

ECO101: Introduction to Microeconomics

Lectures 12-13

Producer Theory

Firms: Uses inputs and factors of production to produce goods and services

Goal of the firm: Profit Maximization

$$\text{Profit} = \text{Total Revenue} - \text{Total Cost}$$

In economics, total cost is measured as the opportunity cost of production (the value of the best alternative use of the resources that a firm uses in production)

A firm reaches **economic efficiency** when the firm produces a given output at the lowest possible cost

The Firm's Decisions

- What goods and services to produce?
- In what quantities to produce?
- How to produce? What factors of production to use?
- Produce or outsource?
- How to market and price its products?



Time frames for decision-making

Short run vs Long run

Some decisions are irreversible (costly to reverse) while some decisions can be easily changed to influence profits

Short-run: a time-frame in which the quantity of at least one factor of production is fixed

Long-run: a time-frame in which the quantity of all factors of production can be varied

Time frames for decision-making

Short Run

Time-frame in which the quantity of at least one factor of production is fixed

For most firms

- capital, land and entrepreneurship are **fixed factors** of production (usually called a firm's plant) e.g. factories, machinery
- labor is the **variable factor** of production

In the short run, to increase output a firm must increase the quantity of the variable factor of production

These decisions are easily reversed

Time frames for decision-making

Long Run

Time-frame in which the quantity of all factors of production can be varied

In the long-run, the firm can change its plant and/or hire more labor to increase output

These decisions are not easily reversed

Output & Costs

Short Run Technology Constraints

In the short-run, in order to increase output, a firm must increase the quantity of labor

Three measures of output:

1. Total Product: The total output that can be produced by a given quantity of labor
2. Marginal Product: The increase in total product resulting from a one unit increase in labor, with all other inputs remaining the same
3. Average Product: The total product divided by the quantity of labor employed (measures worker efficiency)

Output & Costs

Short Run Technology Constraints

Notice the patterns:

1. As no. of labor employed increases, total product increases
2. As no. of labor employed increases, marginal product at first increases then begins to decrease
3. As no. of labor employed increases, average product at first increases then decreases

Table 10.1

Total Product, Marginal Product and Average Product

	Labour (workers per day)	Total product (jumpers per day)	Marginal product (jumpers per worker)	Average product (jumpers per worker)
<i>A</i>	0	0		
		4	
<i>B</i>	1	4		4.00
		6	
<i>C</i>	2	10		5.00
		3	
<i>D</i>	3	13		4.33
		2	
<i>E</i>	4	15		3.75
		1	
<i>F</i>	5	16		3.20

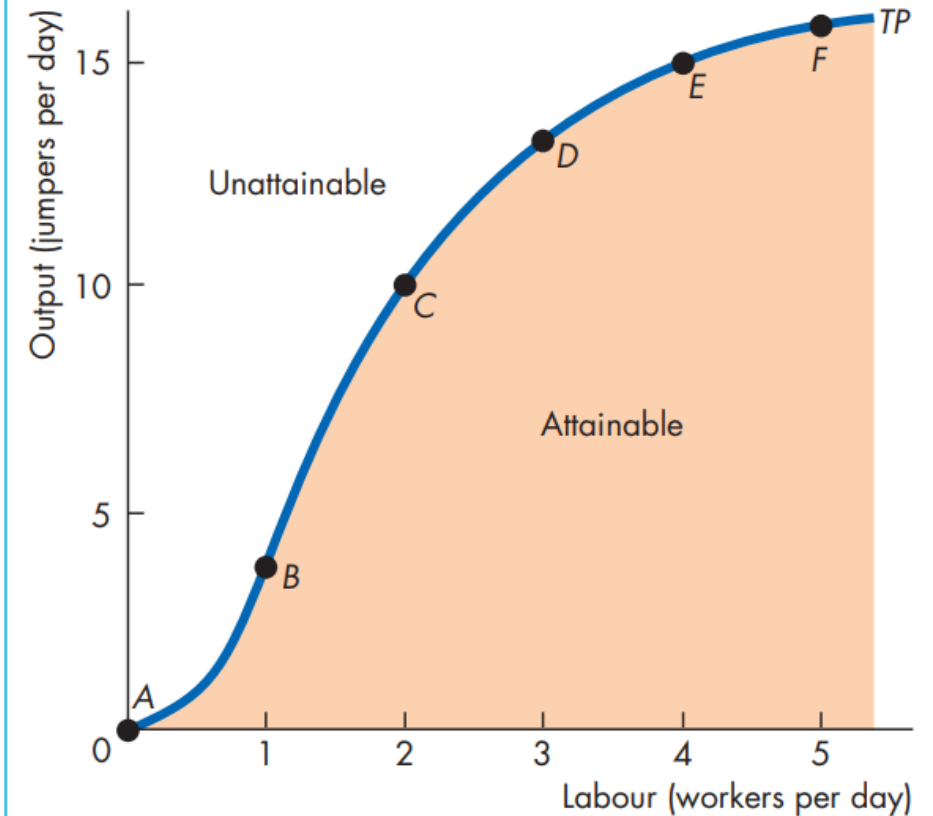
Output & Costs

Short Run Technology Constraints

Total Product Curve: Relationship between total output produced and the quantity of labor employed

- As employment increases from 0 to 1 worker a day, curve becomes steep
- As employment increases from 3 to 4 and onwards, the curve becomes less steep
- The total product curve separates the **attainable** output from the **unattainable** output.
- Points on the TP curve are **efficient**.
- Marginal product is measured by the **slope** of the total product curve

