EFR summary

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Weeks 1 to 7

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Applied microeconomics – IBEB – Lecture 1, week 1 (public) Perfect competition, public goods

Introduction

The **first fundamental theorem of welfare** states that in a perfectly competitive market, efficiency is maximal, full benefits of trade will be exploited and the 'invisible hand' automatically adjusts conditions to desired equilibrium (Adam Smith).

However, in reality, we do not always observe efficient markets. Even under perfect competition, government intervention can sometimes be used to improve market outcomes. Some ways to intervene could be (1) public provision (e.g., education, infrastructure); (2) affecting prices by taxes, excises, and subsidies; (3) regulation; or (4) public production (e.g. defense, income insurance, prisons).

The Public Economics course will be divided into 2 parts. The first part will discuss situations in which markets do not yield socially efficient outcomes and whether government intervention can help with this. The final part discusses redistribution and taxation as well as collective decision-making.

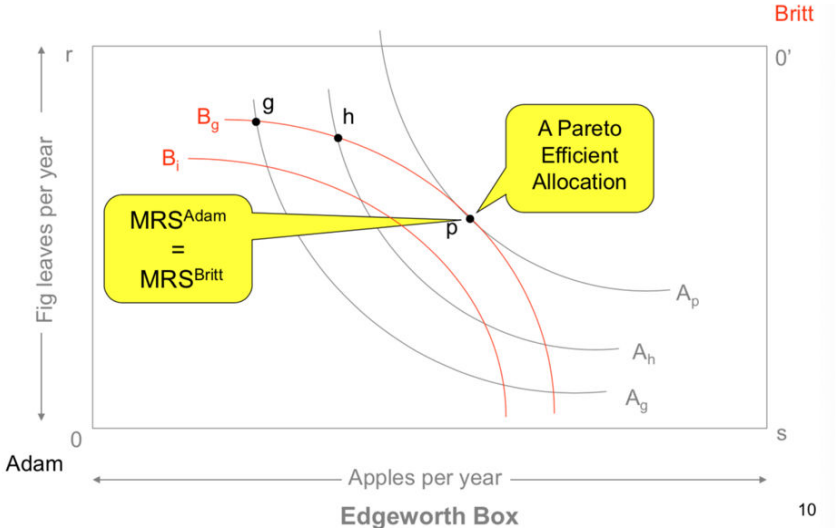
Perfect competition review

Consider (for simplicity) an exchange economy with only two goods and two people (as economic agents). With standard indifference curves, the **condition for maximum efficiency** is given by:

$$MRS^A = MRS^B$$

where MRS represents the ratio at which trading goods does not make individual better/worse off, also the absolute value of the slope of the indifference curve (indicating how much of an extra amount of good Y is needed to compensate for reducing 1 unit of good X).

In the case that MRS^A and MRS^B are not equal, it is possible to make a **Pareto improvement** (an improvement without lowering anyone's utility).



Source: Slide 10, Lecture 1 (Delfgaauw, 2022)

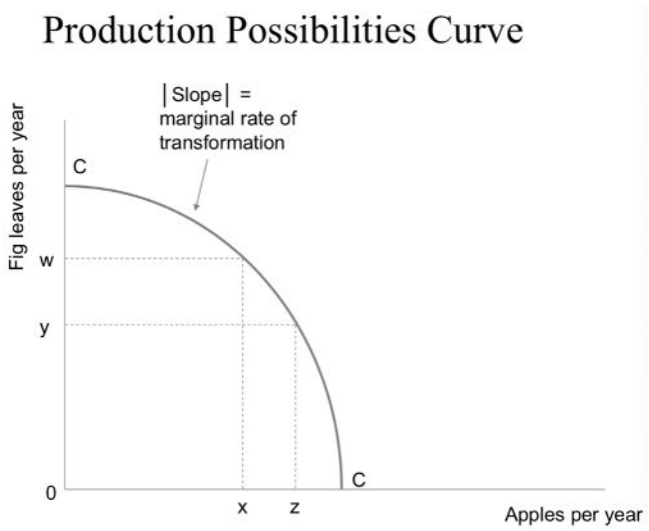
Remember that the Contract Curve is the curve representing or connecting all the Pareto efficient outcomes. It represents the final allocations of two goods between two people that may occur from trading their initial endowments.

Production possibilities frontier

Production Possibilities Frontier indicates the combinations of goods X & Y that can be produced, with a slope known as the marginal rate of transformation (MRT). The MRT is an indication of how much additional good Y can be produced by sacrificing 1 unit of good X. Adding this to our current system of conditions, we obtain the following new condition:

$$MRS^A = MRS^B = MRT = \frac{P_x}{P_y}$$

This again represents a **Pareto efficient equilibrium**. In this case, if one of the MRS is not equal to the MRT, a different product mix would improve the efficiency. The last part of the equation, regarding the prices ratio, shows that the prices will adjust to supply and demand. In other words, this can be summarized as the situation when the marginal benefit is equal to the marginal cost.



Source: Slide 13, Lecture 1 (Delfgaauw, 2022)

Market failures

Four main reasons for market failures are:

1. **Market power:** Monopoly is a good example of this (high barriers to entry, prices above the marginal costs and general "consumer exploitation")
2. **Public goods:** These goods are usually not provided sufficiently without government intervention because of free-rider incentive.
3. Externalities (especially negative)
4. Asymmetric information

The last three of these are also known as the **missing markets**. The markets for these transactions usually fail to be efficient, or in some cases even to exist without intervention.

Government failure is discussed in week 7, but for now, note that the four main reasons for *government* failures are:

1. Lack of information (on individuals' preferences and production processes)
2. Imperfect political representation and problems in aggregating preferences (Arrow's impossibility theorem)
3. Rent-seeking and corruption
4. Limited or misaligned incentives

Public goods

Pure public goods are:

1. **non-rival**: the consumption of the good by one party does not prevent the consumption of the good by another. In other words, once a pure public good is provided, additional consumers of this good do not raise the cost of the good. The marginal cost of providing for an additional consumer is zero.
2. **non-excludable:** it is impossible or extremely costly to prevent anyone from consuming the good (e.g. public roads)

Example 1: The Embankment (market failure to provide a public good)
There are two parties living in a location where there is the danger of flooding, an embankment would help prevent this eventually. The construction of the embankment costs 50 Euros, the benefit to each party is 30 Euros. If the parties work together then they pay only 25 each for the embankment (they evenly split the cost of 50). The possible scenarios are listed below (the payoffs are as (party1, party2)):

		Party 2	
		Construct	Do Not Construct
Party 1	Construct	(5, 5)	(-20, 30)
	Do Not Construct	(30, -20)	(0, 0)

Table 1. Illustration of non-excludability: The Embankment

This is a case known as **free-rider behaviour**. The example illustrates **non-excludability**: both parties would automatically benefit from using the embankment, regardless of their contribution to the process of construction. However, the embankment will not be constructed since it is optimal for both to wait, which is the Nash Equilibrium. This deviates from the globally optimum case where both gain a benefit of worth of euros 5 by sharing construction cost (*a prisoner's dilemma*).

> In this case, they would need to commit which implies there is a requirement for a regulation body (i.e., government intervention) to discourage free-rider behavior.

Example 2: Fishing in a Lake (imperfect public good)
Let us consider a lake that has plenty of fish and is non-restrictive in fishing activities. Everyone is permitted to take their boat out and fish in the lake.

This would then be an example of a non-rival and non-excludable public good since everyone is allowed to use the good, and during the time when there are not a lot of boats, the **additional cost** of a boat to the others is practically zero. However, the size of a lake is not infinite. Therefore, at some point adding one more boat to the lake will have a cost, and fishing in the lake will be a rival good. Although getting on the lake to fish might not impose a cost on you, it imposes a cost for all the other boats on the lake since there is less space to spread fishing nets and potentially fewer fish to catch.

With the advent of a marginal cost of a further boat being larger than zero, we have an inefficient outcome socially; the good is no longer purely public. So how do we deal with the problem of rivalness? We could, for example, start to charge a fee when the amount of boats on the lake has passed a specified threshold. This would then lead to the second line, which represents a socially efficient outcome but includes a transaction cost and makes the good excludable.

The essence of these examples is that there are impure public goods that only satisfy some of the conditions of the public goods, and, in the case of the first example, demonstrate the fallibility of the private provision of public goods.

Efficient provision of public goods

The marginal valuation of an additional unit of **private good** by society is equal to the marginal valuation of the good for the individuals. The quantity consumed differs among people, but everyone pays the same price (so same marginal valuation = MRS). The market generates Pareto-efficient equilibrium, and supply simply equals total demand.

Public goods use a different logic. Public goods are non-rival, so everyone consumes all units of the public good (everyone consumes the same quantity) without having the same marginal valuations. Therefore, the market does not provide an efficient outcome.

Society's marginal valuation for an additional unit of a public good is the summation of individuals' marginal valuations. If what society is willing to pay for the good is higher than the marginal cost of the good then the good should be provided. Expressed as an equation we arrive at the following in a two-person world:

$$MRS^{A}_{goods\ X\&Y} + MRS^{B}_{goods\ X\&Y} = MRT_{goods\ X\&Y}$$

This efficiency condition is also known as the **Samuelson condition**: the total marginal valuation of the last/marginal unit must be equal to the social cost of providing this last unit.

Unlike the efficiency provision in private goods (wherein everyone pays the same price, consumes different quantities, and has the same MRS), the efficiency provision of public goods implies that everyone must consume the same quantity despite different marginal valuations. This often leads to the market failures that, in turn, lead to inefficient outcomes.

Problems in private provision of public goods

As public goods are **non-excludable**, people can benefit from the good without paying for it, and no individual can be 'forced' to pay for the public good provided by others. It is a problem that everyone prefers that others pay for public goods. The **non-rivalness** characteristic also has its issues. If an individual contributes to the supply of public good, others will benefit from the public good. That act of contributing might lack (full) consideration of others also benefitting from their contribution. In both cases, private provision results in **free rider behaviour**, which leads to **under provision** of the public good.

Making consumption excludable and charging 'admission fee' might not be the optimal solutions to the free-rider behaviour, because making good excludable might be costly and public goods are supposed to be non-rival, implying people with very low valuations of the good should be able to consume as well -> fee should be zero. Personalised prices (high price for high valuation, same for low-) is a considerable alternative solution (perfect price discrimination), but this could also be an incentive to lie about valuation (the free-rider problem is not solved).

For example, let N be the number of identical individuals contributing a maximum of 1 unit of a public good, G represents the number of public goods and the price per unit

being p>0. Utility of individual *i* is $\mathbf{U_i = V*ln(G) - p*g_i}$ where V is a parameter and $g_i \in \{0,1\}$. Then, the individual marginal utility results in $\mathbf{MU_i = V/G.}$

To calculate the socially efficient level of G then $\Sigma_i MU_i = p$ which can be rewritten as $NV/G = p$ giving us $G = NV/p$.

If all individuals independently have to decide on whether to buy one unit or not, it will be optimal to buy one unit if and only if $MU_i > p$ and thus $V/G > p$. Therefore, the Nash Equilibrium will be $G = V/p$ and market failure occurs as soon as $N > 1$. Also, generally, efficiency loss is larger in larger populations.

Efficient provision of public goods

Government provision is not a solution that can be made easily. This is because of two main reasons: (1) to finance public goods provision, the government must raise taxes, which might lower efficiency through tax distortions; and (2) government does not know individuals' preferences.

Applied microeconomics – IBEB – Lecture 2, week 1 (personnel) Principal-agent model

The model is a simple yet profound approach to the economic relationships between two or more people. This problem's structure can be applied to a large number of situations (for example, the relationship between a politician (agent) and his voters (principals)), but here we will study employer-worker relationship with this model.

The basics of the model

In a simple principal-agent model, we can define the principal as someone who hires the agent to work for her with the objective of maximizing her profits. For the sake of simplicity, we assume that the sole goal of the principal is to maximize her

profits, and the agent's is to maximize his utility (more income, less effort is preferred). In other words, we assume that both parties are rational economic actors who only care about maximizing their own self-interest.

The basic timeline of this model is given as follows:

The principal gives the agent an offer/contract.

The agent will then have to decide to either accept or reject the offer. In the case the agent rejects, the interaction of the two parties ends. In the other case:

The agent accepts and chooses how much effort he would spend working for the principal.

The total output and the principal's profit is realised, the agent gets paid for the work according to the contract.

The principal's profits are given by $\pi = pQ - Y$, where Q is the agent's output and Y is what the principal pays him. The agent's utility is given by $U = Y - V(E)$, where V is the disutility function of his effort. In general, we assume V(E) is an increasing function that also exhibits increasing marginal costs of effort ($V'(E)>0$; $V''(E)>0$). An example we often use is $V(E) = E^2/2$. It is also important to note that E is not verifiable, whereas Q and Y are more easily measured and visible.

We will assume that the contract indicates $Y = a + bQ$. In other words, the principal and agent agree on a linear contract, where the agent will receive *a* as base pay, plus *b* for every unit of output the agent produces. The production function takes the form of **Q=dE**, where *d* is the factor of transformation from effort to output, i.e. d indicates the worker's productivity (all production capital taken into account).

Solving the agent's problem

As we assume, the agent's objective is to maximize his own utility with respect to the amount of effort units that he spends doing the work. We hence have to:

maximize (w.r.t. E) $a + bQ - 1/2E^2$ $\Leftrightarrow$ maximize (w.r.t. E) $a + bdE - 1/2E^2$

$\Rightarrow bd - E = 0$ $\Leftrightarrow E = bd$

This implies that the base salary a does not influence the agent to spend more effort. The amount of effort spent increases along with the increase in the commission rate

b and the productivity level d. This can be understood as the more productive a worker does his job (given that there is a commission per unit of output), the more effort he would spend doing it.

For the agent to accept the contract, his gained utility must be at least equal to, or more than the utility yielded from the next best alternative (U^{alt}).
Using the disutility function $V(E)=E^2/2$, we have:

$a + bQ - E^2/2 >= U^{alt}$ $\Leftrightarrow a + b*dF - E^2/2 >= U^{alt}$

$\Leftrightarrow$ (given that $E=b*d$) $a +(bd)^2 -(bd)^2/2 >= U^{alt}$

$\Leftrightarrow a >= U^{alt} - (bd)^2/2$.
This value $U^{alt} - (bd)^2/2$ is the minimum value of base payment a that the agent can agree on.

Solving the principal's problem

Based on the analysis we did from the agent's perspective, we now attempt to solve the principal's problem: making a contract (deciding on a and b) that maximize profit:

maximize (w.r.t. b) $pQ - Y$, where p is the price of a unit of output Q.
$\Leftrightarrow$ maximize (w.r.t. b) $p*dE - a - b*dE$
$\Leftrightarrow$ maximize (w.r.t. b) $pbd^2 - (U^{alt} - (bd)^2/2) - (bd)^2$
$\Leftrightarrow$ maximize (w.r.t. b) $pd^2b - U^{alt} - (bd)^2/2$
$\Leftrightarrow pd^2 - d^2b = 0 \Leftrightarrow b = p$

This seems to be an extreme result because it implies giving all revenue as a bonus to the agent. However, this is found in the real world with franchises. In this situation, given the agent's preferences, a franchise situation would be the optimal strategy.

