

# EE211

# PRINCIPLES OF MICROECONOMICS

---

## Topic 7

## Production and Costs in the Short and Long Run

# Introduction

- Firm's objective is to maximize its profit, and the profit is defined by: **Profit = Total Revenue – Total Cost**

$$\pi = TR - TC = (P) \times Q - TC$$

- The components of profits are:

- Price  $\rightarrow$  depends on the market structure

- **Output**  $\rightarrow Q$

- **Cost**  $\rightarrow c(Q)$ ;  $TC = wL + rK$

$\bar{P}$  in competitive market  
 $P$  is determined by producer in monopoly case

- Hence, in this lecture, we will discuss:

- How the firm decides to use inputs to **maximize the output**;
- How the firm decides to use inputs to **minimize the cost**.

# Economic Costs vs. Accounting Costs

- **Accounting costs** (or **explicit costs**) – costs that actually involve a purchase of goods and services by the firm
  - e.g. wage paid to workers, rent, costs of purchasing intermediate inputs
- **Accounting profit = Revenues – Explicit costs**
- **Economic costs** – all costs incurred in the production, including both explicit and implicit costs.
  - Implicit costs are the **opportunity costs** of items for which there is no market transaction (e.g. costs of the **owner's time**)
- **Economic profit = Revenues – (Explicit costs + Implicit costs)**

# Production Function

- **Production function** illustrates the relationship between inputs and outputs for given a technology level, when the inputs are used efficiently.
- In general, a production function can be written as:

$$Q = f(\text{inputs})$$

$$Q = f(x_1, x_2, \dots, x_n)$$

- Simplified version:

$$Q = f(L, K)$$

where Q = output, L = labor, K = capital

# Short-Run vs. Long-Run Production

- The **short run** is the length of time over which **some of the firm's factors of production are fixed**.
- The **long run** is the length of time over which **all of the firm's factors of production can be varied**, but its technology is fixed.

Example:

- Long-run production:  $Q = f(L, K)$
- Suppose capital is held constant at  $K_0$ . Short-run production can be written as:

$$Q = f(L, K_0) = TP_{K_0}(L)$$

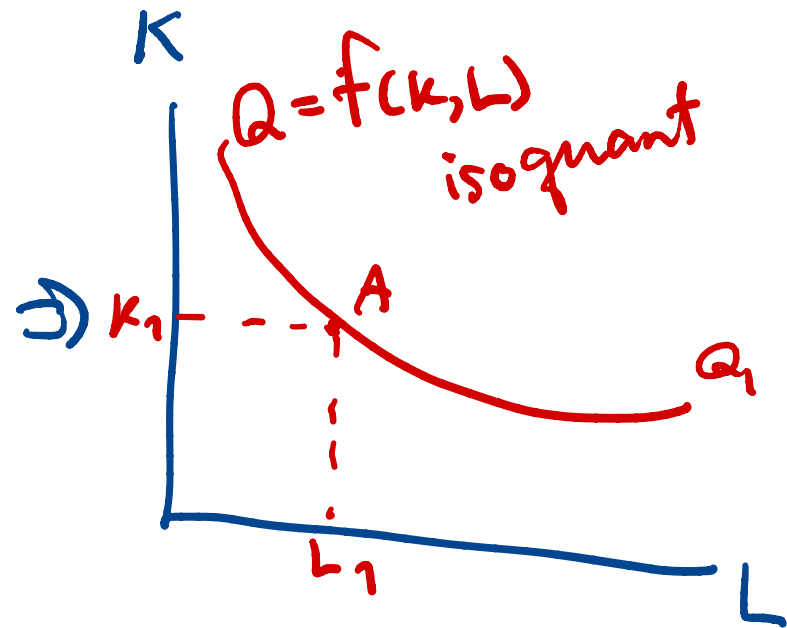
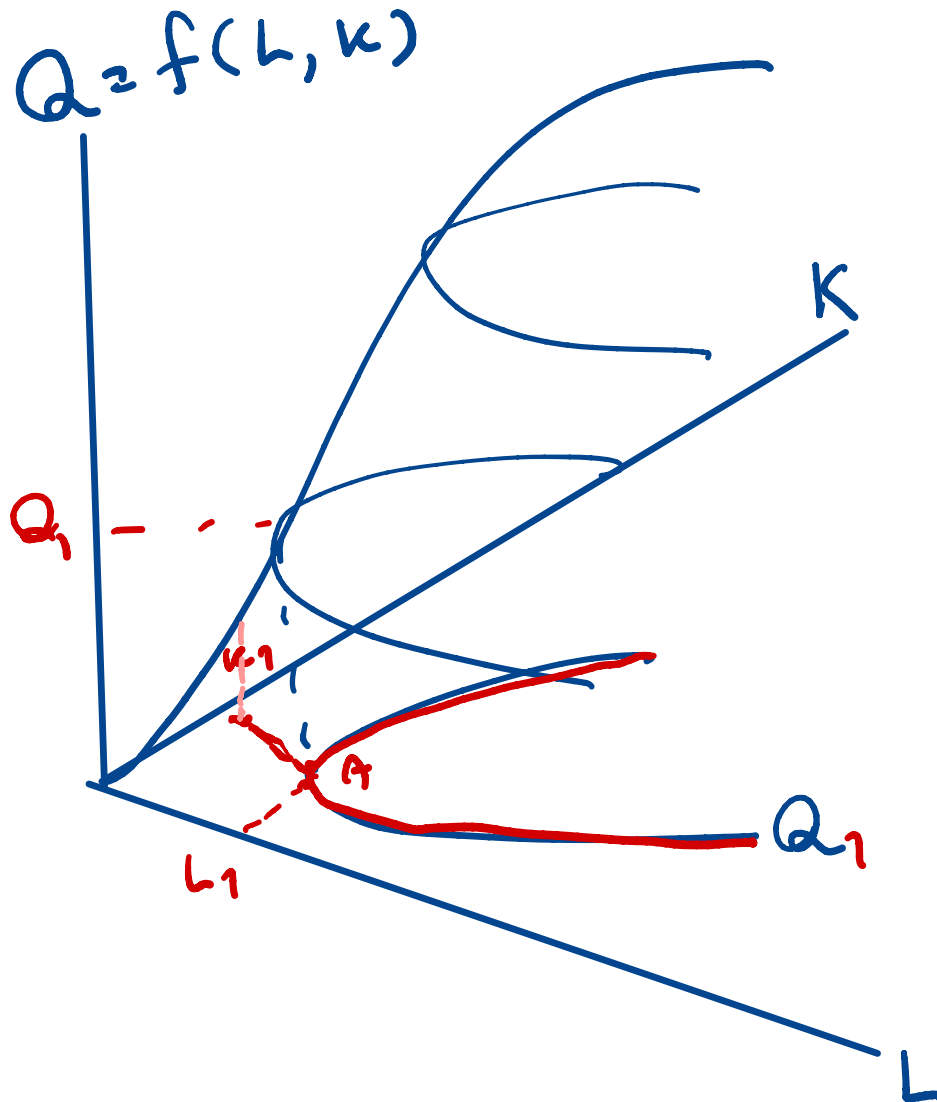
*fixed*