Figure 10.1 Total Product Curve



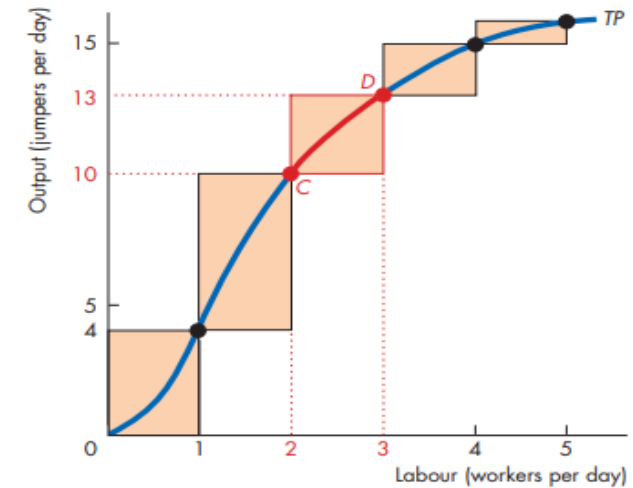
Output & Costs

Short Run Technology Constraints

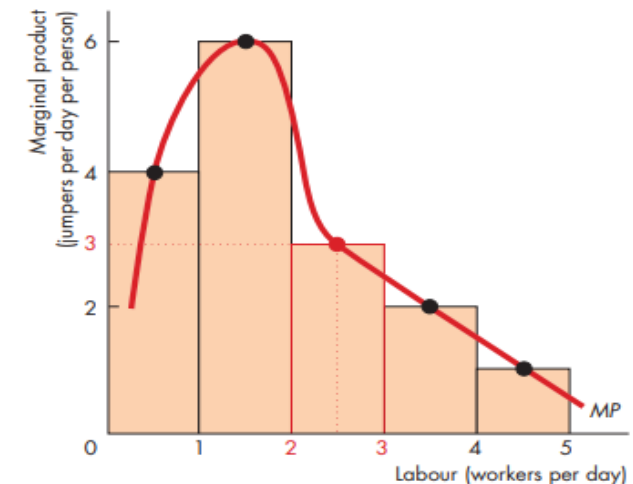
Marginal product is measured by the slope of the total product curve.

- The slope of a curve is the change in the value of the variable measured on the y-axis – output – divided by the change in the variable measured on the x-axis-labor – as we move along the curve.
- As we hire more labor, total product increases (but not at a constant rate)
- Initially when we hire more labor, workers can **specialize** and resources are better utilized causing total product to increase at an increasing rate (**increasing marginal returns**).
- Eventually, production processes reach a point of **diminishing marginal returns**
- Since all other resources and factors remain constant, increasing the number of workers without increasing machinery or capital will lead to falling marginal product.

Figure 10.2 Total Product and Marginal Product



(a) Total product



(b) Marginal product

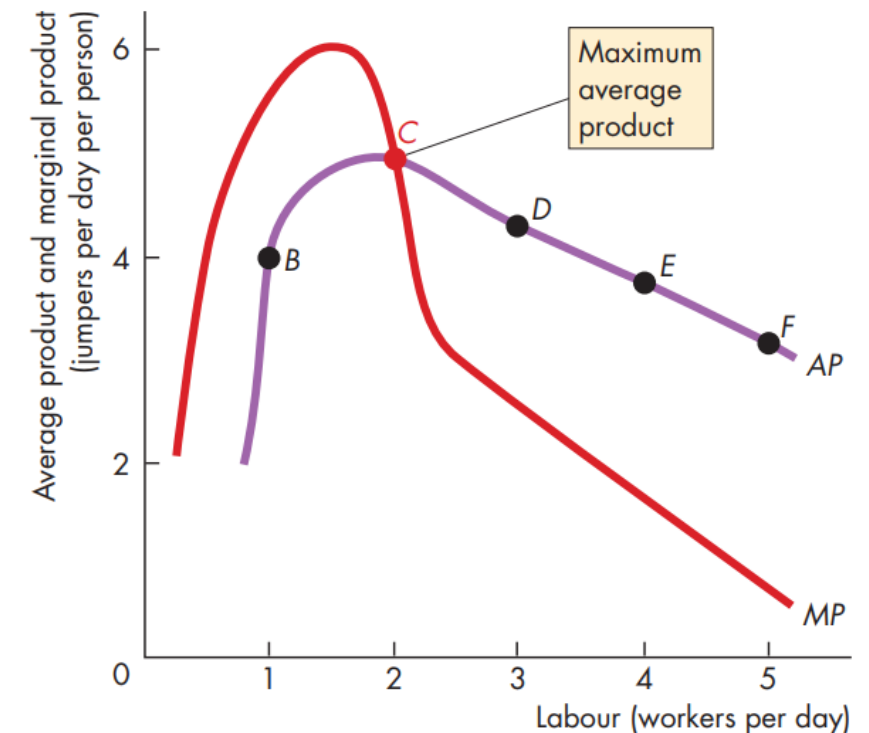
Output & Costs

Short Run Technology Constraints

Average product: Tells us how productive workers are on average

- Average product initially increases then decreases as more labor is hired
- Average product is **largest** when average product and marginal product are equal
- For the number of workers at which the marginal product exceeds average product, average product is increasing.
- For the number of workers at which marginal product is less than average product, average product is decreasing.

