

13 | TOTAL, AVERAGE, AND MARGINAL COSTS

Purpose: To illustrate the relationship between total, average and marginal costs. To show the effects of changes in fixed costs and of per unit (excise) taxes.

Computer file: **newtamc.xls**

Instructions and background information:

You operate the Smiling Dog Vineyard and Winery in Paw Paw, Michigan. The top graph shows the short-run total cost curve for the production of wine. Quantity is the number of cases you produce each year. Total costs are measured on the vertical axis. The base value for fixed cost is \$25,000, and the amount of tax on your output is zero. When you change either fixed cost or the tax the new total cost curve is drawn in the upper diagram.

The bottom graph shows the average and marginal cost curves that correspond to the base case. When you change the level of fixed costs or the tax, Excel draws the new corresponding average and marginal cost curves. When you choose an output level Excel computes and shows the corresponding levels of total, average, and marginal cost.

In both diagrams, output is the independent variable and costs are the dependent variables. You choose a value for output, and the corresponding cost curve shows the value for costs. In the spreadsheet, you can choose Output, Fixed Cost, and the Tax per unit of output. Excel then computes the new total, average, and marginal costs, and redraws the cost curves.

Here are some things to watch for and learn as you do the problems:

- 1) The shape and position of the average and marginal cost curves is completely determined by the total cost curve. All information relating output to costs is contained either in the total cost curve or in the companion set of average and marginal cost curves. Which representation of costs economists use depends on the particular questions that must be answered.
- 2) Average and marginal cost curves have a special geometric relationship that is clearly shown in this problem set. When average cost is declining as output increases, marginal cost is less than average cost. When average cost is rising, marginal cost is greater than average cost. When average cost is neither rising nor falling (at a minimum or maximum), marginal cost equals average cost.

- 3) Marginal cost can be thought of as the cost of one more unit of output. It is the slope of the total cost curve ($\Delta TC/\Delta Q$). It is easy to deduce the general shape of the marginal cost curve by inspecting the total cost curve. In this problem set the total cost curve increases at an increasing rate, so marginal cost rises with output.
- 4) An excise (per unit) tax raises both average and marginal costs by exactly the amount of the tax per unit. Total cost increases by the output times the tax per unit. One consequence of this is that the output at which average cost is minimized is unchanged if an excise tax is imposed.
- 5) An increase in fixed costs raises total cost by precisely the amount of the increase. An increase in fixed costs raises average costs, but leaves marginal costs *unchanged*. This last result follows directly from the nature of an increase in fixed costs. The increase shifts the total cost curve upward, but leaves its slope the same at each output.

Here are some hints to help you get the answers quicker:

- 1) At the minimum average cost, marginal cost equals average cost. The spreadsheet shows a value for the difference between average and marginal costs. You can use Goal Seek or experimentation to find the output that makes this difference equal to zero, that is, the output where average cost is minimized.
- 2) For letter or word answers to some of the questions, be sure to use lower case letters only. Or search the Answer Bin for correct options.

MATH MAVEN'S CORNER: The total cost curve in the problem is given by

$$TC = FC + a(Q) + b(Q^2) + t(Q)$$

where TC is total cost, FC is fixed cost, Q is output, and t is the tax per unit of output. The values of the parameters a and b are chosen randomly. The average cost is TC/Q , and marginal cost is $\partial(TC)/\partial Q$.

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Questions

Set all variables to their baseline values.

- 1) When average cost is declining, is marginal cost GREATER than, LESS than, or EQUAL to average cost?

Set all variables to their baseline values.

- 2) When average cost is increasing, is marginal cost GREATER than, LESS than, or EQUAL to average cost?

Set all variables to their baseline values, and set output 4,000.

- 3) What's the value of average cost?
- 4) Is AC rising at that output? [yes or no]
- 5) What is marginal cost when output is 4,000?

Set all variables to their baseline values, and set output to 1500.

- 6) What's the value of average cost?
- 7) Is AC rising at that output? [yes or no]
- 8) What is marginal cost when output is 1500?

Set all variables to their baseline values.

- 9) At what level of output is average cost a minimum?
- 10) What is average cost (AC) at that output?
- 11) What is marginal cost (MC) at that output?

Set the value of the per unit tax to \$10.

- 12) If output is 4,000, how much did AC increase?
- 13) If output is 4,000, how much did MC increase?
- 14) If output is 4,000, how much did total cost increase?

Set the tax at \$10 per unit of output.

- 15) At what output is the value for the new AC at its minimum?

Set all variables to their baseline values. Now increase the level of fixed cost to \$50,000.

- 16) If output is 4,000, how much did AC increase?
- 17) If output is 4,000, how much did MC increase?
- 18) If output is 4,000, how much did total cost increase?

Set the level of fixed cost to \$50,000.

- 19) At what output is the value for the new AC at its minimum?

- 20) Which option best describes the effect of increasing a per unit tax? [enter a, b, or c]
- a) AC rises by the amount of the tax per unit.
 - b) TC rises by the amount of the tax per unit.
 - c) MC is unchanged.
- 21) Which option best describes the effect of increasing fixed cost? [enter a, b, or c]
- a) TC increases by FC times output.
 - b) AC increases by the amount of FC.
 - c) MC is unchanged.