13 Externalities

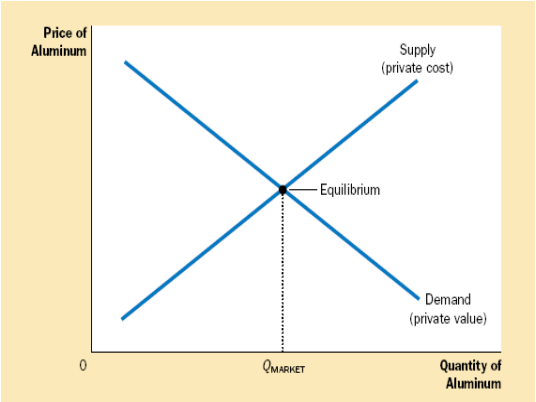
Up until now we have implicitly assumed that each agent could make consumption or production decisions without worrying about what other agents were doing. All interactions between consumers and producers took place via the market, so that all the economic agents needed to know were the market prices and their own consumption or production possibilities. Now we relax this assumption and examine the economic consequences of **externalities**.

We say that an economic situation involves a **consumption externality** if one consumer cares directly about another agent's production of consumption. For example we can have definite preferences about neighbors being too loud in the middle of the night, people smoking in restaurants, pollution caused by cars etc. These are examples of negative consumption externalities. On the other hand we can get pleasure from observing neighbor's nice garden. This is an example of a positive consumption externality. Other examples of externalities include exhaust from cars, restoring buildings, barking dogs, research into technologies, etc.

Similarly, **production externality** describes a situation in which production possibilities of one firm are influenced by choices of the other firm. A classic example is a bee farm and an apple farm located next to each other. Each firm's production positively affects the production possibilities of the other firm. So we have a case of mutual positive production externalities. Similarly, a fishermen care about pollution in the lake because that will negatively affect their catch.

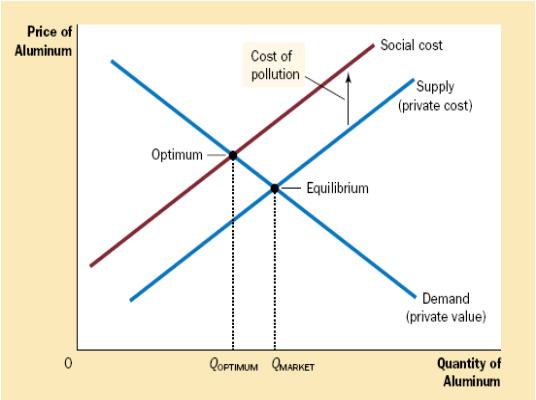
Market inefficiency caused by externality:

As we discussed during previous lectures the supply and demand curves contain important information about costs and benefits. The demand curve for aluminum reflects the value of aluminum to consumers, as measured by the prices they are willing to pay. At any given quantity, the height of the demand curve shows the willingness to pay of the marginal buyer. In other words, it shows the value to the consumer of the last unit of aluminum bought. Similarly, the supply curve reflects the costs of producing aluminum. At any given quantity, the height of the supply curve shows the cost of the marginal seller. In other words, it shows the cost to the producer of the last unit of aluminum sold. The price adjusts to balance the supply and demand for aluminum.



Now lets suppose that aluminum factories emit pollution: For each unit of aluminum produced, a certain amount of smoke enters the atmosphere. Because this smoke creates a health risk for those who breathe the air, it is a negative externality. How does this externality affect the efficiency of the market outcome?

Because of the externality, the cost to society of producing aluminum is larger than the cost to the aluminum producers. For each unit of aluminum produced, the social cost includes the private costs of the aluminum producers plus the costs to those who are adversely affected by the pollution. The social cost of producing aluminum. The social-cost curve is above the supply curve because it takes into account the external costs imposed on society by aluminum producers. The difference between these two curves reflects the cost of the pollution emitted. The intersection of the demand curve and the social-cost curve determines the optimal amount of aluminum from the standpoint of society as a whole.



