



Production Function

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Production Function

- The productive resources, such as labor and capital equipment, that a firm uses to manufacture goods and services are called **inputs** or **factors of production**, and the amount of goods and services produced is the firm's **output**.
- The **production function** is a mathematical representation of the various technological recipes from which a firm can choose to configure its production process. In particular, the production function tells us the *maximum* quantity of output the firm can produce given the quantities of the inputs that it might employ

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

- where Q is the quantity of output, L is the quantity of labor used, and K is the quantity of capital employed. This expression tells us that the maximum quantity of output the firm can get depends on the quantities of labor and capital it employs. We could have listed more categories of inputs, but many of the important trade-offs that real firms face involve choices between labor and capital (e.g., robots and workers for semiconductor firms).

Marginal Product and Average Product

- The average product of labor is the average amount of output per unit of labor.

$$AP_L = \frac{\text{Total Product}}{\text{Quantity of Labor}} = \frac{Q}{L}$$

- The marginal product of labor is the rate at which total output changes as the firm changes its quantity of labor:

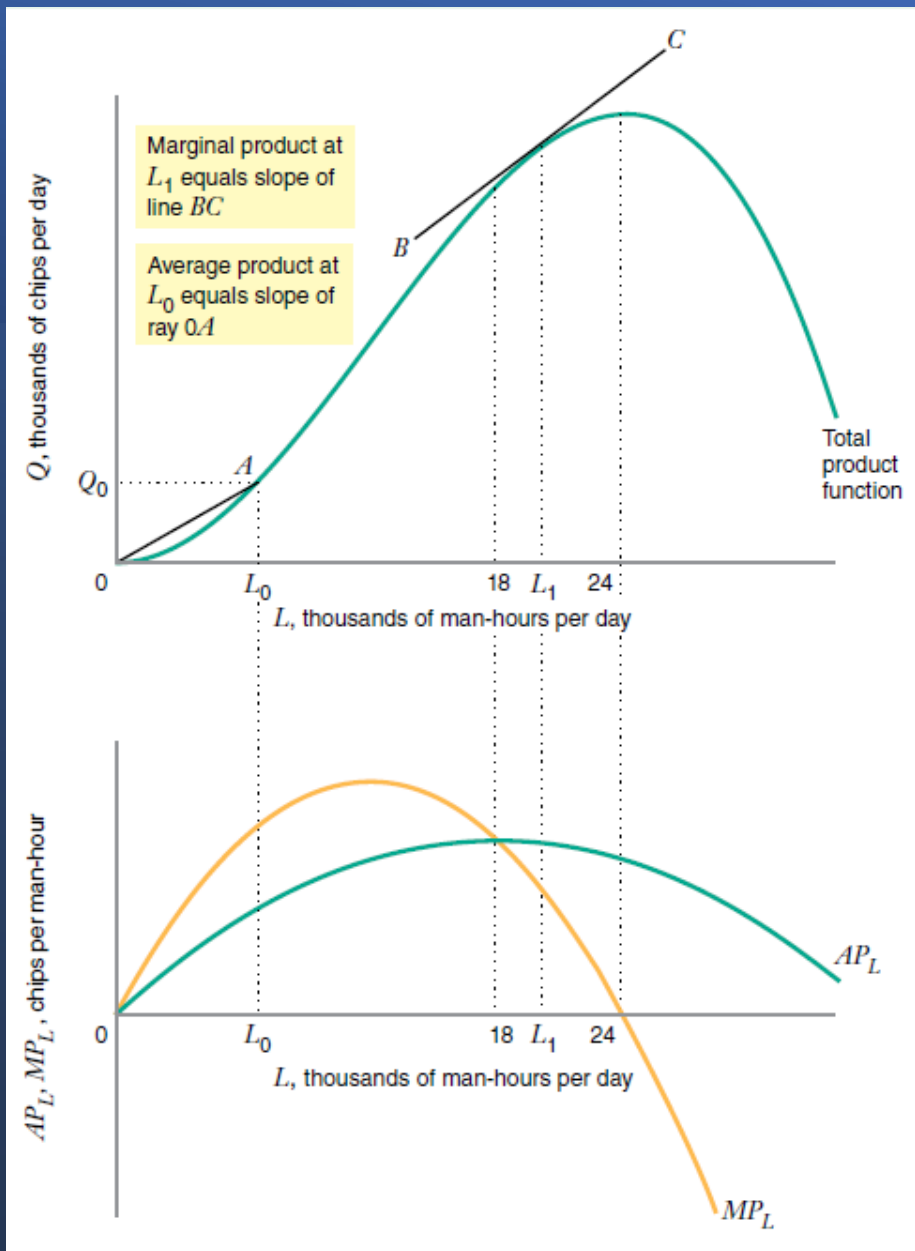
$$MP_L = \frac{\text{Change in Total Product}}{\text{Change in Quantity of labour}} = \frac{\Delta Q}{\Delta L}$$

