

## 2 Market Failure

*Readings: Chapter 4 in Stiglitz & Hardins article.*

In the book, there are short discussions of six basic market failures:

- Imperfect competition (monopoly, oligopoly etc.)
- Public Goods
- Externalities
- Incomplete Markets
- Imperfect Information
- Mysterious Macroeconomic Issues.

In lecture, I'll only talk about monopoly pricing, an example with an externality and an example of an informational failure. We'll discuss public goods at length soon and you should feel free to ignore anything that has anything to do with macroeconomics. However, you should pay attention to the discussion about incomplete markets in the book.

### 2.1 Monopoly Pricing

Recall that we concluded that competitive equilibria will be Pareto efficient. One crucial assumption for this conclusion is that all agents act as price takers: all agents believe that they have no effect on the market prices. This assumption seems relatively OK in some markets, but thinking for example of operating systems for PC computers, it seems borderline ridiculous to postulate that the producers don't recognize that they have some influence over the price.

On the opposite end of the spectrum from a competitive firm we have the case with a monopoly, meaning that a single firm is supplying the market. Like a competitive firm, we

assume that the monopolist strives to generate as large profits as possible. That is, it seeks to maximize

$$py - C(y),$$

where  $C(y)$  is the (minimal) cost to produce output  $y$ . The difference with the competitive firm is that a monopolist understands that it can only sell what the consumers are willing to buy: since it operates alone in the market the firm understands that it is constrained by picking price/quantity combinations along the demand curve.

Let  $D(p)$  denote the (direct) demand for the product and note that the monopolist can sell at most  $D(p)$  units at price  $p$ . The optimization problem for the monopolist is

$$\begin{aligned} & \max_{p,y} py - C(y) \\ \text{subj to } & y \leq D(p). \end{aligned}$$

Clearly,  $y = D(p)$  in a solution since otherwise the sales could be increased without lowering the price, so we may rewrite the problem as

$$\max_p pD(p) - C(D(p)),$$

where we have price as the choice variable. Alternatively we may invert the demand (view it as in the pictures where we have  $y$  as the independent variable and  $p$  as the dependent variable). Then if  $p(y)$  is the *inverse demand* we can write the problem as

$$\max_p p(y)y - C(y),$$

### 2.1.1 Inverse and Direct Demand

Mathematically speaking, if  $y = D(p)$  is the direct demand function, the inverse of  $D$  is a function  $p = D^{-1}(y)$  such that

$$D^{-1}\left(\underbrace{D(p)}_{\substack{\text{quantity} \\ \text{demanded} \\ \text{at price } p}}\right) = p.$$

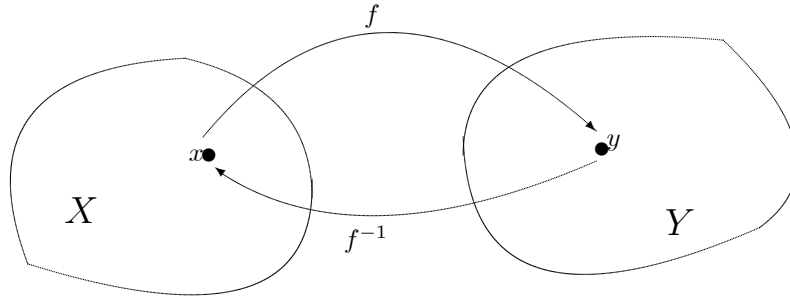


Figure 1: The Inverse of a Function

The concept is illustrated for a general function  $f$  in Figure 1. The point is that if the function  $f$  takes  $x$  to a value  $y$ , then the inverse takes the value  $y$  back to the value  $x$  we started with. This must be so for each  $x$  and each  $f(x)$ , so the inverse reverts the operation of the original function  $f$ . As an example, say that

$$D(p) = a - bp$$

Then, to find the inverse we only need to solve out  $p$  as a function of the quantity. That means that

