

ECON 101: Principles of Economics I

Lecture Note 12

University of Michigan at Ann Arbor

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Lecture 12: Behind the Supply Curve

Wednesday, November 2, 2022 12:31 PM

The Production Function

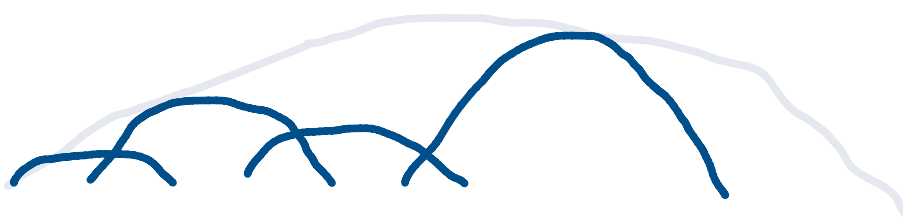
Output is the good or service to be sold in the market

Production function - Relationship between the quantity of inputs a firm uses and the quantity of output produced

- **Fixed input** - an input whose quantity is fixed and cannot be varied
- **Variable input** - an input whose quantity the firm can vary

Long run - the time period in which all inputs can be varied (things that were "fixed" are now "variable")

Short run - the time period in which at least one input is fixed



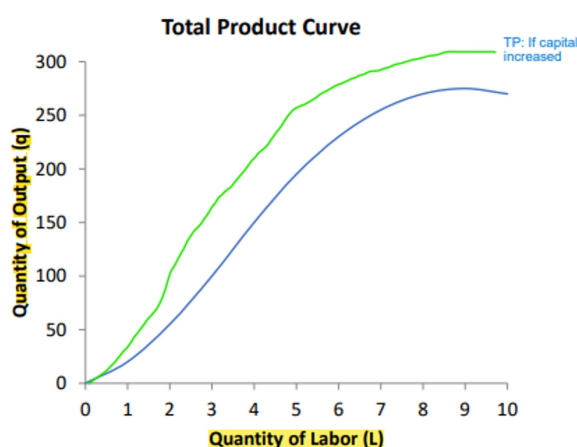
Inputs and output - Simplifying assumptions: 1. short runs, 2. there are two inputs, which are labor and capital (Capital is fixed, labor is variable)

Total product curve - Demonstrates how the quantity of output adjusts with changes in the variable input.

- **Marginal product of an input** - the additional quantity of output that is produced by using that input.

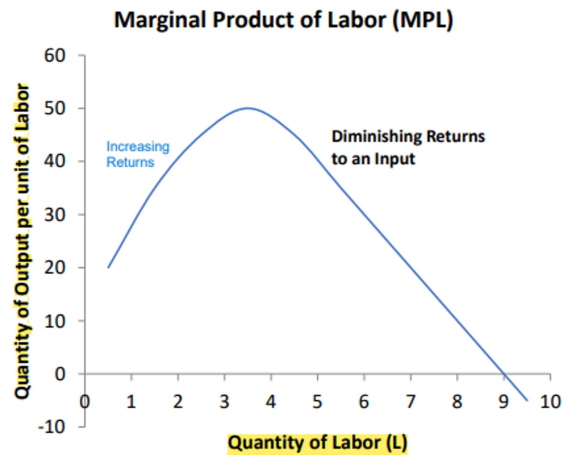
Total Product

Labor (L)	Capital (K)	Output (q)
0	10	0
1	10	20
2	10	55
3	10	100
4	10	150
5	10	195
6	10	230
7	10	255
8	10	270
9	10	275
10	10	270



Marginal Product of Labor (MP_L)

Labor (L)	Output (q)	Marginal Product of Labor (MP _L)
0	0	20
1	20	35
2	55	45
3	100	50
4	150	45
5	195	35
6	230	25
7	255	15
8	270	5
9	275	-5
10	270	



Key Takeaways

Production

- ❖ A firm's **production function** depicts the relationship between the quantity of inputs used and outputs produced.
- ❖ A firm's **total product curve** shows how the quantity of output depends on the quantity of the variable input, for a given quantity of the fixed input, in the *short-run*.
- ❖ The **Marginal Product** is the additional quantity of output that is produced by using one more unit of that input.
 - **Diminishing Returns to an Input** occurs when an increase in the quantity of that input, holding the other inputs fixed, leads to a decline in the marginal product of that input.