Law of Diminishing Marginal Returns

- In most production processes, as the quantity of one input (e.g., labor) increases, with the quantities of other inputs (e.g., capital and land) held constant, a point will be reached beyond which the marginal product of that input decreases.
- This phenomenon, which reflects the experience of real-world firms, seems so pervasive that economists call it the **law of diminishing marginal returns**.

Production function with single input (Short-Run)

1. **A constant state of technology:** The first assumption is that the situation's technological condition remains unaltered. If technology improves, the marginal product may increase rather than decrease.
2. **Variable Factor Proportions:** This presupposes that production factors are variable. The legislation is invalid if the factors of production are fixed.
3. **Homogeneous factor units:** These are units that have the same quality, quantity, and price. In other words, the units are all the same.
4. **Brief Run:** This suggests that this law applies to systems that are only operational for a short period of time and where it is not possible to change all factor inputs.



Stage 1. Increasing Marginal Returns to Labor.

- When there are increasing marginal returns to labor, an increase in the quantity of labor increases total output at an increasing rate. Increasing marginal returns are usually thought to occur because of the gains from specialization of labor. In a plant with a small workforce, workers may have to perform multiple tasks.
- For example, a worker might be responsible for moving raw materials within the plant, operating the machines, and inspecting the finished goods once they are produced. As more workers are added, workers can specialize—some will be responsible only for moving raw materials in the plant; others will be responsible only for operating the machines; still others will specialize in inspection and quality control. Specialization enhances the marginal productivity of workers because it allows them to concentrate on the tasks at which they are most productive.

Stage 2. Diminishing Marginal Returns to Labor.

- When there are diminishing marginal returns to labor, an increase in the quantity of labor still increases total output but at a decreasing rate.
- Diminishing marginal returns set in when the firm exhausts its ability to increase labor productivity through the specialization of workers.

Stage 3. Diminishing Total Returns to Labor.

Or Negative Marginal Return to Labor

- When there are diminishing total returns to labor, an increase in the quantity of labor decreases total output.
- Diminishing total returns occur because of the fixed size of the fabricating plant: if the quantity of labor used becomes too large, workers don't have enough space to work effectively.
- Also, as the number of workers employed in the plant grows, their efforts become increasingly difficult to coordinate.

Relationship between MP and AP of Labor

- When average product is *increasing in labor*, marginal product is *greater than* average product. That is, if AP_L increases in L , then $MP_L > AP_L$.
- When average product is *decreasing in labor*, marginal product is *less than* average product. That is, if AP_L decreases in L , then $MP_L < AP_L$.
- When average product *neither increases nor decreases in labor* because we are at a point at which AP_L is at a maximum, then marginal product is *equal to* average product.

➤ When TP increases at an increasing rate, the MP and AP also increase.

However, at this stage, $MP > AP$

➤ When TP increases at a decreasing rate, the MP and AP start to fall. When MP starts falling significantly and AP falls at a low rate, it means that now $MP < AP$.

➤ When TP falls, MP goes negative, and AP falls consistently remaining above the x-axis.

➤ MP intersects AP when the latter is at the maximum, this is where $MP = AP$

Significance

1. In Stage I, a producer does not work. At this level, as the variable factor grows, so does the marginal product.
As a result, the producer can use more units of the variable to make better use of the fixed components. As a result, the producer would prefer not to stop at Stage I and will endeavor to grow further.
2. Any logical manufacturer will avoid both the first and third stages of production. As a result, producers choose Stage II, which is the stage of declining returns. According to the rule of changing proportions, this is the most important stage of operation for a producer.
3. Producers dislike working at Stage III as well. At this moment, the total product is dropping, and the marginal product is negative. Producers minimize the number of variable components in order to boost output. However, in Stage III, he incurs larger expenditures and receives less income, resulting in lower earnings.

Any Question?