*output*  
*labor*  
*capital*

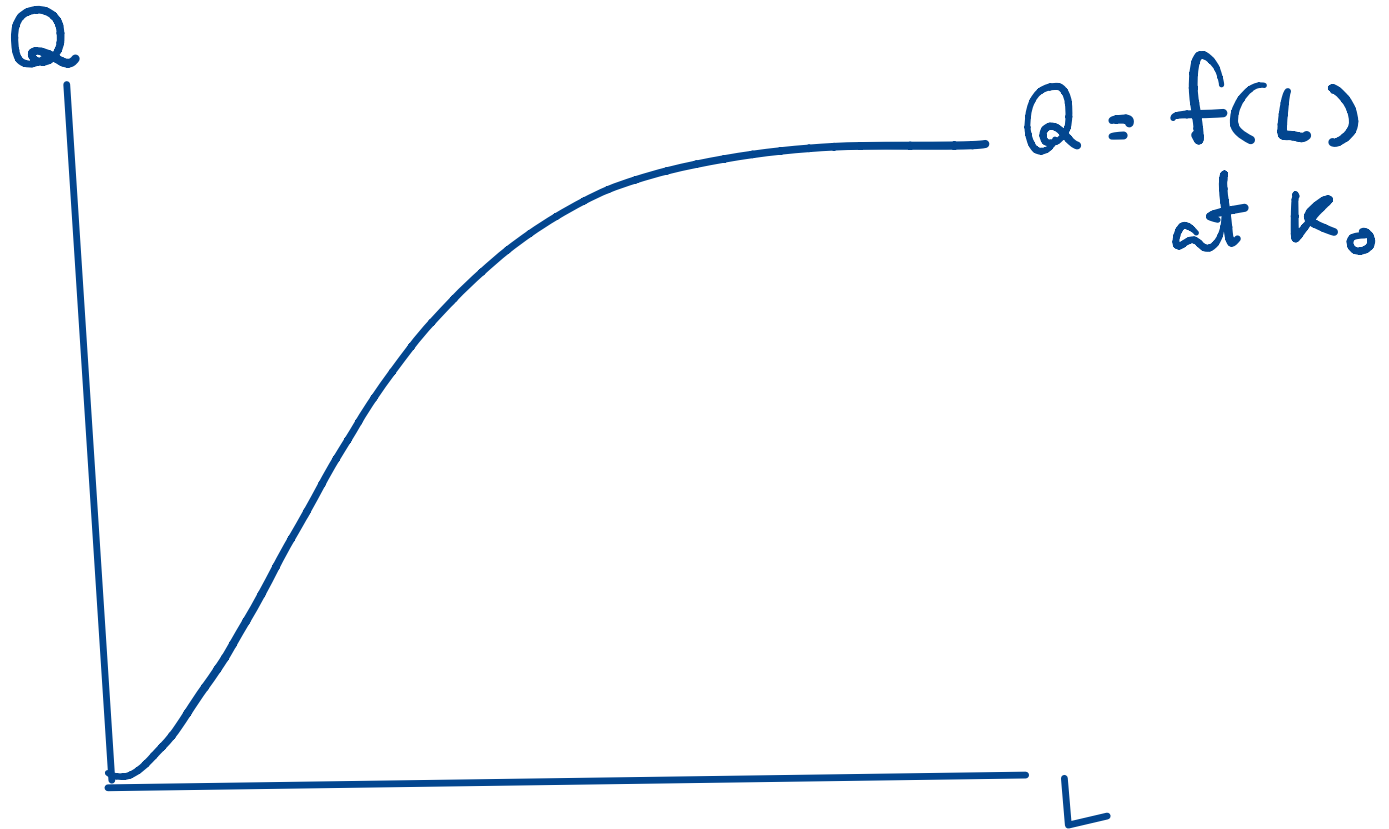
*total product = output*

# Graph: Long-Run Production

$$Q = f(L, K)$$



# Graph: Short-Run Production



# PRODUCTION AND COSTS IN THE SHORT RUN

---

# Topics

- **Production Function in the Short Run**
  - Total product, average product, and marginal product
  - Law of diminishing returns
- **Cost in the Short Run**
  - Total cost, average cost, and marginal cost
  - Short-run costs: TFC, TVC, TC, AFC, AVC, ATC, MC
- **Relationship between production and cost in the short run**

# Production Function in the Short Run

- **Total product (TP):**

$$TP = Q = f(L)$$

- **Average Product (AP)** is the output per unit of input.

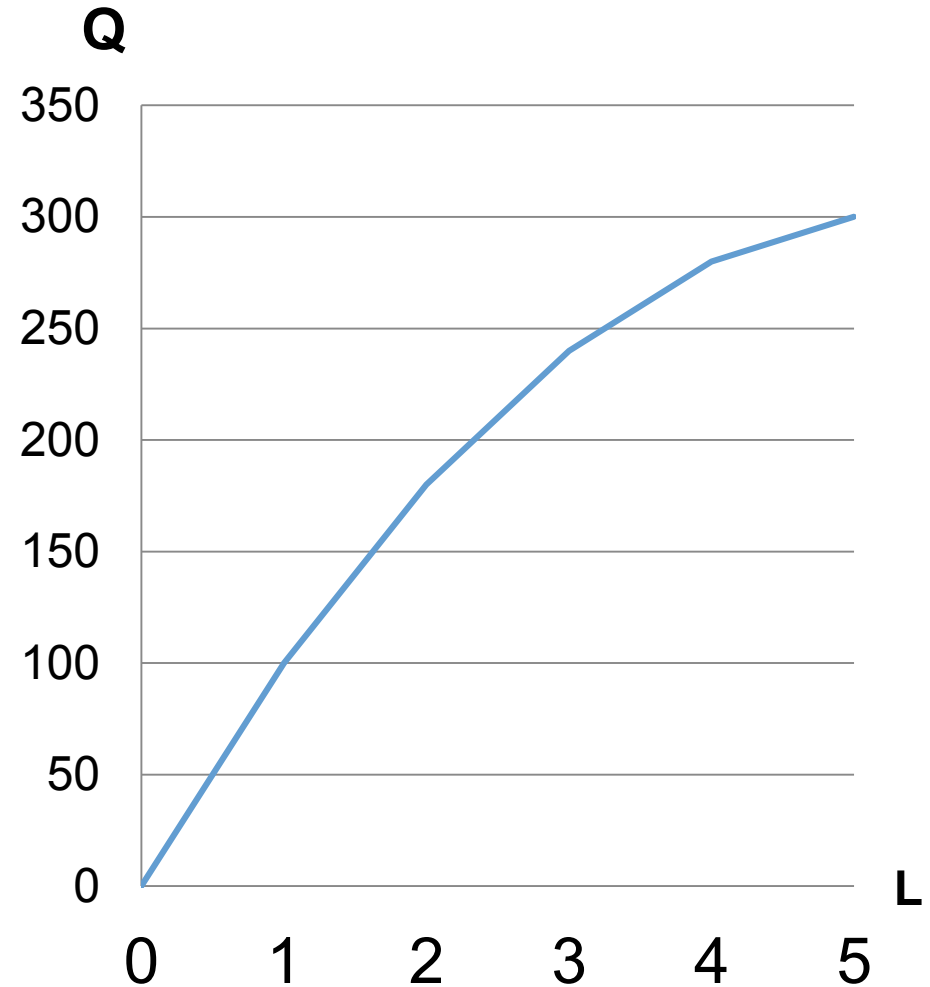
$$AP = \frac{TP}{L} = \frac{Q}{L}$$

- **Marginal Product (MP)** is the increase in output arising from an additional unit of that input, holding all other inputs constant.

