

# Production Function and Constraints

by Sophia Tutorial



## WHAT'S COVERED

This tutorial will cover production function and constraints, through the definition and comparison of fixed and variable inputs.

Our discussion breaks down as follows:

1. Fixed and Variable Inputs
2. Short Run vs. Long Run
3. Production Functions
4. Production Functions vs. Utility Functions

## 1. Fixed and Variable Inputs

We know that factors of production are land, labor, and capital, and firms have to purchase them to produce anything.

These inputs that firms purchase are categorized as either:

- Fixed
- Variable

A **fixed input** is a factor of production or input that cannot be changed in the short run.

This makes sense, if you think about it, because anything that is fixed doesn't change—it stays the same.

No matter how much the firm produces, these do not change, and their cost stays the same as well.

🔗 **EXAMPLE** An example of a fixed input is a factory, building, or office space. Typically, a business would lease this for a period of time. They have a contract and the cost is exactly the same every month. Even if they produce nothing, they still have to pay rent. If they produce more, the rent stays the same.



## THINK ABOUT IT

Here is another way to look at a fixed input. Think about your mortgage or rent. If you vacation for an entire month, can you call the bank and tell them that you didn't live at your place of residence, so you're not going

to pay your mortgage or rent this month? It doesn't work that way. This is what we mean by a fixed input.

A **variable input**, by comparison, is a factor of production or input that depends upon the level of production. Variable inputs change depending on how much we choose to produce.

Businesses are often making production decisions regarding if they should we produce more or produce less. As they produce more or less, these input, as well as their cost, do change.

🔗 **EXAMPLE** Examples of variable inputs include labor or machinery. If a firm decides to produce more, they can quickly hire or buy new machines. If they decide to produce less, they can lay off some workers.

Similarly, if you did go on vacation for an entire month, your utility bills for that month would be less. When you come home, your utility bills will be more. Those utility bills are a variable cost.



#### TERMS TO KNOW

##### Fixed Input

A factor of production (input) that cannot be changed in the short run

##### Variable Input

A factor of production (input) that depends upon the level of production. Variable inputs change depending upon how much we choose to produce

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## 2. Short Run vs. Long Run

These costs actually define the difference between the long run and short run.

The short run is defined not in terms of three months or six months or a year, for instance, but rather in terms of there being at least one fixed input or cost.

🔗 **EXAMPLE** Remember, if something is fixed, it cannot change. For example, you cannot immediately expand your factory or get out of your current lease.

Conversely, the long run is the time in which all of these inputs or costs do become variable.

🔗 **EXAMPLE** For instance, you can renegotiate your lease and make major changes to your firm in the long run.

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## 3. Production Functions

Now, all firms must decide *how* to produce their good or service, factoring in:

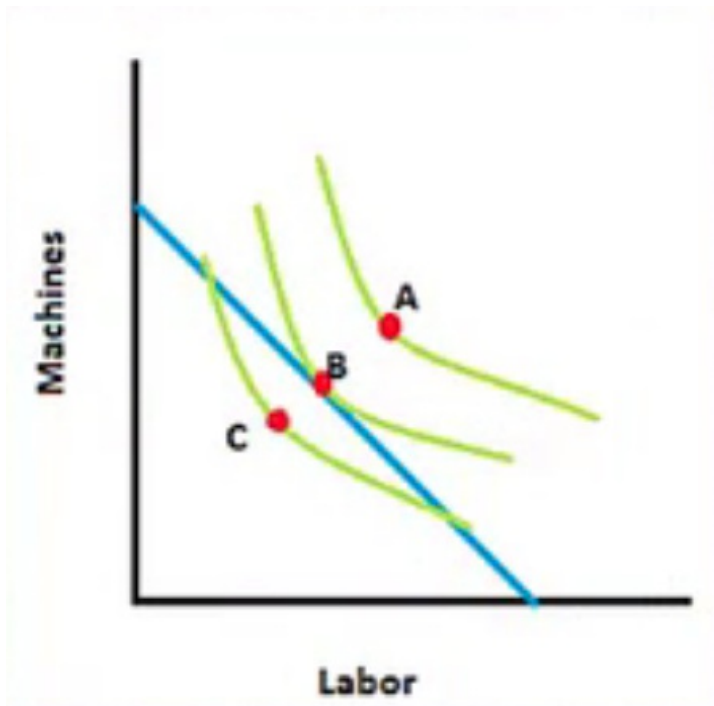
- How many workers should we hire (labor)?
- How many machines should we purchase (capital)?