Figure 10.3 Average Product



Output & Costs

Short Run Costs

In the short-run, in order to increase output, a firm must increase the quantity of labor – which means it must increase its cost

Three measures of cost:

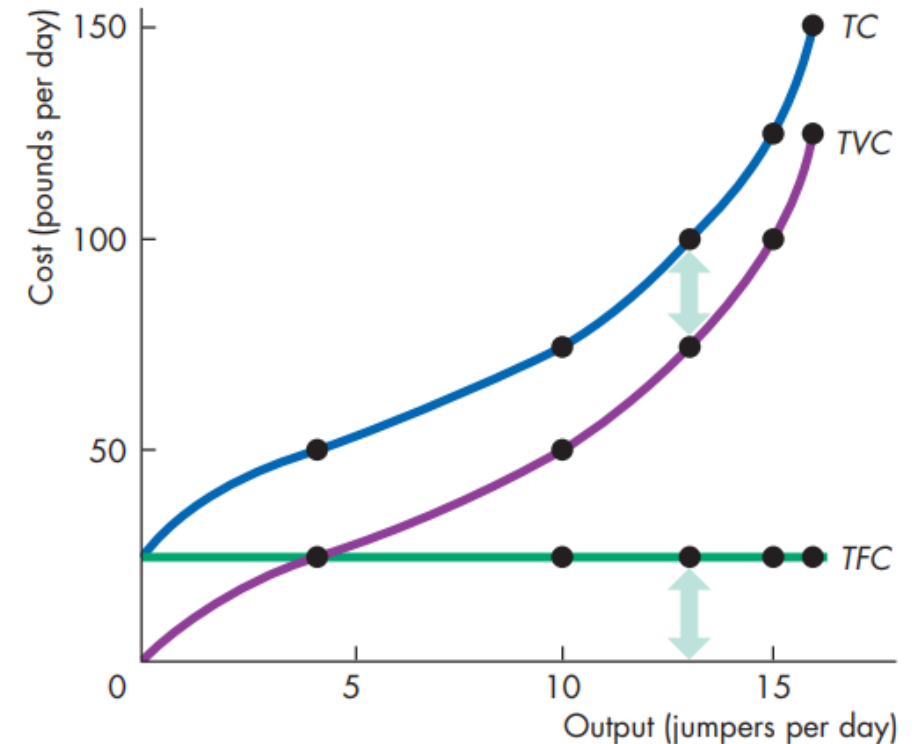
1. Total Cost: Total cost of all resources/factors of production used in the production process
2. Marginal Cost: Increase in total cost that results from a one-unit increase in total product or output
3. Average Cost: Total cost per unit of output produced

Output & Costs

Short Run Cost

- Total cost is the cost of all resources/factors of production used in a production process
- It can be divided into two parts:
- **Total Fixed Cost:** Cost of the firm's fixed inputs/factors. In the short run, total fixed cost does not change as output changes (e.g. factory rent, cost of renting machinery)
- **Total Variable Cost:** Cost of the firm's variable inputs/factors. Total variable cost changes as output changes (e.g. cost of labor)
- $TC = TFC + TVC$
- Total variable cost and total cost increase at a decreasing rate at small outputs and begin to increase at an increasing rate as output increases.

Figure 10.4 Short-run Total Cost



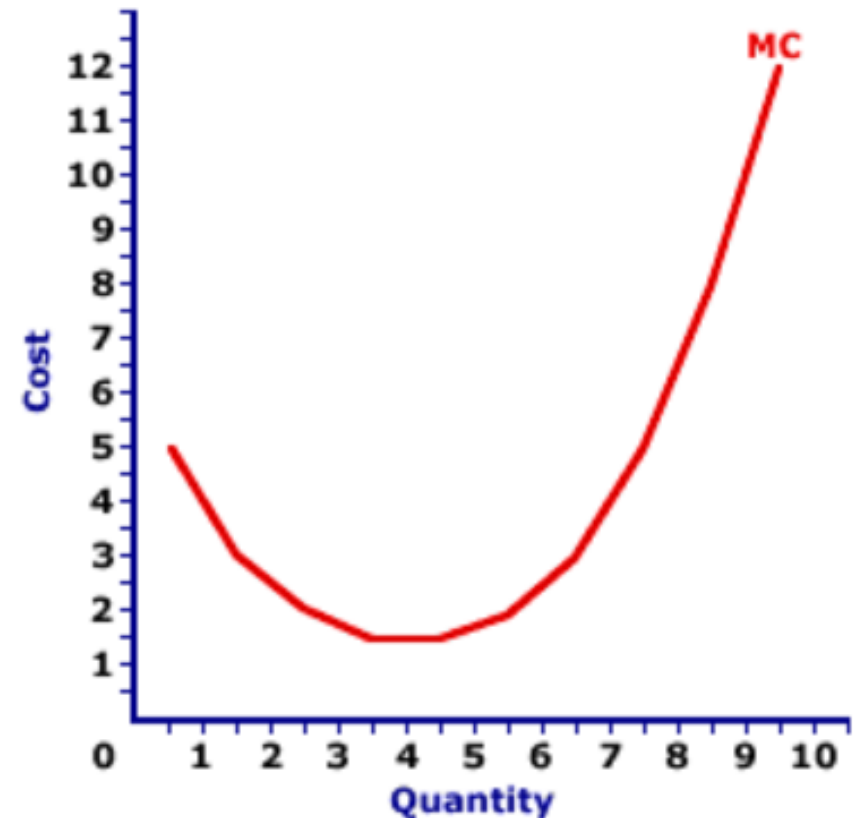
Output & Costs

Short Run Cost

- Marginal Cost: The change in a firm's total costs resulting from a one-unit increase in output

$$MC = \frac{\Delta TC}{\Delta Q}$$

- Marginal cost decreases at low outputs because of economies from greater specialization. It eventually increases because of the law of diminishing returns.
- Recall, Law of Diminishing Marginal Returns: As a firm hires more labor with fixed quantity of other inputs, marginal product of labor eventually diminishes (increases at first then decreases)
- Each additional unit of labor produces a successively smaller addition to the total output
- This means to get the same addition to output, even more workers are required. Therefore, marginal cost (cost of an additional unit of output) also increases eventually



