LECTURE 8
MIDTERM RECAP
CONCEPTS OF COST
COST IN THE SHORT RUN

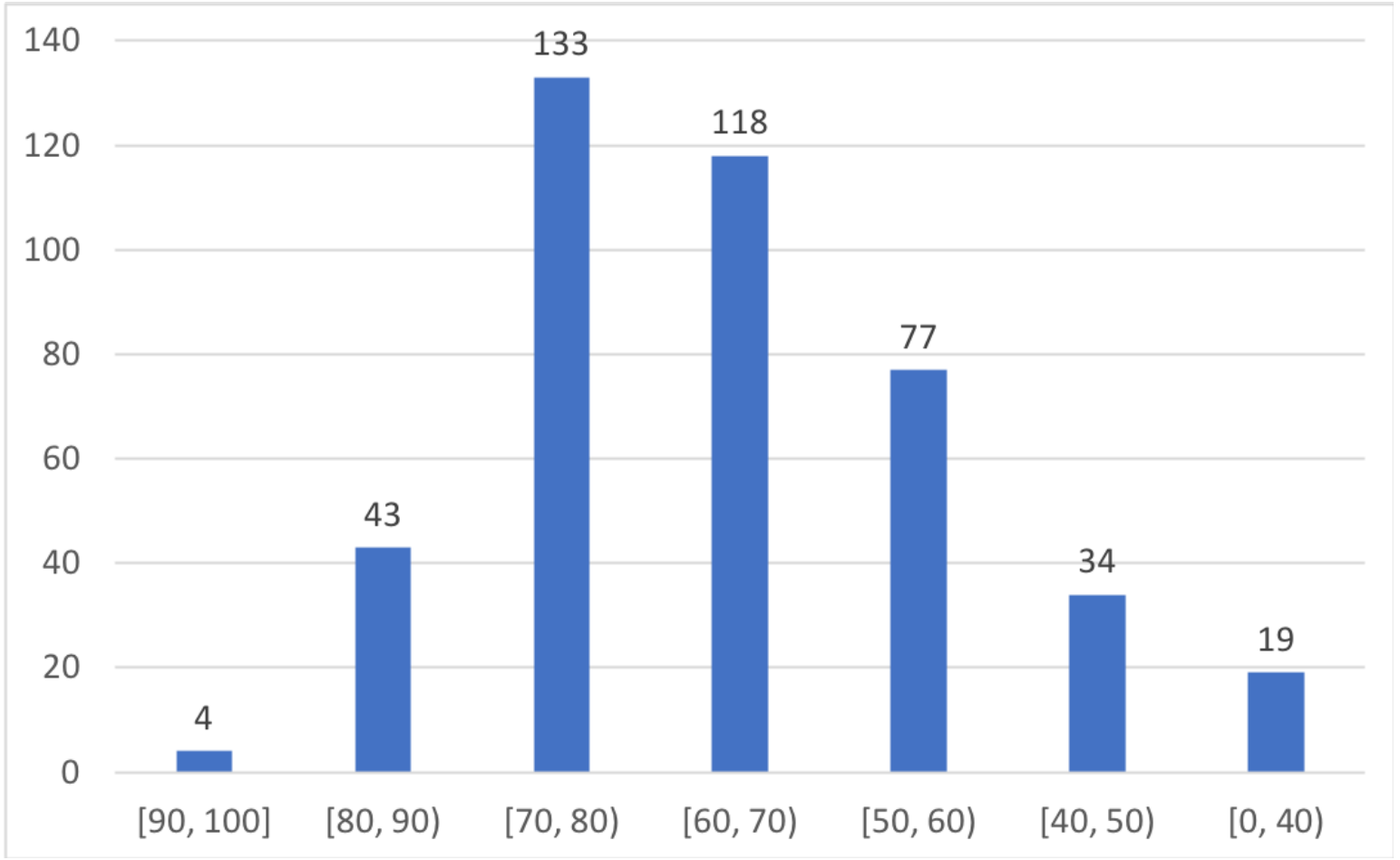
Part 1

Midterm Recap

Midterm Statistics

Median	67
Mean	65.1
Standard Deviation	13.2
Highest Score	100
75^{th} Percentile	74.6
25^{th} Percentile	58