$$\begin{aligned} y &= a - bp(y) \Leftrightarrow \\ p(y) &= \frac{a}{b} - \frac{1}{b}y = A - By \end{aligned}$$

where  $A = \frac{a}{b}$  and  $B = \frac{1}{b}$

## 2.2 The Optimality Condition

Both versions of the problems are equivalent, so in principle it doesn't matter which one to solve. However, it turns out that it is somewhat more convenient to work with

$$\max_y p(y)y - C(y),$$

The first order condition is

$$\begin{aligned} p'(y)y + p(y) - c'(y) &= 0 \Leftrightarrow \\ p'(y)y + p(y) &= c'(y) \end{aligned}$$

To interpret the condition note that  $p(y)y$  is the revenue the monopolist gets if selling  $y$  units. Hence

- $\frac{d}{dy}p(y)y = p'(y)y + p(y)$  is the *marginal revenue*. In words, the additional revenue the monopolist gets for a small extra unit of output
- $C'(y)$  is just the *marginal cost*.
- Thus, the optimality condition is the rather natural condition that the additional revenue from the last small unit outweighs the cost.

Observe that the condition  $p = C'(y)$  has the *exact same interpretation*. The difference is that a competitive firm treats price as given, while the monopolist picks price/quantity combinations on a downward sloping demand curve. Hence the trade-off is different for the monopolist. If the monopolist sells few units it can charge a high price, but the more units it sells the lower price it must charge. When it lowers the price to get one additional unit sold it must lower the price for all units, so the loss in revenue associated with selling one more unit will be higher the more units the monopolist sells. This logic is most easily understood in an example with constant marginal cost and a linear demand.

### 2.3 Example: Linear Demand

Let

$$p(y) = A - By$$

$$c(y) = cy$$

so the problem is

$$\max_y \underbrace{(A - By)y}_{p(y)} - cy = \max_y (A - c)y - By^2$$

The first order condition is

$$\begin{aligned}
 -By + A - By - c &= 0 \\
 &\Leftrightarrow \\
 y^* &= \frac{A - c}{2B}
 \end{aligned}$$

Note that  $(A - By)y$  is the revenue, so

$$A - 2By$$

is the marginal revenue. The problem and its solution can thus be depicted in a graph as in

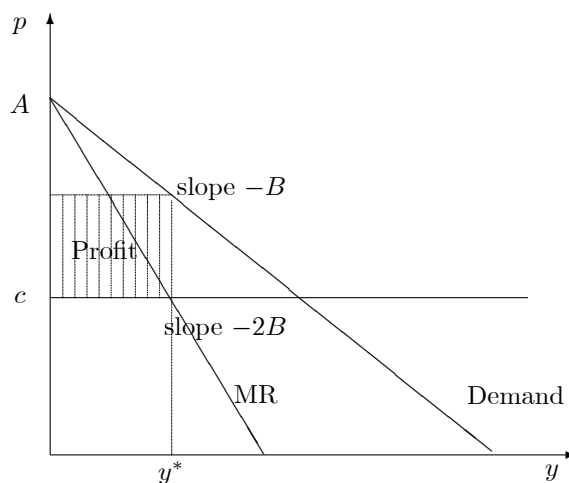


Figure 2: A Profit Maximizing Monopolist

Figure 2, where the demand curve as well as the marginal revenue is drawn. To some of you it may be geometrically obvious that the solution is to set the quantity halfway in between 0 and the quantity where the demand curve intersects the horizontal line at height  $c$ . Solving  $c = A - By$  we get  $y = \frac{A-c}{B}$ , so  $y^*$  is indeed this middle point. To understand geometrically that this is the solution to the profit maximization problem, observe that the monopolist aims to make the rectangle representing profits as large as it can.

- If the quantity sold is small, the profit is a high “thin” rectangle and there are few units to lose revenues from if the quantity is increased/price decreased.