$$MP = \frac{\Delta TP}{\Delta L} = \frac{\Delta Q}{\Delta L}$$

# Example: Production Function in the Short Run

L	Q
0	0
1	100
2	180
3	240
4	280
5	300



# Example 1

L	TP	AP	MP
0	0		
1	100		
2	180		
3	240		
4	280		
5	300		

# Diminishing Marginal Productivity

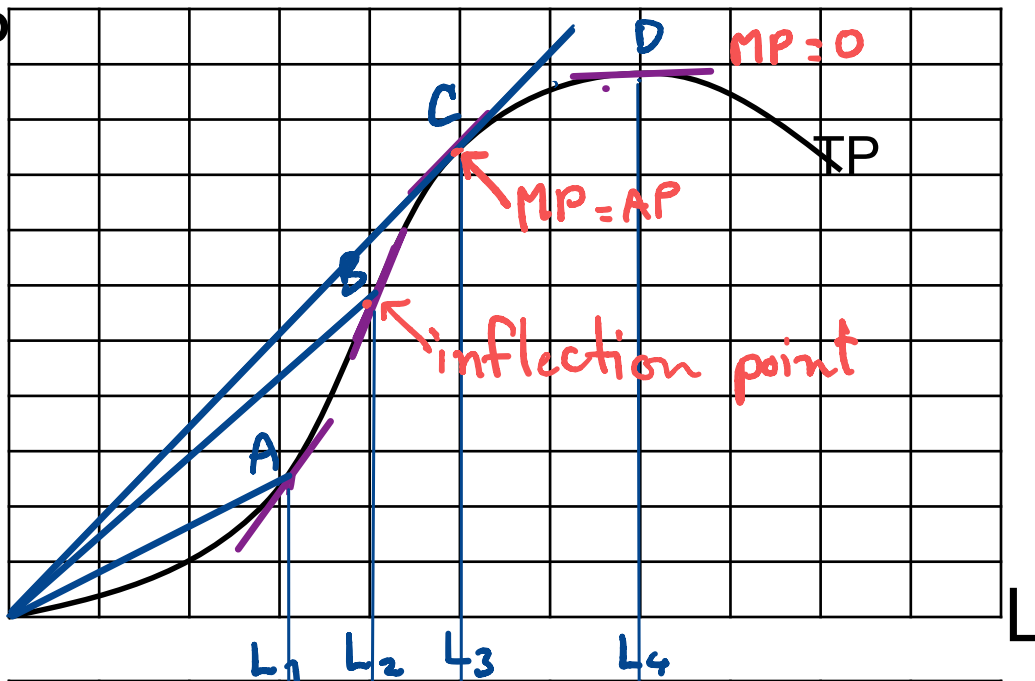
- **Law of diminishing marginal return**

*If increasing quantities of a variable factor are applied to a given quantity of fixed factors, the marginal product of the variable factor will eventually decrease.*

- Example: From previous slide, the output rises by a smaller and smaller amount for each additional worker.

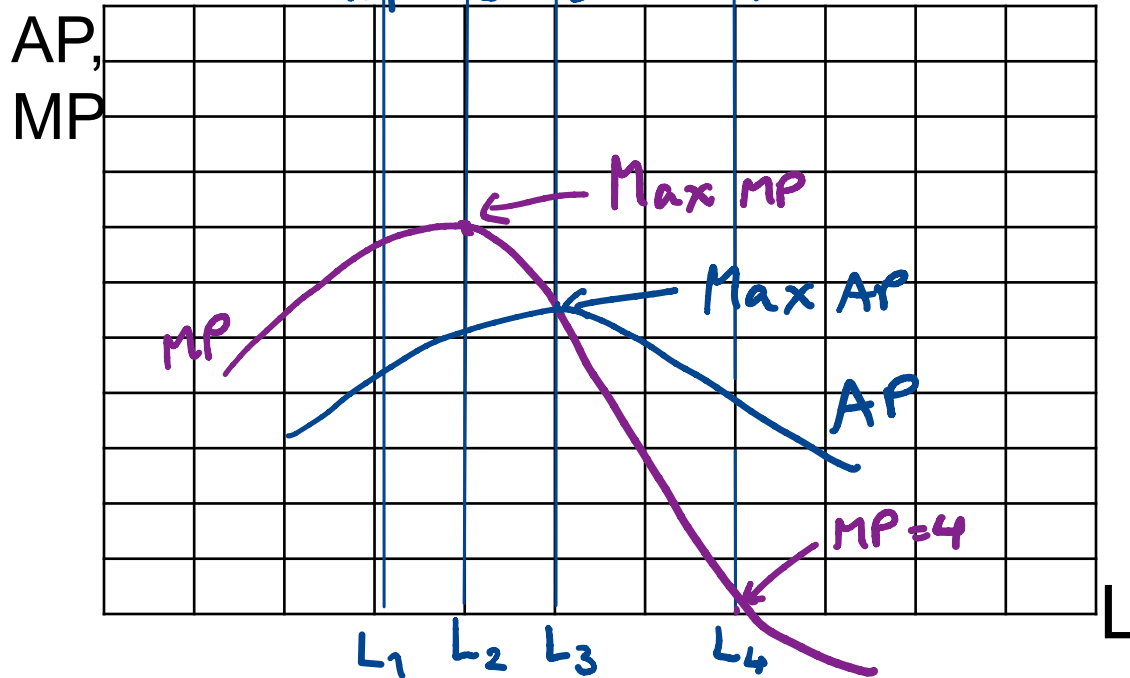
**Why?**

# TP, AP, and MP Curves



$$AP = \frac{TP}{L} = \frac{Q}{L}$$

$$MP = \frac{\Delta TP}{\Delta L} = \frac{\Delta Q}{\Delta L} = \text{slope of TP}$$