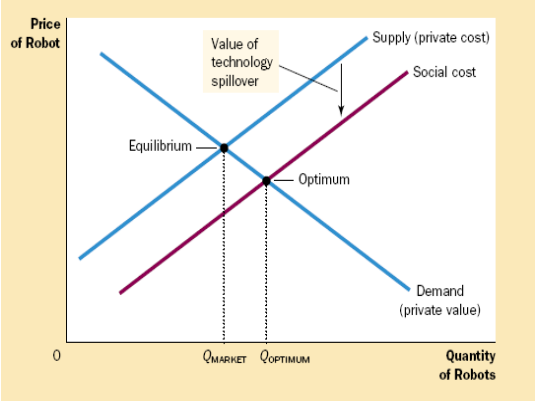
Note that the equilibrium quantity of aluminum, Q_{MARKET}, is larger than the socially optimal quantity, $Q_{OPTIMUM}$. The reason for this inefficiency is that the market equilibrium reflects only the private costs of production. In the market equilibrium, the marginal consumer values aluminum at less than the social cost of producing it. That is, at Q_{MARKET} the demand curve lies below the social-cost curve. Thus, reducing aluminum production and consumption below the market equilibrium level raises total economic well-being.

How can we achieve the optimal outcome? One way would be to tax aluminum producers for each ton of aluminum sold. The tax would shift the supply curve for aluminum upward by the size of the tax. If the tax accurately reflected the social cost of smoke released into the atmosphere, the new supply curve would coincide with the social-cost curve. In the new market equilibrium, aluminum producers would produce the socially optimal quantity of aluminum. The use of such a tax is called **internalizing the externality** because it gives buyers and sellers in the market an incentive to take account of the external effects of their actions. Aluminum producers would, in essence, take the costs of pollution into account when deciding how much aluminum to supply because the tax now makes them pay for these external costs. Taxes enacted to correct the effects of negative externalities are called **Pigovian taxes**, after economist Arthur Pigou, an early advocate of their use.

Example: In many countries, gasoline is among the most heavily taxed goods in the economy. That is probably because of negative externalities of driving cars: pollution, accidents.

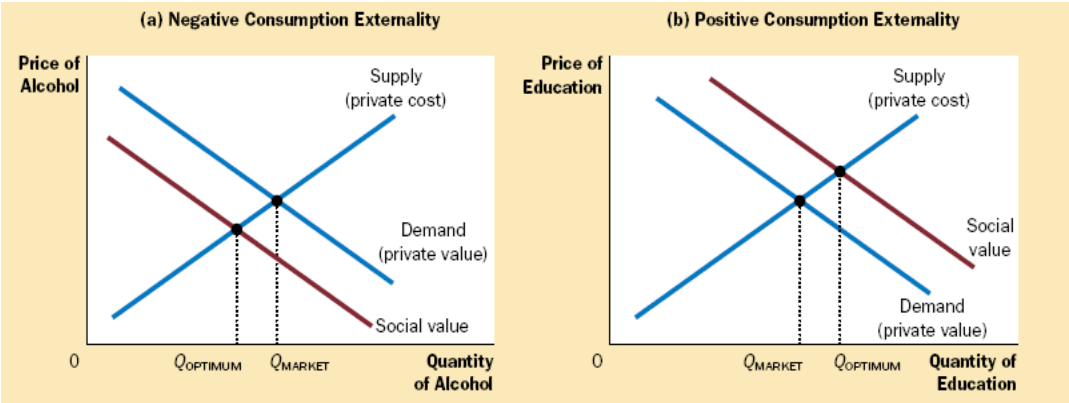
In case of **positive externalities** the situation is different. If the externality benefits bystanders, then the social cost of production is less than the private cost. One example is the market for

industrial robots. Robots are at the frontier of a rapidly changing technology. Whenever a firm builds a robot, there is some chance that it will discover a new and better design. This new design will benefit not only this firm but society as a whole because the design will enter societys pool of technological knowledge. This type of positive externality is called a technology spillover. In this case, the government can internalize the externality by subsidizing the production of robots. To ensure that the market equilibrium equals the social optimum, the subsidy should equal the value of the technology spillover.