Output & Costs

Short Run Cost

- **Average Total Cost:** Total Cost per unit of output
- **Average Fixed Cost:** Total fixed cost per unit of output
- **Average Variable Cost:** Total variable cost per unit of output

$$\frac{TFC}{Q} + \frac{TVC}{Q} = \frac{TC}{Q}$$

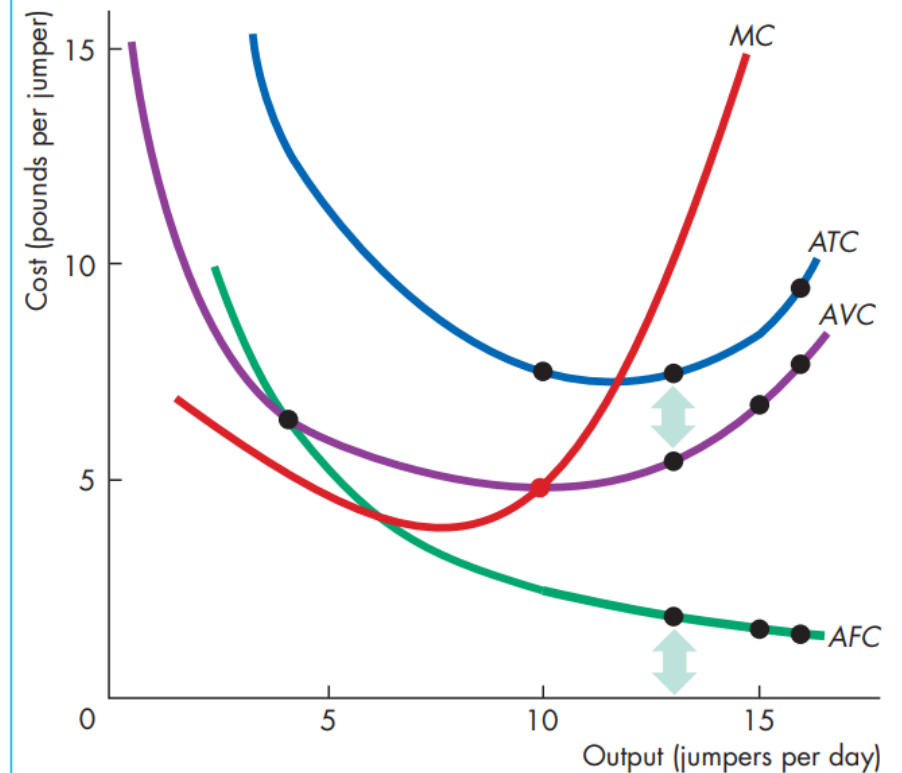
$$AFC + AVC = ATC$$

Output & Costs

Short Run Cost

- Downward sloping Average Fixed Cost (green) curve
- As output increases, same fixed cost is spread over a larger output (no need to pay more rent to produce more jumpers)
- Average Variable Cost (purple) & Average Total Cost (blue) curves are U-Shaped – vertical distance between these two accounts for the AFC
- The distance between AVC and ATC shrinks as output increases because AFC decreases
- The red marginal cost curve (MC) intersects the average variable cost curve and the average total cost curve at their minimum point.
- When marginal cost is less than average cost, average cost is decreasing, and when marginal cost exceeds average cost, average cost is increasing (analogous to relationship between average and marginal products)

