Inputs and Costs
September 21, 2006
Reading: Chapter 8

Begin examination of how firms make decisions using the principles of individual decision making (marginal costs and benefits).

First we examine relation between inputs and outputs.
Second we examine costs and marginal (and other) costs.
Next topic: Marginal benefits for the firm and how they decide how much to produce.

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Inputs and Costs

a. Production function
   - How inputs and outputs are related
   - Diminishing returns

b. Cost function and cost curve
   - Total cost
   - How cost function is related to production function

c. Marginal and average cost

d. Short-run and long-run costs and returns to scale

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Production Function
Definitions

Production function: relationship between the quantity of inputs a firm uses and the quantity of output it produces.

Inputs are of two types:
- Fixed input: an input whose quantity is fixed and cannot be varied in the relevant time period.
- Variable input: an input whose quantity the firm can vary in the relevant time period.

Time periods:
- Short run: time period in which at least one input is fixed.
- Long run: time period in which all inputs can be varied.

Why? Some things take longer to change than others.

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Production Function
Total product curve

The total product curve shows how the quantity of output depends on the quantity of one variable input, for a given quantity of other inputs.

Assume:
- Firm produces one product
- With two inputs, labor and land
- Amount of land held constant

So labor is variable input and land is fixed input.

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Production Function
Marginal Product

The marginal product of an input is the additional quantity of output that is produced by using one more unit of that input.

The marginal product of labor is the additional quantity of output produced by using one more unit of labor.

\[
\text{Marginal product of labor} = \frac{\text{Change in quantity of output}}{\text{Change in quantity of labor}}
\]

\[
\text{Marginal product of labor} = \frac{\Delta Q}{\Delta L}
\]

We have diminishing returns to an input when an increase in the quantity of that input, holding the levels of all other inputs fixed, leads to a decline in the marginal product of that input.

Marginal product can be negative - total product falls as input increased.
Production Function
Marginal Product of Labor Curve

Cost Definitions
- **Fixed cost**: cost that does not depend on the quantity of output produced. It is the cost of fixed inputs.
  - In our example, it is the cost of land
- **Variable cost**: cost that depends on the quantity of output produced. It is the cost of variable inputs for any level of output.
  - In our example, it is the cost of labor
- **Total cost**: Fixed cost + Variable cost
  - \( TC = FC + VC \)

The relation between output and costs is called the total cost function and shown with a total cost curve.

Cost From total product curve to total cost curve

Marginal and Average Cost
Marginal Cost

\[ MC = \frac{\Delta TC}{\Delta Q} \]

Marginal cost is the change in total cost divided by the change in quantity of output.
Marginal and Average Cost

**Average Cost**

*Average total cost*, often referred to simply as *average cost*, is total cost divided by quantity of output produced:

\[ \text{ATC} = \frac{\text{TC}}{Q} \]

*Average fixed cost* is the fixed cost per unit of output:

\[ \text{AFC} = \frac{\text{FC}}{Q} \]

*Average variable cost* is the variable cost per unit of output:

\[ \text{AVC} = \frac{\text{VC}}{Q} \]

**Average Total Cost Curve**

The average total cost curve is U-shaped. At low levels of output, average total cost falls because the *spreading effect* of falling average fixed cost dominates the *diminishing returns effect* of rising average variable cost. At higher levels of output, the opposite is true and average total cost rises.

**Marginal and Average Cost**

**Average cost and marginal cost curves**

- At the minimum-average cost output, average cost is equal to marginal cost.
- At output less than the minimum-average cost output, marginal cost is less than average cost and average cost is falling.
- And at output greater than the minimum-average cost output, marginal cost is greater than average cost and average cost is rising.

Holds for both average total and average variable cost. Why?

**Short-Run and Long-Run Costs**

In the *short-run*, fixed cost is given and outside the control of a firm.

In the *long-run*, the quantity of all inputs is variable: “fixed” cost may also be varied. In the long run, a firm’s “fixed cost” becomes a variable it can choose. For instance, plant size, or size of farm, can be changed.
There is a trade-off between higher fixed cost and lower variable cost for any given output level, and vice versa. But as output goes up, average total cost is lower with the higher amount of fixed cost.

**Short-Run and Long-Run Costs**

**Short-Run and Long-Run Average Total Cost Curves**

- There are **economies of scale** when long-run average total cost declines as output increases.
  - Specialization (division of labor) at higher levels of output
- There are **diseconomies of scale** when long-run average total cost increases as output increases.
  - Problems of coordination and communication
- There are **constant returns to scale** when long-run average total cost is constant as output increases.
  - Replication