Applied microeconomics – IBEB – Lecture 3, week 1 (public) Perfect competition, more on public provision

Market equilibrium

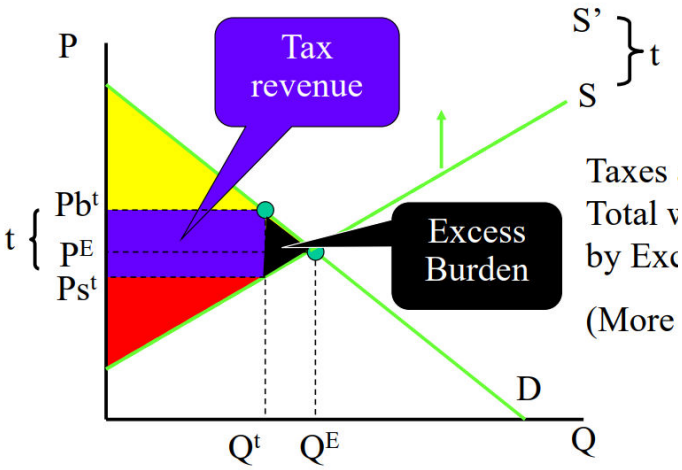
The economy is in equilibrium at the point where the supply and demand curves intersect, yielding the quantity produced, traded and consumed as well as its price.

The producer and consumer surplus represent the benefit that the supply and demand side are receiving from the goods they are producing/consuming. For example, since the equilibrium price is lower than the price that the some of the consumers are willing to pay for a unit of the good, those set of consumers of the market benefit here from the lower price they pay in comparison to their valuation. At this equilibrium then the market has exploited all possible benefits from trade.

The slope of the demand curve represents the marginal valuation that the consumers have for the next unit on the market, in other words how much added value a further product in the market has.
In the case of the producers, a single point on the supply line represents the amount of income the producer needs to produce with the good and make up for the forfeited production of another good. The slope represents the marginal change in this for every extra good produced.

Let us look at an example of the distortionary effects of a tax imposed on the supply side of the economy. In the case of a tax, the suppliers will charge a higher price, since they now have to come up with the amount of taxes in addition to the price they require for production and forgone production. This shifts the equilibrium to the left, with a lower quantity produced, traded and consumed at a higher price than before. The government makes revenue from this, which is the product of the difference in prices (after tax – before tax) and the new quantity sold. From the new equilibrium point, we can also deduce that the consumer and producer surplus have

decreased. Furthermore, there is also an excess burden, which is a benefit that now cannot be exploited by any party (deadweight loss). As such, we clearly see the distortionary effects of a tax on the pure market equilibrium.



Source: Market equilibrium with a unit tax t (Delfgaauw, 2022)

The exchange economy

Before we move to the production factor, we look at an economy with a fixed number of available goods. In this case, we represent our larger economy with a two-person, two good economy that is commonly pictured by an Edgeworth box. In this case, each individual's preferences are reflected by their individual indifference curves. Given an endowment point, we can find a Pareto improvement by having the two individuals trade. A Pareto improvement is a redistribution of goods that makes at least one person better off while not making any other worse off. If we cannot find a Pareto improvement, then we should be at a Pareto Efficient Point (where there is no possible improvement in utility without harming anyone else). There are many Pareto efficient points in the Economy, which are represented by the contract curve. On this curve, all points are efficient.

A condition for Pareto efficient points is that the MRS (Marginal Rate of Substitution) of each party is equal, in other words, where the indifference curves are tangential.

Adding the production factor

In the real economy, we know that the total amounts of goods is not fixed and instead depends on the production choice. This choice is commonly reflected by the production possibilities frontier, which represents the possible quantities of each unit produced. This means that while the number of products is not fixed, the total amount we can produce is. Therefore, each production choice is a trade-off. The Marginal Rate of Transformation represents the slope of this frontier, and means that for a change of one unit of X we can obtain a certain number of units of Y.

This adds to the efficiency condition in the following way: not only must the MRS of each individual be equal, but it must also be equal to the MRT. If this were not the case, there would be a different product mix that could lead to an overall improvement of utility.

Luckily, this not only holds for the two-person economy but also for the aggregate economy. Here, however the people decide based on the ratio of prices. Given the assumptions of perfect competition, we see that at the efficient point the ratio of prices X to Y is also equal to the MRT.

Concluding remarks

We also have to consider the two fundamental theorems of welfare:

> **The first theorem**: Perfect competition always leads to a Pareto efficient equilibrium
>
> **The second theorem**: Given any endowment point, we can reach a Pareto efficient equilibrium

Therefore, important questions to pose are:

> What is the optimal distribution of goods?
>
> Which point on the contract curve is the best?

Unfortunately, economics only has a theoretical construct to possibly answer this question. This theoretical construct is called the social welfare function. It is a

function of the utilities of all individuals in the economy and is designed to give a set of indifference curves that will represent the welfare of the society as a whole and thus in turn help us to deduce a Pareto efficient point that would be welfare-maximising too.

Public versus private provision and production of public goods

Choosing which goods to provide to the public:

- The market leads to the **under provision** of goods, due to free-rider behaviour.
- The government supply often leads to **overprovision**, because people tend to exaggerate their valuation of the good in order to get more for free.

So how do we choose what to provide? Cost Benefit Analysis!
Several questions should be asked here:

- What are the benefits of the proposal to provide this good?
    - Does it improve efficiency or distribution?
- What market failure is being addressed? Why is the government better at providing this good? Who benefits from the provision?
    - At what cost will the provision of this good come?
    - Will the proposal work?
- How will people respond to the provision of this good? Can people circumvent this policy?

These questions are just as true for the private as for the public sector. However, in the public sector there are some extra aspects that we must consider.

Example:
Which discount factor should the government use? The “risk free rate” or a different rate because, for example, society values future generations more.
How do we take non-monetary intangibles into account? Including the subjective feelings of pride and happiness for example. (This has been attempted with surveying).

A good example here is the value of a life; people will often answer priceless, yet we do not take every possible measure to protect our lives, since we often take risky jobs, or don’t wear bike helmets.

Arguments for the provision authority

In some cases, the government not only finances the provision but also owns the factors of production. However, there is an ongoing debate whether the public or private sector should provide the goods. There are many arguments to consider, but here are some examples:

- Through competition, the private market may produce the goods at a cheaper price, however, they may also cut back on quality in order to do so and remain competitive.
- The private sector may better incorporate preferences because they more directly affect the firm's profitability and thus there would be consumer sovereignty.

Applied microeconomics – IBEB – Lecture 4, week 2 (public) Externalities

Definition

We therefore define externalities as the real cost or benefit to the people outside of the market mechanism being affected by the producer or consumer's activity. What we mean by "outside the market mechanism" becomes clear when we look at the characteristics of an externality.
For example, you smoking or driving can result in air pollution, which may harm the other parties in the environment around you (negative externality). However, in the case of walking to work, you are benefiting others by not crowding the streets during rush hour (positive externality).

Characteristics

1. An externality is not explicitly priced and is therefore not within the market. Many economists phrase this as there being a 'missing market' for the externality. For example, a change in housing prices is not an externality as it operates within the market and only affects the distribution and wealth.
2. Externalities can be caused by producers and/or consumers.
3. Externalities involve two or more parties. This means that an effect can only be an externality if there is both a producer of an externality and an entity that consumes the externality (that is affected by the externality). For example, if there is someone alone in a soundproof room talking loudly on a phone, then the loud voice is not an externality because it does not negatively or positively affect anyone directly.
4. Public good is a special case of externalities.

Market failure with externalities

Consider a situation where there is a firm, such as an oil rig in the ocean that lets some oil spill for every unit extracted. Furthermore, there is a group of fishers that have lower catches due to the oil contaminated fish that die. We note that in this case the oil rig will produce at a level that is optimal for itself, where the marginal private benefit (MPB) of an extra unit of oil is equal to the marginal private cost (MPC) of an extra unit of oil, located at point (Q, P) in the graph (Figure 1). However, we have learnt that the social cost line is achieved through vertical summation, as such, when we find the social optimum, we see that it is at (Q*, P*) in the graph. However, the two equilibria do not match. The reason that these two equilibria do not match is that the private party generally does not take the preferences of society into account when they make their profit driven decision. Society on the other hand would take all the costs into consideration and arrive at a different option.

Let us also take note that neither the outcome desired by the fishers desire nor that by the companies are socially optimal: the fishers would choose to have no oil rig and the oil producers would maximize their profit at (Q, P), neither of which is the social optimum. As such, we have a Market Failure occurring here.

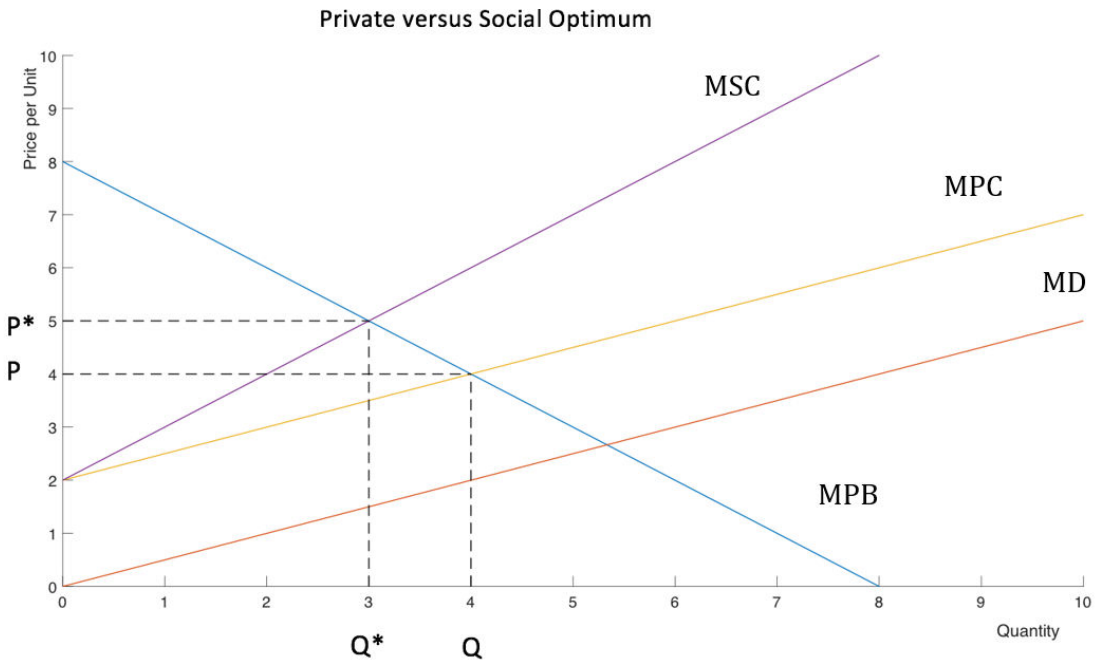


Figure 1: Private versus Social Optimum
Source: Slide 13, Lecture 4 (Delfgaauw, 2022)

In the figure above…

- MPB = Marginal private benefit of producer
- MPC = Marginal private cost to producer
- Q = Profit maximizing outcome derived by equating MPB = MPC
- MD = Negative externality (marginal external cost/ marginal damage)
- MSC = Marginal social cost (MPC = MPC + MD)
- Q* = Socially efficient outcome

In a socially efficient outcome, the total value created by the market, taking into consideration all individuals in a society, is maximal. Hence, we want to equate the social marginal benefit to the social marginal cost.

Because, in the example above, there are no positive externalities, the social marginal benefit is the same as the MPB. However, Because there is a marginal external cost, the MSC lies above the MPC. Equating these two will lead to the social efficient outcome given a negative externality, which, in the example, is Q*.

Analysing the figure, we see that:

- For all units up to Q*, the profit generated for the firm is lower than the cost for the farmers.

With externalities, the market outcome is not socially efficient (overproduction/-consumption with negative ext.; underproduction/-consumption with positive ext.). The main cause is the situation 'missing market': markets for side-effect of production/consumption is missing (not priced, and hence, not taken into account). Missing markets arise when property rights are missing (think about the case of air, public space and natural resources).

Solution via private bargaining/Coase theorem

The first solution to this problem is through private bargaining. The Coase Theorem says that the private parties will negotiate towards the socially efficient outcome from any given starting Q, given the two conditions:

1. There are (transferable) **property rights** established and enforced (implying that the market for the side-market could arise, so that externalities can be internalized)
2. The transaction cost (of negotiation) is sufficiently low

Note that it does not matter which of the parties owns the rights, since it affects only the distribution and not the efficiency of the outcome.

So why does bargaining work?

Consider that we are starting at point Q. The fishermen would like to reduce the amount of oil that is produced. From Figure 2 we can see that the benefit to the fishermen of a reduction in production at Q is larger than the cost of lowering the production to the oil rig.

Therefore, if the fishermen compensate the oil rig for lowering their production then there would be a Pareto improvement (oil rig has the same profits and the fishermen are better off). This would continue until the benefit equals the cost, which occurs at a socially efficient outcome.

The same logic applies if we were to the left of the Q*, in this case the oil rig would compensate the fishermen for their costs since until we reach Q* the benefit to the

company outweighs the costs to the fishermen. This again allows for Pareto improvements until we reach the socially efficient outcome.

If the Coase Theorem holds, market failure due to externalities would be solved without government intervention (given that property rights has already been enforced). However, this requires low transaction cost, which implies that agreements should be easy to arrive at and to enforce (so there should be few parties involved, and no asymmetric information). When transaction cost is too high, negotiations would be limited or would not even happen, and the allocation of property rights would also affect efficiency.

Solutions via government intervention

1. The government's first option to intervene is to use a **Pigouvian Tax**. The idea of this tax is that it should be equal to the **marginal damage** at the **social optimum** (distance from x axis to MD at Q*). This would work for the company as for every unit they produce they would now have to pay a set tax, **shifting their marginal cost curve upward** by the amount of the marginal damage. Effectively, the new intersection of the Marginal Benefit and Marginal Cost curves of the firm are now at **Q***. Pigouvian tax must be **equal to the MEC at the socially efficient level of production**.
2. The government could also use a **Pigouvian subsidy**. This would also equal to the **marginal damage** at Q*. The subsidy would create profit for the company until the point where they produce only Q*. The reason is that the subsidy is higher than the marginal benefit of producing another unit, therefore a profit maximizing company will take the subsidy in favour of the unit. For negative externalities, subsidies are given when companies produce less than what they otherwise would.

So the Pigouvian taxes and subsidies are the level of taxes/subsidies that leads to the socially efficient outcome of the market. In other words, in both cases it is optimal for the company to not produce more than the social optimum. However, both the tax and the subsidy require the government to have perfect information on the entire situation including the pricing of the marginal damage. A side note is that in case of a monopoly, a subsidy is more effective. The reason is that a tax will only change the price of the monopoly's products and will as such be shifted to the consumer to pay.

1. Another government option is to use **regulation**. This would involve setting production amounts or enforcing production standards that simply discourage the people from producing more (negative externality) or less (positive externality) of the good in question. There is no incentive to cross them because of extra punishment.
2. **Cap and trade** is an approach combining of regulation and Pigouvian tax, where (in the case of EU Emissions trading system) the government imposes a maximum on total emission ('cap') and gives (or sells) emission permits to producers. It's allowed to trade permits, and the price of permits arises on the market serves as the cost of emission.