- If the quantity is close to  $A - By$ , then profits is a low “fat” rectangle and there are many units to gain revenues from if quantity is decreased/price increased

It may be visually clear that the profit is the higher with  $y^*$  at the midpoint between 0 and  $A - By$  and one can also show it by pure algebra (no derivatives involved) or elementary (=pretty hard) geometric reasoning. Intuitively:

- Additional revenue from extra unit due to increased sales is approximately

$$p(y + 1) = A - B(y + 1) \approx A - By$$

- Loss in revenue in terms of lower price on **all** units is

$$(p(y + 1) - p(y)) y = (A - B(y + 1) - A + By) y = -By$$

so the change in revenue is approximately  $a - 2By$ .

## 2.4 The Inefficiency of Monopoly Pricing

Consumer(s) value the last unit produced at the monopoly price  $p^m$ . However, the monopolist only gives up the marginal cost  $C'(y^m)$  if producing an extra unit, which the consumer would value at  $p^m$ . Due to this “wedge” between the marginal cost and the willingness to pay for the last unit all agents could be made happier if, in addition to the units traded at monopoly price, the monopolist and the consumer(s) could trade some additional units at a lower price. You may note that the problem is the difference between the marginal cost and the price the consumers pay, so a tax on a good sold by a competitive market (which in the constant returns case would imply that the equilibrium price must be  $c + t$ ) creates an inefficiency for exactly the same reason.

### 2.4.1 Justifying “Deadweight Loss Triangles”

Often times the distortion is quantified in a graph using the “deadweight loss”, which is the triangle between the demand curve, the marginal cost curve and the vertical line at

the monopoly quantity in Figure 2. The intuitive idea is that the demand curve gives the willingness to pay for the marginal unit, the that the distance between the demand and the marginal cost curve gives the “dollars lost” for that unit not being produced. To really make sense of this we’d have to do more careful “welfare analysis”. However if utility is quasi-linear then it is rather easy to demonstrate that this is a valid way to proceed. Suppose  $U(x, y) = x + v(y)$  and that the price of good  $x$  is normalized to one. The problem for a utility maximizing consumer is then

$$\begin{aligned} & \max x + v(y) \\ \text{s.t } & x + py \leq m \end{aligned}$$

Plugging in the constraint and optimizing we get the first order condition

$$v'(y) = p$$

This condition *defines the inverse demand function for  $y$*  (as long as  $m$  is large enough so as to guarantee that the solution is interior), that is

$$p(y) = v'(y)$$

Observe that

$$v(y) - v(0) = \int_0^y v'(y) dy = \int_0^y p(y) dy = \text{Area under inverse demand,}$$

so since

$$x + v(y) \text{ is the utility of consuming } (x, y)$$

$$m + v(0) \text{ is the utility of consuming } x = m \text{ and } y = 0$$

we have that the consumer is happier if consuming  $(x, y)$  than  $(m, 0)$  if and only if

$$x + v(y) \geq m + v(0) \Leftrightarrow$$

$$\text{Area under inverse demand} = v(y) - v(0) \geq m - x$$

**Thus, the area under the inverse demand tells you how many units of the other good the consumer would be willing to give up for  $y$  units of good  $y$  if facing an “all-or-nothing choice”.**

## 2.5 Natural Monopolies

Comparing monopoly pricing with competitive pricing we always find that the monopoly will cause an efficiency loss, while a competitive market will generate a price (equal to the marginal cost) where the traded quantity is efficient (see Figure 2). However, consider Figure 3 where in spite of an upwards sloping marginal cost curve the fixed costs are so large that even with a single firm producing at marginal costs, the firm would make a loss.

