

10 | EXTERNALITIES

Purpose: This problem set illustrates the effect of a negative production externality on social welfare, and shows how a tax can be used to regulate the amount of the external effect created.

Computer file: **ext98.xls**

Instructions and background information:

The spreadsheet shows a hypothetical market for paper. Paper firms, when they produce paper, also create pollution. In this case they cause water pollution because they dump the by-products of paper making into nearby streams and rivers. The marginal external cost (MEC) of papermaking is constant in this problem. That is, each extra unit of paper produced also adds a fixed amount of pollution costs to the environment. For example, if the MEC is \$15.00, then each extra unit of paper produced causes an extra \$15.00 of environmental damage.

The spreadsheet shows the marginal private costs (MPC) of paper production, which is just the supply curve of the firms in the industry. The (marginal) social cost of paper production (MSC) is the sum of the marginal private cost and the marginal external cost. The demand for paper is designated as the marginal private benefit (MPB) from paper consumption. Because there are no external effects on the demand side of the market, this is the same as the marginal social benefit (MSB).

So that you can see what happens when market conditions change, the spreadsheet allows you to change consumer income, a demand factor, and an input price, a supply factor.

Finally, you can change the size of a per unit tax on paper production. The spreadsheet will show, when the tax is greater than zero, the marginal costs to firms of producing more paper, including the tax. By adjusting the tax, you can control how much paper, and therefore, how much pollution is produced.

Your task in the problems is to figure out what the private market does under a variety of conditions, and to figure out what the socially best outcome is in these cases. You are also asked to suggest optimal tax policies that will make the paper firms operate in society's interest.

Here are some important results to watch for:

- 1) When there is a harmful externality, even a competitive market will produce too much of a good from society's point of view.
- 2) But even at the socially best output of the good, there will still be some pollution and pollution cost.

3) If pollution is taxed correctly then changes in the underlying demand and supply conditions in the market will not require adjusting the pollution tax to get the socially best output.

HINTS: Competitive markets will produce where $MPC = MPB$.
Society wants an output where $MSC = MSB$.
An appropriate tax can raise MPC to equal MSC .
Goal Seek can be used to solve all of these problems, but experimentation, especially with changing the tax, is likely to be helpful.

MATH MAVEN'S CORNER: All of the functions in this problem set are linear, but the parameters will vary from one student's problem to another.

EXTERNALITIES

Questions

Set all variables to their baseline values. If the market for output (paper) is competitive, then

- 1) What is the equilibrium quantity that will be traded?
- 2) What is the market price of paper in a free market?

Set all variables to their baseline values.

- 3) When one more unit of output is produced, what is the increase in the cost of pollution (the marginal external cost)?

Set all variables at their baseline values.

- 4) At the free market price and quantity, what is the total cost of the pollution created?
- 5) With all variables at their baseline values, what is the socially best output of paper?
- 6) What is the socially best price? That is, what price SHOULD paper sell for?
- 7) At the socially best price and quantity, what is the total cost of pollution created? [Compare your answer to that for question 4).]
- 8) Set all variables to their baseline values. What tax per unit of output should be imposed on paper firms to get them to produce the socially best output?

Set all variables to their baseline values. Now suppose consumer income rises to \$40,000.

- 9) What's the new free market quantity of paper?
- 10) What's the new free market price of paper?

For the quantity and price you found for the last two questions,

- 11) What are the total pollution costs?

12) With income still at \$40,000., what is the socially best output of paper?

With income still at \$40,000

- 13) What is the socially best price of paper?
- 14) What is the socially best amount of pollution?
- 15) With income still at \$40,000, what tax per unit of output should be imposed on the paper firms to get them to produce the socially best output? [Compare your answer to that for question 8).]

Set all variables to their baseline values. Now suppose that input prices fall to \$10.00.

- 16) What's the new free market quantity of paper?
- 17) What are the total pollution costs at this quantity?

With input prices still at \$10.00,

- 18) What is the socially best quantity of paper?
- 19) What tax per unit of output will get the market to the socially best quantity of paper?
[Compare the tax to the answers to Questions 8) and 15).