Market options

As a last note, there is the possibility for two companies to merge. If we are in a scenario where two companies are producing, and one has a negative externality effect on the other, then through a merger these two companies can avoid the externality and increase the profits they are making. As such, this would be a market solution to an externality.

Applied microeconomics – IBEB – Lecture 5, week 2 (personnel) Efficiency and extensions

Efficiency in terms of social welfare

In this lecture, we define social welfare as the sum of utilities. In a society with a principal and an agent (as continuing our discussion last week), we would have:
Social welfare = $U + \pi$
= $(Y - V(E)) + (pQ - Y)$ (considering the assumption we made in the last lecture, where the utility function is a linear one)
= $-V(E) + pQ$ (the distribution of resources does not influence welfare)
= $-0.5E^2 + pdE$

Maximize (social welfare) with respect to E $\Leftrightarrow$ $-E + pd = 0 \Leftrightarrow E = pd$
This conclusion matches that conclusion that we reached in last week personnel lecture, where the focus was maximizing individual's utility, whereas here we focus on maximizing social welfare.

Suppose that the agent decides on a and b

Last week, we studied the principal-agent problem, assuming that it's the principal who designs and proposes the contract. This time, we will assume the agent would come up with a contract, then the principal can accept or reject. Using backward induction, we will study the game in the steps below:

The agent decides on effort choice:
The agent would like to maximize his utility with respect to the effort made:
Max(w.r.t. E) $a + bdE + 0.5E^2 \Leftrightarrow bd - E = 0 \Leftrightarrow E = bd$

The participation constraint for the principal:
The minimum profit that the principal wants make is the value of the next best alternative:

$\pi = \pi^{alt}$
$\Leftrightarrow pdE - (a + bdE) = \pi^{alt}$
Given that $E = bd$
$\Rightarrow Pdbd - a - (bd)^2 = \pi^{alt}$
$\Leftrightarrow a = -\pi^{alt} - (bd)^2 + pbd^2$
This is the maximum base salary that the agent can expect the principal to pay him, a higher value of a would result in the principal rejecting the contract.

Choice of a and b
Here, as the agent has found the optimal level of effort E and base salary a in terms of bonus b, the agent now has to decide on b to maximize his utility:
Max(w.r.t. b) $a + bdE - 0.5E^2 \Leftrightarrow$ Max(w.r.t. b) $-\pi^{alt} - (bd)^2 + pbd^2 + bdbd - 0.5(bd)^2$
$\Leftrightarrow$ Max(w.r.t. b) $-\pi^{alt} + pbd^2 - 0.5(bd)^2$
$\Rightarrow pd^2 - bd^2 = 0 \Leftrightarrow b = p$
Here, we found out that the optimal choice of bonus b is the same from the principal's and the agent's perspectives. As b=p, we would then have $a = -\pi^{alt}$ $-(bd)^2+pbd^2 = -\pi^{alt}$.

This implies that the agent would design a contract which has a negative base salary equal to the value of the principal's next best alternative, and then have all of the revenue created. (Example: a catering company pays an amount forward to the university to sell food on campus, and does not have to share profits made with the university later)

Situation where the base salary has a minimum level specified

Back to the scenario where it's the principal who proposes a contract to the agent, and here there is a minimum base salary a* specified (for example, by law), which is large enough for the agent to accept for sure.

The agent maximize utility by deciding on effort spent:
Max(w.r.t. E) $a^* + bdE - 0.5E^2$
$\Leftrightarrow E=db$

The principal designs the contract (deciding on b):
Max(w.r.t. b) $pE - (a^* + bE)$
$\Leftrightarrow$ Max(w.r.t. b) $pdb - a^* - db^2$
$\Leftrightarrow dp - 2db = 0 \Leftrightarrow b = 0.5p$
This result indicates an inefficient outcome $E = b = 0.5pd$, which is much less than the previous case where we arrive at $E = pd$.

Extensions to the model

It's important to have a careful second look at the assumption behind the principal-agent model.

1. The worker's intrinsic motivation can be presented by γE, where γ represents positive rate of utility gained by spending effort working of the agent. But this only influence the bonus pay b, base pay a is not affected by the agent's intrinsic motivation to spend effort.
2. Allowing for some uncertainly in the model by making the production function not only a function of effort E, but also other bad/good luck variable. A risk-averse agent's decision would be affected by the introduction of this factor in the model. For the agent to accept the contract with uncertainty, the

principal needs to adjust the bonus b to compensate for the expected loss utility faced by the agent.

3. **Multi-task principal-agent problem**: the agent is hired to do more than one task for the principal. The production function is then q = k(g+h), where g is the effort the agent spent on task 1, and h is that on task 2.

The utility of the agent is presented with the function:
$U = W + \gamma q - 0.5\theta g^2 - 0.5\theta h^2 - 0.5\theta(g+h)^2$

Solving the problem from the agent perspective, he would maximize utility U with respect to g and h (solve with Lagrangian first order conditions), resulting in $g = h = \gamma k/3\theta$.

Two potential practical solutions for the Multitask problem are:

1. Try to measure (and possibly reward) the "less important" or less visible variable, or
2. Redesign jobs to not include both jobs. E.g., separate jobs for market research and sales, rather than combining both into one. For market research it is hard to measure output, thus you would look for someone with high intrinsic motivation for this job, and look for a risk-seeking, high bonus-accepting sales person.

Applied microeconomics – IBEB – Lecture 6, week 3 (public) Education and common resource problem

Education

First, let us consider an important fact: education is NOT a public good. Education is in fact a private good. The reasons are the following:

- Education is rival since the more students there are the higher the cost and the benefit is lower. Thus, the MC of an additional student is not equal to zero
- If legally permitted, education can be excludable by law, by entrance requirements or by cost

From the individuals' perspective, education is an investment, because:

1. It has a cost of both the actual tuition fees and the earnings that the person foregoes (to pursue (higher) education)
2. There are future benefits of education, which include a potential higher income and productivity and knowledge that is intrinsically valuable. Note that on average it is also the highly productive that choose education in the first place, merely improving that.

Now the question we are investigating has really become: why is there so much public involvement in (the provision of) education? For this we have the three following reasons.

Reason 1: education has a large selection of positive externalities

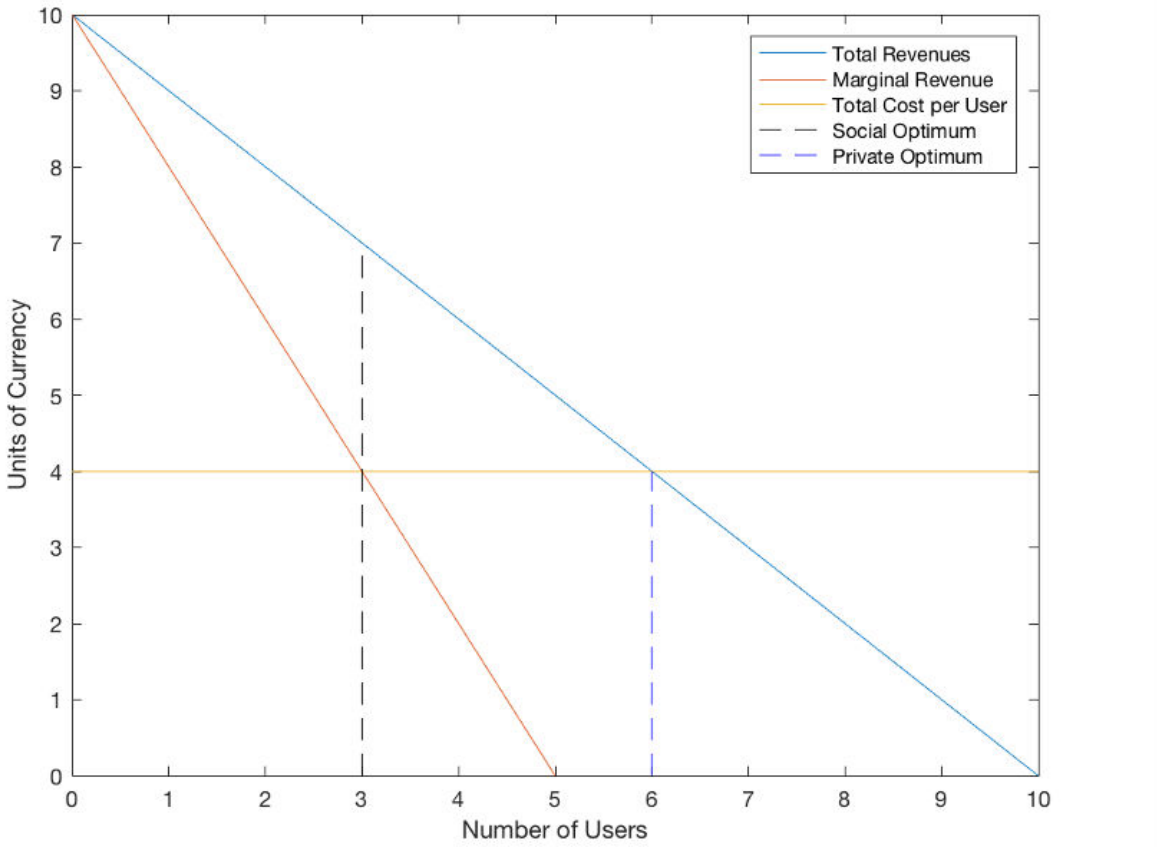
The social benefits of the educated class are larger than the private benefits of this class. Here are several examples:

1. Those with a higher education, on average, have a higher wage; therefore, they are also in a higher tax bracket and results in a higher income tax, making government's revenue significantly increase.
2. When a bigger proportion of the population is highly educated, society as a whole is prone to making better informed and educated participation in public issues, which benefits all members of that society (for example in voting).
3. There is also the Spill over effect of knowledge. For example, in a population, the highly educated will share their knowledge with the lower educated possibly in daily interactions (transmission of knowledge).

However, as was discussed in the lecture, the subsidy for education should ideally bring back the equilibrium to the (socially) optimal point. What this means is that when the informed rational person is making his choice to attend education and sees that he is facing the full cost of education + only the tax-discounted benefits

(around 40 cents per dollar in earnings for a high tax bracket), then the person is less likely to choose education. However, if the government's subsidy for the education is of the size related to the lower benefits, then the decision is back at a level where these effects have been cancelling each other out.

This can be seen in the graph below showing the private and social optima, where the social optimum is reached with a **Pigouvian subsidy**.



Source: Private and Social Optimum with Pigouvian Subsidy (Delfgaauw, 2022)

Reason 2: imperfect capital markets

While there are people that have sufficient wealth to finance their full cost of education, there are also people who need to find loans to pay for their tuition. If they attempt to acquire this loan from the market, they are charged very high-risk premiums (higher interest rates) and have much stricter requirements with the loan. The reason for this is the fact that to a profit seeking loan enterprise there is high risk in investing in human capital. This is because of asymmetric information and the

fact that there is no collateral for human capital. This can result in the reduced enrolment for the less wealthy students, or (too) large student debt.

The government can on the other hand do better (this is a line of argumentation, not absolute truth) by providing student loans with lower interest rates and longer payback schedules. These can be paid off through the higher income and productivity later (people are in a higher tax bracket implying government gain in revenues).

Reason 3: for the reasons of fairness, equality and paternalism

The **social norm** is that we desire equal opportunities based on forecasting independent of the subject's background, family or wealth. The government can reach **Commodity Egalitarianism,** meaning that everyone has an equal amount and right to commodities such as education.

The way to implement this is to maximize efficiency at MSB=MC, which implies that there should be more education provided for smart students. However, this creates unequal opportunities. To create equal opportunities, we would need to provide more education to the lower educated and less to the smarter.

Should public sector or private sector provide education?

The arguments for relying on the **private sector** (for example through a voucher system) are that the schools can then decide on the quality/cost of education which would be optimal due to competition in the market. And if the cost is larger than the voucher (subsidy) then the parents would have to pay out of their own wealth.

However, there are counterarguments for private education including the fact that (1)parents may be unable to judge the quality of the education, and (2) market for education would potentially end up with the wealthy gaining a better education (distributional inequality).

On the other hand, the publicly provided schools may **crowd out** the private sector by simply not leaving any room for the private sector to derive profits and so potentially leaving the educational system at a lower rate of profit than with competition.

The common-pool problem

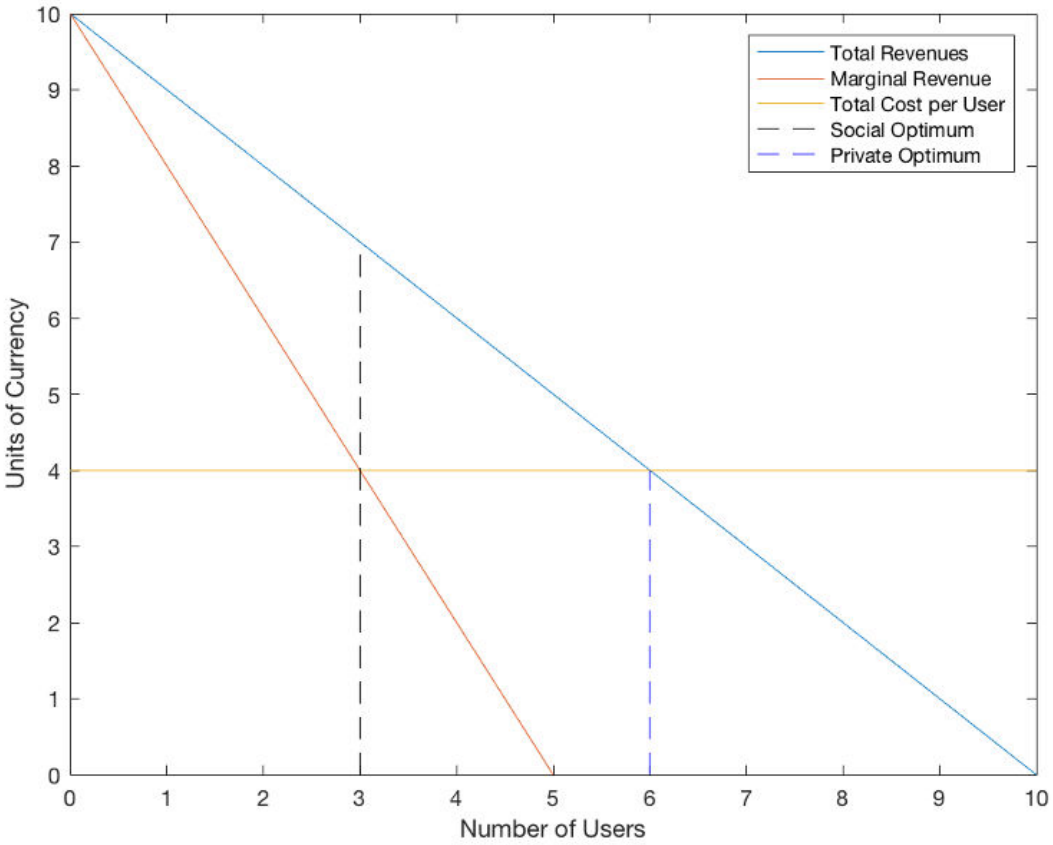
The **Common-pool problem** is an issue that arises when some resources are rival but non-excluded:

- The non-excluded property of these resources is due to insufficiently defined or unenforced property rights
- The rival property implies that the marginal cost of more producers or consumers is positive and not zero

This often leads to the overcrowding of the resources because the individual may fail to take into account the preferences or the costs of the other individuals using the resource. This is known as the Tragedy of the Commons, the inefficiency that arises from not taking one's effects of using a shared resource on other users' costs and/or benefits into account. The tragedy of the commons Is the inefficient use of a resource resulted by the failure of an individual to take Into account the negative externality of his actions.