Figure 10.5 Marginal Cost and Average Costs

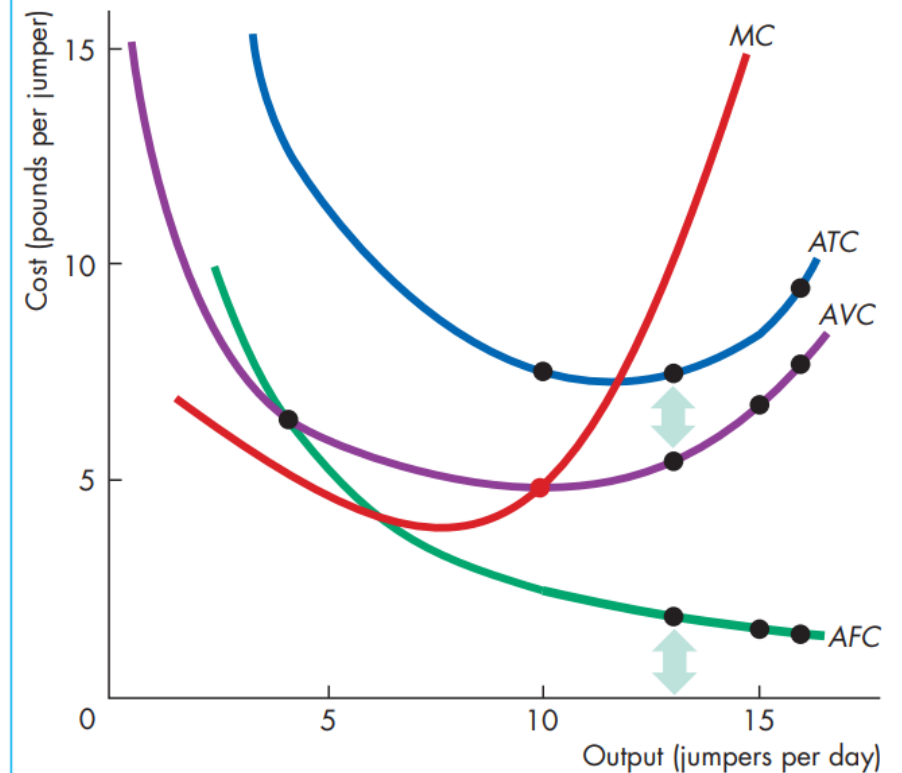


Output & Costs

Short Run Cost

- AVC (purple) curve is U-shaped
- As output increases, ever-larger amounts of labor are needed to produce an additional unit of output – due to diminishing marginal returns
- So as output increases, average variable cost decreases initially, but eventually increases
- Initially, as output increases, both average fixed cost and average variable cost decrease, so average total cost (ATC) decreases and slopes downwards
- But as output increases further and diminishing returns set in, average variable cost begins to increase.
- Eventually, average variable cost increases more quickly than average fixed cost decreases, so average total cost increases and the ATC curve slopes upward.

Figure 10.5 Marginal Cost and Average Costs



Output & Costs

Shifts in the cost curves

A firm's cost curves shift in the short-run due to two main factors:

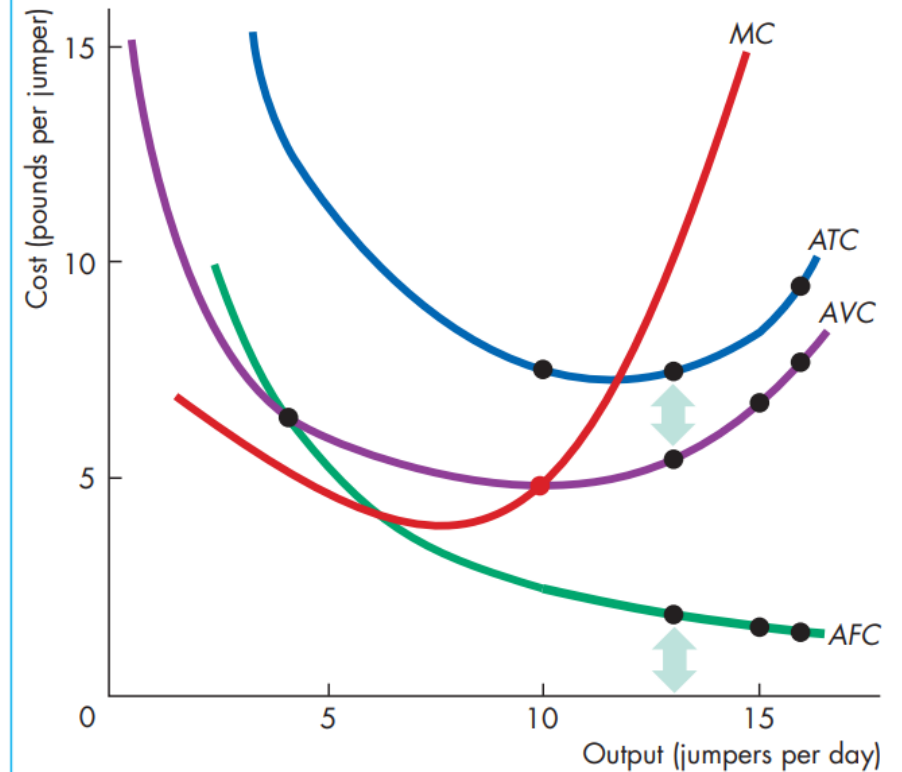
1. **Technology:** Any technological advancement that makes the production process more efficient will shift product curves upwards and cost curves downwards (using the same resources, we can produce more products at a lower cost)
2. **Prices of factors of production:** An increase in the price of a factor of production increases costs and shifts the cost curves upwards.

Figure out on your own:

Which curves will shift if rent increases?

Which curves will shift if wage rate increases?

Figure 10.5 Marginal Cost and Average Costs



Output & Costs

Long Run Costs

- In the long-run, all factors can be varied (labor, land, capital)
- In the long-run, all costs are variable costs
- In the long-run if a firm wants to increase its output, it can
 - Hire more labor
 - Increase quantity of raw materials or other inputs
 - Build a new plant/factory/acquire new space
 - Buy or hire new machinery

Output & Costs

Long Run Costs

- Long-run costs depend on the firm's **production function**
- A production function describes the relationship between the maximum output attainable and quantities of different inputs used in the production process (usually labor and capital)
- Some production processes use more labor and less capital while others use lower quantities of labor and more capital – why?
- Different combinations of inputs can be used depending on factor prices

Output & Costs

Long Run Costs

- The table shows total product for different combinations of labor and capital
- Quantity of capital is defined by plant size
- For a given quantity of capital, as we increase labor, the **marginal product of labor** diminishes
- For a given quantity of labor, as we increase capital, the **marginal product of capital** diminishes (increases first, then decreases)
- The marginal product of capital is the change in total product resulting from a one-unit increase in capital

The Production Function

Labour (workers per day)	Output (jumpers per day)			
	Plant 1	Plant 2	Plant 3	Plant 4
1	4	10	13	15
2	10	15	18	20
3	13	18	22	24
4	15	20	24	26
5	16	21	25	27
Knitting machines (number)	1	2	3	4