Midterm Distribution



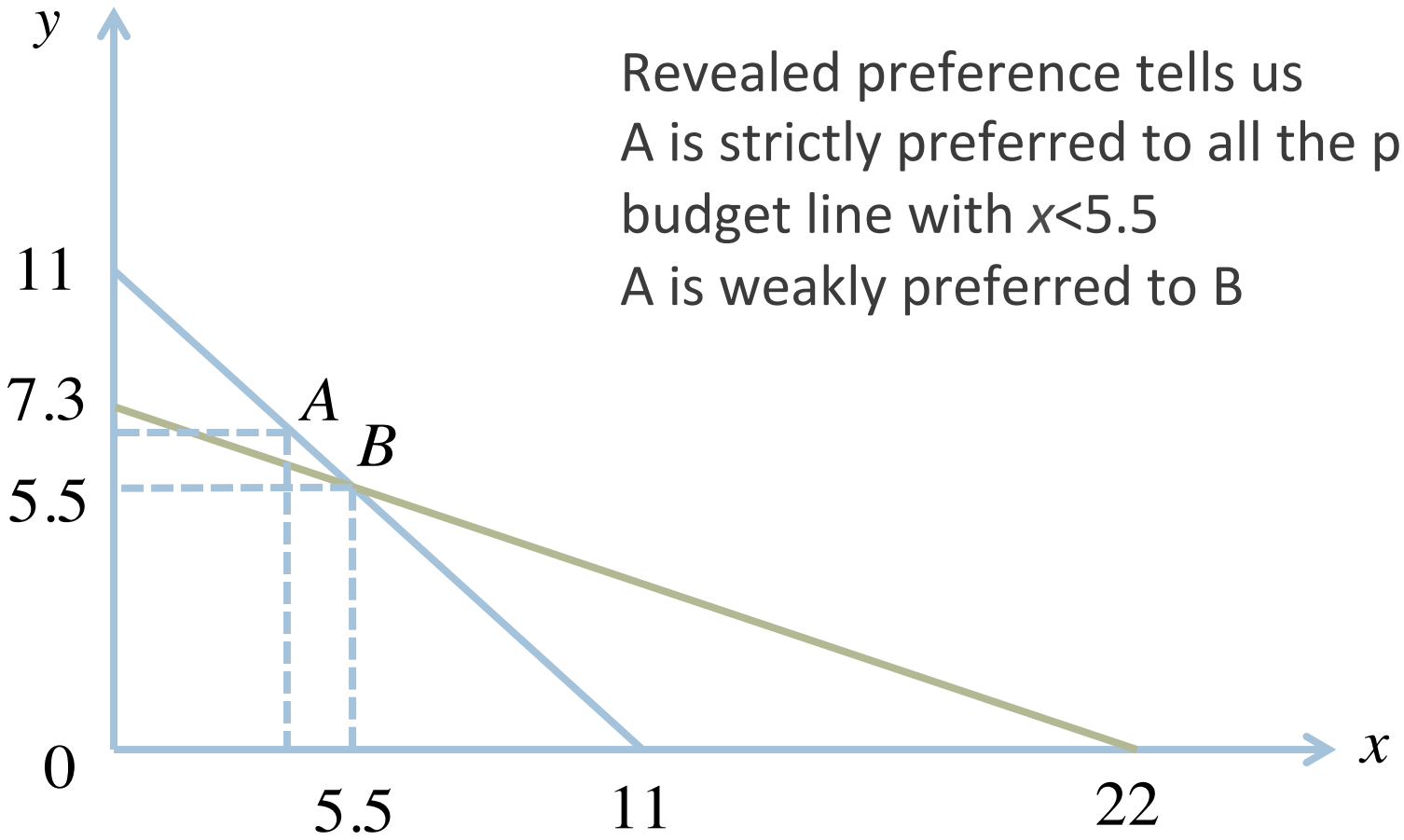
Midterm MCQ 1-4

- MCQ 1: budget line
  - More than half got it wrong
- MCQ 2: tangency condition
- MCQ 3: Engel curve, inferior good vs. Giffen good
- MCQ 4: Pareto efficiency vs. Pareto improvement
  - Practice Problems 4: question 1

