Externalities

Definition of a fundamental externality: An fundamental externality exists when the actions of one party affect the welfare or the production possibilities of another party, even if this other party’s private consumption does not change.

In an equilibrium all agents are doing the best they can, given what the others are doing. Definition of an inefficient externality: An inefficient externality exists when, in an equilibrium, some agent could act differently at a cost less than the total benefit to others.

Example (negative externality): A corn farm uses fertilizer which runs off into the water, causing algae to grow and killing the fish. This negatively affects the local population, who made a living from fishing. Other negative externalities: any type of pollution, global warming, noise that affects other people.

Example (positive externality): A homeowner spends $50,000 dollars fixing up her house. This causes the values of neighboring houses to rise. Other examples: vaccination lowers the probability of others’ getting infected; successful research done by one firm increases the production possibilities of other firms.

Section 5.2 - Private-sector solutions to negative externalities

Coase’s idea: If the allocation with externalities is inefficient, it means it is possible for one party to be made better off without anyone being made worse off. In that case, why can’t the affected parties to an externality bargain over outcomes until the efficient outcome is reached?

Consider the example of a steel plant that dumps sludge into a nearby river, which kills the fish in the river. Fishermen are affected by this externality. Suppose the fishermen own the river. They would force the steel plant to stop dumping its sludge into the river. They would have the right to do so, since they have the rights over the river.

If the only way to get rid of sludge is to dump it into the river, then the only way to end this pollution is to shut down the steel factory. In this case, the steel plant owner might offer the fishermen to pay them for each unit of steel produced. The steel plant owner and the fishermen would have to compromise based on how much loss the fishermen make from the dead fish, and how much benefit the steel plant owner gets from having the steel plant operate.

This kind of agreement is called internalizing the externality. The steel firm is forced to include the costs of pollution in its private costs. The damage to the fish becomes another input cost to the firm. This works because the fishermen have property rights over the river. They can use the market to get compensated from the steel plant for its pollution.
Part I of the Coase theorem: When there are well-defined property rights and costless bargaining, negotiations between the party creating the externality and the party affected by the externality can bring about the socially optimal market quantity.

This means that externalities don’t necessarily require government intervention. The only role for the government is to assign property rights. Once this is done, the socially efficient outcome will result from bargaining among the party creating the externality and the affected parties.

Part II of the Coase Theorem: The efficient solution to an externality does not depend on how the property rights are assigned. It just needs the property rights to be assigned somehow. In the steel firm/fishermen example, suppose the steel firm owned the river instead of the fishermen. Then the fishermen couldn’t make the steel plant pay $100 compensation for each unit of steel produced. However, they could pay the firm $100 for each unit of steel not produced. This would lead to the steel firm incorporating the $100 cost per unit into its private costs, as firms count opportunity costs as costs. Each unit of steel produced is $100 forgone. So the private marginal cost curve rises to become the social marginal cost curve, if marginal damage to the fish equals $100 per unit of steel.

If the benefit to the steel plant owner from having the steel plant operate is greater than the harm caused to the fishermen by the steel plant’s pollution, then there will be a range of dollar values that the steel plant owner could pay the fishermen that would compensate them for the pollution. In other words, there is an amount of money that both the steel plant owner and the fishermen can agree on in order for the steel plant to continue its operation.

In the case where the benefit to the steel plant owner from continuing operation is greater than the harm caused to the fishermen from the pollution, it is efficient for the steel plant to continue operation (total surplus is maximized among the possible outcomes). Thus, bargaining among the parties affected by the externality has led to the efficient outcome being implemented in this case.

In the case where the harm caused to the fishermen from the pollution is greater than the benefit to the steel plant owner from continuing operation, it is efficient to shut down the steel plant. In that case, there will be no amount of money that the steel plant owner will be willing to pay the fishermen (and that the fishermen will accept) to continue operation.

Problems with Coasian solutions
The Coase solution often does not work in practice. For example, one cannot often observe cases of people affected by pollution offering compensation to a polluting firm in exchange for reducing production. However, individuals have often sued businesses for harm caused by their pollution. Suing is a way to enforce a property right.