From Production to Costs

Fixed cost - Costs associated with fixed inputs

Variable cost - Costs associated with variable inputs

The **total cost** of producing a given quantity of output is the sum of the fixed cost and the variable cost of producing that quantity of output.

$$TC = FC + VC$$

Marginal Cost - Change in total cost generated by one additional unit of output.

$$MC = \frac{\Delta TC}{\Delta q} = \frac{\Delta VC}{\Delta q}$$

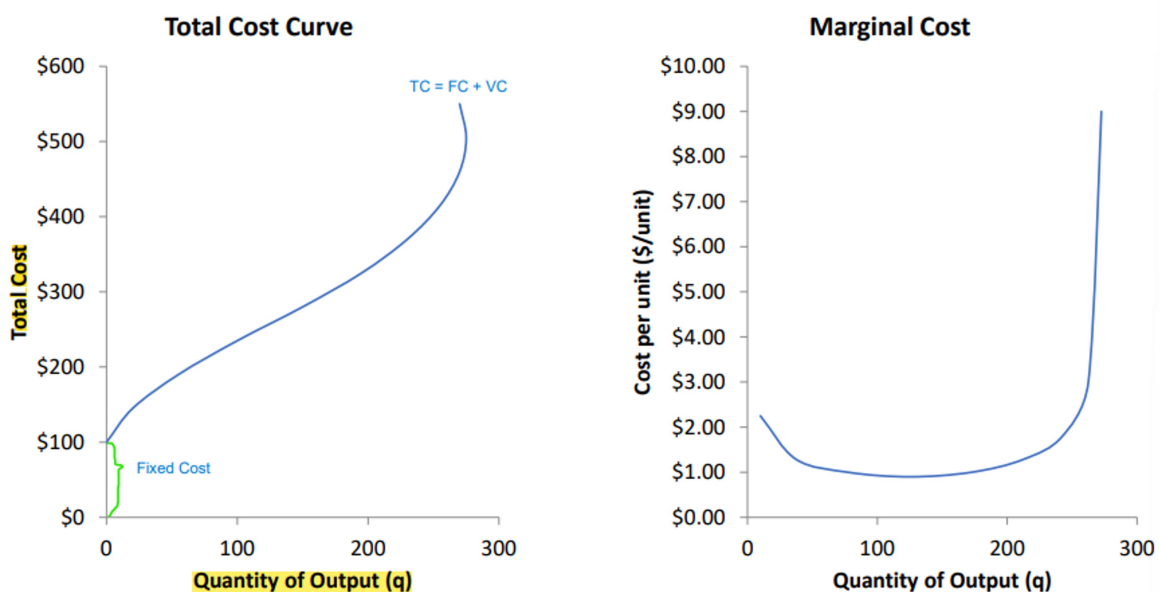
Total Cost

Wage rate = \$45 Rental Rate of Capital = \$10

Labor (L)	Variable Cost	Capital (K)	Fixed Cost	Output (q)	Total Cost	Marginal Cost
0	\$0	10	\$100	0	\$100	\$2.25
1	\$45	10	\$100	20	\$145	\$1.29
2	\$90	10	\$100	55	\$190	\$1.00
3	\$135	10	\$100	100	\$235	\$0.90
4	\$180	10	\$100	150	\$280	\$1.00
5	\$225	10	\$100	195	\$325	\$1.29
6	\$270	10	\$100	230	\$370	\$1.80
7	\$315	10	\$100	255	\$415	\$3.00
8	\$360	10	\$100	270	\$460	\$9.00
9	\$405	10	\$100	275	\$505	--
10	\$450	10	\$100	270	\$550	

We can calculate **variable cost**, **fixed cost**, and **marginal cost** when we only have **output (q)** and the **total cost**.