Midterm MCQ 5

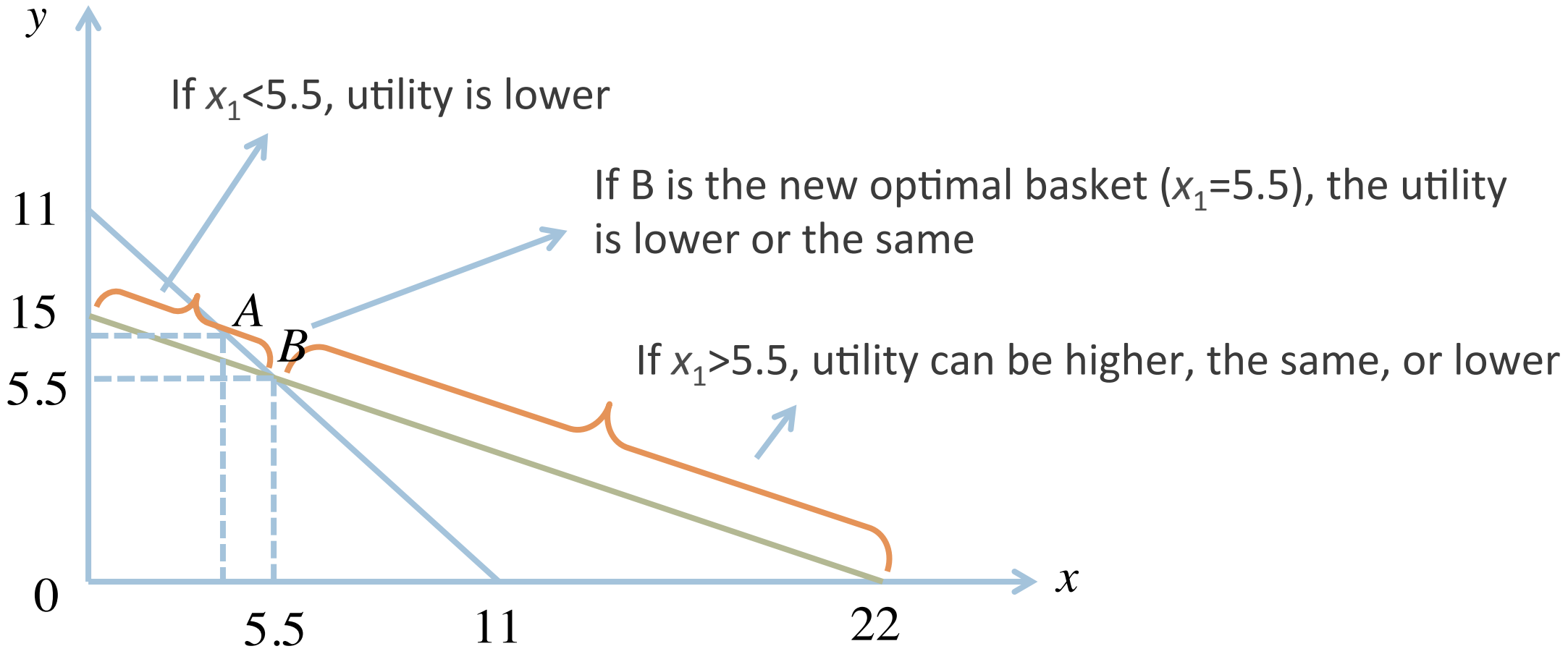
- Initially, price of *x* is \$2, price of *y* is \$2, income is \$22
  - Optimal basket is (4, 7)
- The price of *x* becomes \$1, price of *y* becomes \$3, income still \$22
  - There is a new optimal basket (x_1, y_1)
- The intersection point of the two budget lines
  - (5.5, 5.5)
- The original optimal basket lies above the new budget line
  - \$1*4+\$3*7=\$25>\$22