It can be represented by the following graph, where we see that the difference between the marginal revenue curve and the revenue curve is the negative externality that should be changed. There are several ways of achieving this:

1. We could institute a Pigouvian tax of the level between the yellow total cost and blue revenue at the social optimum (Figure 2).
2. We could also simply set a quota for the number of people that are allowed to use the resource.
3. Elinor Ostrom (winner 2009 Nobel-prize Economics): the option of governance by community in which the community comes together to decide how much to use the resource to optimize the community's income. This is somewhat similar to a Coase Theorem with implicit contracts.



Source: Private and Social Optimum with Pigouvian Subsidy (Delfgaauw, 2022)

Applied microeconomics – IBEB – lecture 7, week 3 (public) asymmetric information

Introduction

Asymmetric information leads to market failure. Before getting into the examples of asymmetric information, it is important to make a distinction between imperfect information and asymmetric information:

- With **imperfect information**, we deal with the uncertainty that all parties face, which is incorporated in the market, which functions with this imperfection
- **Asymmetric information** on the other hand deals with the situations where one party has information that is superior to the other parties around it. A common example is second-hand items, where the seller usually knows much more than the buyer. There are two main issues that arise from asymmetric information, namely (1) that of a moral hazard (ex: employees slacking off, unnecessary repairs of a car machine, etc), and (2) adverse selection (ex: quality of second-hand items are unkown).

Moral hazard

This is the case of asymmetric information where one party may take actions that harm the other party while the other party may not observe these actions. For example, the effort of employees. Now, you might think this is similar to an externality, however, an externality deals with a cost or benefit to a *third party* while moral hazard deals with the parties *involved* in the transaction and unobservable actions. These actions benefit the agent but cost others (individually rational but socially inefficient). Thus, it leads to reduced efficiency, or may even obstruct transactions.

Several examples of moral hazard:

1. An example of moral hazard could be when a person is taking a loan from an institution. In this case the borrower may productively use the money and later pay back the bank in full, or the person could invest in risky start-up companies and end up in trouble with the bank after a couple interest payments. We see that the socially efficient action would be to use the money productively and to pay back the loan. However, the customer has more utility from investing in the companies, and the bank may not observe what the borrower does with the money. Hence, the bank may anticipate this and charge a higher interest to cover the potential loan write-off and possibly make profit. However, then there would not be any customers to take out the loan in question since no customer would want to pay such high interest. A further complication is that a person who is undoubtedly going to use the money productively may not be able to credibly convince the bank of this, and as such suffer under the same high interest as the risky individual. We conclude that the individuals, acting on

their preferences, take individually beneficial actions, such as investing in the start-ups that are not socially efficient (for the bank).
2. Another example is the action of increasing your consumption of a good, when another person is paying for the good.

The question now is how we can improve to avoid these inefficiencies. We see that the Coase Theorem no longer applies, since it is hard to agree upon an unobservable action as both parties would not know if the other transgressed the agreement. However, there are three methods:

- **Monitoring**: this is probably the most commonly thought of method for limiting these actions, but the high cost often makes it unprofitable
- **Pay-for-Performance**: this is based on factors that are observable to the other party. However, it may lead to an inefficient allocation of risk between the parties as well as other distortions since there is no perfect link between the actions and the performance (otherwise they would be observable)
- Restricting the given actions through **regulation**: this is the last option; however, this regulatory approach also restricts the possible value of the transaction. Not only that, but it is already hard to observe the action for the other party

There is also the possibility of implicit contracts and reputation. This however requires that actions are observable and that future outcomes are sufficiently important.

Adverse selection

Adverse selection occurs when one party has **better information on a given 'fixed' aspect of a transaction,** which affects the value of the transaction in question. For example, when an employee knows his productivity, but the hiring firm does not. These are based on fixed characteristics relevant to the transaction in comparison to moral hazard that is about undertaking actions that cannot be observed by others.

The result of the adverse selection is that the informed parties will self-select themselves into and out of transactions such that the uninformed parties get the worst possible outcome.

This is a common example in second hand markets, such as furniture. There is a large difference in quality of the products, of which *only the sellers know the actual quality*. The price would be the same for all items of the same type of furniture, since the buyers do not know the quality of the product in question. However, we know that some of the sellers have higher quality products than the other sellers and these sellers would not be willing to sell for the given price. This would lead to a *lowering of the given price*, as the buyers anticipate this. This has one of two outcomes:

- The market finds an equilibrium where a seller is indifferent between selling at that price and not selling.
- No product will be sold.

In either case, the outcome is inefficient as only the low-quality items are potentially sold.

Application: insurance

In many insurance markets, both moral hazard and adverse selection play a role. This is because risk-averse people dislike uncertainty in their income/wealth, which implies that risk-averse people prefer a certain income over an uncertain income with the same average.

Insurance works by pooling many uncorrelated risks, hence if everyone pays expected (= average) loss in advance, then by the law of large numbers, this should be about enough to compensate those who actually 'lose'. (One remark is that risks must be uncorrelated, otherwise actual pay-out either very small or very large. Therefore, there is no private insurance for natural disasters.)

However, insurance can come with two main problems, namely:

1. Moral hazard → The probability and size of loss depend on choices/behaviour. After acquiring insurance, some individuals may alter their behavior, increasing the anticipated loss.
2. Adverse selection → People may be better knowledgeable than insurance companies about the factors that influence projected loss, and insurance is more valuable for those who anticipate substantial losses.

As shown above, probability and/or level of loss may be affected by individuals' characteristics or behaviour, which leads to the case of adverse selection and moral hazard. This results in market failures:

- Markets do provide some insurance, but are not efficient
- Markets do not provide insurance at all

Applied microeconomics – IBEB – lecture 8, week 3 (personnel) pay for performance in practice

Optimal monitoring

To study how much should the principal pay for monitoring agent's behaviour, we now consider a simplified case of the principal-agent problem where the agent only has two choices on exerting efforts: working hard (with effort level E*) or working less or shirking (with effort level 0).

In this model, V(E) denotes the agent's cost of effort function, B = V(E*) – V(0). The benefit of the principal if the agent exerts E* is denoted by G. When the agent works hard, B is observed, but when the agent works less, the principal is only able to detect this with a probability of p. This level of p is chosen by the cost function c(p) where c'(p)>0 (so the function is increasing). Another choice/decision that the principal needs to make is choosing a F (where $\overline{F}$ is the maximum level). This is a non-monetary fine (but affects the agent's utility) imposed to the agent if the principal detects that the agent's effort=0.

The agent decides on effort choice:

The agent's utility when working hard is Y – V(E*), and his utility when working less is Y – V(0) -pF. The condition for the agent to work hard is:

$$Y - V(E^*) \geq Y - V(0) - pF$$

$$\Leftrightarrow pF \geq V(E^*) - V(0) = B$$

The principal's choice of p and F:

The principal's utility when the agent works hard = G + Q – c(p) – Y. The principal should choose p and F based on that, also taking (1) prospect theory, (2) fairness and (3) false positive into account.
The principal's utility when the agent works less = Q – Y`. Obviously, the wage paid to the agent in this case should be less than the first case, where the agent works hard and the principal has to pay cost of monitoring c(p). The difference in wage (Y-Y`)turns out to be B = V(E*) – V(0). It can be inferred that the principal should incentivise the agent to work hard when G – c(p) - B ≥ 0.

Social welfare

Consider the case of the agent exerting high effort: Y – V(E*) + G – c(p), and the case of the agent working less: Y – V(0). It appears that the agent benefits the society by working when G – c(p) – (V(E*) – V(0)) = G – c(p) – B ≥ 0.

Hence, if shirking is not socially optimal, contracts must satisfy a non-shirking condition by which the product of the fine for shirking (F) and the probability of getting caught (p) is high enough to deter all shirking.

Evidence on employee motivation

Empirical methods: Randomized Controlled Trials (RCTs) is a great method of estimating the causal effects of HRM innovations on organizational productivity, profits, workers' job satisfaction, turnover, and other outcomes. When an RCT has been designed and executed correctly, a simple comparison of mean outcomes between the treated and control groups after the treatment is imposed will measure the causal effect of the treatment. Multiple regression analysis is a statistical technique that can easily control for a very large number of confounding factors.

In the mid-1990s, Safelite Auto Glass introduced a new incentive scheme called the Performance Pay Plan (PPP) that gave its employees a performance-based bonus above a weekly target. Multiple regression analysis shows that the PPP system raised overall productivity by 44%, half of which occurred because Safelite's existing employees increased their output level (incentive effect). It appears that there is also

a selection effect that made the other half of the productivity raise: The new scheme raised the average ability of the workers Safelite was able to attract and retain.

Applied microeconomics – IBEB – lecture 9, week 4 (public) redistribution

Background and some figures

Redistribution involves altering the distribution of a good or consumption possibility across individuals/households. Common examples are the rich being taxed and the poor being subsidised, but there are several other examples including the young to the old and the healthy to the sick.

Often these redistributive policies are based on census data of, for example, the percentage of the population per different income category. However, we must be vigilant when interpreting this data, as the data collection is often deceiving. This is due to some practical issues:

- The **units of observation** (one person, or a household). The problem here is what if two people are as good off as 1.5 making it beneficial to join together, rendering individual counts inaccurate.
- The **before-** and **after-tax** (or contributions/benefits) data
- The **in-kind** versus the **cash** benefits (many benefits from the government are not in cash, but in goods/services provided)
- There exists arguments stating that **consumption-based data** may provide a better assessment of wellbeing
- Data on wealth is often less reliable/complete than income data.

Reasons for redistribution

The reason that we will address is very non-definitive: 'society' thinks that redistribution can generate a better distribution than what the market generates by

itself. The next portion discusses different views on whether the government should undertake redistribution policies.

Utilitarianism

As we have seen in the beginning of this course, economists have developed the concept of the **social welfare function**, a function that gives an idea or shape of how an optimal distribution should look. A good example is the **utilitarian (additive) function** which looks as follows:

$$W = f(U_1, U_2, ..., U_3) = \sum_{i=1}^{n} U_i$$

To arrive at a result with this utility function, three distinct assumptions are required:

1. The utility of individuals depends only on income (= consumption possibilities).
2. The utility functions are upward sloping; however, they exhibit diminishing marginal utility of income.
3. The total amount of income to be distributed is fixed.

With these conditions, we arrive at the optimum where **the marginal utility of every individual should be equal** (otherwise, there could be an improvement in the sum). Furthermore, if we additionally assume that the utility function is the same for all individuals, this would imply that to maximize social welfare, the income of all individuals should be equal. Thereby, we arrive at **total income equality**.

objections

Whether these assumptions are reasonable is very debatable, but here are some of the objections:

- Can we really assume that everyone derives utility in exactly the same way? And only dependent on income? It is impossible to determine whether individuals have identical utility functions and we cannot be certain whether they derive the same satisfaction from the consumption of goods.
- What if the marginal utility was not downward sloping in income? This may be the case for consumption, as with microeconomic theory. Although the MU of a *good* may decrease with consumption, this may not be the case for *income* as a whole. However, there are not many arguments for why this should be the case with income as it increases the consumption possibilities overall (so you

could buy more variation and get a higher non-diminishing utility). For example, if we take assumption 1 as given and say that the utility functions were constant. Then the distribution of the income would make absolutely no difference

- What if the utility function also depends on the leisure time, or on consumption of a set of goods rather than pure income?

Rawlasian Social Welfare

There are several other social welfare functions. In the lecture, there was also the example of the **Rawlsian social welfare function,** which aims to maximize the utility of the individual with the lowest welfare. This type of social welfare is also called the max-min criterion. This welfare theorem implies that income distribution should be perfectly equal, except to the extent that departures from equality increase the welfare of the worst-off individual.

This welfare function does not prevent inequality, since if through the increase in wealth of a rich individual (who, for example, employs the lowest utility individual) the utility of the lowest individual rises, this would be an option that is valid to take.

Though the Rawlasian outlook on social welfare has different implications from that of the utilitarian additive utility function, it shares the utilitarian outlook. This outlook assumes that social welfare is some function of individual utilities. It assumes that redistribution policies must be derived from the social welfare function.

This introduction shows that the form chosen for the social welfare function is the crux of determining what the optimal distribution of income among the considered population is. This is often the location of heated debate.

Reasons for government intervention through applying the market failure framework

In the previous parts of the course we have learned to look at the reasons for the government to intervene at the market through the perspective of market failures. We can apply this framework to the current situation as well (note we are using the utilitarian function):

The welfare (redistributive) state as a public good

We could for example argue that all individuals benefit from the redistribution of income from the rich to the poor. Naturally, we can think of reasons that the poor would benefit from this, yet the **rich also benefit** for several reasons including the on average higher health level (lower health insurance cost) and the lack of beggars to be seen around the cities. However, there is a large problem of **free riding** here. The government in this case could simply force the entire population to participate in this programme. However, there might be heated debate in defining who exactly is poor, how much to give each person and the difficulties with the large administrative effort. The reasoning here can be found with an extreme perspective. Let us suppose that each person would be better off if income were distributed more equally between all people, but no single individual alone is willing to transfer (free riding). Here the government's mandatory programme would make this transaction forced and cost-free, leading to a higher general utility

Looking at the externalities of poverty

In this case, we can look at the effect on the well-being of others (see above, as to why the rich would be better off), as well as the spill-over effects of poverty. This is not an extensive analysis, since in principle it follows the same argument as for welfare being a public good

Incomplete information

Suppose that people are very optimistic about their future (e.g. the generation of baby boomers). These people might assume continuously rising living standards and lower the amount paid to pensions and savings. Thereby, if the living standards stagnate or decrease these people would become poor. The government here might act in a paternal way by avoiding this through redistribution methods such as social security and old age benefits.

Redistribution as poverty insurance

Moral hazard and adverse selection come with the fact that if people know that there is redistribution, they might intentionally put less effort into competing for a high

wage (moral hazard) or they might opt into the insurance because they know they are of the low productivity class (adverse selection).
The Government may enforce the **mandatory participation** which eliminates the problem of adverse selection and prevent these problems of asymmetric information by **imposing fines** for fraud and rules for job searches (as examples).

Efficiency effects of redistribution

There is a method of thought in which the distribution and efficiency questions are kept strictly independent of one another. However, we may argue here that they are tied together because the redistribution of income might affect the behaviour of individuals and the efficiency of the implementation of the plan. There are several aspects that specifically affect the efficiency:

Cash vs. in-kind benefits

The problem with these is that while there is a theoretical argument for the distribution of cash (people can use it more specifically to increase their utilities), the government is often seen distributing in kind benefits such as food stamps. The government in this case is engaging in paternal action (for example by making an alcoholic parent buy food for the family rather than alcohol). However, this is less efficient because the consumption choices of the individuals now are much more limited and potentially cannot reach the social optimum.

