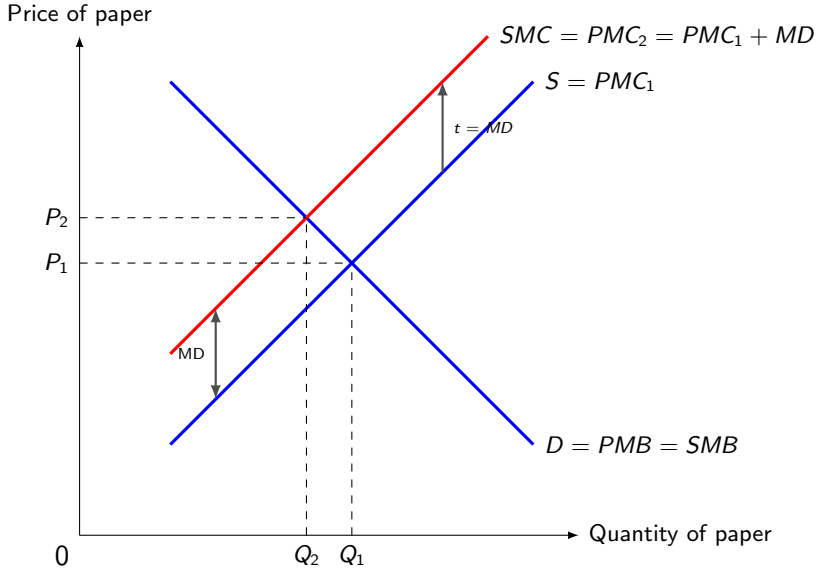
Public policy makers employ two types of remedies to resolve the problems associated with negative externalities:

1. **Price policy**: corrective tax (subsidy) equal to marginal damage (marginal benefit) per unit,
2. **Quantity regulation**: government forces firms to produce the socially efficient quantity.

Corrective Taxation

- The government can achieve the same outcome as "internalizing the externality" by taxing the paper producer an amount MD for each unit of paper produced.

Negative Production Externality



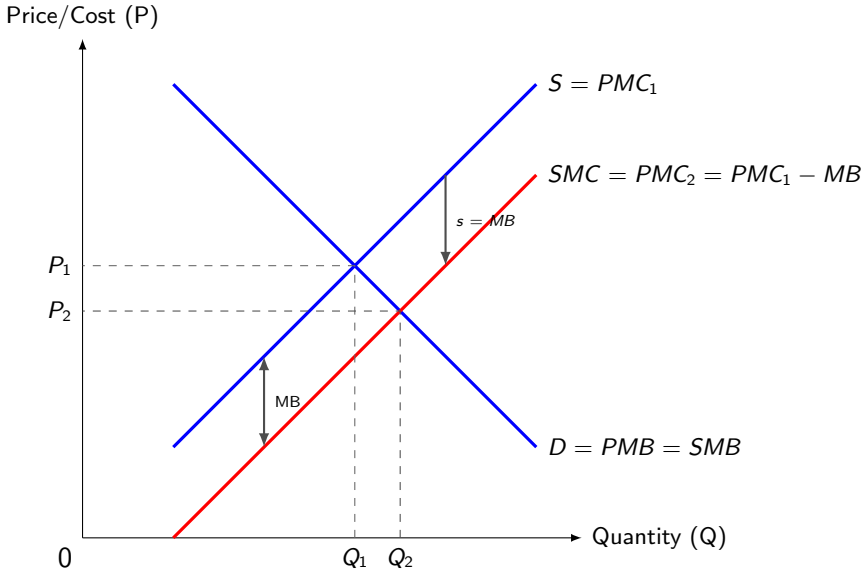
Example

The private marginal benefit associated with a product's consumption is $PMB = 350 - 4Q$ and the private marginal cost associated with its production is $PMC = 6Q$. Furthermore, the marginal external damage associated with this good's production is $MD = 4Q$. To correct the externality, the government decides to impose a tax of t per unit sold. What tax t should it set to achieve the social optimum?