Midterm MCQ 5 Cont'



Revealed preference tells us
A is strictly preferred to all the points on the new budget line with $x<5.5$
A is weakly preferred to B

Midterm MCQ 5 Cont'



Midterm MCQ 5 Cont'

- A. If x_1=5.5, utility is still the same
  - It could be lower
- B. If x_1>5.5, utility is higher
  - It could be lower or the same
- C. If utility is lower, x_1<5.5
  - The correct statement is "if x_1<5.5, utility is lower"
- D. If utility is higher, x_1>5.5
  - Correct

Midterm MCQ 6

- Utility function is

$$U(x,y) = x^2 + y^2$$

  - Same as in homework 1 question 1
- Corner solution
- *X* is cheaper than *y*
  - The consumer only buys *x*
- When *x* becomes even cheaper
  - The consumer still only buys *x*

Midterm MCQ 6 Cont'

- The initial optimal basket is

$$x = \frac{I}{P_x}, y = 0$$

- The new optimal basket is

$$x = \frac{I}{aP_x}, y = 0$$

- Basket C (new price old utility) is the same as the initial optimal basket
- Basket D (old price new utility) is the same as the new optimal basket

Midterm MCQ 6 Cont'

- CV is

$$I - \frac{I}{P_x} \times aP_x = I - aI$$

- EV is

$$\frac{I}{aP_x} \times P_x - I = \frac{I}{a} - I$$

- Since EV=2CV,

$$\frac{I}{a} - I = 2(I - aI) \Rightarrow a = \frac{1}{2}$$

Midterm Structured Question 2 b)

- Utility function is

$$U(v,m) = 2\sqrt{v} + m$$

- Price of vegetables is \$2, price of meat is \$12, income is \$120
  - Initial optimal basket is v=36, m=4
- Suppose there is a \$50 spending limit on vegetables, what is the optimal basket?
  - NTUC Fair Price implemented this spending limit after DORSCON orange
- The spending constraint binds
  - The new optimal basket is v=25, m=5.83

Midterm Structured Question 2 c)

- What if we increase the price of vegetables so that the consumer spends $50 on vegetables?
  - The consumer buys less vegetables than in part b)
  - Since income is still $120, the consumer still spends $70 on meat
  - Since the price of meat is the same, the consumer buys the same amount of meat as in part b)
- General result: the consumer's utility is lower compared to the under the spending limit

Midterm Structured Question 2 b) and 2 c)

- What is the difference between the two?
  - Spending limit vs. higher price
- For consumers who initially spend more than $50 on vegetables
  - They spend $50 under both policies
  - Higher utility under spending limit
- For consumers who initially spend $50 or less on vegetables
  - Not affected by spending limit
  - Lower utility if the price of vegetables is higher

Midterm Structured Question 3 c)

- Dr. Zhang

$$U(h,s) = 4h + s$$

- Dr. Yang

$$U(h,s) = 3h + 2s$$

- Each has an income of $240 and gets a voucher of $40 on hot pot
- For each consumer
  - Either uses all income and voucher to buy hot pot
  - Or only uses the voucher to buy hot pot and uses all income to buy salad

Midterm Structured Question 3 c)

- Case 1: both only use the voucher to buy hot pot
- This is when

$$P_h > 4P_s$$

- The optimal basket for both is

$$h = \frac{40}{P_h}, s = \frac{240}{P_s}$$

- Dr. Yang always gets higher utility

$$U_{Zhang} = \frac{160}{P_h} + \frac{240}{P_s} < U_{Yang} = \frac{120}{P_h} + \frac{480}{P_s}$$