Why does the Coase solution rarely work in practice? One problem is that the
cause of the damage must be identified - the assignment problem. There may be multiple causes for the death of all the fish in a river. Another problem is that some dollar amount of damage to the affected parties must be determined. Bargaining may break down over how much should be paid by the fishermen to the steel plant, or by the steel plant to the fishermen. Also, the fishermen may not agree among themselves how the payment made by the steel firm should be distributed among them. The more agents causing the externality, and the more people affected by the externality, the greater these problems become.

The holdout problem - suppose the assignment problem can be overcome, and it is determined that each unit of sludge from the plant kills $1 worth of fish for each of 100 fishermen.

Suppose that the fishermen have property rights over the river and the steel plant can’t produce unless all 100 fishermen say it can. Using the Coasian solution, each of the 100 fishermen gets paid $1 per unit of steel production in order for the plant to be allowed to continue production. The last fisherman will realize that the steel plant can’t produce without his permission. He can demand to be paid more than $1 in order for the firm to continue operation. This holdout problem can lead to a breakdown of negotiations. The more people are affected by the externality, the stronger the holdout problem becomes.

The free rider problem

Perhaps the holdout problem could be avoided by assigning property rights to the side that has the fewest agents. In this case it would be be the steel plant. But this causes a new problem.

Suppose the steel plant has property rights over the river and it agrees to reduce production by 1 unit for each $100 received by the fishermen. Suppose the optimal reduction in steel production (where social marginal benefits and social marginal costs are equal) is 100 units. Each fisherman pays $100, the total is $10,000 and the plant reduces production by 100 units.

Once 99 fishermen have each paid $100 and output has been reduced by 99 units, the last fisherman may consider that the last unit of output reduction is not worth $100 to him, once 99 units of output reduction have already taken place. He may not pay the $100. Knowing that this will happen, the previous fishermen may also not pay their $100. This free rider problem is another way in which the Coasian solution can fail to be implemented.

Transaction costs and negotiating problems

The 100 fishermen would have to organize themselves and to decide on a price to charge or pay the steel plant. This may bear some costs. For an externality like global warming, everyone in the world is affected, and everyone would have to agree on prices to charge. Moreover the fishermen and the firm may not be able to agree on a price.

Section 5.3 - Public sector remedies for externalities
The US government has usually imposed quantity restrictions rather than Pigouvian taxes on polluters. For example when it wanted to reduce the amount of sulfur dioxide (SO$_2$) in the 1970s, it put a limit on the amount of sulfur dioxide that producers could emit. In 1987 when it wanted to eliminate the use of chlorofluorocarbons, it banned their use rather than impose a large tax on products using CFCs.

If the government had perfect information about supply, demand and marginal damage caused by production of polluting goods, then quantity restrictions and a tax would be identical. The government would mandate that the efficient amount be produced.

Taxes and Regulations - the case of the Baltic Sea

The Baltic Sea is one of the most polluted bodies of water on earth. To remedy this, Sweden started the Baltic Sea Joint Comprehensive Environmental Action Programme (JCP) in 1990. This was an agreement to coordinate cleanup among 14 countries close to the Baltic Sea. Both taxation and regulation have been used. Poland used fines and fees levied on domestic polluters to fund cleanup of its wastewater.

Section 5.4

Taxation is called a price approach to addressing externalities because it reduces a negative externality by increasing the price, or increases a positive externality by reducing the price.

Take the case of pollution as an externality.

Instead of adjusting the price of pollution causing activities, the government could adjust the quantity.

In addition, there are other ways to reduce pollution besides reducing production of a pollution-causing good. For instance, installing catalytic converters in cars, smokestack scrubbers for power plants to remove SO$_2$ from the emissions.

Quantity approach.

Instead of the market for the good (steel) whose production causes pollution, consider the market for pollution reduction. On the graph, the x-axis shows quantity of pollution reduction and the y-axis shows cost (to the firm) and benefit (to society) of pollution reduction. Thus, as you move to the right on the graph, there is more pollution reduction and less pollution.