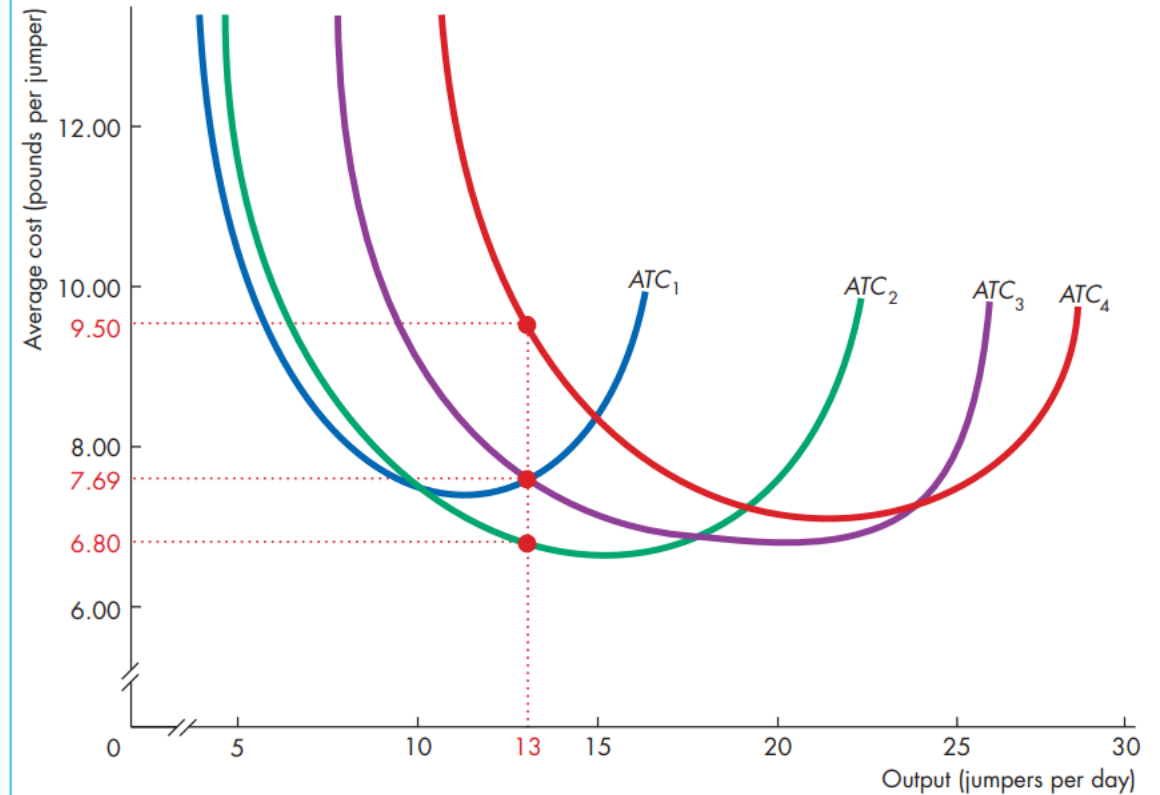
The table shows the total product data for four quantities of capital – four plant sizes. The bigger the plant size, the larger is the total product for any given amount of labour employed. But for a given plant size, the marginal product of labour diminishes as more labour is employed. For a given quantity of labour, the marginal product of capital diminishes as the quantity of capital used increases.

Output & Costs

Long Run Costs

- The figure shows short run average total cost curves for four different quantities of capital
- Note: Each short-run ATC curve is U-shaped (diminishing returns to labor)
- For each short-run ATC curve, the larger the plant, the **greater** is the output at which average total cost is a minimum.
- The minimum average total cost for a larger plant occurs at a greater output than it does for a smaller plant
- The larger plant has a higher fixed cost and therefore, for any given output level, a higher average fixed cost.