Midterm Structured Question 3 c) Cont'

- Case 2: Dr. Zhang uses the income and voucher to buy hot pot, Dr. Yang uses the income to buy salad and the voucher to buy hot pot
- This is when

$$\frac{3P_s}{2} < P_h < 4P_s$$

- Dr. Zhang's optimal basket and utility is

$$h = \frac{280}{P_h}, s = 0, U_{Zhang} = \frac{1120}{P_h}$$

- For Dr. Zhang to get higher utility, we need

Midterm Structured Question 3 c) Cont'

$$U_{Zhang} = \frac{1120}{P_h} > U_{Yang} = \frac{120}{P_h} + \frac{480}{P_s}$$

- Which means

$$P_h < \frac{25P_s}{12}$$

- Case 3: both only buy hot pot
- This happens when

$$P_h < \frac{3P_s}{2}$$

- Dr. Zhang always gets higher utility because of higher marginal utility of hot pot

Some Logistics

- Let me know if you have any questions regarding the midterm grading
- Final exam
  - Comprehensive but focuses on the materials after the midterm
  - Same type of questions and similar style
  - Fewer MCQs and more structured questions
- Change of homework groups
  - Allowed if it is a Pareto improvement
  - If there is any change to your group, inform your tutor by next week (week 10)

Part 2

Concepts of Cost

Opportunity Cost

- Opportunity cost is the cost associated with the best alternative that is not chosen
  - Suppose the firm has two alternative ways of using its capital, A and B
  - If the firm chooses A, the opportunity cost is the payoff the firm could have earned had it chosen B
- To determine opportunity cost
  - Ask “What does the firm/decision maker give up?”

Explicit vs. Implicit Costs

- Suppose you own and run a small software development firm
  - Wages to employees: $200,000
  - Rent: $50,000
  - Utilities and supplies: $60,000
- All the above are the *explicit costs* of running your own firm
- Your best alternative is to work for Google for $100,000 per year
- The $100,000 is an *implicit cost*

Economic Costs

- Your opportunity cost of running your own firm is
  - 200,000+50,000+60,000+100,000=$410,000
- By running your own firm
  - You are incurring all the explicit costs
  - And forgoing the salary you could have earned if you chose the best alternative
- Economic costs
  - Are the same as opportunity costs
  - Include all explicit and implicit costs

Sunk Cost

- Sunk cost is cost that can never be recovered no matter what you do
  - Costs resulted from past decisions and cannot be avoided
  - No future decisions can change sunk costs
  - Sunk costs are irrelevant for future decisions
- To determine sunk cost
  - Ask “What costs *do not* vary across alternatives?”

Example: Leasing Expenditure

Suppose you own a retail chain. You are considering a temporary shut down of one the stores for a month. You do not own the property and you have to pay the rent no matter what.

	Revenue	Rent	Other costs
Stay open	$20,000	$5,000	$24,000
Shut down	0	$5,000	0

Example of Sunk Cost Fallacy: Driving in Singapore

- Do people drive more when they paid more for their cars?
- Sunk costs associated with buying a car in Singapore
  - COE (Certificate of Entitlement)
  - ARF (Additional Registration Fee)
- An increase in purchasing price (due to an increase in COE or ARF) by one standard deviation leads to an increase in driving by 9.48 km per month
  - Source: Ho, Png, and Reza (2017), *"Sunk Cost Fallacy in Driving the World's Costliest Cars"*.

Part 3

Cost in the Short Run

Where are we?

