COASE THEOREM EXAMPLE

What has become known as the Coase Theorem is the proposition that in the absence of transactions cost the level of production of goods or services in an industry in which there are externalities is independent of whether or not the party who perpetrates negative externalities is legally liable for the costs of the externalities on other parties. The income distribution does of course depend upon whether or not the perpetrator is liable, but that is a different matter.

To illustrate Coase Theorem suppose there is a railway that runs coal-burning steam locomotives through a farming area and caused fires in the crop fields at harvest time. The crop damage from each train run is $200. Suppose the cost of running trains on a line next to a farming area are as follows:

Number of trains per day	Private Costs	Crop Damage	Social Cost
1	$100	$200	$300
2	$200	$400	$600
3	$400	$600	$1000
4	$700	$800	$1500
5	$1100	$1000	$2100
6	$1600	$1200	$2800

If the revenue from a train run is $350 how many runs would the railway run if no compensation is required for crop damage?

This question can be answered by comparing the revenue to the private costs and finding the number of runs which give the maximum difference between revenue and private costs; i.e.,

Number of trains per day	Revenue	Private Costs	Profit
1	$350	$100	$250
2	$700	$200	$500
3	$1050	$400	$650
4	$1400	$700	$700
5	$1750	$1100	$650
6	$2100	$1600	$500

As can be seen from the table the maximum profit is achieved running 4 trains. On the other hand if the crop damage costs are imposed upon the railway company then the costs to the railway company are increased by the amount of the damage. The profit picture for the railway changes to the following.

# of trains per day	Revenue	Private Costs + Damage Costs	Profit
1	$350	$300	$50
2	$700	$600	$100
3	$1050	$1000	$50
4	$1400	$1500	-$100
5	$1750	$2100	-$350
6	$2100	$2800	-$700

As the above table shows the maximum profit for the railway company is achieved with 2 runs per day. The profit of the railway company corresponds to the net social benefit of running the trains. In this case it makes a great deal of difference (in terms of the number of trains run) as to whether the railway company is liable for the crop damage. Two trains per day is the socially optimal number of train runs, but four trains seems to be what would occur in the absence of legal liability concerning the crop damage.

What Ronald Coase did was to examine what alternatives there might be to government-enforced legal liability to deal with the externality problem. Coase suggested that the farmers could pay the railway not to run trains. To keep matters simple suppose the farmers told the railway that they would be willing to pay the railway $1200 not to run any trains and deduct $200 from this payment for every train run. The revenue to the railway would consist of the revenue made from operating the trains plus the payment received from the farmers. The profitability picture for the railway would be as follows:

Number of trains per day	Revenue from train operation	Private Costs to Railroad	Payment from farmers	Profit of Railroad
0	$0	$0	$1200	$1200
1	$350	$100	$1000	$1250
2	$700	$200	$800	$1300
3	$1050	$400	$600	$1250
4	$1400	$700	$400	$1100
5	$1750	$1100	$200	$850
6	$2100	$1600	$0	$500

As can be seen from the above table the railway achieves its maximum profit with two train runs per day, which is the socially optimal number of train runs. This is the essence of Coase's Theorem: The same levels of production are achieved whether the perpetrator of the negative externalities is legally liable for the externality costs or is the victims of the negative externalities make a payment to the perpetrator that is reduced by the amounts of the externalities. Note that the level of production of crops is determined as well as the number of trains run per day. The second part of Coase's Theorem is that the levels of production achieved under either legal liability or the payment scheme is socially optimal.

Of course the profits of the farmers and the railway are drastically different depending upon whether the railway is legally liable for crop damage.
The figure of $1200 is completely arbiitrary in the above illustration. Any other figure would do just as well and the same result in terms of number of trains per day would result.
The above illustration made use of the total revenues and total costs, both private and external. The quicker method to determine the number of train runs that would be most profitable uses the marginal revenues and marginal costs. These marginal quantities are shown below:

Number of trains	Marginal Revenue	Marginal Private Costs	Marginal Crop Damage	Marginal Social Cost
1	$350	$100	$200	$300
2	$350	$200	$200	$400
3	$350	$300	$200	$500
4	$350	$400	$200	$600
5	$350	$500	$200	$700
6	$350	$600	$200	$800

If the marginal revenue at n runs per day is greater than the marginal costs at n then the total profit is higher at n+1 runs than it is at n runs. On the other hand, if the marginal revenue at n runs per day is less than the marginal costs at n then the total profit is higher at n-1 runs than it is at n runs. In the above example, at 3 runs the marginal revenue is $350 but the marginal private cost is $300 so, in the absence of legal liability for crop damage or a payment from farmers, the railway company's profit is higher at 4 runs than at 3. But at 4 runs the marginal revenue of $350 is less than the marginal runs the marginal private cost of $400 so the profit is higher at 4 runs than it is at 5. Therefore the maximum profit occurs at 4 runs per day. Finding the maximum profit level of production is a matter in this case of finding a level at which the marginal cost switches from being less than marginal revenue to being more than marginal revenue.

When the marginal cost of crop damage are included the marginal cost at 3 runs is $500 which is greater than the marginal revenue of $350 therefore 3 per day is a more profitable level of operation than 4. However in this case the marginal revenue of $350 at 2 runs is less than the marginal cost of $400 therefore 2 runs is more profitable than 3 runs. The marginal cost at 1 run per day $300 is less than the marginal revenue of $350 therefore 2 runs per day is more profitable than 1 run per day.

Source: https://www.sjsu.edu/faculty/watkins/coasetheorem.htm