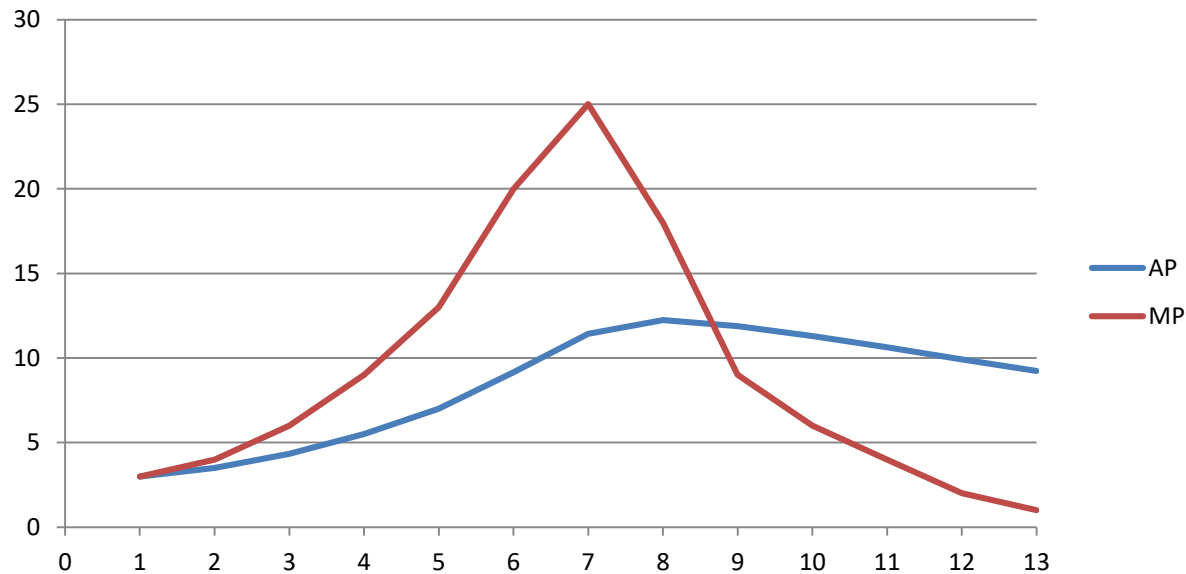
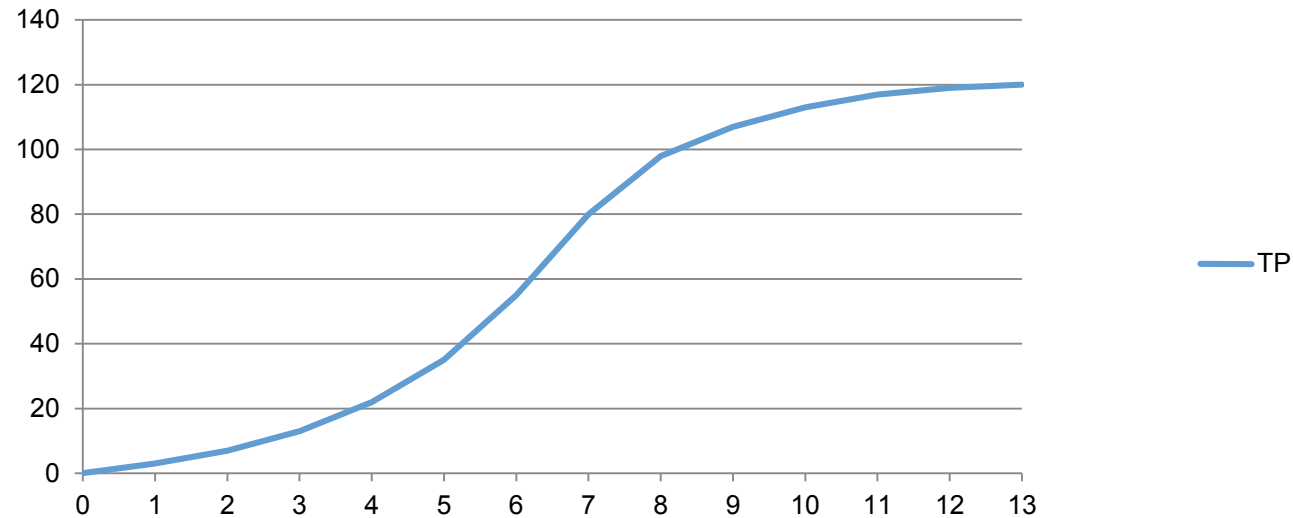


L	MP	AP
$L_1$	MP > AP	AP $\uparrow$
$L_2$	MP > AP	AP $\uparrow$
$L_3$	MP = AP	AP is max.
$L_4$	MP < AP	AP $\downarrow$

## Example 2 (Exercise for Own Practice!)

L	TP	AP	MP
0	0		
1	3	3.00	3
2	7	3.50	4
3	13	4.33	6
4	22	5.50	9
5	35	7.00	13
6	55	9.17	20
7	80	11.43	25
8	98	12.25	18
9	107	11.89	9
10	113	11.30	6
11	117	10.64	4
12	119	9.92	2
13	120	9.23	1

# Graph (Plot TP, AP, MP from the previous table using excel)



# Costs in the Short Run: TC, TFC, and TVC

- **Total costs (TC)** - the sums of all costs that the firm incurs to produce a given level of output.

$$TC = TFC + TVC$$

- **Total fixed cost (TFC)** – all costs of production that do not vary with the level of output
- **Total variable cost (TVC)** – total costs of production that vary directly with the level of output

# ATC, AFC, AVC, and MC

- **Average total cost (ATC)** – Total costs per unit of output

$$ATC = \frac{TC}{Q} = AFC + AVC$$

- **Average fixed cost (AFC)** – Total fixed costs divided by the number of units of output

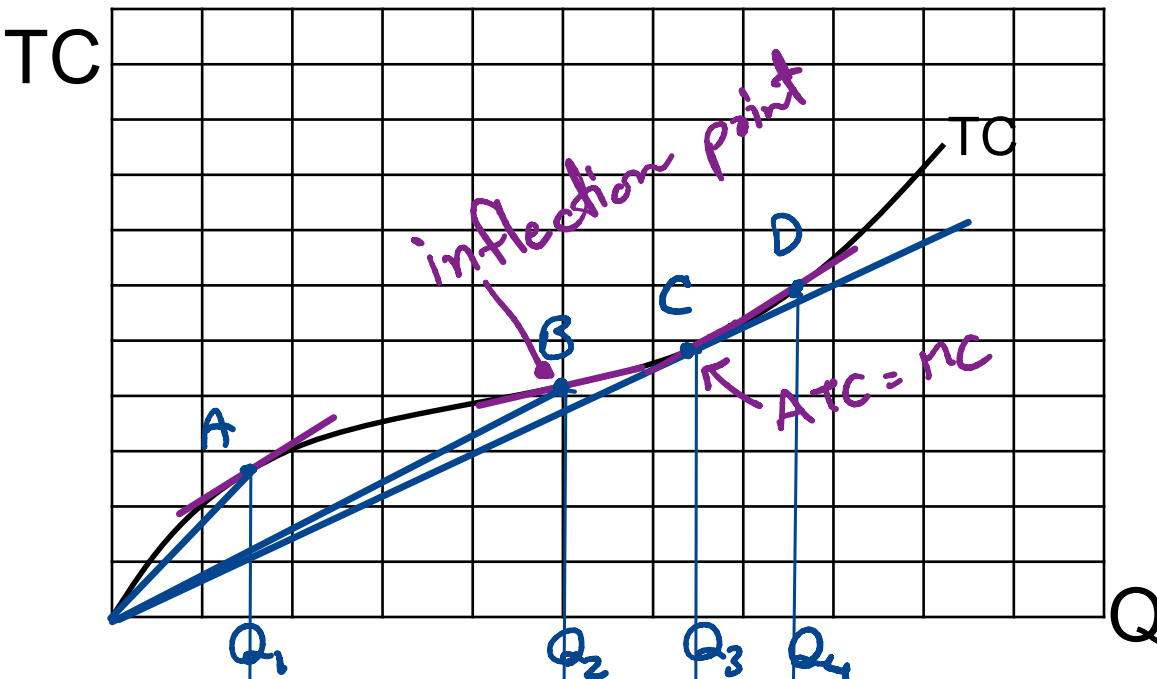
$$AFC = TFC/Q$$

- **Average variable cost (AVC)** – Total variable costs divided by the number of units of output

$$AVC = TVC/Q$$

- **Marginal cost (MC)** – The increase in total cost resulting from increasing output by one unit

