1 Production

Profit (π) The difference between revenues (R) and costs (C).

$$\pi = R - C$$

Capital (K) Inputs that are not exhausted with a single use.

Labor (L) Human inputs into production.

Materials Raw goods that are used as inputs to production.

Production Function A function that gives the maximum amount of output we can make given the quantities of inputs that we use.

$$q = f(L, K)$$

Short Run A period of time such that at least one production input is fixed.

Fixed Input An input that cannot be changed in the short run. This is usually capital.

Variable Input An input that can be changed even if we are in the short run. This is usually labor.

Short Run Production Function A production function where capital is fixed so only labor can vary.

$$q = f(L, \bar{K})$$

Long Run A period of time such that all production inputs can be changed.

Total Product of Labor The total amount of output that can be produced by a given amount of labor.

Marginal Product of Labor The amount of output than an additional worker will provide, keeping all other factors constant.

$$MP_L = \frac{\partial q}{\partial L} = \frac{\partial f(L, \bar{K})}{\partial L}$$

Average Product of Labor The average amount of output produced by each worker.

$$AP_L = \frac{q}{L} = \frac{f(L, \bar{K})}{L}$$

Law of Diminishing Marginal Returns As we increase the use of a certain input, the marginal productivity of that input will eventually decrease if all other inputs are kept constant.

Isoquant A curve that shows the different combinations of labor and capital that produce a single level of output.

$$\bar{q} = f(L, K)$$

Properties of Isoquants:

1. Isoquants represent larger quantities as you move in the northeast direction.
2. Isoquants can never cross.
3. Isoquants slope downwards.

Marginal Rate of Technical Substitution The number of extra units of capital needed to replace one unit of labor that enables a firm to produce the same level of output. Essentially how many units of capital a worker is equivalent to.

$$MRTS = -\frac{\frac{\partial f(L,K)}{\partial L}}{\frac{\partial f(L,K)}{\partial K}} \approx \frac{\Delta K}{\Delta L}$$

Constant Returns to Scale A production function such that if we increase every input by a certain percentage, then output also increases by that same percentage.

$$f(\lambda L, \lambda K) = \lambda f(L, K)$$

Increasing Returns to Scale A production function such that if we increase every input by a certain percentage, then output will increase by *more* than that percentage.

$$f(\lambda L, \lambda K) > \lambda f(L, K)$$

Decreasing Returns to Scale A production function such that if we increase every input by a certain percentage, then output will increase by *less* than that percentage.

$$f(\lambda L, \lambda K) < \lambda f(L, K)$$

2 Input Choices and Costs

Isocost Line All the combinations of labor and capital that have to same total cost.

$$\bar{C} = wL + rK$$

At optimal point (L^*, K^*) where a firm is producing a given quantity at the lowest possible cost, the marginal rate of technical substitution is equal to the input price ratio. At this point the output per dollar for labor and capital are equal.

$$MRTS = -\frac{w}{r} \Leftrightarrow -\frac{MP_L}{MP_K} = -\frac{w}{r} \Leftrightarrow \frac{MP_L}{w} = \frac{MP_K}{r}$$

Expansion Path The quantities of labor and capital that minimize cost for any given output level.

3 Exercises

1. Steve is running a company that makes extra strength sunscreen for gingers. The quantity of sunscreen Q_S Steve can make from labor and capital is given by the production function $Q_S(L, K) = L^{\frac{1}{4}}K^{\frac{3}{4}}$.

   (a) Does Steve's firm display constant, increasing, or decreasing returns to scale?

   (b) Suppose the current wage is \$8 and the current rental rate is \$48. Steve has decided to use 80 units of labor and 30 units of capital to produce his current level of output. Is he minimizing the costs for his firm? If not, should he use more labor or more capital?

   (c) Can Steve's firm produce the same quantity and get to the cost minimizing level of labor and capital in the short run?

2. Jalen has invented a new type of basketball shoes with springs that allows short people to dunk. His cost function of producing the shoes is given by $C(q) = 4q^2 - 20q + 100$. Suppose the \$100 fixed cost is not *sunk*, so that Jalen does not have to pay it if he decides not to produce.

   (a) What is the average cost for producing shoes?

   (b) What is the marginal cost for producing shoes?

   (c) When is average cost increasing?

   (d) What is the average variable cost?

   (e) If the price that Jalen can sell shoes at is \$12, how much will Jalen produce? What is his profit?

   (f) If the price that Jalen can sell shoes at is \$28, how much will Jalen produce? What is his profit?