- Production function
  - How firms turn L and K into Q
- Optimal choice of L and K
  - To produce a certain amount of output Q_0, how much L and K should the firm use?
  - How much does it cost to produce Q_0?
  - Cost curve: cost as a function of Q
- Optimal choice of Q
  - At any given price, how much output should the firm produce?
- Firm's supply curve
  - Output Q as a function of market price

Short-Run vs. Long-Run in Production

- Suppose firm uses *L* and *K* to produce
- In the short-run
  - At least one input is fixed at a particular level
  - Usually we assume *K* is fixed
- In the long-run
  - Firm is free to adjust both inputs

Short-Run Total Cost

- Suppose
  - price of labor is *w* per unit
  - price of capital is *r* per unit
- Suppose in the short run, capital is fixed at K_0
- Total cost in the short run is

$$STC = wL + rK_0$$

How much labor should the firm use?

- Assume the firm maximizes profit
  - Profit=total revenue-total cost
- For any output level Q_0
- The firm chooses L to *minimize* the total cost of production

$$\min_{L} \quad wL + rK_0$$

$$s.t. \quad F(L, K_0) = Q_0$$

Example: Short-Run Labor Choice

- Suppose the production function is

$$Q = KL$$

- In the short run, capital is fixed at K=2
- If the firm wants to produce 4 units, the firm needs 4/2=2 units of labor
- For any output level Q, the amount of labor the firm needs is

Example: Short-Run Total Cost Curve

- Suppose w=2 and r=3
- If the firm wants to produce 4 units of output, its short-run total cost is

$$STC = wL + rK = 2 \times 2 + 3 \times 2 = 10$$

- The firm's *short-run total cost curve* is

$$STC(Q) = wL + rK = 2L + 3K = 2(\frac{Q}{2}) + 6 = Q + 6$$

- Definition 8.1 *Short-run total cost curve* is short-run total cost as a function of Q
  - Holding w and r fixed

Example: Short-Run Total Cost Function

- Suppose we do not know the values of *w* and *r*
- If the firm wants to produce 4 units of output, its short-run total cost is

$$STC = wL + rK = 2w + 2r$$

- The firm's *short-run total cost function* is

$$STC(Q, w, r) = wL + rK = w(\frac{Q}{2}) + 2r$$

- Definition 8.2 *Short-run total cost function* is short-run total cost as a function of *Q*, *w*, and *r*

Variable Cost vs. Fixed Cost

- Definition 8.3 *Variable cost* (*VC*)
  - Cost that varies as *Q* changes
  - When *Q* is 0, variable cost is 0
- Definition 8.4 *Fixed cost* (*FC*)
  - Cost that does not vary with *Q* as long as *Q*>0
- In the short run, for any *Q*>0
  - $STC(Q)=wL+rK_0=VC(Q)+FC$
  - Fixed cost=rK_0