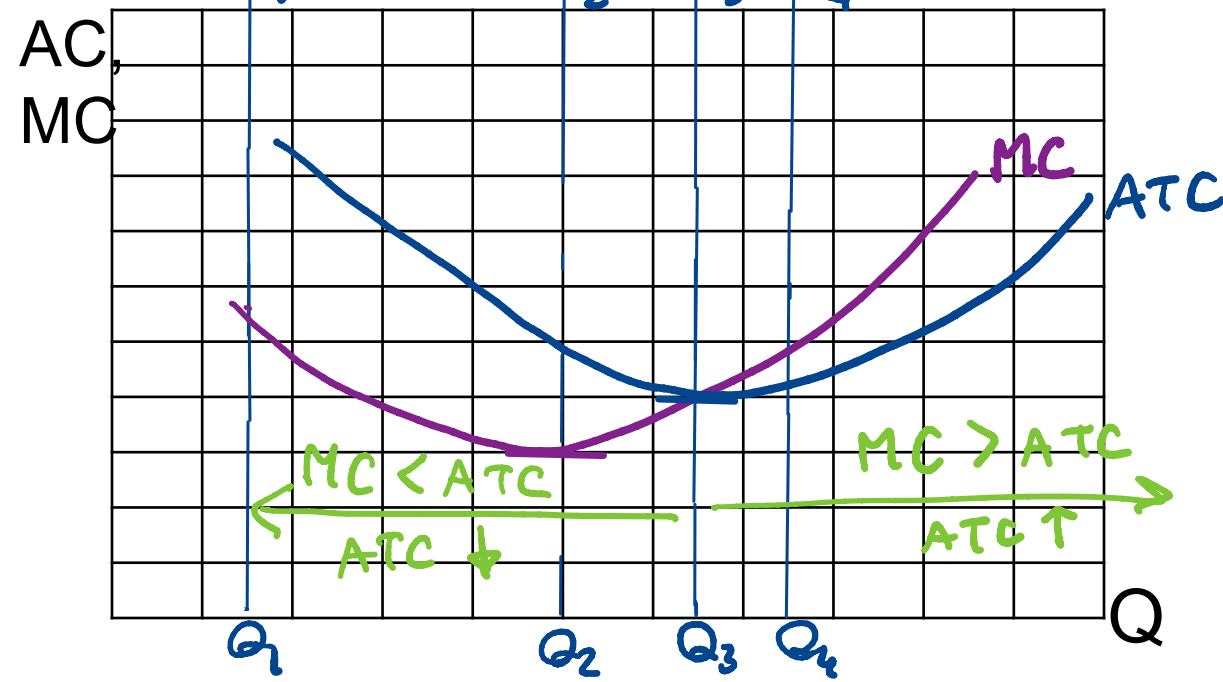
$$MC = \frac{\Delta TC}{\Delta Q}$$



# TC, ATC, and MC Curves

$$ATC = \frac{TC}{Q}$$

$$MC = \frac{\Delta TC}{\Delta Q} = \text{slope}$$

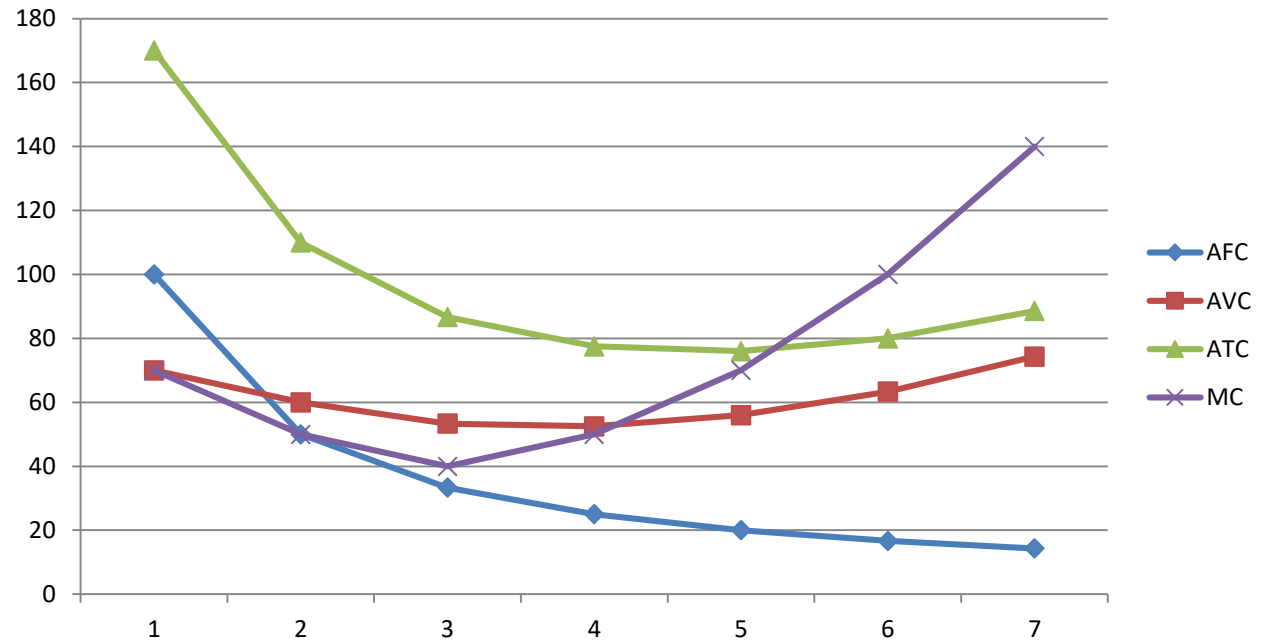
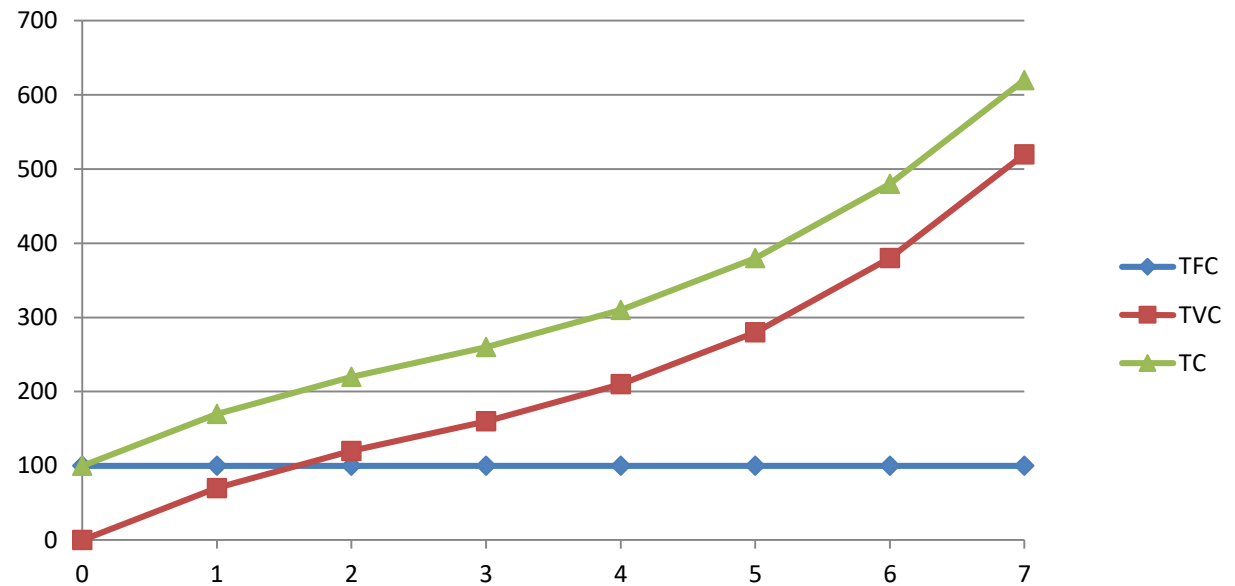