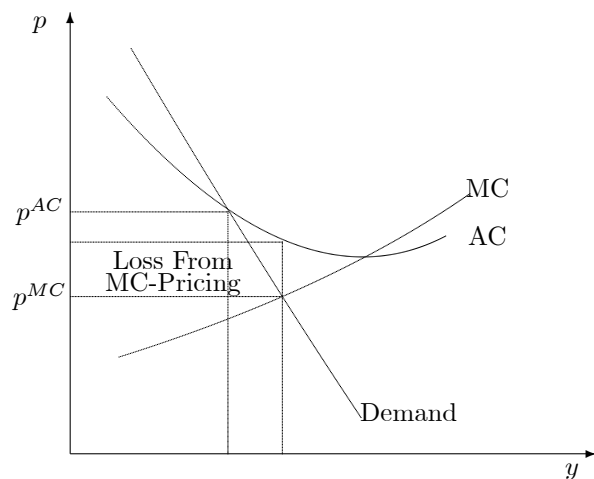


Figure 3: A Natural Monopoly

Here we note that:

1. A profit maximizing monopoly would be willing to enter (the higher price indicated is the “break even price” and for some higher prices profits are strictly positive).
2. While there is a “deadweight loss” that can be depicted in the usual way, at least a monopoly is better than the good not being produced.
3. Could imagine the government running production and set prices equal to marginal cost. However:

This would require taxation of some other sector  $\Rightarrow$  another distortion.

Could also create other types of inefficiencies having to do with firm getting incentives to overstate costs, which opens up a whole array of possibilities to use regulated monopolies as a way for politicians to thank big donors for campaign contributions. For this type of reasons many economists (in particular those associated with the “Public Choice” line of thinking are very critical towards any type of government involvement in sectors where it is not absolutely necessary.

4. Could also imagine the government having the monopolist setting a price so as to break even exactly (by decree), but again this would require the regulator to know quite a bit about the cost structure.

Anyway, the idea of a natural monopoly is the basic economic rationale for regulating public utilities. This form of intervention have a bit of a dubious track-record and nowadays there is wide-spread scepticism towards this idea.

## 2.6 A Simple Example with a Production Externality

Consider the following simplistic model of a production externality;

1. Bart can build a plant producing, say, timber. If building the plant some toxic waste will be emitted into the sea, killing a significant number of fish. Assume that Bart earns a profit of  $v_B$  if the timber plant is set up.
2. Lisa is a fisherwoman who fishes in the waters that will be polluted by Barts’ plant (if set up). Assume that the value of her catch is  $v_L$  if the plant is not built and that it is 0 if the plant is built (i.e., she cannot sell salmon with two heads that contain too much PCB).
3. In order to facilitate a clear analysis of the efficiency problem *we assume that Bart and Lisa are the only economic agents in our model economy, that Bart only cares about the profit he can make and that Lisa only cares about the value of her catch.* For example, we assume that there is no agent that assigns any value to a clean ocean etc. This

is only to simplify the discussion. If there are agents who assigns a value to a clean ocean, we can easily add such considerations without changing the qualitative insights from the analysis.

4. Bart and Lisa are also endowed with some good  $x$  that can be used as a transfer. Barts' utility function is

$$U_B = \begin{cases} x + v_B & \text{if plant built} \\ x & \text{if plant not built} \end{cases}$$

and Lisa has utility function

$$U_L = \begin{cases} x & \text{if plant built} \\ x + v_L & \text{if plant not built} \end{cases}$$

Let the endowments of  $x$  be  $e_B$  and  $e_L$  respectively and assume that the  $e_B > v_L$  and  $e_L > v_B$

### 2.6.1 No Intervention Benchmark

Since the setup is so simple, this is trivial. That is, Bart will build the plant if and only if  $v_B \geq 0$ . This is economically efficient if and only if  $v_B \geq v_L$ , whereas if  $0 < v_B < v_L$ , this leads to an economic inefficiency since if Lisa would transfer, say  $\frac{v_S + v_B}{2}$  units of good  $x$  to Bart for the promise not to build, then Lisas utility is

$$\underbrace{e_L - \frac{v_L + v_B}{2} + v_S}_{\text{Lisas' utility if bribing not to build}} = e_L + \frac{v_L - v_B}{2} > \underbrace{e_L}_{\text{Lisas' utility if build}}$$

and Barts utility is

$$\underbrace{e_B + \frac{v_L + v_B}{2}}_{\text{Barts' utility if bribed not to build}} > \underbrace{e_B + v_B}_{\text{Barts' utility if build}}$$

### 2.6.2 Coases' Solution: Well-Defined Property Rights

One way (that is not quite complete) of explaining the problem that gives rise to the inefficiency is that there is nobody who have property rights to the sea. According to Coase (and

most any other economist in the Chicago tradition) the cure to such a problem is to assign well-defined property rights.

