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**Principles of Economics**

# Production

Introduction:
In this relatively brief set of notes, we will attempt to model the things that affect a firm's level of production—its units of output of product.

A term:
Define *total product* (abbreviated "Q") as the total number of units of a product that a firm produces.

Model:
1. A firm requires resources (land, labor, and capital) that it uses to produce stuff.

2. If the firm employs more resources then it will get more units of output—more total product. (Q will be larger.)

> Example:
>
> A farm needs workers (labor), arable land (land), tractors fertilizers and seeds (capital).
>
> More workers, more land, and more tractors fertilizer and seeds will increase the farmer's crop yield.

Short Run vs. Long Run
The *short run* is a period of time too short for the firm to vary the use of at least one of its resources. (The firm has at least one *fixed* resource.)

> Example: A wheat farmer who has already planted 100 acres of land cannot increase (or decrease) this amount of land used for wheat farming until the next planting season.

The *long run* is a period of time long enough for the firm to vary its use of all of its resources.

## **Short Run Production**: A simplified tabular example

Consider a wheat farmer who only needs two resources—land and labor—to produce wheat. In the short run her use of land is fixed.

Implication:
Since land is fixed, the only way for the farmer to increase output in the short run is to add more workers.

Suppose that this table shows how the total production of wheat (measured in bushels) would increase if more workers are employed:

| # of workers employed | total product, Q | |
|---|---|---|
| 1 | 1000 | |
| 2 | 2500 | |
| 3 | 3500 | |
| 4 | 4000 | |
| 5 | 4400 | |
| 6 | 4700 | |
| 7 | 4800 | |
| 8 | 4850 | |

A term:
Define *marginal product* as the increase in total product when one more unit of a variable resource is employed (holding the use of all other resources constant). In our farmer's case, she is holding land constant and increasing labor. The marginal product of labor is the increase in wheat production as each successive worker is employed.

Voila:

| # of workers employed | total product, Q | marginal product of labor |
|---|---|---|
| 1 | 1000 | 1000 |
| 2 | 2500 | 1500 |
| 3 | 3500 | 1000 |
| 4 | 4000 | 500 |
| 5 | 4400 | 400 |
| 6 | 4700 | 300 |
| 7 | 4800 | 100 |
| 8 | 4850 | 50 |

Diminishing marginal product:

Notice for our farmer in the short run, marginal product eventually declines as more and more workers are employed (never to rise again). I hope that this makes sense to you; you see, the farmer has a fixed amount of land and is cramming more and more workers onto it. It will be more and more difficult to increase wheat output, since the land is being strained.

This result—diminishing marginal product--is so important that it is known as:

*The Law of Diminishing Returns:*
In the short run the marginal product of the variable resource eventually declines.

(In our farm example, returns begin to diminish with the third worker, and continue to diminish with the $4^{th}$, $5^{th}$, etc.)

Notes about the law of diminishing returns:

1. This law applies only in the short run when there is a fixed factor.

2. This law applies to **every** firm in the short run—big or small. It is really a law of physics. It becomes physically more difficult, beyond some point, to increase production in the short run, because the fixed resource gets strained beyond its efficient capacity.

Now that we have looked at short run production (when at least one resource is fixed), let's turn to look at long run production (when all resources can be varied).

**Long Run production and *returns to scale***

Suppose a firm doubles the use of all of its resources in the long run. What will happen to its total product? Will it:

--more than double?
--exactly double?
--less than double?

Well, this depends on the type of firm.

Examples:

A microchip make requires a big manufacturing plant to be efficient; the bigger the plant, the more efficient is production. For this type of firm (and most manufacturing firms), when it doubles its resource use, its total product more than doubles.

A service provider such as a barber gains no efficiencies by getting bigger, since to cut each head of hair one needs 1 haircutter, one pair of scissors, and one chair. For this type of firm (and most service firms), when it doubles its resource use, its total product exactly doubles.

A firm that is already too big may get less efficient if it gets even bigger. For this type of firm, doubling resource use will cause total product to less than double.

Terms:

*Increasing returns to scale* occur when total product more than doubles if resource use doubles.

*Constant returns to scale* occur when total product exactly doubles if resource use doubles.

*Decreasing returns to scale* occur when total product less than doubles if resource use doubles.

So much for these notes!