Cost Curves



Average Costs

Average total cost, often referred to simply as average cost: $ATC = \frac{TC}{q} = \frac{FC+VC}{q} = \frac{FC}{q} + \frac{VC}{q} = AFC + AVC$

Average fixed cost: $AFC = \frac{FC}{q}$ ($AFC = ATC - AVC$)

Average variable cost: $AVC = \frac{VC}{q}$ ($AVC = ATC - AFC$)

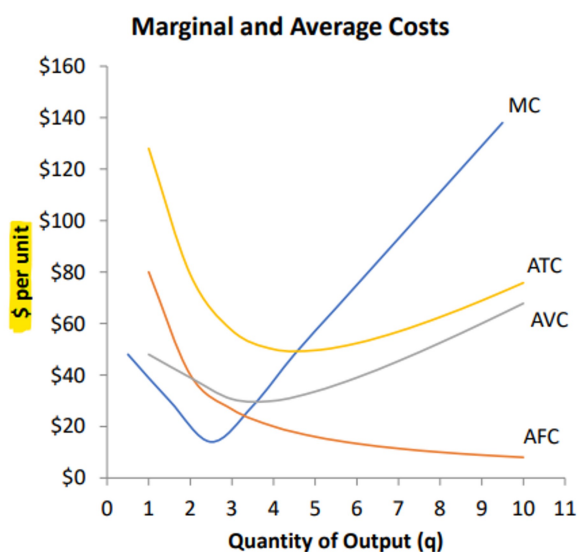
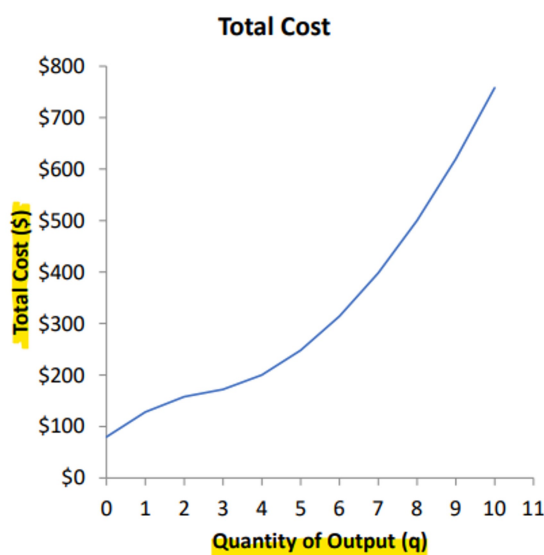
Key Takeaways

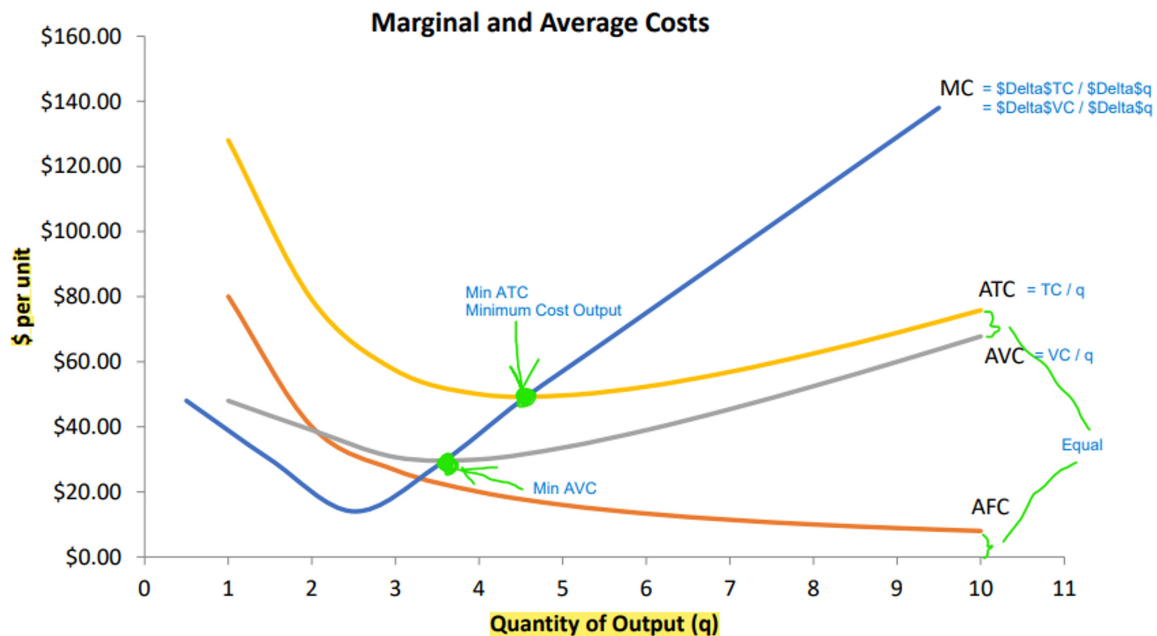
What are the different kinds of costs?