Figure 10.8 Short-Run Costs of Four Different Plants

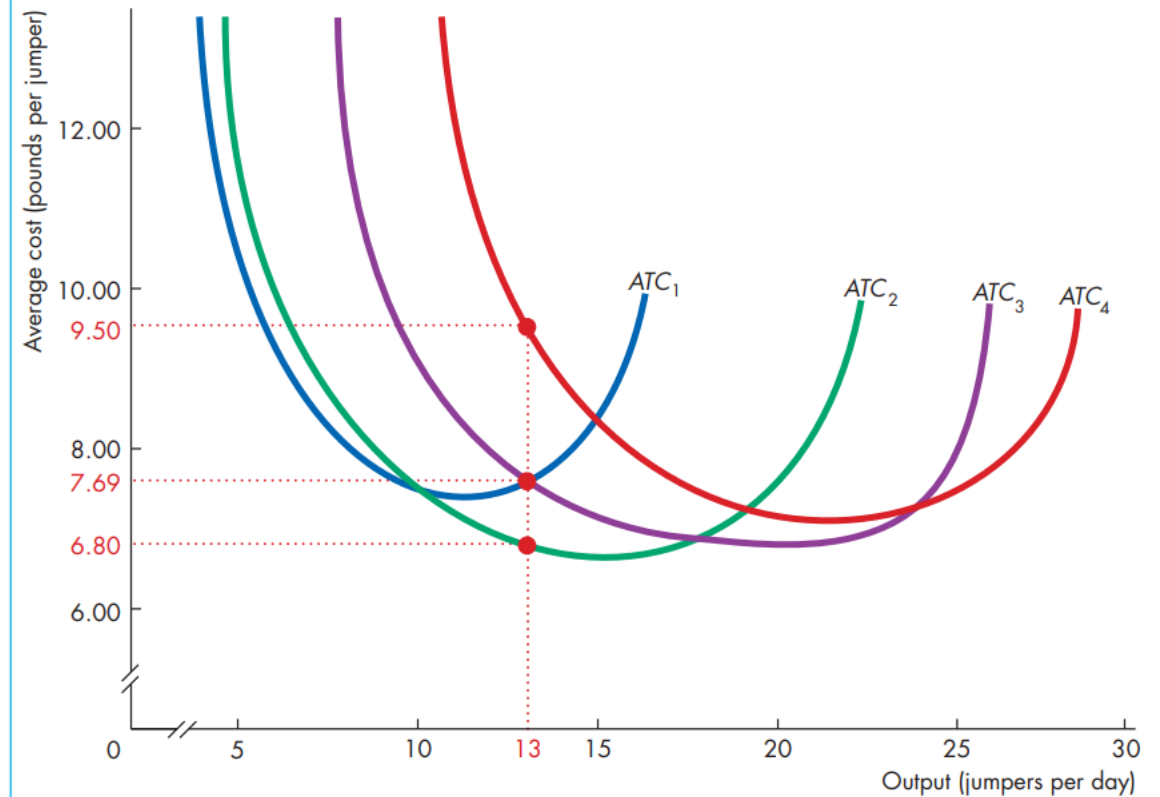


Output & Costs

Long Run Costs

- In the long run, a firm chooses its plant size depending on the output that it plans to produce.
- This is because the average total cost of producing a given output depends on the plant size.
- Suppose the firm wants to produce 13 jumpers in a day
- With one plant (ATC₁), ATC = £ 7.69
- With two plants (ATC₂), ATC = £ 6.80
- With three plants (ATC₃), ATC = £ 7.69
- With four plants (ATC₄), ATC = £ 9.50
- The economically efficient plant size for producing a given output is the one that has the lowest average total cost (in this case ATC₂).

Figure 10.8 Short-Run Costs of Four Different Plants

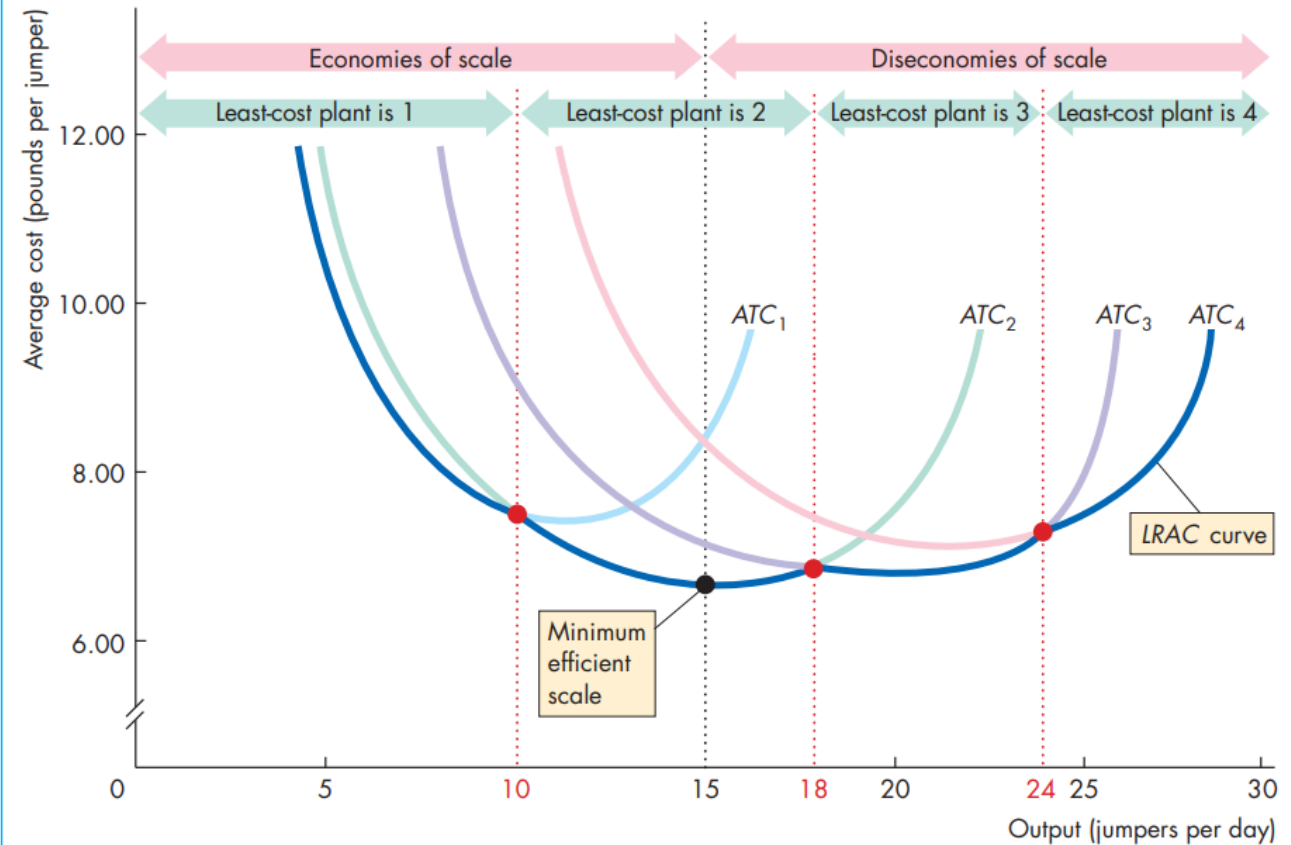


Output & Costs

Long Run Costs

- When a firm is producing a given output at the least possible cost, it is operating on its long-run average cost curve.
- The **long-run average cost curve** is the relationship between the lowest attainable average total cost and output when both the plant size and labor are varied
- Long-run average cost curve is made up from the lowest ATC for each output level – the least costly way of producing a given level of output
- The deep blue curve is the LRAC curve

