# Chapter seven

# Technology, production and costs

- **The firm is an organization that uses inputs, such as machines, workers, natural resources, to produce output of goods and services.**

- **Most firms produce goods or service to earn profit but there are non profit firms, such as universities.**

- **A firm's technology is the processes that the firm uses to turn inputs into outputs.**
- **In economy, technology depends on many factors, such as skill of manager, training of workers, and the speed and efficiency of machines and equipment.**

# The Short Run and the Long Run in Economics

- **In the short run, technology and capital are fixed, while the number of workers is variable.**

- **In the long run, the firm is able to vary all inputs, adopt new technology, and change the size of physical plant. In the long run, technology and capital are variable factors.**

- **Of course, the actual length of time in the short run will differ from firm to another firm. A pizza restaurant is able to increase its physical plant by adding some ovens, tables and chairs in a few weeks. In contrast, BMW may take more than one year to increase its capital.**

# *Production function*

- ***Production function***: **is the relationship between the quantity of inputs and the quantity of output.**

**Output = function (labor, capital and technology)**

**Example: suppose that Salma owns a pizza restaurant. In the short run, Salma can increase or decrease the quantity of pizza (total product) by changing the number of workers. She does not have time to build a large restaurant, install additional ovens or redesign the layout of the restaurant. The next table shows the relation between the quantity of workers and output.**

| Number of workers | ovens | Quantity of pizza | Marginal product | Average product |
|---|---|---|---|---|
| 0 | 2 | 0 | 0 | 0 |
| 1 | 2 | 200 | 200 | 200 |
| 2 | 2 | 450 | 250 | 225 |
| 3 | 2 | 600 | 150 | 200 |
| 4 | 2 | 700 | 100 | 175 |
| 5 | 2 | 760 | 60 | 152 |
| 6 | 2 | 800 | 40 | 133.3 |
| 7 | 2 | 800 | 0 | 114.3 |
| 8 | 2 | 790 | -10 | 99 |

***Total product (TP)***: **is the quantity of output obtained from the quantity of inputs.**

***Marginal product of labor (MP)***

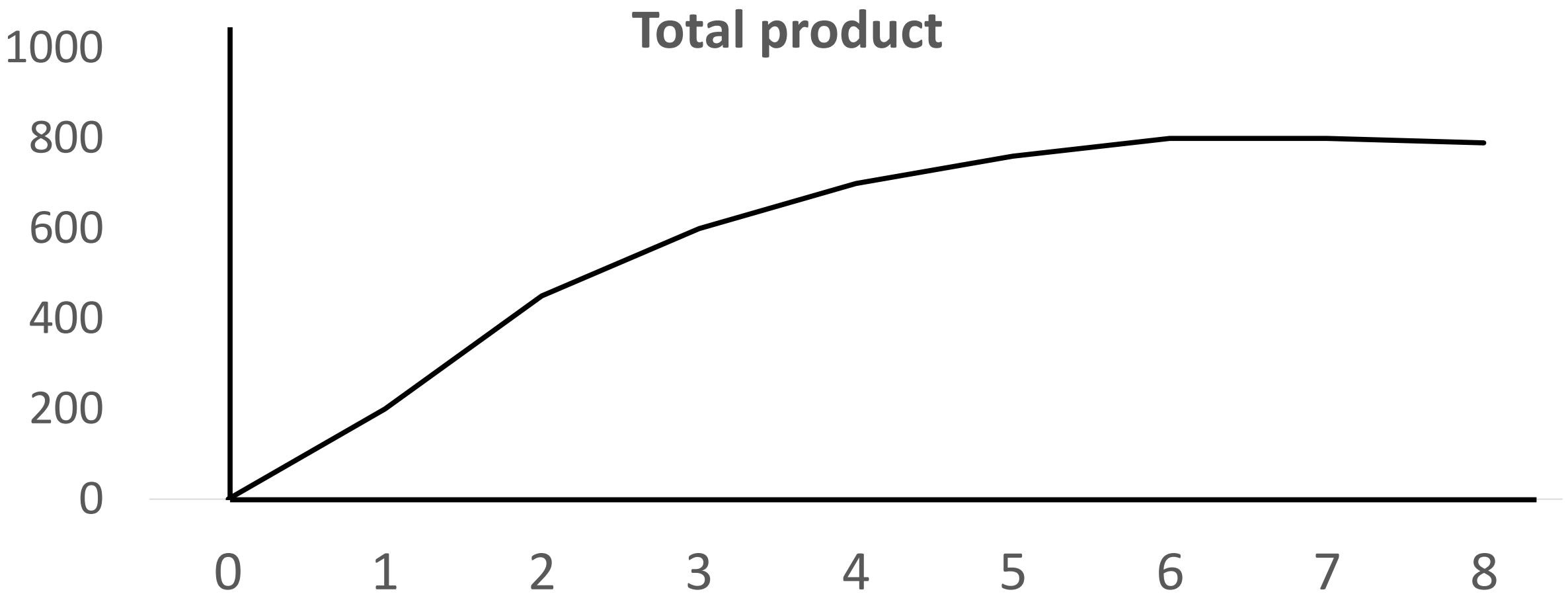
**Marginal product of labor is the change in output (total product) obtained from an additional unit of labor.**

$$\text{Marginal product of labor} = \frac{\text{change in total product}}{\text{change in labor}}$$

***Average product of labor (AP):*** **is the total product divided by the quantity of labor.**

$$\textit{Average product of labor} = \frac{\text{total product}}{\text{quantity of } \textit{labor}}$$