Subsidies

- Recall that **externalities can be positive**.
- Coasian solution to cases such as the oil exploration case would be for the other oil producers to take up a collection to pay the initial driller to search for more oil reserves.
- The government can achieve the same outcome by making a payment, or a **subsidy**, to the initial driller to search for more oil.
- The amount of this subsidy would exactly equal the benefit to the other oil companies.
- It would cause the initial driller to search for more oil because his cost per barrel has been lowered.

Positive Production Externality



Example

Consider the same private benefit and private cost as before:

$$PMB(Q) = 350 - 4Q, \qquad PMC(Q) = 6Q.$$

Now suppose production generates a *positive* externality: the marginal external benefit is $MB(Q) = 4Q$. The government wants to set a per-unit subsidy s so that the private market outcome coincides with the social optimum. What subsidy s should the government set?

Regulation

If the government knows where the socially optimal level of production is, why doesn't it just mandate that production take place at that level and forget about trying to give private actors incentives to produce at the optimal point?

- In the 1970s, the U.S. government wanted to reduce emissions of sulfur dioxide. It did so by **putting a limit or cap on the amount of SO_2** that producers could emit.
- In 1987, nations of the world wanted to phase out the use of chlorofluorocarbons which were damaging the ozone layer. The banned the use of CFCs.

In practice, there are complications that may make taxes a more effective means of addressing externalities.

From Externalities to Public Goods

- Externalities and public goods are both examples of **market failures**.
- In externalities, individual decisions do not account for the effects on others.
- In public goods, the good is **non-rival** and/or **non-excludable**, leading to underprovision.

Public Goods

Public goods are the basis of the state.

Public goods include all the services that are required for a state to function: defense, law and order, rules of property and contracts, social and economic infrastructure, basic education and health services, waste collection services and many other services that provide collective as well as private benefits that markets for one reason or another are unlikely to provide.

Characteristics of Goods

Definition

- A good is **non-excludable** if, when supplied to one person, another person cannot be excluded from consuming it or, more broadly, benefiting from it.
- A good is **non-rival** when one person's consumption of the good does not diminish the supply of the good to others.

These characteristics create market failures.

- Non-excludable goods are under-supplied.
- Non-rival goods are under-consumed.

Classification of Goods

	Rival	**Non-rival**
Excludable	Private goods (*ice cream*)	Impure public good (*cable TV*)
Non-excludable	Impure public good (*crowded city sidewalk*)	Pure public good (*national defense*)

Private and Public Goods

- *Pure private goods* are those goods and services which are excludable and rival in consumption.

$$\sum_{i=1}^{N} X_g^i = Y_g{}^1$$

- *Pure public goods* are those goods are services which are non-excludable and non-rival in consumption.

$$X_g^i = Y_g$$

[1] Y_g is the supplied of good g and X_g^i is the consumption demand by individual i of good g.

Optimal Provision of Private Goods

Two consumers (A and B) and two private goods, x and y. Good y is the numéraire: $P_y = 1$.

Consumers: Each consumer chooses (x_i, y_i) to maximize utility. Optimality implies:

$$MRS^A_{x,y} = \frac{MU^A_x}{MU^A_y} = P_x, \qquad MRS^B_{x,y} = \frac{MU^B_x}{MU^B_y} = P_x.$$

- Since all face the same prices, their marginal rates of substitution must coincide.

Producers: Firms choose output of x to maximize profits:

$$MC_x = P_x.$$

- Firms equate marginal cost to the market price.

Competitive equilibrium condition: $MRS^A_{x,y} = MRS^B_{x,y} = MC_x$.

Optimal Provision of Private Goods

Interpretation: The competitive equilibrium is socially efficient.

- Without market failures, each consumer's marginal rate of substitution equals the **social marginal benefit (SMB)** of good x. The marginal value to society coincides with the marginal value to any one individual, because goods are private and everyone faces the same prices.
- Similarly, when markets are competitive and firms take prices as given, the marginal cost of producing x equals the **social marginal cost (SMC)**. Firms internalize all production costs, so market marginal cost reflects true social cost.

