

Exercise walk-through

3.1

The Production Function

AP Microeconomics

The production function: one oven or two?

A bakery combines workers and ovens to make loaves. Its **production function** links inputs to output.

Choose the time horizon

Today: hire workers, but no new oven.
Next year: change workers and ovens.

Which case is short run? Which input is fixed today?



A machine is capital; whether it is fixed depends on the decision period.

The production function: one oven or two?

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Choose the time horizon

Today: hire workers, but no new oven.

Next year: change workers and ovens.

Which case is short run? Which input is fixed today?

Today is **short run** : fixed oven. Next year's plan is **long run** : all inputs variable.



A machine is capital; whether it is fixed depends on the decision period.

One oven: calculate the workers' contributions

Try before the solution

The oven and technology stay unchanged. With no workers, output is zero. Each worker works the same daily hours.

Workers L	0	1	2	3	4
Loaves per day TP	0	10	24	33	39

Calculate each worker's marginal product and average product at $L = 3$. When do diminishing marginal returns begin? Is total output then falling?

$MP = \Delta TP / \Delta L$ measures extra output; $AP = TP / L$ measures output per worker.

Diminishing marginal returns: less extra output

Workers L	1	2	3	4
Total product TP	10	24	33	39
Marginal product MP	10	14	9	6

The third worker

$$MP = \Delta TP / \Delta L$$

$$MP = (33 - 24) / (3 - 2) = 9 \text{ loaves per worker-day.}$$

$$AP = TP / L = 33 / 3 = 11 \text{ loaves per worker-day.}$$

MP falls from 14 to 9 with the third worker: diminishing marginal returns begin here, holding other inputs fixed.

TP still rises from 24 to 33 because MP is positive. Falling MP does not mean falling TP.

Exercises 2.1-2.3

2.1 State the difference between the short run and the long run.

[2]

2.2 Total product rises from 20 to 26 when a fourth worker is hired. Find the marginal product of the fourth worker.

[2]

2.3 State the law of diminishing marginal returns.

[1]

Exercises 2.1-2.3

2.1 State the difference between the short run and the long run.

[2]

2.1

- in the short run at least one input is fixed; in the long run all inputs are variable

2.2 Total product rises from 20 to 26 when a fourth worker is hired. Find the marginal product of the fourth worker.

[2]

2.2

- $MP = \frac{\Delta TP}{\Delta L} = \frac{26 - 20}{1} = 6$ units

2.3 State the law of diminishing marginal returns.

[1]

2.3

- as more of a variable input is added to fixed inputs, its marginal product eventually falls

Exercises 3.1-3.2

3.1 In the short run, at least one input is

[1]

☐

A variable

B fixed

C zero

D free

3.2 Diminishing marginal returns means marginal product eventually

[1]

☐

A rises

B falls

C stays constant

D is always zero

Exercises 3.1-3.2

3.1 In the short run, at least one input is

[1]

☐

A variable

B fixed

C zero

D free

3.1 B

- fixed.

3.2 Diminishing marginal returns means marginal product eventually

[1]

☐

A rises

B falls

C stays constant

D is always zero

3.2 B

- falls.

Exercise 3.3 (a)

3.3 A factory adds workers to a fixed set of machines. Output for 1, 2, 3, 4 workers is 10, 22, 30, 34 units.

(a) Find the marginal product of the third worker.

[1]

Exercise 3.3 (a)

3.3 A factory adds workers to a fixed set of machines. Output for 1, 2, 3, 4 workers is 10, 22, 30, 34 units.

(a) Find the marginal product of the third worker.

[1]

(a)

- $30 - 22 = 8$ units

Exercise 3.3 (b)

3.3 A factory adds workers to a fixed set of machines. Output for 1, 2, 3, 4 workers is 10, 22, 30, 34 units.

(b) Find the marginal product of the fourth worker.

[1]

Exercise 3.3 (b)

3.3 A factory adds workers to a fixed set of machines. Output for 1, 2, 3, 4 workers is 10, 22, 30, 34 units.

(b) Find the marginal product of the fourth worker.

[1]

(b)

- $34 - 30 = 4$ units

Exercise 3.3 (c)

3.3 A factory adds workers to a fixed set of machines. Output for 1, 2, 3, 4 workers is 10, 22, 30, 34 units.

(c) State whether diminishing marginal returns have set in.

[1]

Exercise 3.3 (c)

3.3 A factory adds workers to a fixed set of machines. Output for 1, 2, 3, 4 workers is 10, 22, 30, 34 units.

(c) State whether diminishing marginal returns have set in. [1]

(c)

- yes – marginal product is falling