# Example 3 – AFC, AVC, ATC, MC

$$\begin{aligned}
 &= TFC/Q & & TVC/Q & & AFC + AVC & & \frac{\Delta TC}{\Delta Q}
 \end{aligned}$$

Q	TFC	TVC	TC	AFC	AVC	ATC	MC
0	100	0	100	n/a	n/a	n/a	n/a
<u>1</u>	<u>100</u>	70	<u>170</u>	100	70	170	$\frac{70}{1} = 70$
2	100	120	<u>220</u>	50	60	110	$\frac{50}{1} = 50$
3	100	160	260	33.3	53.3	86.7	40
4	100	210	310	25	52.5	77.5	50
5	100	280	380	20	56	76	70
6	100	380	480	16.67	63.3	80	100
7	100	520	620	14.28	74.3	88.6	140

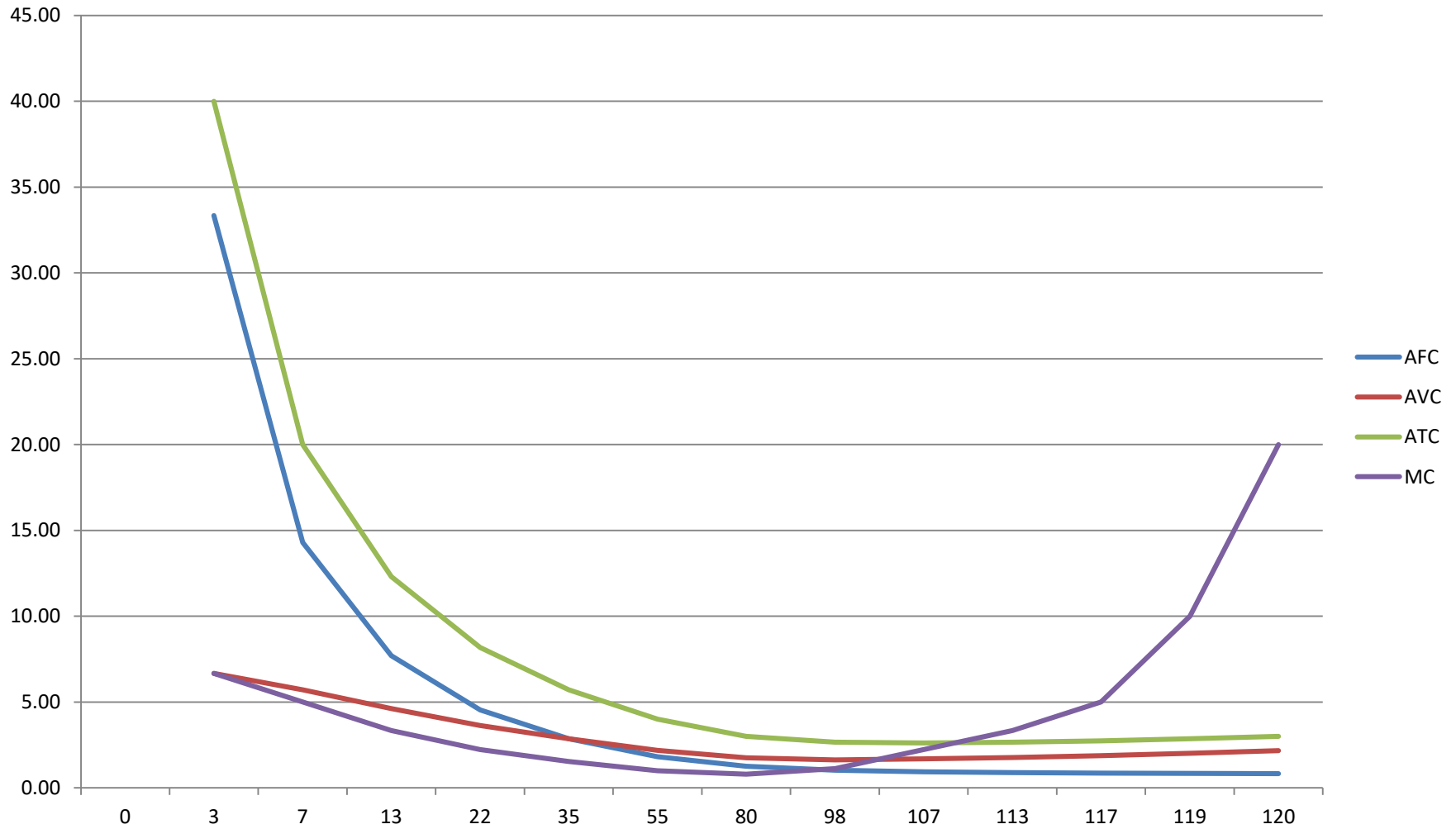
# Example 3: Graph



## Example 4 (For Own Practice)

Q	TFC	TVC	TC	AFC	AVC	ATC	MC
0	100	0	100	n/a	n/a	n/a	n/a
3	100	20	120	33.33	6.67	40.00	6.67
7	100	40	140	14.29	5.71	20.00	5.00
13	100	60	160	7.69	4.62	12.31	3.33
22	100	80	180	4.55	3.64	8.18	2.22
35	100	100	200	2.86	2.86	5.71	1.54
55	100	120	220	1.82	2.18	4.00	1.00
80	100	140	240	1.25	1.75	3.00	0.80
98	100	160	260	1.02	1.63	2.65	1.11
107	100	180	280	0.93	1.68	2.62	2.22
113	100	200	300	0.88	1.77	2.65	3.33
117	100	220	320	0.85	1.88	2.74	5.00
119	100	240	340	0.84	2.02	2.86	10.00
120	100	260	360	0.83	2.17	3.00	20.00

# Example 4: Graph



# Changes in Cost Curves

- ① Suppose rent increases.  $\rightarrow$  MC? ATC?
- ② Suppose a  $\$t$ /unit tax is imposed on the production.  $\rightarrow$  MC? AC?