They must consider what combination of labor and capital will minimize their costs and maximize profit.

To do this, they use a **production function**, which is a mathematical relationship between inputs and output. In

the context of economics of the firm, cost and profit can be determined through cost and profit functions.

Here is a production function for a product such as cars, for example. The axes reflect two different inputs: machines and labor.



A production function lists all possible combinations of workers and machines that can make different quantities of a product—in this case, cars.

The points labeled A, B, and C represent different quantities of cars being produced. As the points extend farther from the point of origin, they represent larger and larger quantities of output being produced.

The green curves are called isoquants. They represent combinations of labor and machines that will produce a certain amount of output.

Anywhere along each curve would represent the combination of labor and machines that produces each respective amount of output.

The blue line represents combinations of labor and machines for a given cost, called isocosts.

If you look at the one isocost curve on this production function, note that the point of contact with the y-axis represents the extreme of spending the entire budget on only machines and no workers.

The point of contact with the x-axis represents the other extreme of spending the entire budget on all workers and no machines, or having no capital input at all.

Anywhere else along the curve reflects combinations of labor and machines that all cost the same amount.



#### TERM TO KNOW

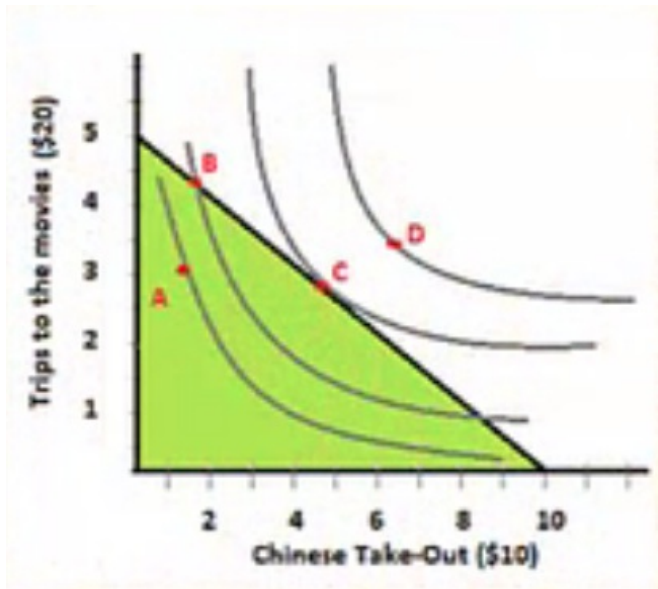
### Production Function

A mathematical relationship between inputs and output. In the context of economics of the firm, cost/profits can be determined through cost/profit functions.

## 4. Production Functions vs. Utility Functions

Let's compare a production function to a utility function.

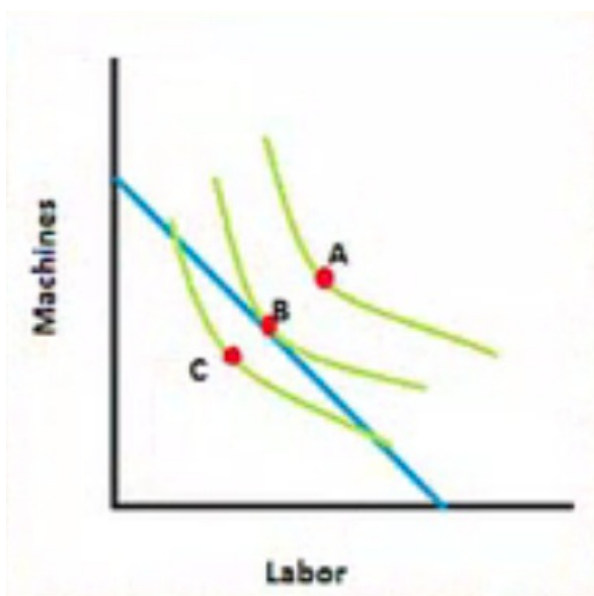
The utility function below shows the indifference curves and the line representing the budget constraints. Anything within the green area is within the budget.



