

The Production Function

AP Microeconomics | Unit 3 | total, marginal and average product; diminishing marginal returns

Running example. A pizza kitchen with one oven (the fixed input) hires cooks (the variable input).

1. Total, marginal, average

Three measures of output

Total product (TP): all the output the workers make together.

Marginal product (MP): the extra output from one more worker, $MP = \frac{\Delta TP}{\Delta L}$.

Average product (AP): output per worker, $AP = \frac{TP}{L}$.

workers	TP	MP	AP	
0	0	–	–	
1	10	10	10	increasing marginal returns
2	25	15	12.5	increasing marginal returns
3	36	11	12	diminishing marginal returns
4	44	8	11	diminishing marginal returns
5	48	4	9.6	diminishing marginal returns
6	48	0	8	TP is at its maximum
7	45	–3	6.4	negative marginal returns

2. Diminishing marginal returns

Law of diminishing marginal returns

As more of a **variable** input is added to a **fixed** input, the marginal product of the variable input eventually falls.

- **Increasing returns:** MP rises (workers specialize).
- **Diminishing returns:** MP falls but is positive. Output still *rises*, more and more slowly.
- **Negative returns:** MP is below zero. Total output *falls*.

It is a short-run law (something is fixed), and the cause is the fixed input, not worse workers. TP is at its maximum where $MP = 0$.

3. How MP and AP fit together

MP above AP AP is rising

MP below AP AP is falling

MP = AP AP is at its **maximum**

Like grades: a new score above your average pulls the average up, and one below pulls it down. The same relationship holds between marginal cost and average cost.

4. From product to cost

Every cook is paid \$30 an hour. The cost of one more pizza is the wage divided by the marginal product:

$$\text{2nd cook: } \frac{\$30}{15} = \$2 \text{ per extra pizza}$$

$$\text{5th cook: } \frac{\$30}{4} = \$7.50 \text{ per extra pizza}$$

The link to cost

When marginal product falls, marginal cost rises. The MC curve is the MP curve turned upside down.

Where students lose points

1. Saying diminishing returns means output falls: it means MP falls.
2. Finding where returns start to diminish from TP instead of from MP.
3. Blaming the workers: the cause is the fixed input.
4. Mixing up marginal (ΔTP) and average ($TP \div L$).
5. Forgetting that MP crosses AP at the maximum of AP.

Now practise it

Theory sticks once you use it. On **sad-academy.com** you'll find practice questions for this exact subtopic in the AP format, and an AI that grades your free-response answers against the scoring guidelines, the way an AP reader would.

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