The crowding out of private redistribution

If, as is common, there is mandatory participation in these redistributive programmes via the government, then this may **crowd out** the private market. For example, the public social security program may discourage the saving of money for retirement. As well as the lower contributions to charity because we are already helping the poor through the government programmes.

The effect on the labour supply

Generally, the programs that are implemented are means-tested. This means that the eligibility of an individual to the programme is dependent upon their income.

However, there is the potential of inefficiency here because if the benefit does not decrease at some point then there is low incentive to work. Essentially this has led to a decrease in benefits as income increases, which function similarly (in effect) to an income tax that starts out positively.

The effect on worker incentive

The implementation of the redistributive programme will often change a worker's choice between leisure and work because it effectively puts a kink into the budget constraint of the worker. This may lead to a higher utility level when working less (depends on the utility function). There is a detailed mathematical example in the slides. But the essential idea is as follows:

We assume a perfectly competitive market, which implies that the wage that is presented to the worker is equal to his marginal productivity. In equilibrium then the **MRS** (Marginal Rate of Substitution) is equal to this **wage** (this is efficient because society's benefit is matched with cost and worker's benefit).

If we now introduce a programme that redistributes income (for example, giving our worker more benefits depending on his income), then a new equilibrium arises with for example an MRS = 0.75 wage. The wage however still represents the marginal productivity of the worker and as such the worker now works less than what the benefit level he is paid for expects him to. This can lead to inefficiency.

Applied microeconomics – IBEB – lecture 10, week 4 (personnel) non-classical motivators

Pay enough or don't pay at all

The experiments in the paper ***Pay enough or don't pay at all*** by Gneezy and Rustichini (2000) was discussed in the lecture. In the first part of the study, university

students were invited to the lab to participate in an experiment, where they would have to answer a series of questions. Without them knowing, they are divided into four groups. The only difference between the groups is the incentive for them to attempt to answer these questions correctly.

Group	Incentive	Outcome (average number of questions answered correctly)
Control group	No incentive	28
T1	3 cents per correct answer	23
T2	30 cents per correct answer	35
T3	1 euro per correct answer	34

While it is expectable that there is a significant increase in the outcome of T2 compared to T1, the fact that there is a significant decrease in the outcome with the introduction of the 3 cents per correct answer (T1 vs. Control group) and there is no significant increase when the incentive goes from 30 cents to 1 euro per correct answer is hard to understand with standard economics theories.

In the second part of the study, high school students were asked to work (with a base payment) for a charity. Their job is to go door to door, asking people to raise money for the charity. Again, without them knowing, they are divided into three groups with different treatments.

Group	Incentive	Outcome (average amount raised)
Control group	No bonus	80
T1	1% commission	50
T2	10% commission	73

Here, the observed result (that the outcome decrease with the introduction of bonus as incentive) is also difficult to understand from the classical theories perspective.

These results raise two questions:

1. Why is it the case that people work (quite well) with no incentive?
2. Why do people sometimes response to incentives in a negative way?

Possible explanation

When the case that the monetary incentive is too low (the case of T1 in the first mentioned experiment), people might take the task less seriously than when there is no monetary incentive.

- Another example is that when a (relatively) small fine applied for parents picking up their children late from kindergarten. When there is no fine, parents tend to feel sorry for the teacher having to stay late to wait for them to pick up their children, so they would try to come early. But when there is the low fine, they get it as the signal that it is not that bad to come late, and it turned out that more parents came late than before the fine is introduced.

As suggested by the study of Gneezy, U. (2003) – The W effect of incentives, to some extent, a small fine/reward would have a counter effect: people would perform worse when there is a small fine or reward associated with their performance. Fine and reward are only worth it when these are sufficiently high.

Non-monetary incentives

One of the intrinsic motivations that we must consider is **public image concerns** (*what would others think of me?*). The lecturer discusses an experiment study conducted by Ariely, Bracha and Meier. (2009) in ***Doing Good or Doing Well? Image Motivation and Monetary Incentives in Behaving Prosocially***. In this experiment, students are asked to do some tasks, where for each well-done task they have done, a small amount of money is transferred to a charity. The students are divided into four groups (without knowing about the groups other than theirs own). To study how public image motivation influences the participants' performance, the study varies the image motivation by varying observability and bonus given out of outcome. The study results are as follow:

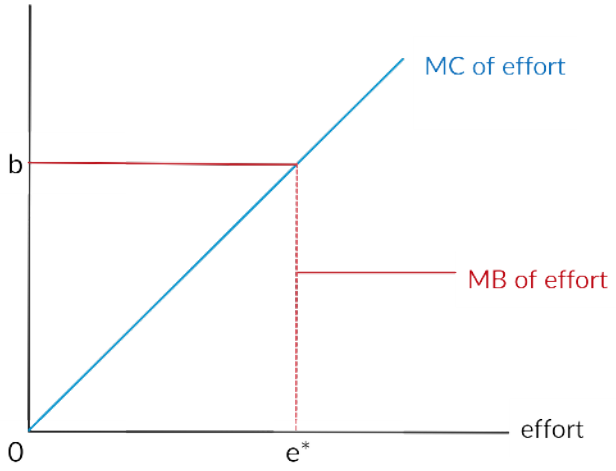
Group	Treatment	Outcome
1	Unobserved individual output, no bonus	517
2	Unobserved individual output, bonus	737
3	Observed individual output, no bonus	900
4	Observed individual output, bonus	814

It turns out that people perform better when their outcome is observed by the public. When not being observed, the result is as expected that a bonus increases the outcome. However, when being observed by other people, participants perform worse when they are given a bonus out of the total amount they made for the charity. The reason behind this is that the imagine motivation decreases when others can see that there is also some monetary incentive for the participants.

Prospect theory

According to **prospect theory**, people usually behave with their current **reference point** (of well-being) in mind. A loss amount of income decreases people's utility significantly more when their income is below their reference point than when their income is higher than their reference point. This is the **loss aversion** phenomenon.

Using graphical analysis, we can have a further look at this loss aversion phenomenon. Consider the case of a worker who has to decide on the level of effort exerted for the job. His marginal cost (MC) of effort is represented by the function MC = θe; his income is calculated by Y = a+be. It is observed that initially, the marginal benefit (MB) of the worker's effort is b. But at the point where MB=MC, the MB of the employee decrease significantly. The optimal outcome is that the worker chooses to exert e* units of effort, and get income Y* = a + be*.



The theory can explain the behaviour of taxi driver. A study by Farber, H. (2014) suggests that taxi drivers tend to have a reference point of daily income, which they have much fear of not achieving, but do not care so much to earn more than that. This example illustrates loss aversion in reality.

Fryer et al. (2012) also illustrate loss aversion with a field experiment on incentivising teachers to perform better. Base on the idea of exploiting loss averse employees, the experiment divides the teachers into three groups. All else (relatively) equal, these groups of teachers are incentivised as follow: For group 2 and 3, the expected value of the incentive is the same, but we observe differ outcomes. This is explained that the teachers' performance is better when the incentive is framed as a loss rather than a gain. When the teachers get the $4000 up front, their reference points apparently increase, and the utility loss from having to pay back this amount would be larger than the utility gained with the $8000 bonus from the initial reference points.

Group	Incentive	Outcome
1	No incentive	-
2	$8000 bonus in the end of the year if they perform well.	Better than no incentive
3	$4000 bonus in beginning of the year. At the end of the year, if they do not perform well, they would have to pay the $4000 back.	Best in the three cases

For group 2 and 3, the expected value of the incentive is the same, but we observe differ outcomes. This is explained that the teachers' performance is better when the incentive is framed as a loss rather than a gain. When the teachers get the $4000 up front, their reference points apparently increase, and the utility loss from having to pay back this amount would be larger than the utility gained with the $8000 bonus from the initial reference points.

Present bias

We consider a dynamic principal-agent problem with three periods (where the wage is only paid after the last period), focusing on the agent's choice of effort with the presence of discount factor δ and present bias factor β.

First, we examine the agent decision making ***when there is no present bias***. For this agent, the discounted utility funtion at period 0 would be

$U = u_0 + \delta u_1 + \delta^2 u_2$

$U = \delta^2(w + be_0 + be_1 + be_2) - V(e_0) - \delta V(e_1) - \delta^2 V(e_2)$

The agent when planing ahead would want to maximize his utility with respect to e_0, e_1, and e_2. This is given by the FOCs below:
$\delta^2 b - V'(e_0) = 0$
$\delta b - V'(e_1) = 0$
$b - V'(e_2) = 0$

Now we consider the case where he does not plan ahead in the beginning of the first period but chooses his effort level in each period. The utility functions that he considers each time would be:
(0) $U = \delta^2(w + be_0 + be_1 + be_2) - V(e_0) - \delta V(e_1) - \delta^2 V(e_2)$,
(1) $U = \delta(w + be_1 + be_2) - V(e_1) - \delta V(e_2)$,
(2) $U = (w + be_2) - V(e_2)$.

Taking the FOCs for each of those with respect to the effort level that he would have to decide on e_0, e_1, and e_2, we would have:
$\delta^2 b - V'(e_0) = 0$
$\delta b - V'(e_1) = 0$
$b - V'(e_2) = 0$

As we can see from these examinations, it does not matter when the agent makes the decision, as the optimal planned effort levels over his "life-time" is the same as the effort levels that he would chooses each period without a plan beforehand.

Now we examine the agent decision making ***when the agent is present biased***. For this agent, the utility funtion at period 0 would be:
$U = u_0 + \beta\delta u_1 + \beta\delta^2 u_2$
$U = \beta\delta^2(w + be_0 + be_1 + be_2) - V(e_0) - \beta\delta V(e_1) - \beta\delta^2 V(e_2)$

The agent when planing ahead would want to maximize his utility with respect to e_0, e_1, and e_2. This is given by the FOCs below:
$\beta\delta^2 b - V'(e_0) = 0$
$\delta b - V'(e_1) = 0$
$b - V'(e_2) = 0$

Now we consider the case where he does not plan ahead in the beginning of the first period but chooses his effort level in each period. The utility functions that he considers each time would be
(0) $U = \beta\delta^2(w + be_0 + be_1 + be_2) - V(e_0) - \beta\delta V(e_1) - \beta\delta^2 V(e_2)$

(1) $U = \beta\delta(w + be_1 + be_2) - V(e_1) - \beta\delta V(e_2)$,
(2) $U = (w + be_2) - V(e_2)$.

Taking the FOCs for each of those with respect to the effort level that he would have to decide on e_0, e_1, and e_2, we would have:
$\beta\delta^2 b - V'(e_0) = 0$
$\beta\delta b - V'(e_1) = 0$
$b - V'(e_2) = 0$

The examinations show that when deciding e_1 in period 0 (planned), β plays no role, but when deciding e_1 in period 1, β does affect the optimal effort level chosen. In both of the cases, the income is to be received in the future, but when making decision in period 0, the effort to be exerted is realised as also in the future. When making decision in period 1, on the other hand, the effort to be exerted is realised by the agent as in the present. This is commonly known as the "not-today" mindset, where the decision maker that has present bias prefers to avoid bearing cost (here: effort cost) (and/or to gain satisfaction) in the present more strongly than in the future.

Applied microeconomics – IBEB – Lecture 11, week 4 (personnel) Hiring and training

Reciprocity at work

In the principal-agent problem, the gift-exchange game (or trust game) is a situation when the principal offers a generous "wage" to the agent, and the agent (is expected to) work hard to repay for the "gift". Offerman's (2002) hot response game shows two important remarks regarding reciprocity: (1) Negative reciprocity is stronger than the positive one, and (2) Intentions matter for reciprocal behaviour.

Reciprocity can be viewed in 2 ways:

1. Generosity comes with an expectation (or obligation/pressure) to return the favour

2. There is a lack of information regarding the nature of a principal (who we can assume is either kind or selfish).

To differentiate the two, we have to look at actions. Paying a high base salary can signal that you are a kind principal, which makes the agent more likely to be compassionate and put in high effort in return. This is **conditional altruism**. Note that it may also be beneficial for a selfish principal to mimic the actions of a kind principal to get the agent to put in more effort.

Employee selection

The selection issue is not only about selecting people to hire, but also about composing a good team for the organisation (this includes multiple facets, for example avoiding good employee quitting and the decision of firing people).

When discussing the selection problems, we assume that each worker has a particular productivity (might differ from one worker to another, but for each worker it does not change). To find out what type of workers the firm should hire, we need to look at the benefit (productivity) and cost (wage) of hiring the worker.
This means that for a firm with a linear production function who is using 2 labour types, the employer must hire the worker with the higher productivity to wage ratio, that is MP/w. When employees are perfect substitutes in production and there is a linear production function, cost-minimizing Companies' hiring practices react quickly to pay fluctuations. A cost-reducing employer should choose a "some of each" worker mix that equalizes MP/w earned on each worker type when two distinct labor types are imperfect substitutes in production.

There are also other restrictions which may play a role in the problem, for example, space restriction.

Risky versus safe workers

We first only consider a period of 1 year, where hiring a safe worker would yield 200.000 revenue per year and hiring a risky worker would offer a probability of 50% that you hired a star with a net revenue of 500.000 per year. The other 50% is that you hired a “disaster”, with a net revenue of -100.000 euro per year. Expected value

brought by the risky worker is also 200.000. This makes the employer indifferent between the two types of workers when considering the period of one year.

Now consider a two-year period. In the same pattern with the previous case, the safe worker would bring 400,000 euro of net revenue for the company, while the risky worker would yield an expected revenue = 200.000 + 0.5 * 500.000 = 450.000. As you can always fire the risky worker when you find out he is a disaster, the longer period you consider, the more attractive the option of hiring a risky worker is.

In a country with high firing cost, the risky worker becomes less attractive to employer. Adding to the expected revenue calculated earlier is the expected cost of firing the disaster worker with a probability of 0.5. Moreover, in the context of a dynamic game, we also need to consider hiring a new worker in the case that the risky worker turns out to be a "disaster". Another thing to be considered is the threat of rival firm trying to attract the "star" worker to work for them. This crucially depends on the information that is spread in the labour market, and strongly influences the attractiveness of a risky worker.

The option value and attractiveness of risky workers increase with how risky they are but decline with the level of dismissal costs. Risky workers are therefore also less valuable in labour markets where worker productivity is public information because firms may be reluctant to chance on employees who have uncertain prospects.

Applied microeconomics – IBEB – Lecture 12, week 5 (public) Taxation: incidence and distortion

General remarks on taxation

For a functioning government, the right to tax is important. Tax revenue is needed for financing public provision of goods, anti-poverty measures (redistribution), Pigouvian subsidies, "input cost" government.

Evaluation of taxes can be done by looking at efficiency and distribution. The efficiency goals consist of minimising distortionary effects and correcting market failure in case of externalities. Distribution (or incidence) of tax burden is evaluated via questioning who suffers (and how much) in the society. Such an evaluation determines whether tax is distributed through horizontal equity or through vertical differentiation. Horizontal equity is the distribution by which people are considered equal and thus pay the same amount of tax. Distribution through vertical differentiation implies that citizens who are better off pay more taxes.

