

Output Optimization: Marginal Revenue Product

by Sophia



WHAT'S COVERED

This tutorial will cover output optimization, specifically focusing on marginal revenue product. We will discuss how diminishing returns applies to labor, and explore how a firm uses marginal revenue product to determine how much labor to hire and capital to purchase.

Our discussion breaks down as follows:

1. Total Product and Marginal Product
 - a. Diminishing Marginal Returns
2. Output Optimization: Marginal Revenue Product

1. Total Product and Marginal Product

All firms must decide how to produce their good or service.

In addition, most firms employ a combination of labor and capital, which requires them to ask themselves these questions:

- How many workers should we hire (labor)?
- How many machines should we purchase (capital)?

The key idea is that they will hire the combination of labor and capital that will optimize their output, so today's tutorial will discuss using a marginal revenue product to determine what combination will do this.

Now, we know that the point of owning a business is to make a profit, and profit equals revenues minus cost.

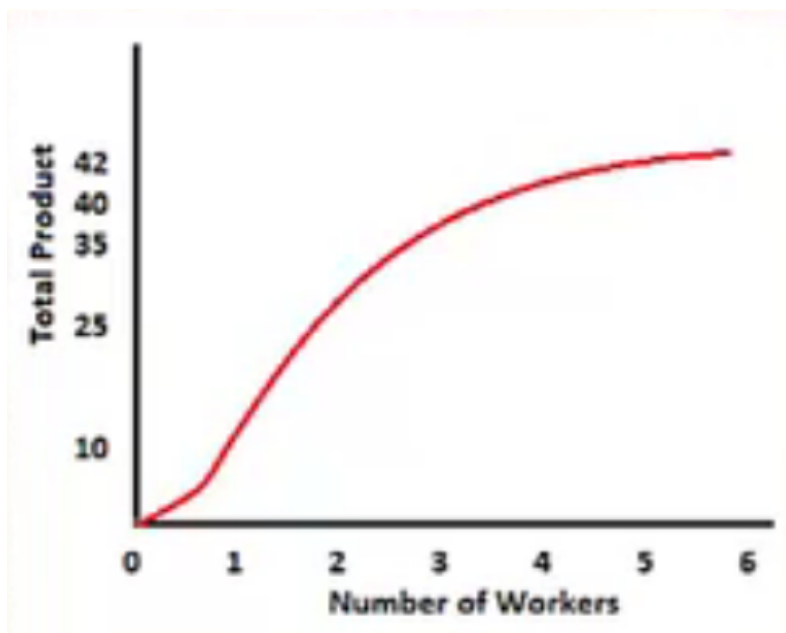
Profit = Revenues - Costs

However, marginal revenue product combines the concepts of revenue with the cost of the capital or labor to figure out what will maximize profits, so we are focusing on both components of this equation.

In review, total product is the total amount that can be produced depending on the number of employees (labor) or machines (capital).

Number of Employees	Total Product
0	0
1	10
2	25
3	35
4	40
5	42
6	42

Here you can see the shape of the curve.

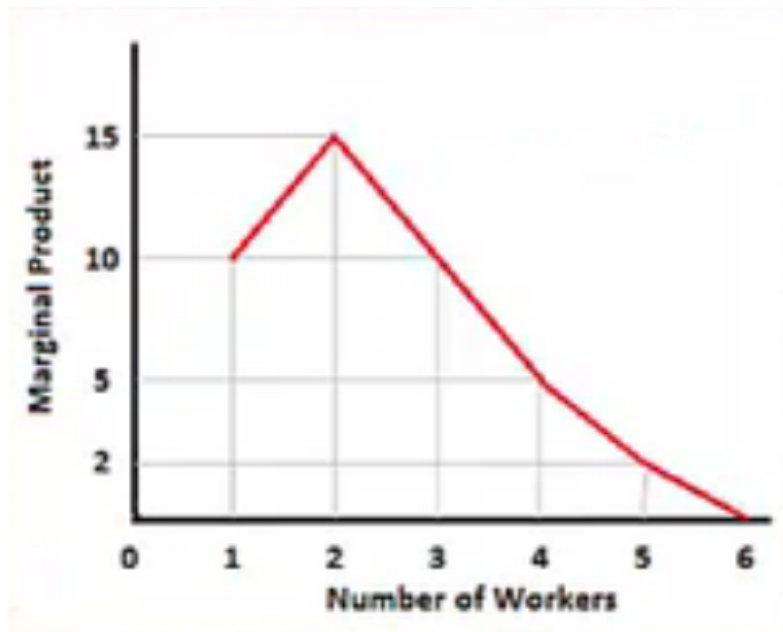


The marginal product looks at the additional amount each worker or each machine would bring in to the business.