The externalities discussed above are associated with the production of goods. Some externalities, however, are associated with consumption. The consumption of alcohol, for instance, yields negative externalities if consumers are more likely to drive under its influence and risk the lives of others. Similarly, the consumption of education yields positive externalities because a more educated population leads to better government, which benefits everyone.

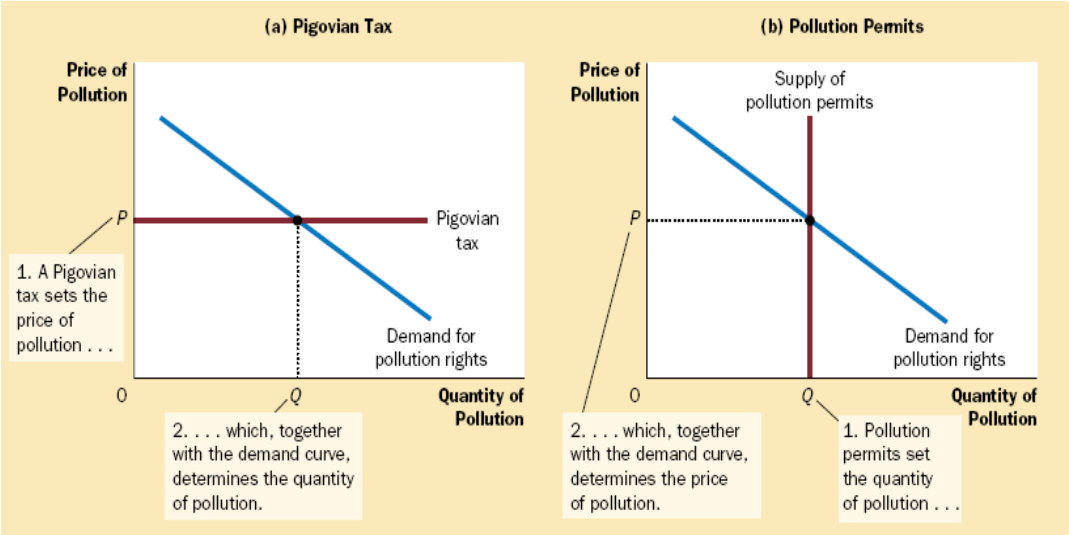
Once again, the government can correct the market failure by inducing market participants to internalize the externality. The appropriate response in the case of consumption externalities is similar to that in the case of production externalities. **To move the market equilibrium closer to the social optimum, a negative externality requires a tax, and a positive externality requires a subsidy.** In fact, that is exactly the policy the government follows: Alcoholic beverages are among the most highly taxed goods in our economy, and education is heavily subsidized through public schools and government scholarships.



Regulation:

Instead of Pigovian taxes the government can decide to adopt the regulation and require each factory to reduce its pollution. The firms can trade the permits for maximum pollution between them. The deal must make the owners of the two factories better off, because they are voluntarily agreeing to it. Moreover, the deal does not have any external effects because the total amount of pollution remains the same. The firms that can reduce pollution only at high cost will be willing to pay the most for the pollution permits. The firms that can reduce pollution at low cost will prefer to sell whatever permits they have.