Assume that the social marginal benefit of pollution reduction is constant over quantities of pollution. At each level of pollution reduction, the social marginal benefit to reducing pollution more is constant.

On the other hand, the private marginal cost curve of the firm’s pollution reduction is upward-sloping. This means that the first units of pollution are relatively cheap to reduce, but at higher levels of pollution reduction, additional units of
reduction are more expensive.

There are no externalities from the production of pollution reduction. The externalities come from the end product, reduced pollution, not from the process of reducing the pollution. Therefore, the private marginal cost of pollution reduction is also the social marginal cost of pollution reduction.

The private marginal benefit (to the firm) of pollution reduction is zero at every level of pollution. Reducing pollution does not give the firm any private benefit (this is the same as saying that the pollution does not impose any private cost on the firm).

The equilibrium level of pollution will be at the intersection of the private marginal benefit curve with the private marginal cost curve. This is at zero amount of pollution reduction - the maximal amount of pollution.

The efficient level of pollution reduction is at the intersection of the social marginal cost curve (which equals the private marginal cost curve) with the social marginal benefit curve. This is at a positive amount of pollution reduction. So again, there is too much pollution in equilibrium relative to the efficient amount.

Compare price and quantity regulation in this model. The optimal tax equals the marginal damage done by pollution. Suppose this is $100 (every unit of pollution causes $100 in damage). If this tax is imposed, then the plant pays $100 for each unit of pollution it emits. Every unit of pollution reduction that costs less than $100 is worth it to the plant, because they will pay less than $100 for the pollution reduction and save $100 in tax. Thus the firm will reduce pollution up to the point where their private marginal cost of pollution reduction equals $100. This is the efficient amount of pollution reduction. Thus the Pigouvian tax has the effect of raising the firm’s private marginal benefit curve up to equal the social marginal benefit curve.

For quantity regulation, the government would mandate that the plant reduce pollution to the efficient amount. To do this, the government needs to know both MD and SMC. If the MD curve were not constant, then for price regulation the government would need to know both MD and SMC as well (ask about this).

Now consider two firms dumping 200 units each of sludge into the river every day. The marginal damage done by each unit of sludge is $100. Technology is available to reduce the amount of sludge created by each unit of production, but the technology has different costs to the two firms. For firm A pollution reduction is cheaper at any level of pollution reduction than for firm B.

Policy option 1: quantity regulation

The government could mandate a total reduction of 200 units. Typically the government would have the firms each reduce pollution by 100 units. This is not an efficient solution, because the firms have different costs of pollution reduction. The total costs of pollution reduction could be decreased if firm A
reduced its pollution by 1 unit and firm B increased its pollution by 1 unit. The efficient solution is where each plant has an amount of pollution reduction where its marginal cost curve intersects with the social marginal benefit of pollution reduction curve. This is at 50 units of pollution reduction for firm B and 150 units of pollution reduction for firm A.

Policy option 2: price regulation through a corrective tax

A tax of $100 per unit of sludge is imposed on the firms. Each firm reduces pollution until its marginal cost of pollution reduction equals $100. This leads to an efficient outcome. Firm A has 150 units of pollution reduction and firm B has 50 units of pollution reduction. Thus, if only the total efficient level of pollution reduction and the marginal damage are known to the government, a corrective tax is a more efficient way to get to the socially efficient outcome.

Policy option 3: quantity regulation with tradeable permits

The government issues permits that allow one unit of pollution each. When a firm has emitted 1 unit a pollution, it turns in 1 permit to the government. In this case, the government issues 200 permits, since it wants there to be only 200 units of sludge. Initially it gives 100 permits to each plant. Plant A will sell permits to plant B, because plant A’s cost of pollution reduction is lower than plant B’s. For the first permit sold, A will charge a price that is between A’s marginal cost of pollution reduction and B’s marginal cost of pollution reduction. They will trade permits until plant A’s marginal cost of pollution reduction equals plant B’s. At that point they will no longer find it optimal to trade, because there will be no price they can agree on. At this point, the efficient amount of pollution reduction by both firms has been reached. The only information required by the government is the total marginal cost and the marginal damage.