Four general remarks on taxation:
1. We need to consider that it is always the people that pay the taxes. For example, a corporate tax levied on firms is not paid by an extra entity but by the owners of that firm (through lower income for example).
2. There are two types under consideration. The unit tax is the same for every unit produced, while the ad valorem tax is a certain percentage of the price (so it increases with price).
3. It is important to stress that the above-mentioned characteristic of tax is determined with the help of the average tax rate, which is the ratio of taxes paid to income. Note that this is not always equal to the marginal tax rate.
4. Lastly, we define the progressiveness of tax as follows:

- A tax is considered progressive if it increases as the individual's income increases (high tax for those with high income, and low tax for those with a low income)
- A tax would then be considered regressive if the opposite occurs
- Finally, a tax is considered proportional if it is constant in income

Universal basic income: is the public pension that doesn't depend on the individual's age. That is, everyone gets an amount B with no conditions

Incidence: distribution of tax burden

This part of our analysis through the now known framework of efficiency and distribution begins with distribution. Here we question not only who pays for the tax but also who bears the economic burden. This leads to two definitions:

- Statutory incidence is regarding the entity that pays, in the sense of transferring the money to the treasury and is prescribed by the law. It is the legal incidence of the tax.

- Economic incidence is regarding those who bear the burden of tax. This is determined by te price changes included by a tax. The economic incidence therefore depends on an individuals sources and uses of income. Imposing a tax affects all parties involved in the production and consumption of the goods in question. In other words, the market decides. This leads to tax shifting, which occurs when the groups made worse off by the tax is not synonymous to the party that pays.

Note that economic incidence is completely independent of the statutory incidence. This means that the person paying the tax is completely irrelevant to who has to effectively bear the tax. This is determined purely through the market.

Partial equilibrium analysis of the distributional effects

In partial equilibrium, the concept of elasticity is of large importance. The general definition of elasticity is the following:

$$\varepsilon = \frac{\frac{\partial Q}{Q}}{\frac{\partial P}{P}} = \frac{P}{Q}\frac{\partial Q}{\partial P}$$

which goes to say that elasticity is the percentage change in the quantity as the result of a 1% change in the price of the good. This can be taken further to say that a perfectly elastic demand/supply is a horizontal line and a perfectly inelastic demand/supply is a vertical line. The more elastic, the lower the share of the tax burden.

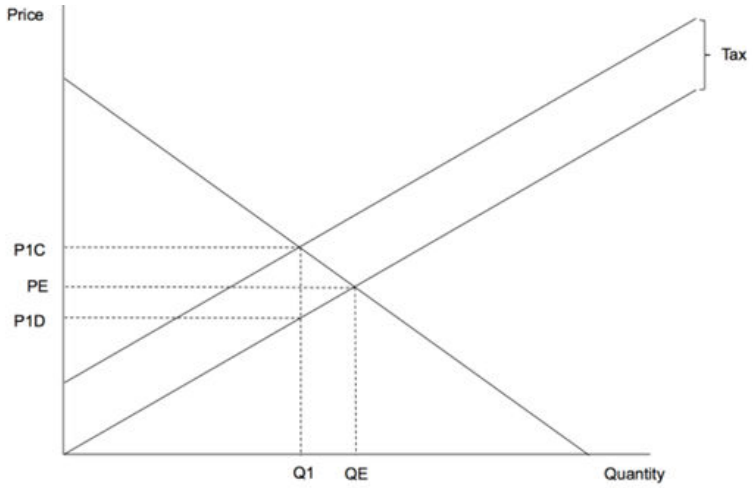


Figure 1: Unit tax on the supply side

In this diagram (Figure 1), we see an introduction of a unitary tax on the supply side. This distorts the equilibrium to the left, with higher prices for consumers and lower income for suppliers. The tax burden is split between consumer and producer (Consumer → (P1C-PE)*Q1, Producer → (PE-P1D)*Q1).

why does this happen?

Intuitively we can argue the following: The difference in the consumer and supplier price is the unit tax (P1C=P1D+Unit Tax). Therefore, the quantity demanded decreases as at the new price consumers are willing to buy less and quantity supplied increases with price. Which leaves only one point where the new Quantity demanded = Quantity Supplied and the price equation P1C=P1D+Unit Tax holds.

As we said earlier, the tax depends on the elasticity. As such the tax burden (in the example faced by both rather equally) shifts with changes in elasticity. It can be summed up by saying that the tax for one party (buyer or seller) decreases with an increasing elasticity (inelastic leads to high burden) given the elasticity of the other party (buyer or seller).

General equilibrium analysis of the distributional effects

There may be the situation that a tax in one market has a spill-over effect into other markets. This requires us to analyse the effects of this tax on the general equilibrium rather than the partial single market. In this case, we look at it through the lens of the Harberger model.

Let us assume that there are two production factors Labour and Capital that are present in the two markets of food production and housing production. Furthermore, the supply of each factor is fixed but mobile between the sectors, with food production being the more labour intensive. Lastly, we assume perfect competition, identical preferences, and constant returns to scale.

In this framework, let us put a tax on capital. There are two effects:

- The output/income effect, which can be described in the following way: with a tax the product becomes more expensive, and the consumer buys less food.

Therefore, some of the labour and capital moves into housing production as the food market adjusts production. Since housing is capital intensive, this causes the relative price of capital to increase.

- Meanwhile, with the substitution effect we see that with a tax on capital the producers now have to pay more for this input. They may then substitute in more labour instead; this leads to a relative decrease in the price of capital. Thus, tax distorts behaviour through the substitution effect.
  - If tax revenue is less than the loss in welfare, there exists an excess burden.
  - For a Lump-sum tax, substitution effect is 0 and there is no distortion of behaviour or excess burden.

The total effect is then ambiguous.

The efficiency effect of taxations

When the government imposes a tax, the taxes are not lost. They are transferred to the government, yet this transfer in and of itself is not an inefficiency. However, with the imposition of the tax there is usually an Excess Burden. As seen in the previous diagram (Figure 1), imposing a tax causes a loss to producer and consumer surplus. This loss is partially captured in taxes for the government, yet there is a small area that is simply not captured by anyone, and is a surplus that is lost, thereby causing an inefficiency.

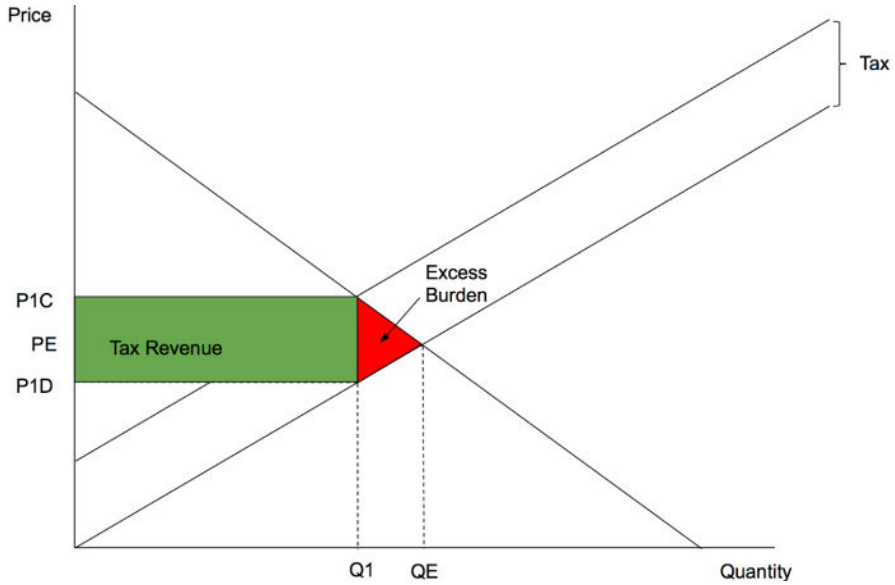


Figure 2: Efficiency effects of imposing a unit tax on the supply side

In Figure 2, the excess burden is the red triangle between the old and new equilibrium. This excess burden occurs on a market level.

We might explain this by equilibrium theory. We know that in the original equilibrium MRS=MRT=Px/Py (see previous summaries). With the imposition of a unit tax the consumer's MRS goes to (Px+t)/Py whereas the MRT remains at (Px-t)/Py, therefore the MRS no longer equals the MRT and we are not at an efficient equilibrium.

The efficiency effects on an individual level

We consider here the two-good economy for one individual. Consider the general good and a further good such as bread. Furthermore, consider that the individual's income is fixed. If we impose a tax on the bread, then the individual's budget constraint rotates inwards, and he is on a lower indifference curve.

In this case, we know that the tax revenue is the difference between his new budget constraint and the untaxed budget constraint for his new equilibrium quantity of bread (B1).

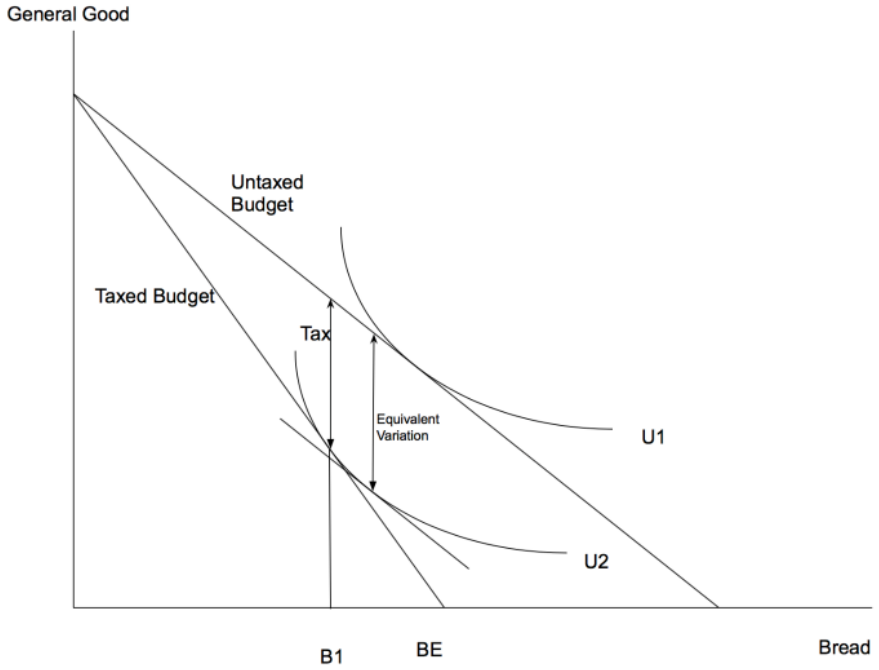


Figure 3: Efficiency effects of imposing a tax on bread (individual level)

Here we also note that there is an equivalent variation. This is the amount of money we would be able to detract from the individual's fixed income to arrive at the same indifference curve (U2) as with the tax without a change in relative prices. This means that if the equivalent variation is larger than the tax revenue, we have an excess burden present.

The equivalent variation is actually the same as the income effect, which in itself does not cause an inefficiency. It is only the substitution effect (difference to tax revenue) that is responsible for the inefficiencies. For instance, if we impose a tax on bread then the consumer can buy less goods (income effect). The relative price of bread has also increased, and the consumer might shift consumption away from the bread to the non-taxed general good. This causes the excess burden, which is because of the tax revenue being smaller than the equivalent variation.

Are there taxes without any excess burden?

Yes. There are indeed taxes that do not contain an excess burden, these are known as **"Lump Sum Taxes".** They do not distort behaviour, since the substitution effect is 0. An example of this would be a population wide "head tax", meaning that if you have a head, you pay this tax, so there is no way around this tax by changing your consumption, one simply has to pay it.

Applied microeconomics – IBEB – Lecture 13, week 5 (personnel) Monopsony, efficient wages, and employee training

Monopsony

The case of monopsony is when the elasticity of labour supply to the firm is low, i.e. firms will not lose many workers when they cut wages. This is a very controversial issue, since in a lot of markets in the world, there seem to be too much monopsony power for employers.

We build a model of a firm's profit depending on the wage that it pays its workers.

Profit = (Q - W)*N(W). Here, N represents the number of the firm's workers, which is an increasing function of W. Maximizing profit with respect to W, we would have the FOC: -N(W) + (Q – W)*N'(W) = 0. In this equation, we can interpret N(W) as the marginal cost, and (Q-W)*N'(W) as the marginal revenue.

To rewrite the FOC in term of an elasticity, we first multiply all the terms in the equation by W/N.

$$-W + (Q - W)*N'(W)*W/N = 0 \quad (1)$$

We see the term $N'(W)*W/N$ here in the equation. This is the wage elasticity of the labour supply (denoted by η), we would have the profit-maximizing wage expressed as below:

$$(1) \Leftrightarrow W = Q * \eta/(1 + \eta)$$

Looking at the extremes: when η is extremely big (tends to infinity), $\eta/(1+ \eta)$ tends to 1, and therefore W is equal to Q (what a worker brings to the firm) in this case. This is when there is a lot of competition (perfect competition) where employers compete for workers. Consider another case when $\eta = 1$, then $W = 0.5Q$. This shows that the higher wage elasticity of workers is, the higher wages are in optimal state.

Hence, in extreme conditions:

(1) When labor supply is completely inelastic ($\eta = 0$) : Profit-maximizing wage is also 0
   - Cutting the offered wage will not cause any workers to leave. Employees will stay even if wage is 0.

(2) When workers are paid their full productivity ($w = Q$) : labor supply is infinitely elastic.
   - Cutting wage by a little bit will cause ALL employees to quit. In this situation, firms will have to earn zero profits and pay employees their full profits.

A simple implication of this model in reality is the labour market in the city compared to one in the countryside. In small villages, there is not many employers, whereas in the city, there are often large number of employers. The competition for workers in the city is much more intense, and workers of a particular occupation would have much more choices of which employers to work for in the city. Therefore, companies in the city cannot pay low wages, otherwise no worker would work for them.
The gender differences in pay (men usually get paid higher than women) is another fact that this model can partially explain. It is observed that men are more mobile in

the labour market than women (for example, there exist cases where when the husband gets an offer to work at the other side of the country, his family would move with him; but when the wife gets such an offer, her family is less likely to move). The predication behind this is that the male labour supply is more elastic to agents than the female labour supply. Employers can hence afford to pay women less than men.

Reasons for high wages

Higher relative wages can bring in higher revenues and profits as quantity of workers increase. The quality (productivity) of labour attracted by high wages may also increase. The third reason for paying high wages is that high wages increase the motivation level of workers (possibly caused by reciprocity, motivation to keep their job, etc.). High wages may also result in reducing turnover. However, these benefits would not be obtained when the rival companies also increase their employees' wages, because these arguments are based on relative wages in the economy.

Deferred compensation as an incentive device

One puzzle that employers might face is that old employees get paid a lot, yet are not always the most productive. To study this puzzle, we use a simple model where workers can choose between working and shirking. Shirking is detected with probability π, and being caught shirking means getting no wage and being fired.

Consider first an old worker in the last year of his work life. His utility when working is $W - V$, where V is the cost of effort. When shirking, his utility is $(1 - \pi)W + 0\pi$. Hence, for old workers to work, W should be greater or equal to V/π. For example, if $\pi=0.5$, the old worker should be paid twice his cost of effort to not shirk.