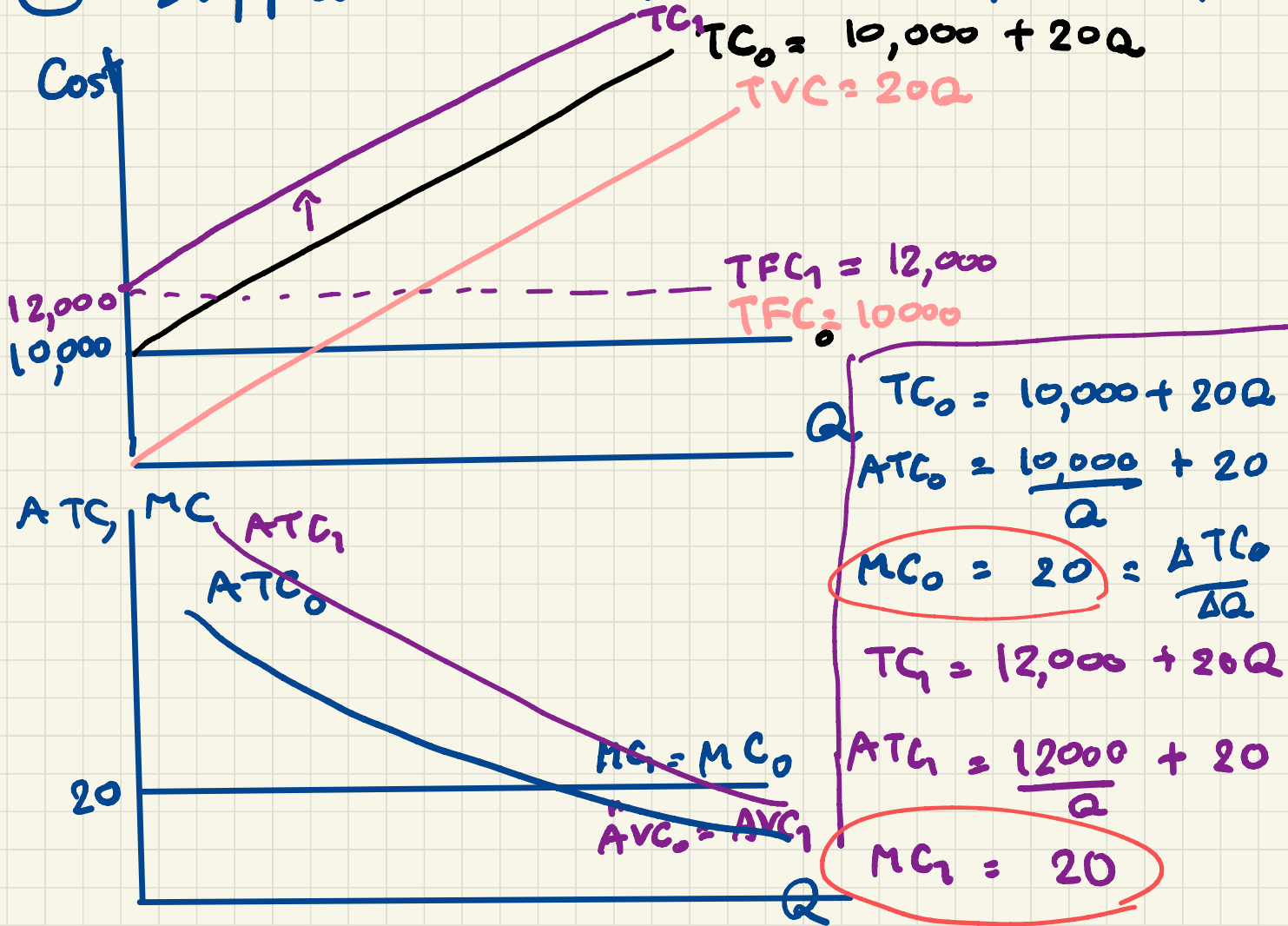
Ex. Coffee shop.

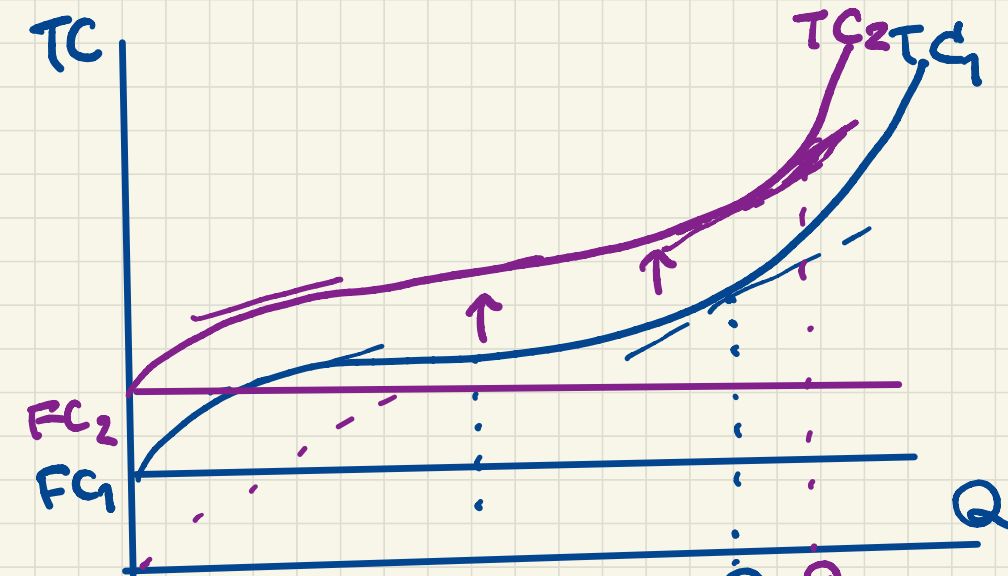
- Fixed cost  $\rightarrow$  rent 10,000 baht/mo.

- Variable cost  $\rightarrow$  20 baht/cup.