Number of Employees	Total Product	Marginal Product
0	0	--
1	10	10
2	25	15

3	35	10
4	40	5
5	42	2
6	42	0

Graphically, it looks like this:



This example illustrates the marginal product of labor (MPL) since we are looking at how much each employee adds to total production.

1a. Diminishing Marginal Returns

Notice how even though hiring more employees results in total product increasing, the additional amount each worker adds is decreasing.

This is the concept of diminishing marginal returns.

Workers can specialize in the beginning, so the second employee is better than the first in terms of what he or she adds, because there is so much for them to do when they can divide and conquer and specialize on devoted tasks.

At some point, though, even though total product is increasing, it begins to diminish in terms of how much additionally they are producing. This is because there is a fixed input in the short run, so there simply isn't quite as much for them to do.

Most people are under the impression that firms should just continue hiring as many employees as they possibly can.

However, each employee is costly, so we need to consider what each employee is generating for the firm?

⇒ **EXAMPLE** For example, the sixth employee--regardless of how little the cost--is likely not going to be beneficial to hire since they generate no additional product.

So, how many workers should the firm hire to optimize output? We will explore the answer next.

2. Output Optimization: Marginal Revenue Product

Now that a firm has all of this information, how will they use it?

Well, we need to link all of this to the revenue they can generate and the cost of the inputs (labor and capital).

Therefore, we need to look at the price of the product and the cost of labor or capital.

Here is a chart that contains the total marginal product and marginal revenue product.

Number of Employees	Total Product	Marginal Product	Marginal Revenue Product
0	0	--	--
1	10	10	\$100
2	25	15	\$150
3	35	10	\$100
4	40	5	\$50
5	42	2	\$20
6	42	0	\$0

Remember, marginal revenue product is the additional amount of revenue that one more unit of labor or capital generates for the firm.

Assuming the price of the product was \$10, we take our marginal product and multiply it by the price.



FORMULA TO KNOW

Marginal Revenue Product

$$MRP = \text{Marginal Product} \times \text{Marginal Revenue (Price of Good)}$$

⇒ **EXAMPLE** For example, the second worker generated 15 additional units. If we can sell them for \$10 each, this provides an additional \$150 of revenue. However, the fifth worker only generates \$20 worth of additional revenue for the firm because they only contribute two additional products.

Now we need to compare marginal revenue product to how much each worker is costing us.

In this example, let's assume that the cost of a worker is \$80. Should we hire a third worker?

Well, that third worker is going to cost us \$80, but they are generating \$100 worth of revenue.

So, is it worth it? Yes. It will add \$20 to profit, because again, their MRP is \$100 and their cost is only \$80.

What about hiring a fourth worker? Again, they cost \$80.

In this case, the additional revenue brought in by the fourth worker in terms of their production is only \$50. Therefore, this would not be a good decision because profit would fall by \$30.

This how we use this information to optimize our output or optimize how many workers we should hire.



THINK ABOUT IT

What would happen if the cost of labor went up? Suppose wages went up and now it is going to cost \$100 to hire each worker. Should we hire the third worker?

In this case, we should only hire up to the third worker, because that third worker will generate \$100 of revenue and cost \$100.

Prior to the third worker, we could actually get more out of it by continuing to hire. However, we would never want to go beyond the third worker, where it is costing more to hire than the amount generated in revenue.



BIG IDEA

A firm will optimize their output by hiring up to the point where the marginal revenue product of each input equals the cost of the input.

It is important to note that while our example has focused on labor, a firm would do the same thing with things like machines or their capital.

They would equate their marginal revenue product of capital with the cost of that capital. As long as they do that with both, that would be optimizing their output.



SUMMARY

Today we learned about the different ways of looking at production: **total product**, **marginal product** and average product. We also learned how the firm uses the marginal product of labor and capital and **marginal revenue product** to determine how much labor to hire and capital to purchase to **optimize their output**, keeping in mind the concept of **diminishing marginal returns**.

Source: Adapted from Sophia instructor Kate Eskra.



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