Thus, competitive markets equate social marginal benefit and social marginal cost
$SMB = SMC$ *achieving the efficient allocation of private goods.*

Optimal Provision of Public Goods

Two consumers (A and B) and a public good G, plus a private numéraire good y ($P_y = 1$).

Consumers: Each consumer chooses y_i taking G as given. Their marginal willingness to pay:

$$MRS^A_{G,y}, \qquad MRS^B_{G,y}.$$

- Each unit of G provides utility to both consumers.

Producers / Government: Producing G costs:

$$MC_G.$$

- The marginal cost is borne once, regardless of the number of beneficiaries.

Optimal Provision of Public Goods

For a public good, each unit provides utility to all consumers. The social marginal benefit (SMB) is obtained by summing the individual marginal benefits:

$$SMB = MRS^A_{G,y} + MRS^B_{G,y}.$$

Efficiency condition (Samuelson Rule):

$$SMB = MC_G \quad \Longrightarrow \quad MRS^A_{G,y} + MRS^B_{G,y} = MC_G.$$

Interpretation:

- For public goods, it is socially optimal for firms to produce until the marginal cost equals the benefit to all consumers.
- The public good is non-rival; because it can be consumed jointly by all consumers, society would like the producer to take into account the sum of all consumer's preferences.

Private Provision of Public Goods

Two consumers (A and B) and two goods: a public good G and a private good y with prices $P_G = P_y = 1$. Income is constant and equal to M.

Total provision: $G = g_A + g_B$

Individual problem:

$$\max u_i(G, y_i) = 2\ln(y_i) + \ln(g_A + g_B) \quad \text{s.t.} \quad y_i + g_i = M$$

Each consumer's optimal contribution:

$$g_A = \frac{M - 2g_B}{3}, \quad g_B = \frac{M - 2g_A}{3}$$

The more one consumer contributes, the less the other wants to contribute. $\Rightarrow$ **Free-rider problem**.

In equilibrium:

$$g_A^* = g_B^* = \frac{M}{5}, \quad G^* = \frac{2M}{5}$$

Private Provision of Public Goods

Socially Optimal Level

The social optimum is the quantity of the public good at which the sum of the individuals' marginal rates of substitution equals the marginal cost (price ratio).

In this example: $MC = 1$.

Samuelson condition:

$$\frac{M - g_A}{2(g_A + g_B)} + \frac{M - g_B}{2(g_A + g_B)} = 1$$

Solving this equation yields the socially optimal contributions:

$$g_A^{SO} = g_B^{SO} = \frac{M}{3}, \qquad G^{SO} = g_A + g_B = \frac{2M}{3}.$$

$G^{SO} > G^*$: the public good is **underprovided** by the private market due to the **free-rider problem**.

Can Private Providers Overcome the Free Rider Problem?

The free rider problem does not lead to a complete absence of private provision of public goods.

The private sector can in some cases combat the free rider problem to provide public goods by charging user fees that are proportional to their valuation of the public good.

When is private provision likely to overcome the free rider problem?

1. **Some individuals care more than others:** Private provision is particularly likely to surmount the free rider problem when individuals are not identical and when some individuals have an especially high demand for the public good.
2. **Altruism:** When individuals value the benefits and costs to others in making their consumption choices.
3. **Warm glow:** Individuals care about both the total amount of the public good and their particular contribution as well.

Private Provision of Public Goods

Different Types of Individuals

- Suppose each consumer has an income of €100.

$$g_a = g_B = \frac{M}{5} = \frac{100}{5} = 20, \quad G = 2 \times 20 = 40$$

- Now suppose that consumer A has an income of €125 while consumer B has an income of only €75.

$$g_A = \frac{M_A - 2g_A}{3}, \quad g_B = \frac{M_B - 2g_B}{3}$$

yielding $g_A = 45 and g_B = -5$ (0) so that $G = 45$.

Having one economic agent with a higher income leads the outcome to be closer to the social optimum.

Public Provision of Public Goods

The private sector will generally underprovide public goods so that the government can potentially improve efficiency by intervening.

In principle, the government could solve the optimal public goods provision problem and intervene to achieve that outcome but it faces some significant issues.