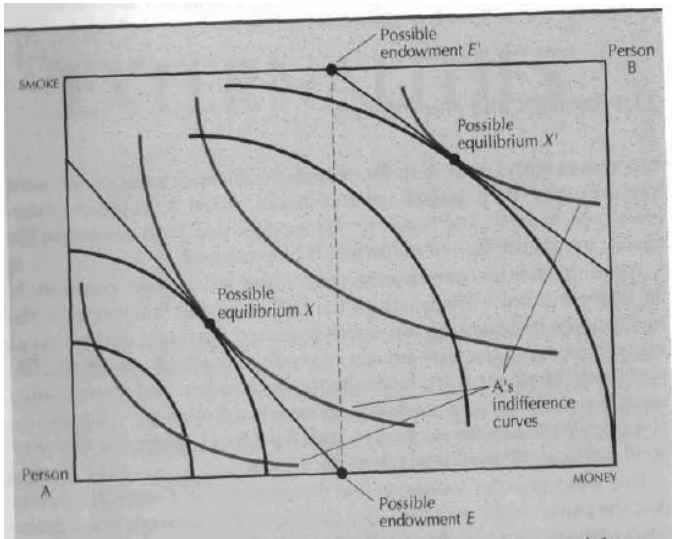
The similarity of the two policies can be seen by considering the market for pollution. Both panels in the figure below show the demand curve for the right to pollute. This curve shows that the lower the price of polluting, the more firms will choose to pollute. In panel (a), we use the Pigovian tax to set a price for pollution. In this case, the supply curve for pollution rights is perfectly elastic (because firms can pollute as much as they want by paying the tax), and the position of the demand curve determines the quantity of pollution. In panel (b), we set a quantity of pollution by issuing pollution permits. In this case, the supply curve for pollution rights is perfectly inelastic (because the quantity of pollution is fixed by the number of permits), and the position of the demand curve determines the price of pollution.



Property rights:

We will illustrate the problem of externalities on the following example: There are two roommates, A and B, who have preferences over "money" and "smoke." We suppose that both consumers like money, but that A likes to smoke and B likes clean air. We can depict the consumption possibilities for the two consumers in an Edgeworth box. The length of the horizontal axis will represent the total amount of money the two agents have, and the height of the vertical axis will represent the total amount of smoke that can be generated. The preferences of agent A are increasing in both money and smoke, while agent B's preferences are increasing in money and clean air-the absence of smoke. We will measure smoke on a scale from 0 to 1, where 0 is no smoke at all and 1 is the maximum amount of smoke. The corresponding picture is very similar to the classic Edgeworth box but has a different interpretation.

The a,mount of smoke is a good for A but bad for B, so that B is moved to a more preferred position as A consumes less smoke. We measure A's money horizontally from lower left-hand corner of the box and B's money horizontally from the upper right-hand corner. But the total amount of smoke is measured vertically from the lower left-hand corner. Money can be divided between two consumers, but there is only one amount of smoke that they must both consume. In ordinary Edgeworth box B is better off when A reduces the consumption of good 2 because then B gets to consume more of it. Here, B is also better off when A consumes less of good 2 but for a different reason: B is better off when A smokes less because both consumers have to consume the same level of smoke and smoke is bad for B.



Preferences for money and smoke. Smoke is a good for person A but a bad for person B. Which equilibrium we end up at depends on which endowment we start at.

Now when we know preferences of two consumers we will also illustrate their endowment. We assume that both consumers have the same endowment of money and hence the endowment point will lie somewhere on the vertical line connecting points E and E'. The initial endowment depends on the legal system. Let's start by considering a legal situation where person B has a legal right to clean air. Then the initial endowment is labeled E; it is where A has (100,0) and B has (100,0). This means that both A and B have \$100, and that the initial endowment is clean air. One of the aspects of having a property right to clean air is having the right to trade some of it away for other desirable goods - in this case, for money. It can easily happen that B would prefer to trade some of his right to clean air for some more money. The point labeled X is an example of such a case. As before, a Pareto efficient allocation is one where neither consumer can be made better off without making the other one worse off.

We could alternatively assume that A had a right to smoke as much as he wants and B would have to pay to A to reduce his consumption of smoke. This situation corresponds to the endowment labeled E'. Again consumer will trade with each other and move to a point X'. Both possible outcomes X and X' are Pareto efficient.

The only problem arises if the **property rights** are not well defined. If A believes that he has the right to smoke and B believes that he has the right for clean air, we have difficulties. **The practical problems with externalities generally arise because of poorly defined property rights.** In our example we would end up in point E which is not Pareto efficient.