This particular utility function looks at consumer choices and preferences between two goods--trips to the movies and Chinese take-out.

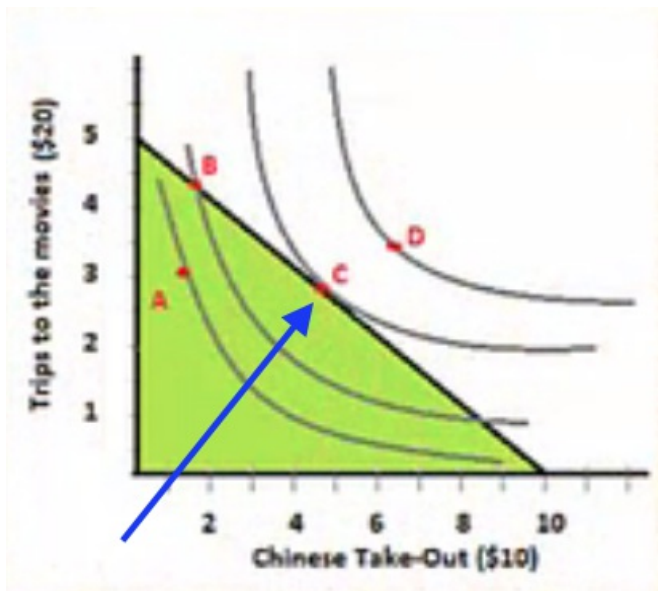
A utility function is used to determine how consumers can maximize their utility within a budget constraint.

It is very similar to the production function. Instead of looking at consumer preferences, the production function looks at firm choices between two inputs.

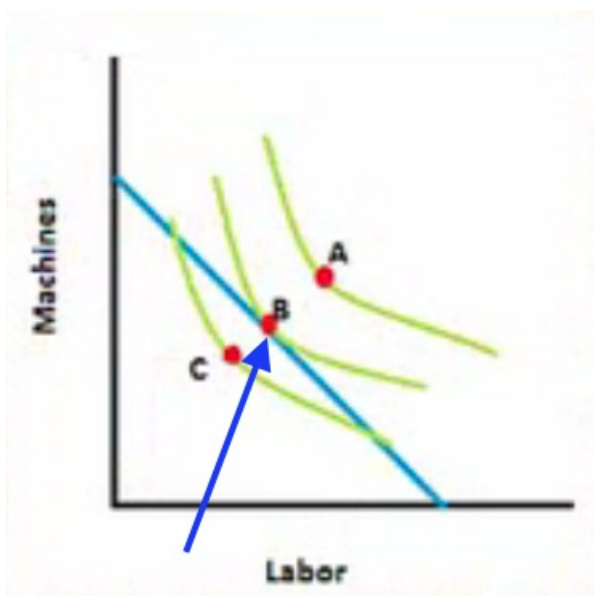


Firms maximize their returns by minimizing cost according to their production function.

So, consumers maximize utility by consuming on the highest indifference curve within the budget constraint.



Producers, on the other hand, will minimize cost by selecting the combination of machines and labor according to this production function in the same way--on the highest isoquant curve within their budget, on the blue isocost curve.



## SUMMARY

Today we learned about the different types of inputs for firms: **fixed and variable inputs**. We learned how these help us to define the **short run vs. long run**. Remember, in the short run, there is at least one fixed input, while in the long run, everything becomes variable. Lastly, we learned how **production functions** are similar to **utility functions**, but they help firms to maximize their returns.

Source: Adapted from Sophia instructor Kate Eskra.



## TERMS TO KNOW

**Fixed Input**

A factor of production (input) that cannot be changed in the short-run.

**Production Function**

A mathematical relationship between inputs and output. In the context of economics of the firm, cost/profits can be determined through cost/profit functions.

**Variable Input**

A factor of production (input) that depends upon the level of production. Variable inputs change depending upon how much we choose to produce.