Public Provision of Public Goods

The Problem of Crowd-Out

Assume the government requires each consumer to contribute a fixed amount $\bar{g}_i$ to the public good.

Budget constraint:

$$y_i + g_i + \bar{g}_i = M_i \quad \Rightarrow \quad y_i = M_i - g_i - \bar{g}_i$$

The individual still chooses a voluntary contribution g_i but:

- They are forced to contribute $\bar{g}_i$ regardless of preferences.
- This reduces disposable income available for voluntary giving.

How does this mandatory contribution affect voluntary contributions g_i?

Crowd Out

Effect on Voluntary Contribution

Individual problem:

$$\max_{g_i} \; 2\ln(M_i - \bar{g}_i - g_i) + \ln(g_i + g_j + \bar{g}_i + \bar{g}_j)$$

Compared to the no-mandate case:

$$\text{Budget before: } y_i + g_i = M_i \quad \text{Budget now: } y_i + g_i = M_i - \bar{g}_i$$

Solving the first-order condition for g_i under the mandate yields:

$$g_i = \frac{M_i - \bar{g}_i - 2(g_j \bar{g}_j)}{3}$$

An increase in $\bar{g}_i$ reduces g_i one-for-one:

$$\frac{\partial g_i}{\partial \bar{g}_i} = -1$$

If the government raises mandatory contributions by 1, each consumer reduces voluntary contributions by 1.

Crowd Out

Assume $M_i = M$ and $\bar{g}_i = \bar{g}_i \ \forall i$. The budget constraint becomes $y_i = M - g_i - \bar{g}$. Each consumer maximizes

$$u = 2\ln(M - g_i - \bar{g}) + \ln(g_1 + g_2 + 2\bar{g})$$

Solving the first-order conditions yields that:

$$g_1^* = g_2^* = \frac{M}{5} - \bar{g}$$

and

$$G = g_1^* + g_2^* - 2\bar{g} = \frac{2M}{5}$$

G remains unchanged. Government provision fully crowds out private provision.

Contracting Out

The government should intervene but how should it intervene?

While the private sector underprovides public goods on its own, private-sector actors may still play a useful role in achieving the optimal level of public goods provision.

Contracting out: an approach through which the government retains responsibility for providing the good or service but hires private-sector firms to actually provide the good or service.

- Governments can harness the forces of competition in this context through competitive bidding, asking a number of private firms to submit bids for the right to perform the service or provide the good.
- The government then grants the right to provide the good or service to the private entity that can provide the good most efficiently.

Contracting Out

Problems

In practice, however, there are two problems with contracting out:

1. The private sector's incentives may not align with public goals, leading to lower public costs but worse outcomes along other dimensions that policy makers may care about.
2. Bidding in contracting out is often far from competitive. In many situations, government bureaucrats may exploit their power and award contracts not to the most efficient, lowest-cost bidder but to the one that assists them in maximizing their own power or, in the case of kickbacks and bribes, even their personal wealth.

Exercise

The town of Musicville has two residents: Bach and Mozart. The town currently funds its free outdoor concert series solely from the individual contributions of these residents. Each of the two residents has a utility function over private goods (X) and total concerts (C), of the form $u = 3\ln(X) + 2\ln(C)$. The total number of concerts given, C, is the sum of the number paid for by each of the two persons: $C = C_B + C_M$. Bach and Mozart both have income of 60, and the price of both the private good and a concert is 1. Thus, they are limited to providing between 0 and 60 concerts each.

1. How many concerts are given if the government does not intervene?

Exercise

2. Suppose the government is not happy with the private equilibrium and decides to provide 8 concerts in addition to what Bach and Mozart may choose to provide on their own. It taxes Bach and Mozart equally to pay for the new concerts. What is the new total number of concerts? How does your answer compare to (1)? Have we achieved the social optimum? Why or why not?

Exercise

3. Suppose that instead an anonymous benefactor pays for 8 concerts. What is the new total number of concerts? Is this the same level of provision as in (2)? Why or why not?

References I


Gruber, J. (2023). *Public Finance and Public Policy*. 7th Edition, Worth Publishers.


Abelson, P (2008). *Public Economics: Principles and Practice*