- ❖ **Total Costs** are made up of Fixed and Variable Costs:
 - **Fixed costs** associated with fixed inputs (i.e. they don't change in the short run)
 - **Variable costs** associated with variable inputs (i.e. they can change in the short run)
 - The *changes in total cost* generated by one additional unit of output are known as **marginal cost**.
 - ❖ Since variable cost is the only cost that changes, marginal cost is also measuring the change in variable cost generated by one additional unit of output.
- ❖ Total, fixed, and variable costs can be divided by the *quantity of output* to generate **average total cost, average fixed cost, and average variable cost**.
 - $ATC = AFC + AVC$

Example:

Output Quantity	FC	VC	TC	AFC	AVC	ATC	MC
0	\$80	\$0	\$80				\$48
1	\$80	\$48	\$128	\$80.00	\$48.00	\$128.00	\$30
2	\$80	\$78	\$158	\$40.00	\$39.00	\$79.00	\$14
3	\$80	\$92	\$172	\$26.67	\$30.67	\$57.33	\$28
4	\$80	\$120	\$200	\$20.00	\$30.00	\$50.00	\$48
5	\$80	\$168	\$248	\$16.00	\$33.60	\$49.60	\$66
6	\$80	\$234	\$314	\$13.33	\$39.00	\$52.33	\$84
7	\$80	\$318	\$398	\$11.43	\$45.43	\$56.86	\$102
8	\$80	\$420	\$500	\$10.00	\$52.50	\$62.50	\$120
9	\$80	\$540	\$620	\$8.89	\$60.00	\$68.89	\$138
10	\$80	\$678	\$758	\$8.00	\$67.80	\$75.80	





Key Takeaways

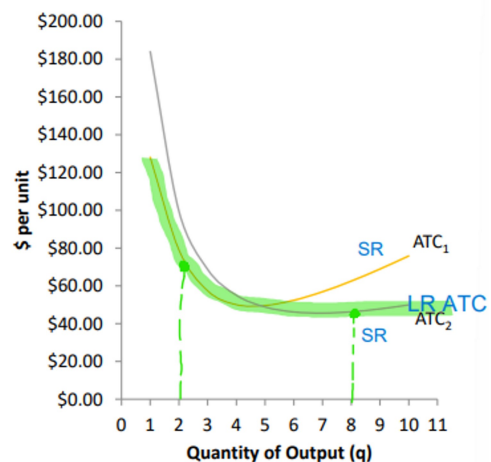
Implications of average costs

- ❖ When we graphically compare our average cost curves, we can see...
 - **The spreading effect:** as fixed costs are spread across units, *larger output levels result in lower average fixed costs*. This effect contributes to average total cost's initial downward (negative) slope.
 - **The diminishing returns effect:** as more units are produced, more variable input is required to produce the same incremental unit of output, resulting in a higher average variable cost. This effect contributes to the upward sloping part of average total cost.
- ❖ As a result, we **see** on the graph that:
 - At the *minimum-cost output*, average total cost is **equal to** marginal cost;
 - At output *less than the minimum-cost output*, marginal cost is **less than** average total cost and average total cost is falling;
 - And, at output *greater than the minimum-cost output*, marginal cost is **greater than** average total cost and average total cost is rising.

