

This is a numerical example of the problem covered in class.

There is an open access lake where anybody can go fishing. However, for each additional fishermen that enters the lake the amount of available fish goes down and the marginal as well as the average product goes down. The fishermen have the option to take an outside job that pays W.

We want to know what will happen if there is no government intervention. Do we get an efficient allocation of resources? Too much fishing? Not enough fishing?

First, we will consider the problem without any intervention, private markets are left alone (this is the Fishermen problem). Second, we will talk about the social planner role and options.

The following table shows the total, average and marginal product as well as the outside wage.

Fishermen	Total Product	Average Product	Marginal Product	Wage	
1	500.0	500.0	500.0	496.0	499
2	999.5	499.8	499.5	496.0	499
3	1498.5	499.5	499.0	496.0	499
4	1997.0	499.3	498.5	496.0	499
5	2495.0	499.0	498.0	496.0	499
6	2992.5	498.8	497.5	496.0	499
7	3489.5	498.5	497.0	496.0	499
8	3986.0	498.3	496.5	496.0	499
9	4482.0	498.0	496.0	496.0	499
10	4977.5	497.8	495.5	496.0	499
11	5472.5	497.5	495.0	496.0	499
12	5967.0	497.3	494.5	496.0	499
13	6461.0	497.0	494.0	496.0	499
14	6954.5	496.8	493.5	496.0	499
15	7447.5	496.5	493.0	496.0	499
16	7940.0	496.3	492.5	496.0	499
17	8432.0	496.0	492.0	496.0	499
18	8923.5	495.8	491.5	496.0	499
19	9414.5	495.5	491.0	496.0	499
20	9905.0	495.3	490.5	496.0	499

1) Fishermen Problem

The problem of the fishermen is to make as much money as possible. In the table above you can see that everytime a fishermen enters the lake total production increases because there are more resources devoted to fishing.

Note that what each fishermen gets is the average product (the fishing skills are the same across fishermen). However, since they all compete for the available fish what one fisherman gets the others do not. The fish is a public good with competition in consumption and no exclusion (common goods).

Hence, whenever an additional fisherman enters the lake the extra catch goes down even though what they all get is the average product.

An additional fisherman also reduces the average product, but this extra fisherman does not care about his effect on the average product as long as this is higher than the wage. In other words, every additional fishermen imposes an externality on the others already fishing in the lake.

If the fishermen are left alone they will continue to enter the lake as long as the average product is higher than the wage.

If the wage is \$496 as shown above a total of 17 fishermen will enter the lake and the fish production is going to be \$8432.

2) The social planner problem

Remember, the social planner is a benevolent dictator, he only wants to help. He observes that since the fishermen do not care about the external effects of their actions, society as a whole is at an inefficient place.

Why?

Observe the fourteenth fishermen that enters the lake, if he enters the lake he will get \$496.8, if he takes the outside job he only gets \$496, he obviously decides to enter the lake.

However, the EXTRA money the whole society obtains from the tenth fishermen is only \$493.5 (the marginal product at 14). If the fishermen takes the outside job the extra money produced is \$496, which is higher than the marginal product of the fishermen at 14.

We have a case where the market solution is not efficient and it is due to the externality created (reduced catch) when a fishermen enters the lake because the fish (as stated above) is a public good.

What is the optimal solution for society as a whole?

The society will benefit from having an extra fishermen as long as his additional production is higher than the outside wage. Society will be hurt if the outside job generate more wealth (wage) than the extra catch. In this particular example, this is going to be true above 9 fishermen, hence the optimal number of fishermen and total fishing production is 9 and \$4482, respectively.

The private market produces too much fishing.

Now that he knows what the optimum solution, what can he do.
 For the moment we will explore two solutions:

A) Entrance Fee

The social planner can set an entrance fee to the lake equal to the difference between the marginal and the average product at the efficient level of fishermen (9 in this case). $\text{Fee} = \$498 - \$496 = \$2$

This way, every fishermen that wants to use the lake pays \$2. This is how the table changes.

Fishermen	Total Product - Fee	Average Product - Fee	Wage	Fee Paid
1	498.0	498.0	496.0	2
2	995.5	497.8	496.0	4
3	1492.5	497.5	496.0	6
4	1989.0	497.3	496.0	8
5	2485.0	497.0	496.0	10
6	2980.5	496.8	496.0	12
7	3475.5	496.5	496.0	14
8	3970.0	496.3	496.0	16
9	4464.0	496.0	496.0	18
10	4957.5	495.8	496.0	20
11	5450.5	495.5	496.0	22
12	5943.0	495.3	496.0	24
13	6435.0	495.0	496.0	26
14	6926.5	494.8	496.0	28
15	7417.5	494.5	496.0	30
16	7908.0	494.3	496.0	32
17	8398.0	494.0	496.0	34
18	8887.5	493.8	496.0	36
19	9376.5	493.5	496.0	38
20	9865.0	493.3	496.0	40

Now, the fishermen will continue entering until the Average Product-Fee = Wage, which by planner's design is going to be equal to the marginal product at the optimum.

B) Assign property rights

Remember that in many cases the source of the externality is the absence of well defined property rights. This is an example of such situations, since everybody can enter the lake there is too much fishing.

The planner can privatize the lake (gift, auction, etc.). Once, the lake is private the firm in charge of the lake will start hiring fishermen. Note that the firm cares only about profits (they are not environmentalists).

Using our first table we can see that the firm will hire an extra fishermen as long as the additional product generated by the worker (marginal product) is higher or equal than the additional cost (wage).

For instance, if the firm already has nine fishermen an extra fishermen will cost them \$496 and that worker will increase total product by only \$495.5 (marginal product). Thus, the firm will not hire the tenth fishermen.

What happened?

Since the firm does not care about the single catch of each fishermen but about the whole production of the lake, they will "internalize" the external effect of the additional fishermen (reduced catch) and choose the profit maximizing solution which is also the socially optimum level of fish production (private markets work again)