Say first that Lisa has the property rights (or, equivalently, that citizens have “rights to clean water”). Then, Lisa will demand at least  $v_L$  to allow Bart to pollute. If  $v_B < v_L$  Bart would therefore not be willing to Bribe Lisa (which is good from an efficiency point of view since the plant should not be built in this case). If on the other hand  $v_B > v_L$ , then any bribe in between these values would work, and the plant should be built in this case. With a little leap of faith we may assert that the bargaining outcome in this case should be efficient, in which case we would conclude that the right decision will always be made if Lisa has the right to clean water.

Symmetrically, suppose that we have “rights to pollute”. Then, Bruce will not accept any bribe below  $v_B$  and Lisa is willing to pay at most  $v_L$ , so if  $v_B > v_L$ , Lisa will be unwilling to Bribe Bart not to build, whereas if  $v_B < v_L$ , any bribe in between the two values will lead Bruce not to build. In each case (with the same leap of faith as above), economic efficiency is guaranteed.

This example illustrates a very important cornerstone in modern liberal economic thought/ideology (it doesn't quite qualify as theory). The conclusion is that an efficient solution will be achieved *independently of who is assigned the property rights, as long as there is someone who holds the property rights*. Somewhat misleadingly, this is referred to as the Coase Theorem (since there is a lack of both exact assumptions and proof the word “theorem” is somewhat puzzling). A more complete statement of the assertion is as follows: If property rights are well-defined and there are no transactions cost [my remark: I don't quite know how one should think of “transactions costs”], then bargaining will lead to an efficient solution. An implication of this would thus be that no government intervention is required to deal with externalities (a conclusion that would apply to public goods too, since this is a special case of an externality). All that is needed, is to specify property rights to everything that could possibly be affected by external effects.

## 2.7 Example of an Informational Failure: The Market for Lemons

In many ways, a more fundamental source of markets performing badly is that there are reasons to believe that the market will supply too little information. Surprisingly (as Stiglitz has made important contributions on this) the book is not very clear on what the problem is. In particular, it is stated that “imperfect information” on the part of consumers is a problem. To be more precise, we should make the following distinction:

- Imperfect information in the sense of regular uncertainty (for example, the fact that a farmer doesn’t know what the weather will be like) is not necessarily a problem. In theory, the risk corresponding with uncertainty can be allocated efficiently provided that:
  1. All agents are equally well informed about the relevant probabilities and,
  2. The probabilities are not affected by what the agents are doing
- In contrast, “imperfect information” is a problem if either:
  1. Agents have *different* information (an example is provided below)  
or
  2. Some agents can take unobservable acts that affect the probabilities (an obvious example is the market for auto insurance, where driving habits seem to be a major factor in accident probabilities).

### 2.7.1 Model

Imagine a very simple economy where there is a large number of sellers and a large number of buyers. Each seller has a car that he/she may or may not sell depending on the price and buyers are interested in at most one car. However,

- There are two sorts of cars. A fraction  $\alpha$  are “peaches” or good cars that have been handles carefully by the first owner, while a fraction  $1 - \alpha$  are “lemons” or bad cars that have been handled not so carefully.