Figure 10.9 The Long-Run Average Cost Curve

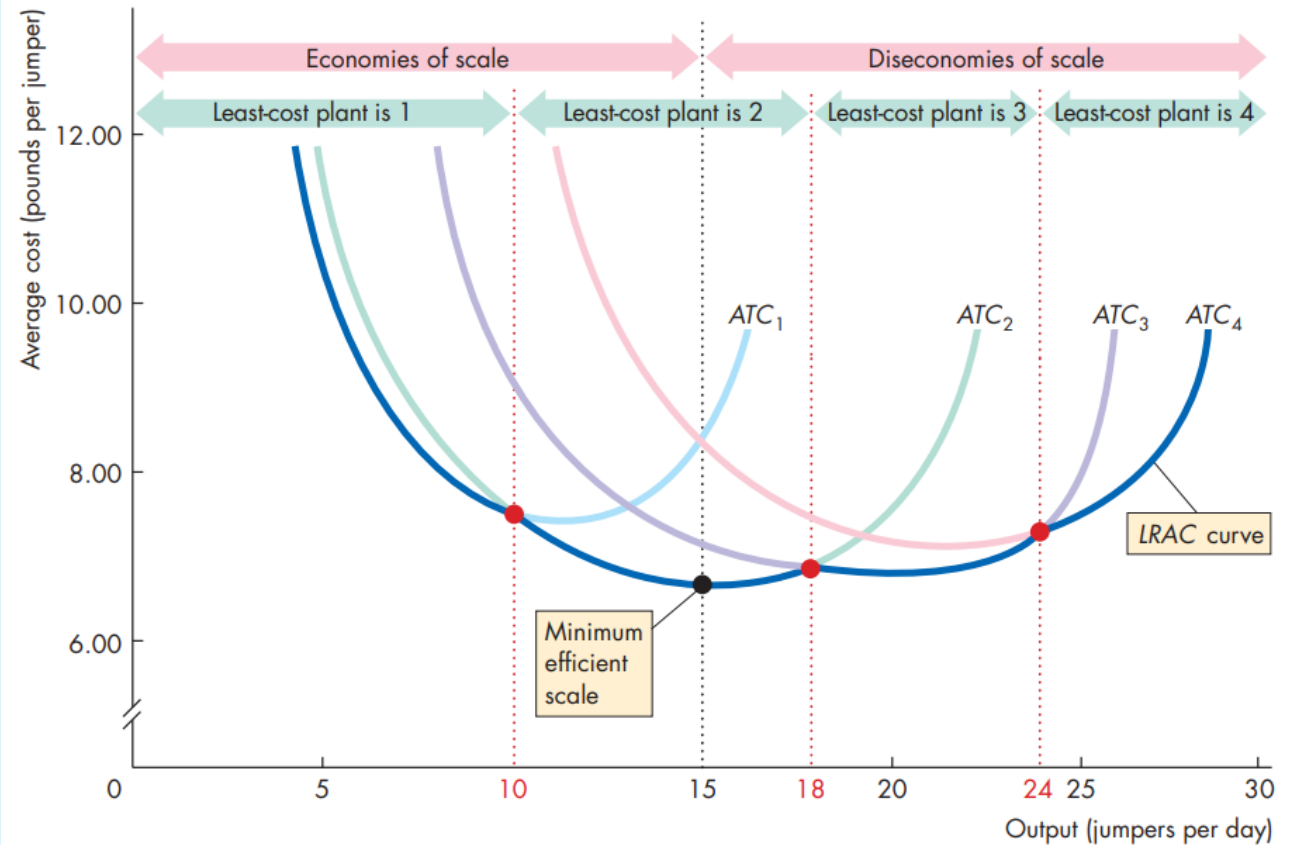


Output & Costs

Long Run Costs

- The long-run average cost curve LRAC consists of pieces of the four short-run ATC curves.
- For output up to 10 jumpers a day, the average total cost is lowest on ATC1.
- For output rates between 10 and 18 jumpers a day, average total cost is lowest on ATC2.
- For output rates between 18 and 24 jumpers a day, average total cost is lowest on ATC3.
- For output rates in excess of 24 jumpers a day, average total cost is lowest on ATC4.

Figure 10.9 The Long-Run Average Cost Curve



Output & Costs

Long Run Costs

The LRAC curve shows that this production process experiences economies of scale for outputs up to 15 jumpers a day.

Economies of Scale: As we produce more, our average cost fall – this happens because of greater specialization of both labor and capital

Diseconomies of scale: As we produce more, our average cost rises (due to technology used by firm and other firm-related aspects)

When diseconomies of scale are present, the LRAC curve slopes upward.

Constant returns to scale are features of a firm's technology that keep average total costs constant as output increases.

When constant returns to scale are present, the LRAC curve is horizontal.

Figure 10.9 The Long-Run Average Cost Curve