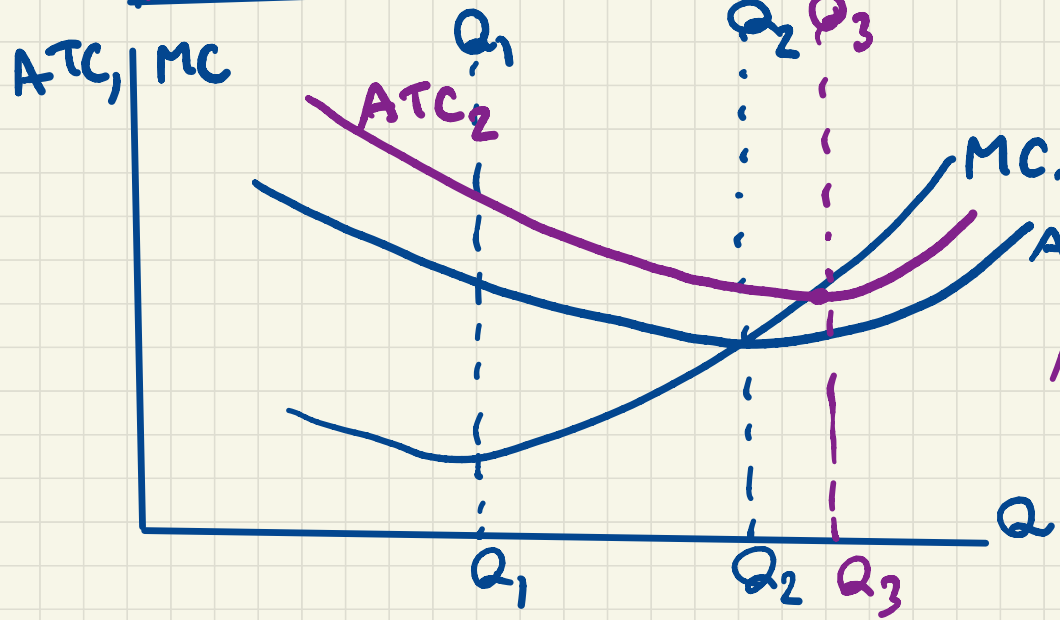
$$TC(Q) = 10,000 + 20Q$$

① Suppose rent increases to \$12,000/mo.





Suppose  
fixed cost  
increases.



ATC ↑ b/c  
AFC ↑

② Suppose a  $t$ /unit tax is imposed on the production.

$$TC_0(Q) = TFC_0 + TVC_0(Q) = C_0 + TVC_0(Q)$$

$$TC_1(Q) = TFC_0 + TVC_1(Q)$$

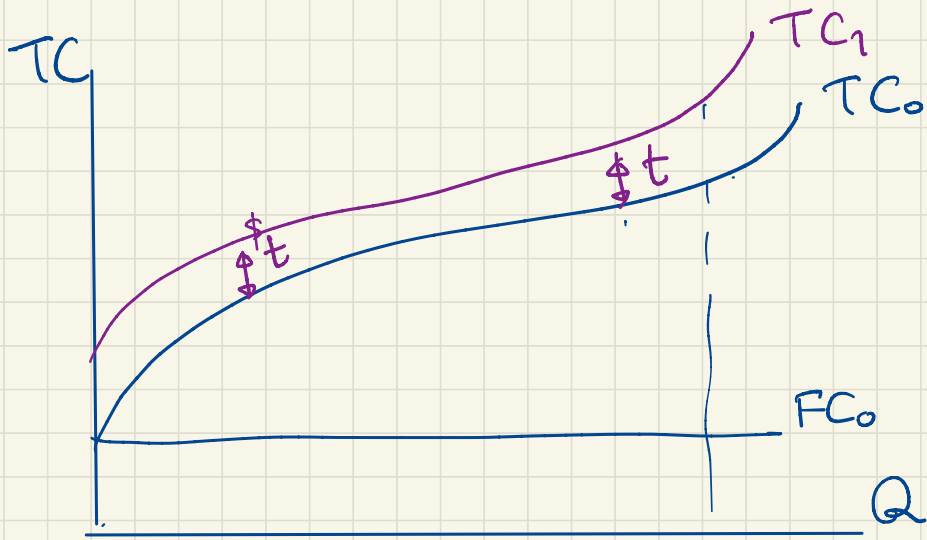
$$= TFC_0 + TVC_0(Q) + tQ = TVC_1$$

$$ATC_0 = AFC_0 + AVC_0(Q)$$

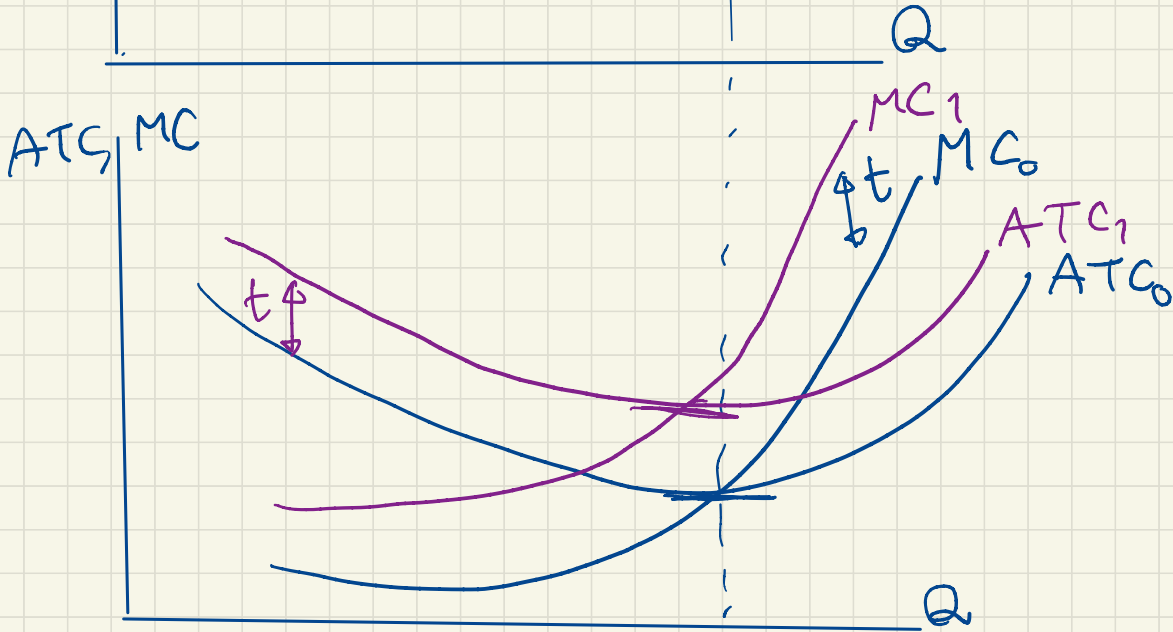
$$MC_0 = \frac{\Delta TC_0}{\Delta Q} = \frac{\Delta TVC_0}{\Delta Q}$$

$$ATC_1 = AFC_0 + \frac{(TVC_0 + tQ)}{Q} = AFC_0 + AVC_0 + t$$

$$MC_1 = \frac{\Delta TC_1}{\Delta Q} = \frac{\Delta (TFC_0 + TVC_0 + tQ)}{\Delta Q} = \frac{\Delta TVC_0}{\Delta Q} + t$$



\* Variable cost  $\uparrow$   
 $\Rightarrow MC \uparrow$   
 $ATC \uparrow$



# Relationship between Production and Cost in the Short Run