- Each potential buyer values a good car more than a bad car. Let  $V_G > V_B$  denote the number of dollars a buyer would be willing to give up for a good and a bad car respectively ( $V$  may be thought of a “valuation”)
- A seller also values a good car more than a bad car. Let  $W_G > W_B$  denote the sellers’ valuations for good and bad cars.
- To make the problem interesting we also assume that  $V_G > W_G$  and  $V_B > W_B$ , which means that if everyone could observe the quality of the car, then any price  $p_G$  for good cars and  $p_B$  for bad cars such that  $V_G \geq p_G \geq W_G$  and  $V_B \geq p_B \geq W_B$  would imply that sellers want to sell and buyers would want to buy, which would make all parties better off than in a situation where no cars were traded.

### 2.7.2 Competitive Equilibrium with Observable Types

Exactly how the competitive prices will be determined in this very stylized models will depend crucially on whether there are more buyers than sellers or the other way around:

- If there are more buyers than sellers, the prices will be  $p_G = V_G$  and  $p_B = V_B$  (any lower price would generate excess demand)
- If there are more sellers than buyers then the situation is more complicated and there are a few different cases to go through, but at least one of the seller types will then sell at their reservation price ( $W_G$  or  $W_B$ )

However, no matter which case we look at the competitive equilibrium will always exhaust all gains from trade and the relative number of sellers and buyers will only affect the trading prices.

### 2.7.3 Equilibrium

The point with the lemons model is that in many situations, the buyer doesn’t really know what he/she is buying (aside from second hand cars, just think about restaurant meals at

big tourist destinations). Now, let's ask if the market still can exhaust the gains from trade in this situation?

1. In order for the market to be efficient, then all cars must be traded (since a buyer values a car of any type more than a seller)
2. However, a buyer is only willing to buy if the expected gain from doing so is larger than the price, that is (under the assumption that all cars are traded) a buyer is willing to buy a car if

$$p \leq \alpha V_G + (1 - \alpha) V_B$$

3. A seller of a "lemon" wants to sell if the price is

$$p \geq W_B,$$

while,

4. A seller of a "peach" is willing to sell if

$$p \geq W_G$$

Since  $W_G > W_B$  we see that the seller of a lemon wants to sell whenever a seller of a peach wants to sell, which should be rather obvious. However, for the seller of the peach to sell and buyers to be willing to buy it must be that

$$W_G \leq p \leq \alpha V_G + (1 - \alpha) V_B$$

Putting in some concrete numbers, say

$$V_G = 2000$$

$$W_G = 1500$$

$$V_B = 1000$$

$$W_B = 500$$

then the condition becomes

$$1500 \leq p \leq \alpha 2000 + (1 - \alpha) 1000$$

We conclude that if  $\alpha < \frac{1}{2}$  then  $\alpha 2000 + (1 - \alpha) 1000 < 1500$ , which means that **there is no price such that the buyers would be willing to buy and the owners of good cars would be willing to sell**. Hence, the informational asymmetry leads to a situation where **mutually beneficial trades don't take place**.

The example is highly stylized example of the “lemons problem” or a situation that sometimes is referred to as adverse selection. In words the problem is that the existence of bad cars makes the second hand car market a worse deal than it would otherwise have been for an owner of a good car. The higher the proportion of bad cars on the market, the more the market price will reflect the value of a bad car, which will discourage owners of good cars to sell. This in turn will of course be realized by buyers who would simply assume that if a car is for sale, then there must be a problem.

Other markets where there are reasons to believe or evidence that adverse selection is a problem:

1. Life/health insurance. If premiums are fair for the population as a whole the insurance may be a bad deal for healthy people who would refuse to buy (insure themselves by savings) and only attract the sick and dying. The market tries to deal with this by physicals/restrictions on mountain climbing & parachuting/pre-existing conditions etc., but it is unclear to what extent these remedies work.
2. The labor market.
3. (Classic example) Bad currency drives out good currency (Greshams Law). Idea, owner of coin can shave of a small piece in a way that is undetectable without careful measurement. The gold obtained can then be used to produce new coins. Now, if accepting a coin in a trade the trader would assess some probability that the coin has been shaved, implying that holders of unshaved coins will withhold their coins from trade (or shave them). In the end only shaved coins will circulate.