Supposed X is the discounted value of keeping the job after the period being considered. For the old worker, X is 0, but for the young worker, X is positive. Therefore, for the young worker to not shirk, W is at least equal to $V/\pi - X$. The larger X is, the lower the company has to pay the young worker compared to the old worker.

Training

The remaining portion of the lecture is devoted to looking at investments made in the training of already-hired employees. Here, businesses and employees may each

bear a portion of the costs associated with obtaining certain abilities and profit from the increased productivity those skills produce.

worker-financed training

One benefit of (formal) education/training is that it increases one's future earnings. Most empirical research estimates the returns to education to be about 7-9%.

Optimal schooling choice can be found by building a simple two-period model. In the first period, one can choose to work or go to school, and in the second period, one will work. Unskilled wage is J and skilled wage is K, where K>J. The cost of tuition and related cost is C. Discount rate is r. Going to school in the first period is optimal if return to education exceed sum of direct costs and indirect cost of schooling (forgone earnings):

$$-C + K/(1+r) > J + J/(1+r)$$

Hence, employee investments in their own education/ training are more likely to pay off when (1) there is high effectiveness to the training, (2) low opportunity & direct costs to training, (3) low interest on the cost of the training, (4) a shorter training period , and (5) a longer time period by which the effects of the training can be reaped. Moreover, worker-financed training is also more worth it the more likely the employee is to remain in the labour market and continue the skills he has learned.

on-the-job training

One important distinction to make is between general on-the-job training and firm-specific on-the-job training.

General on-the-job training provides skills that the workers can apply in a position in other firms. Optimally, workers should be paid more after obtaining this kind of training, but they should be paying for the training cost themselves, as they benefit from it. Examples of general skills include proficiency in software such as that of MS office, C+++, accounting skills, etc. . The value of acquiring general skills increases with the worker's expected future labor force attachment.

A firm-specific training program improves workers' productivity specifically on the tasks performed for the firm, but these skills cannot be applied elsewhere. As this firm would then benefit from the more skilled workers without the threat of spilling these

benefits to other rival firms, the firm should pay for the training cost for its workers. These skills are only useful if the employee stays with the current employer. Examples of firm-specific skills include knowledge of the company's internal procedures, culture, politics, and other skills that are not widely utilised in the employee's labour market. The value of acquiring firm-specific skills increases with the worker's expected retention rate at the firm where that worker was trained.

Investment in firm-specific training is therefore most attractive when turnover is likely to be low and when workers are likely to stay in the firm for a relatively long period. It is also more effective if the interest funds used to finance the training are low (r), and if the training period is short. Likewise, workers will only accept low starting-wage when a firm is likely to keep the worker.

Applied microeconomics – IBEB – Lecture 14, week 6 (public) - Optimal taxation

There are three main parts that are discussed in this summary, as were in the lecture:

1. The first, and main, question that will be dealt with is: given a fixed amount of revenue that must be collected, what is the least inefficient way in which this can be done? (minimizing total Excess Burden)
2. Whether a proposal (for intervention or redistribution) will still improve social welfare when we account for excess burden?
3. Lastly, we will consider several qualities to evaluate taxation systems (efficiency and distributional issues)

Minimizing the excess burden

Given that we need to raise a certain amount of revenue **R** and we are not using a lump sum tax (which would cause zero inefficiency), how is this best done? This implies that we want to distort as little as possible and ignore distribution, assuming that all individuals are equal.

Assume that we are in a world with the goods **X**, **Y** and leisure **L**, as well as a fixed number of hours available **T** and a wage **w**. Then we know that we can write the budget constraint as:

$$wT = P_x X + P_Y Y + wL$$

How should we tax different commodities such that we raise R at minimal total excess burden?

First option

Our first option to consider here is if we could just tax all commodities (including leisure) equally. This would imply that there would be no excess burden since the prices would all be changed equally in proportion (no change in relative prices).

$$wT = (1 + t)P_x X + (1 + t)P_Y Y + (1 + t)wL$$
$$w\frac{T}{1+t} = P_x X + P_Y Y + wL$$

According to the second equation, an equal tax on all commodities would be exactly the same as a tax on the time endowment. This in turn would be *alike to a lump sum tax.* However, this is technically not entirely possible since we are not able to tax leisure as a commodity.

Second option

Our second option, considering that we are not able to tax leisure, then is to tax all the other commodities equally:

$$wT = (1 + t)P_x X + (1 + t)P_Y Y + wL$$
$$\frac{w}{1+t}(T - L) = P_x X + P_Y Y$$

This does involve an excess burden since it distorts relative prices and there exists a substitution effect (changed behaviour). Leisure has now become more attractive to the individual, causing a distortion. In other words, it is now less attractive to work in comparison to having leisure time. Note that taxing all goods except leisure at the same rate gives the same budget constraint as a proportional income tax.

Conclusion

Hence, given our goal, we must focus on taxing commodities despite the excess burden that it may cause. Now, we must ask ourselves- which commodities should we tax and at which rate?

The Ramsay rule

We have just concluded that the tax on all commodities leads to an excess burden. This can be minimized effectively by the Ramsey Rule which we will derive now.

In order to derive Ramsey's rule, we are going to make several simplifying assumptions:

1. Supply curves are perfectly elastic/horizontal
    a. (meaning that all effects on a market run through the demand and constant marginal costs).
2. Cross-price elasticities are 0, such that goods are neither substitutes nor complements
    a. (meaning that the effects of a certain tax on a good are contained in this good's market).

From the previous weeks, we know that the **Excess burden** can be calculated as (t is an ad valorem tax):

$$EB = \frac{1}{2}\left(tP_0\right)(\Delta Q)$$

In reality it is often hard to measure the change in Q because it is usually not extremely large or has happened in a wide range. However, we do know the elasticity of demand:

$$\varepsilon_D = \left|\frac{P_0}{Q_0}\frac{dQ}{dP}\right|$$

Using the fact that with an ad valorem tax the change in price is equal to tP_0:

$$\Delta Q = \varepsilon_D t Q_0$$

This implies that instead of using the change in Q we can use the elasticity of demand in order to calculate the Excess Burden as follows:

$$EB = \frac{1}{2}\varepsilon_D Q_0 P_0 t^2$$

In case of a **unit tax (u)**, this becomes:

$$EB = \frac{1}{2}\varepsilon_D \frac{Q_0}{P_0} u^2$$

Two important results can be implied from the equation above. Firstly, EB increases in demand elasticity. The larger the elasticity of demand, the larger the distortion and excess burden. This is because there would be a larger reduction in quantity after an increase in consumer price. Hence, we would need a lower tax rate for goods that are less elastic in demand.

The second result is that EB increases quadratically in tax rate. A higher tax rate implies a higher increase in the EB if the tax rate increases.

Therefore, we can minimise the excess burden (quadratic in tax) by spreading this tax across several markets (to keep the specific tax rates lower). More precisely, it would be ideal to tax high elasticity markets with a low tax, and low elasticity markets with a high tax.

What we need to do in order to formulate this as a ratio is to find **the optimal point**. The optimal point occurs when the marginal excess burden of good X is equal to that of good Y. In other words, the marginal excess burden should be equal across commodities.

To get R in revenue we must tax a good X as follows, giving the marginal increase of the tax per euro of extra revenues as well:

$$t = \frac{R}{PQ} \qquad \Rightarrow \frac{dt}{dR} = \frac{1}{PQ}$$

We know that the Marginal Excess Burden is the change in the Excess burden for every change in the amount of revenues we wish to collect:

$$MEB = \frac{dEB}{dR} = \frac{dEB}{dt}\frac{dt}{dR} = (\varepsilon t PQ)\left(\frac{1}{PQ}\right) = \varepsilon t$$

Inverse elasticity rule

Equalizing this across goods yields the Ramsey Rule (or "inverse elasticity rule"):

$$MEB_x = MEB_y \quad \Rightarrow \quad \varepsilon_x t_x = \varepsilon_y t_y \quad \Rightarrow \quad \frac{t_x}{t_y} = \frac{\varepsilon_y}{\varepsilon_x}$$

This means that for a higher elasticity there should be a lower tax, until the equation is balanced again. The ratio of tax rates is *inversely proportional* to the ratio in elasticities.

In effect, this can also be derived using Lagrange on the total excess burden under the restriction that revenue equals to R.

The implication of the tax lowering efficiency

We know that excess burden is a cost to society, and therefore should be taken into account in a cost benefit analysis done by the government on spending the money. Optimally this would imply that the marginal benefits of the last euros of a subsidy given by the government are equal to the marginal cost of the subsidy, the marginal cost of the subsidy being the value in money in addition to the excess burden. The Marginal Cost of Public Funds (MCPF) is calculated by estimated labour elasticities and tax levels. It proves that there is a tradeoff between efficiency and distribution. In OECD countries, the Marginal Cost of Public Funds (MCPF) is approximately 1.2 to 1.3.

The evaluation of taxes

In his blog, Gregory Mankiw proposes four categories to measure the impact of a tax.

1. **Efficiency:** is the distortion of individual choices through changes in relative price minimized?
2. **Egalitarianism:** Is the distribution of income more equal after taxes?
3. **Intergenerational Equity:** the revenue from the taxes should be such that the current generation does not burden the future generations with increased debt (currently a large problem with high government debt and an ageing population).

4. **Stabilisation:** is the dampening of the business cycle (Keynesian perspective) achieved through the taxes? (Timely increase and decrease of expenditure can dampen the business cycle. Usually, the government acts rather late though, and the business cycle ends up being more extreme).

Depending on which of these categories is prioritized, there is a trade-off in the taxes implemented (distribution vs. efficiency) as criteria 1, 2, and 3 demonstrate.

Applied microeconomics – IBEB – Lecture 15, week 6 (personnel) - Competition in the workplace

application of tournament theory

There are certain similarities between the case of a tournament and a firm's promotion system. For a tournament, there are fixed prizes and fixed number of winning positions. Also, in a tournament, the winner(s) is determined by comparing his performance with other competitors. In other words, relative performance matters. We can observe the same things in the case of an organisation: there are an order of (fixed) positions where the higher the position is, the more benefit (and responsibilities in most cases) the workers can obtain. To get promoted, a worker needs to be evaluated as being better than his co-workers (relative performance is, hence, what matters here).

Tournament theory can be found applicable in analysing various other cases. For example, consider the case of construction firms competing for the best design for a public building project – it is not about how good the design is, but about whether it is the best *in comparison* with other firms' design.

Back to the case of a firm that wants to maximize its profit by creating a competitive working environment. For simplicity, we assume this small firm has a manager and two workers. The manager creates an incentive of offering promotion (with value Z) for the worker that is observed to perform better than the other during a given period

(here hiring an outsider for the position is not an option for the manager). To perform better, a worker intends to stay at work until a bit later than usual. The other worker observes this and decides to stay a little longer than that. This pattern of the two workers observing each other and try to perform better than the other continues until the marginal cost of staying at work longer would be greater than the expected marginal benefit.

Out of this competition of the two workers, the firm/the manager obtains the most benefit. Therefore, the manager would try to make the working environment very competitive. However, this also has a drawback. If the working environment is too competitive (and therefore, stressful), the firm might not be able to hire the two workers in the first place as they can anticipate the disadvantages of such a working environment, or the workers might quit if they feel too stressful (participation constraint).

promotion system (relative performance-based system)

In many cases, a relative-performance-based system is better than an absolute-performance-based system. An absolute performance-based system can be ineffective when there is an abnormal factor that makes the expectation on the worker's performance too difficult to achieve. For example, offering a reward when a salesman achieve at least 3% increase in sales could be ineffective. This is when even avoiding loss is hard for that particular period (caused by various unexpected factors), then the goal of increase in sale could be considered too ambiguous and the salesmen would not care about that incentive at all.

a simplified model

Consider a firm employing two identical employees (i and j), assuming there are only two periods. Both periods have equal length.

Hence, in the model, the firm is a principal that designs the tournament. The agents, who are 2 or more workers, decide on their career and choose their effort. Moreover, assume that in the second period, agents no longer exert effort. This assumption is for simplicity.

To create a competitive working environment, the firm promises giving a promotion (with value **Z**) in the second period for a worker based on the workers' performance the first period. In other words, the "winner" will receive salary B = W + Z and the "loser" will just receive W.

Promotion decision of the firm is based on the workers' relative performance, which depends on effort exerted and on luck. When worker's luck follows a uniform distribution, the chance of worker **i** to be promoted can be described by:

$$p_i = 0.5 + \pi(e_i - e_j).$$

The equation above aims to depict the chance of agent i in getting a promotion. The formula implies that if the two workers work equally hard, both will have promotion probability of 0.5. When worker i works harder than j ($e_i > e_j$), worker I has higher chance (not certain). Also, when noise π is too small (π=0), promotion decision only depends on luck. In this situation, How hard you work would be inconsequential to get a promotion. In contrast, when π is very great in value, luck plays no role.

the optimal wage scheme of the model

1. Determine worker's effort for all wage schemes, taken as given willingness to participate.

The worker's function of utility is given by:

$$U = W + p_i(W+Z) + (1 - p_i)W - 0.5\theta e_i^2 = p_iZ + 2W - 0.5\theta e_i^2.$$

As $p_i = 0.5 + \pi(e_i - e_j)$, we would have $U = (0.5 + \pi(e_i - e_j))Z + 2W - 0.5\theta e_i^2$.
The worker would maximize his utility => Taking the FOC for optimal effort, we would obtain: $e_i = \pi Z/\theta$. We can interpret this optimal value of e_i as the less noise plays a role, the higher is effort.

2. Derive the level of the base salary necessary to attract worker for all wage schemes, using the result on effort.

Expected lifetime (two periods) utility from working for this firm is given by:

$$(0.5 + \pi(e_i - e_j))Z + 2W - 0.5\theta e_i^2$$

Let V denotes the expected lifetime utility per period of the next best alternative to this job. The participation constraint is then:

$$(0.5 + \pi(e_i - e_j))Z + 2W - 0.5\theta e_i^2 = 2V$$

As we have found out earlier, the two workers' optimal choice of effort would be $e_i = e_j = \pi Z/\theta$. Plugging these in, we would have:

$$[0.5 + \pi(\pi Z/\theta - \pi Z/\theta)]Z + 2W - 0.5\theta(\pi Z/\theta)^2 = 2V$$

$$\Leftrightarrow \ldots \Leftrightarrow W = V - 0.25*Z + 0.25*(\pi Z)^2/\theta \text{ (the workers' participation constraint)}$$

$$dW/dz = -0.25 + 0.5*\pi^2 Z/\theta$$

This result shows that the derivative of W wrt z is negative for low Z, positive for high Z.

3. Find the wage scheme that maximizes profits, using the results on optimal effort and base salary.

Assume an unit of effort is worth P to the firm. The firm's profit would then be given by: $2Pe - Z - 4W$. Substituting worker participation constraint W and the worker's effort choice e into the profit function, we would have:

$$2P\pi Z/\theta - Z - 4[V - 0.25Z + 0.25*(\pi Z)^2/\theta]$$

$$\text{FOC (maximizing wrt Z): } 2P\pi/\theta - 1 - 4[-0.25 + 0.5\pi^2 Z/\theta] = 0$$

$$\Leftrightarrow 2P\pi/\theta - 1 + 1 - 2\pi^2 Z/\theta] = 0$$

$$\Leftrightarrow Z = P/\pi$$

Optimal promotion bonus can be concluded to increase with the firm's value of effort (P) and to increase with noise (a lower π implies a higher Z).