# Relation between output and labor



**Example: This table shows the relation between labor and total output, holding other inputs fixed (capital and technology).**

| Number of workers | Total Product | Marginal Product | Average Product |
|---|---|---|---|
| 1 | 10 | 10 | 10 |
| 2 | 30 | 20 | 15 |
| 3 | 60 | 30 | 20 |
| 4 | 80 | 20 | 20 |
| 5 | 90 | 10 | 18 |
| 6 | 90 | 0 | 15 |
| 7 | 80 | -10 | 11.4 |

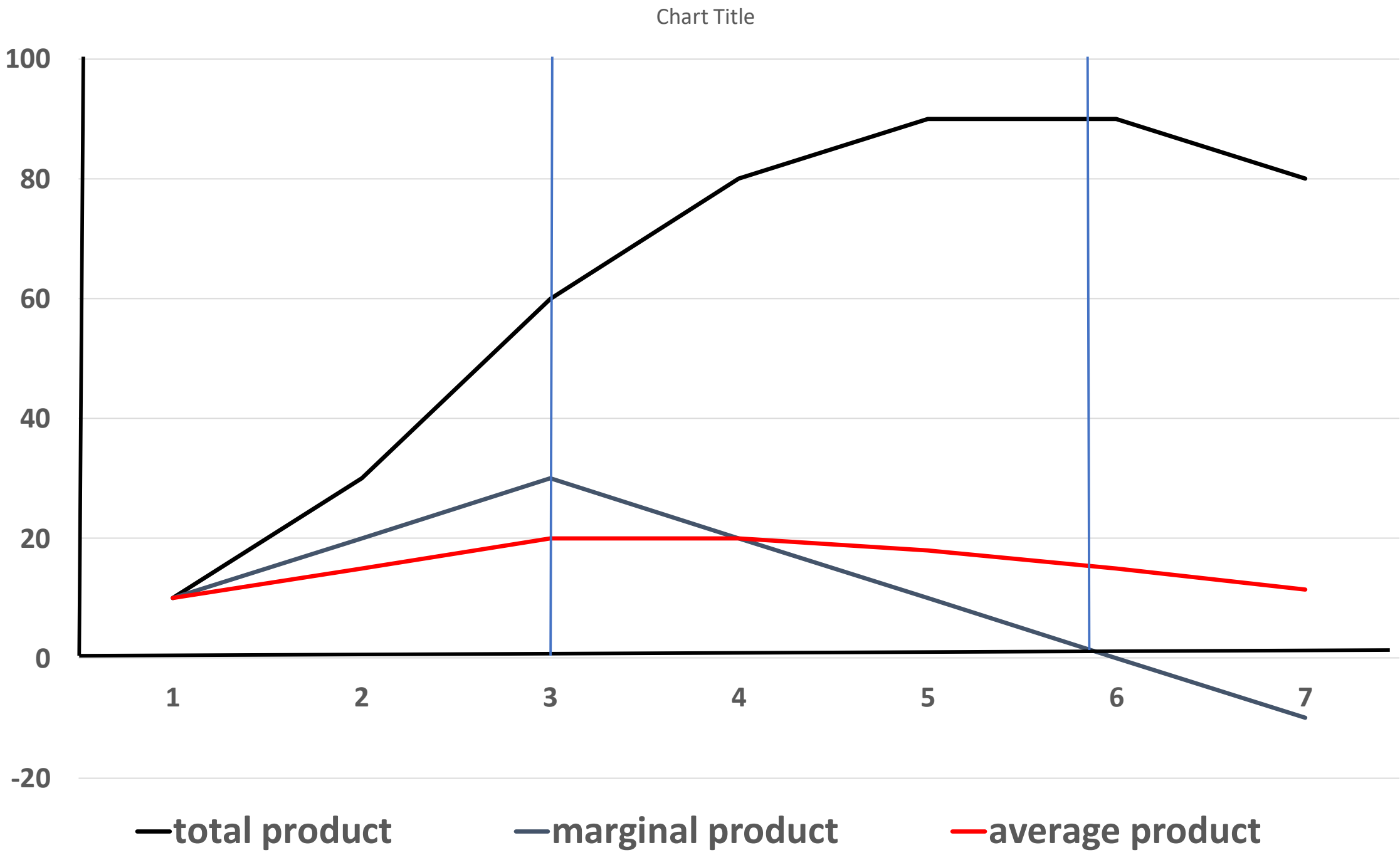


Chart Title
100
80
60
40
20
0
-20
1
2
3
4
5
6
7
total product
marginal product
average product

# Relation between total and marginal products

- **When total product increases, the marginal product is positive.**
- **When total product is constant (at the maximum point), the marginal product is zero.**
- **When total product decreases, the marginal product is negative.**

# Relation between average and marginal products

- **When average product increases, the marginal product is above the average product.**
- **When average product is constant (at the maximum point), the marginal product equals the average product.**
- **When average product decreases, the marginal product is below the average product.**

# Law of diminishing returns

**The marginal product of labor declines as the amount of labor increases, holding other inputs constant.**

| Labor | Total Product | Marginal Product | Average Product |
|---|---|---|---|
| 1 | 100 | | |
| 2 | 250 | | |
| 3 | 450 | | |
| 4 | 650 | | |
| 5 | 800 | | |
| 6 | 900 | | |
| 7 | 900 | | |
| 8 | 800 | | |

1. *What is the definition of marginal product and average product?*
2. *Could you estimate marginal and average products?*
3. *Could you graph the relation between total product, average product and marginal product?*

# The relation between total, average and marginal products