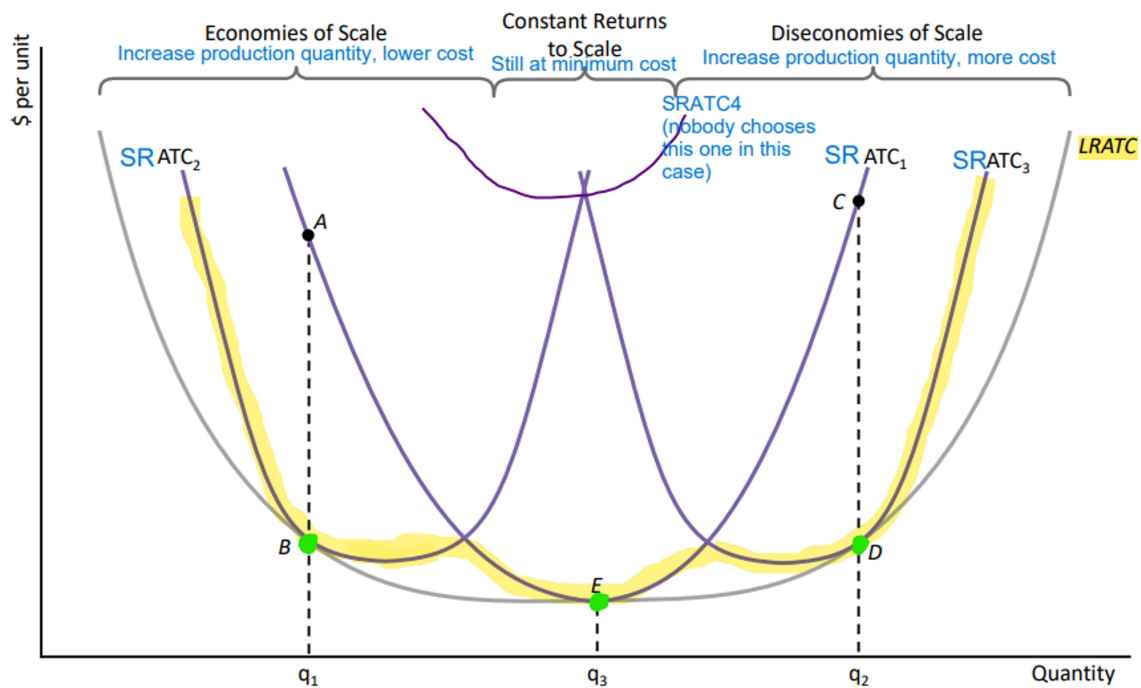
The same is true for average variable cost and marginal cost

Choosing Fixed Inputs (when they become variable inputs in long run decisions)

	Fixed Cost = \$80			Fixed Cost = \$160		
Quantity	VC	TC	ATC ₁	VC	TC	ATC ₂
0	\$0	\$80		\$0	\$160	
1	\$48	\$128	\$128.00	\$24	\$184	\$184.00
2	\$78	\$158	\$79.00	\$39	\$199	\$99.50
3	\$92	\$172	\$57.33	\$46	\$206	\$68.67
4	\$120	\$200	\$50.00	\$60	\$220	\$55.00
5	\$168	\$248	\$49.60	\$84	\$244	\$48.80
6	\$234	\$314	\$52.33	\$117	\$277	\$46.17
7	\$318	\$398	\$56.86	\$159	\$319	\$45.57
8	\$420	\$500	\$62.50	\$210	\$370	\$46.25
9	\$540	\$620	\$68.89	\$270	\$430	\$47.78
10	\$678	\$758	\$75.80	\$339	\$499	\$49.90



Long Run ATC and Short Run ATC (for a single firm)



Key Takeaways

Long-Run Decisions

- ❖ In the *long-run*, all inputs are variable and thus all costs are adjustable.
 - In the long-run, rational firms will choose the combination of inputs that minimize their average cost. These choices can be seen in the long-run average total cost curve.
- ❖ **Long-run average total cost curve** shows the relationship between output and average total cost when inputs that were fixed in the short run have been chosen to minimize average total cost for each level of output.
 - This is the combination of all the lowest cost short-runs for producing the good.

Key Takeaways

Long-Run Decisions

- ❖ Depending on a firm's current location along their long-run average total cost, the firm may naturally increase in size, decrease in size, or remain at the same size.
 - **Economies of scale** are where long-run average total cost *declines* as output increases.
 - ❖ Firms will want to expand their scale of production in this range, if possible.
 - **Diseconomies of scale** are where long-run average total cost *increases* as output increases.
 - ❖ Firms will want to reduce their scale of production in this range.
 - **Constant returns to scale** occur when long-run average total cost is *constant* as output *increases*.
 - ❖ Firms have no internal incentive to change their scale of production in this range.