Substitute $Z = P/\pi$ into $e = \pi Z/\theta$, we would have $e = P/\theta$. This implies that worker's effort increases with firm's value of effort and decrease with worker's cost of effort. As we can see, in the end, noise π has no effect on effort, as its effect on effort is neutralised by a higher promotion b.

We also see that, in this situation, we would expect the principal to be indifferent between a tournament setup and a bonus or piece-rate scheme. Extensions can however be made to differentiate the two models. For example, if we include measurement costs, we would expect these to be higher in the piece-rate model (where everyone must be observed) than in the tournament model (where we might expect that some participants do not have to be observed in detail as they are almost guaranteed to be promoted or not i.e. the workers not in the middle of the effort distribution, such as a worker who is known to excel, or one who is not focused on future progression). We could also consider the common luck effect, which could

make the bonus model more volatile than the tournament model, as everyone is affected by macroeconomic conditions in, for example, their sales outcomes in the bonus model.

One downside of the internal competition model is that there is an incentive for workers to want their colleagues to fail, which may make the working environment worse and negatively affect profits.

Applied microeconomics – IBEB – Lecture 16, week 6 (personnel)- Discrimination

Discrimination in the labour market can be tested by submitting multiple applications to a large number of similar companies with the same qualifications, CV and motivations, but only changing the name or picture or background of the applicant. This kind of study is called a **correspondence** or **audit study**. Changing the decision to accept or reject an applicant based on a factor such as ethnicity, religion, gender are illegal.

Causes of discrimination

1. **Tastes/preferences of recruiters/managers**
    a. When recruiters/managers prefer to surround themselves with certain types of people, and discriminate to satisfy their preference.
    b. Hiring managers may have preferences that favour people who they can easily identify with in a group, such as those who look like them or are of the same race and/or gender.
2. **Tastes/preferences of customers/employees**
    a. When certain applicants are hired because managers have reason to believe that the customers or other employees prefer to be surrounded by this type of person.

3. **Statistical discrimination**
    a. When someone is hired over another because that type of person is on average more productive at some job e.g. women on average have better fine motor skills than men
    b. In other words, this is considered to be unbiased employer beliefs about the relative productivity of two groups.
    c. This can be a *self-fulfilling prophecy*, because there is a lesser incentive for the discriminated group to invest in gaining the kind of education or skills to let them get the job they are statistically discriminated in, and this reinforces and magnifies the statistical differences over time.
4. **Biased beliefs**
    a. Biased belief is similar to statistical discrimination, but instead it is based on false assumptions or untrue statistics.

Discrimination can also be a conscious or unconscious decisions. This is of course very difficult to determine, however there are some methods to reveal unconscious biases, such as the implicit association test.

Consequences of discrimination

In a for-profit firm, different types of discrimination can have different effects on profits:

1. **Tastes/preferences of recruiters/managers**
    a. Is bad for profits, because it can lead to a suboptimal selection of workers.
2. **Tastes/preferences of customers/employees**
    a. Can be good for profits, because customers are more satisfied and employees can be more productive working with people they prefer.
    b. However it can be suboptimal In the long run as it may be better to let the biased employees/customers go and create a new, unbiased workforce/customer base.
3. **Statistical discrimination**
    a. Can be good for profits (depending on the strength of the statistics), especially when there are a large number of employees and the trends are more evident, although it should be more profitable regardless of firm size

4. **Biased beliefs**
    a. Is bad for profits as the bias is based on false assumptions.

Discrimination can also cause vicious cycles and self-fulfilling prophecies as mentioned previously. Widespread recruiter/manager/employee/customer biases can result in certain demographics not seeking the education or training that they would need for jobs that they are less likely to get due to discrimination. This can then result in future statistical discrimination and unfulfilled potential.

Similarly, the presence of a biased manager may negatively affect a discriminated worker's productivity (because of lack of career prospects or other aspects), thus confirming the bias and enlarging the problem. This is called the **stereotype threat effect**.

(Possible) Interventions

1. Give sufficient time and resources to recruiters – biases are increased by time pressure and stress. This leads them to relying on stereotypes and "gut reactions". Changing the decision environment to give recruiters access to a quiet area and more time may decrease bias.
2. Monitor recruiters through tests such as the implicit association test
3. Blind recruiting – make certain parts of an application that should not influence the success of an applicant anonymous (e.g. name, ethnicity, religion, age, gender)
    a. Sometimes this is not effective because, at some stage in the process, an applicant must be un-anonymised and there is still the opportunity for discrimination at this point.
    b. Blind recruiting can also be ineffective because by restricting employer's access to specific information, recruiters may rely more on other worker characteristics that signal missing information. This causes them to rely on their assumptions on information yet again.
4. Raising awareness – for example diversity training (although diversity training is not always very effective), or making people aware of their unconscious biases.

The government can also try to intervene. One possibility is to actively try to find and fine discriminatory firms.

Applied microeconomics – IBEB – Lecture 17, week 7 (public) - Collective decision-making

In the lectures up until now, we have taken the government as an entity that benefits the society. More specifically, a government where merely the effects of a specific intervention in a normative sense were considered. Now we will look at the positive analysis in terms of how the decisions at the government should be made and are made in practice.

The government is often said to be serving the people, however the people as an entity does not exist. The reason for this is that individual preferences for collective actions are different and idiosyncratic in nature. Some people wish the collective to go one way, whereas another might disagree. In other words, there will always be a winner and a loser to any given decision, thus it implies that government involvement does not necessarily lead to a pareto improvement, i.e. government failure.

There are four main reasons for government failure:

1. Imperfect political representation and problems with aggregating preferences
2. A lack of information about individuals' preferences and firms' production processes
3. Rent-seeking and corruption by those in government ("regulatory capture")
4. Limited or misaligned incentives in case of public production.

Individual preferences in collective decisions

As mentioned above, individual preferences have an effect upon collective decisions. For example, different parties will react differently to public expenditure on issues such as social security. We assume that the individual preferences are depending on income and prices (taxes), to show that even with identical individual preferences (utility functions) the optimal outcome may differ across individuals for some decisions.

In the world of this example, there is an ad valorem (proportional) tax on income to finance social security. If there are n individuals who differ in income Y_i, and average income is Y_m then tax $t=G/(N*Y_m)$ where G is the public expenditure on public goods. Thus the tax cost on increasing income is $tY_i=(G*Y_i)/(N*Y_m)$ where the marginal effect of G is:

$$\frac{\partial tY_i}{\partial G} = \frac{Y_i}{NY_m}$$

We also have two completely identical individuals with the only difference being income. The high-income individual (A) has to pay more (proportional tax) but may have a lower demand for social security benefits compared to the low-income individual (B) who pays less for the social security program. In essence, the price that the high-income individual faces is too high for the benefit of more social security of the individual. Therefore, we can say that the low-income individual might desire more social security (it benefits him and costs a lower absolute amount) whereas the high-income individual benefits less but pays more.

Collective decision-making procedures

There are three distinct procedures: dictatorships (social planning), direct democracy and representative democracy. Dictatorships are generally not desirable, and as such will not be discussed much further.

Direct democracy

Direct democracy generally works through referenda and implies that every person who votes has a say. There are two versions of this: the first is unanimity (everyone has to agree in order to implement a decision) and majority voting (the majority choice will be implemented).

- With **unanimity**, the immediate question that might arise is 'how we manage to get all parties to agree to a proposal?'
  In practice, unanimity decisions are rarely effective or get implemented. However, there is a theoretical method in which everyone can be tested to agree. This solution is to implement **Lindahl prices**. This is a form of taxation in which each individual pays for public goods according to their marginal benefits. In other words, individuals report their willingness to pay. In practice,

this would probably result in a huge free-riding problem, as well as it being very costly to determine each individual's marginal benefit.

- The second way to come to a decision in direct democracies is to use **majority voting**. This can be with a simple majority of 50% or with a specified scheme, such as a two thirds majority. A large issue with this is that minorities are easily repressed, since the majority will win the vote in the first place. Furthermore, there is an issue with the **voting paradox.** This is a situation in which individually transitive preferences do not translate to collectively transitive preferences.

Take this example:

	Person A	*Person B*	*Person C*
Most Preferred	*Z*	*Y*	*X*
Second Preferred	*Y*	*X*	*Z*
Least Preferred	*X*	*Z*	*Y*

In this case, we see that every person has a clear order of preferences (transitive). However, if we vote in these orders then we cycle: X vs Y (Y wins) -> Y vs Z (Z wins). Now X should lose against Z, however this is not the case. We have obtained non-transitive preferences.

There are several extra issues with this voting method.

- The first is **agenda setting power**, i.e. each party would like to have the power to set the order of voting such that they get their desired outcome by design.
- This leads directly to the second issue, which is **strategic voting**, since people know that someone is setting the agenda the people might be incentivized to not vote sincerely in the first round in order to get a more desired outcome later.

Arrow's impossibility theorem

Five criteria for a voting system to be ideal are:

1. **Unrestricted domain** (all individual preferences should be allowed).
2. **Pareto-criterion** (if all prefer X to Y then the voting system should return X).
3. **Non-Dictatorship.**
4. **Transitivity** (if X>Y and Y>Z then X>Z).

5. **Independence of Irrelevant Alternatives** (if for options X,Y X>Y then adding an option Z should not change X>Y).

According to Arrow's Impossibility Theorem, it is not possible to find a decision-making procedure that always fulfils the 5 criteria introduced above. However, for a given state (e.g. identical preferences) it is possible to find a method that gives exactly these results. On the other hand, this implies that a direct democracy cannot prevent "unreasonable outcomes".

Majority Voting does yield a stable outcome with "single peaked" preferences. This means that we can find an outcome such that each individual can have an ordering of preferences and always attempts to get as close to his preference as possible. This means if we vote between two alternatives we can put all individuals on a line (of how strongly their preference is for an alternative). This means that the median voter determines which of the choices will be made.

Representative democracy

In representative democracy, the voting is outsourced to professional politicians. This has several **benefits**:

- It is too costly to have a referendum for each decision
- Information collection may be too expensive for the individual, so having professionals makes it easier.

However, there are several **problems** with this as well:

- Politicians may not know citizen's preferences.
- Politicians may also not be willing to inform themselves and end up misrepresenting information.
- Politicians may not make decisions in the interest of citizens.

Applied microeconomics – IBEB – Lecture 18, week 7 (personnel)- Teams

Workers' behaviour under team performance-based pay

Consider a simple model where two people work together, and they decide their exerted effort level independently. The team output is given by $Q = e_1 + e_2$, where e_i is effort level of worker i. The reward for each worker is W = 0.5pQ, where p is the unit price of the output. Here we assume p = 10.
Each worker's utility function is U = W – 0.5e^2, where 0.5e^2 is the cost of effort.

For worker 1 to maximize his utility (U = 0.5p(e1 + e2) – 0.5e1^2), he would choose an effort level that satisfies the FOC. This gives 0.5p – e1 = 0, so the optimal effort level for worker 1 is found to be e1 = 0.5p = 5. Doing the same analysis for worker 2, the optimal e2 is also found to be = 5. In this scenario, each of the workers would have their utility levels value to 37.5.

Simply have a look at the case where both of the workers work twice as hard, we can see that their utility level would be 50, which is clearly better for both of them. This can be explained by the fact that when deriving the optimal effort level previously, positive externality of the other worker's exerting effort has not been taken into account.

Social welfare is maximized when we jointly consider both of the workers' utility gain from the work. Social welfare = total utility = $p(e_1 + e_2) – 0.5\ e_1^2 – 0.5\ e_2^2$. Taking the FOCs, the optimal effort level will be $e_1 = e_2 = p = 10$.

An empirical study

Some organisation psychologists who are interested in this problem worked with a big farm growing oranges to conduct a field study regarding people's productivity in

teams. In this farm, the farm owner pays (a large number of) workers to pick oranges daily. The method randomized controlled trial (RCT) is employed in this experiment: a proportion of workers are randomly selected to work and get paid in teams of four, while the remaining group of workers still working under the conventional conditions (individual performance-based pay). It is observed that on average, having people working in a team decreases productivity by 25%. This can be attributed to free riding. However, there are other sources of influence on productivity as well, namely task-specialisation and knowledge spill-overs (people with different sets of skills and knowledge can cooperate and/or learn from each others) are the two positive influence sources. Without taking these into account, we might underestimate how severe the free-riding problem is.

To examine whether the team size has an effect on the production outcome, we have a look at the discussed problem, now consider a team of N people instead of two people. Study the problem from worker 1's perspective, we would have the output function: $Q=e_1 + (N-1)e_i$; the wage for each worker: $W = P[e_1 + (N-1)e_i]/N$ and the utility function of worker 1: $U = W - 0.5(e_1\text{^}2)$. (P is still 10 here.) Applying the FOC to maximize utility with respect to effort, we would get the optimal effort level of worker 1 to be $e_1 = 10/N$. This implies that as the team gets bigger, the optimal effort level from the individual's perspective would become smaller. The team output where each worker chooses to exert effort level 10/N would be Q= Ne = 10.

Possible solutions

The first proposed solution is to change the rule regarding workers' wages. We previously consider the cases where income is divided equally to all the workers. Now, assume that each worker would have a unique wage function, which would be the total output's value times a unique multiplier. However, plugging this into the problem, we would find out that this method does not work, i.e. the free-riding problem is not lessened at all.

The second possible solution is to introduce a bonus into the model. Consider the case of a principal hiring two workers to work in team, the wage offered in the contract is then W = a + bQ. Worker 1 would maximize his achieved utility by applying FOC to $a + b[e_1 + e_2] - 0.5e_1\text{^}2$ with respect to e_1. This would give $e_1 = b$ (= p =10). Each worker would receive a bonus income of bQ = 200, which is equal to the revenue = Qp. The base payment a must then be 0 at max, and the principal's profit is 0 when a=0.

Another possible solution is the “ambitious boss” solution, that the principal set $w_1 = w_2 = 100$ if $Q = 20$, otherwise the two workers would not receive any wages. Suppose that worker 1 is pessimistic and thinks that $e_2 = 0$. The best choice for worker 1 would be exerting no effort at all, then $U_1=0$. If worker 1 think that worker 2 would exert $e_2 = 10$, worker 1’s best choice would then be exerting $e_1 = 10$ as well, $U_1=50$. We can see that if both of the workers are pessimistic about the other, the outcome is worse than when they trust each other and both work hard.

The last case to consider is when the workers care about each other (altruism). Exercise 8.1 (Topic 8 of Personnel Economics: Teams) illustrates this case, introducing the term $(+ \gamma U_2)$ into worker 1’s utility function U_1, where γ shows how much worker 1 care about worker 2’s utility. When γ approaches 1, we can find out that the individual’s optimal effort level will be approximately the social optimal level. This implies that the more workers care about the others’ utility, the less of a problem free riding is.

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