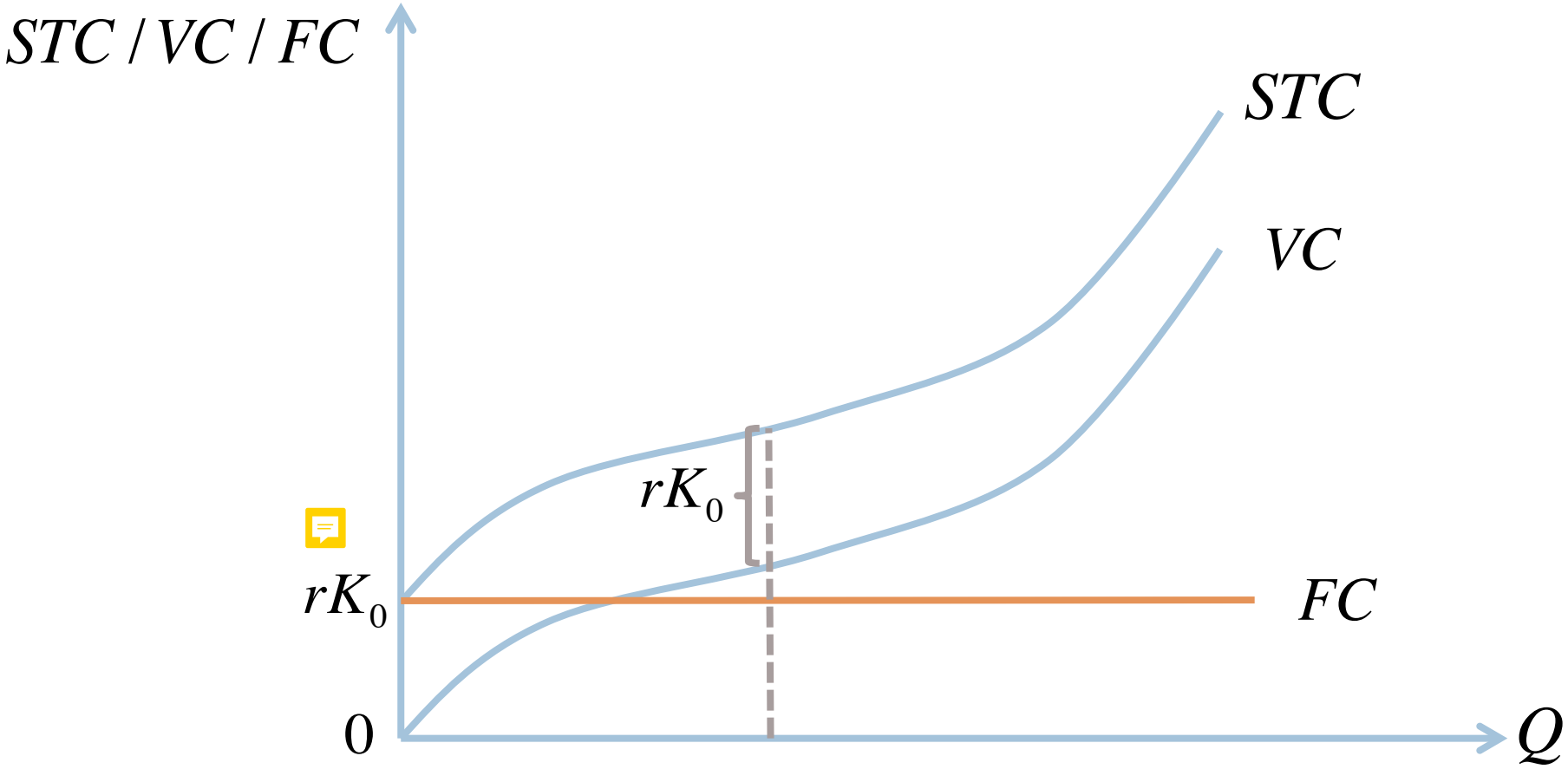
Fixed Cost vs. Sunk Cost

- Suppose you rent a plant for production
  - The monthly rent is $10,000
- Suppose you want to temporarily shut down the plant, i.e., produce Q=0
- Non-sunk fixed cost
  - If you can sublet the plant to another firm at $10,000 per month
  - The rent is not sunk
- Sunk fixed cost
  - If you cannot sublet
  - The rent is sunk

Sunk Cost and *STC* at *Q*=0

- Recall short-run total cost curve
  - $STC(Q)=VC(Q)+FC$
- If FC is non-sunk, then
  - $STC(0)=$
- If FC is sunk, then
  - $STC(0)=$
- If part of FC is sunk, then
  - $STC(0)$=the sunk part of FC

STC, VC, FC in Graph



Short-Run Marginal Cost

- Definition 8.5 *Short-run marginal cost* measures the rate at which short-run total cost changes with output

$$SMC(Q) = \frac{dSTC(Q)}{dQ} = \frac{\Delta STC(Q)}{\Delta Q}$$

where ΔQ is extremely small

- Slope of the short-run total cost curve
- Slope of the short-run variable cost curve

$$SMC(Q) = \frac{dSTC(Q)}{dQ} = \frac{d(VC(Q)+FC)}{dQ} = \frac{dVC(Q)}{dQ}$$

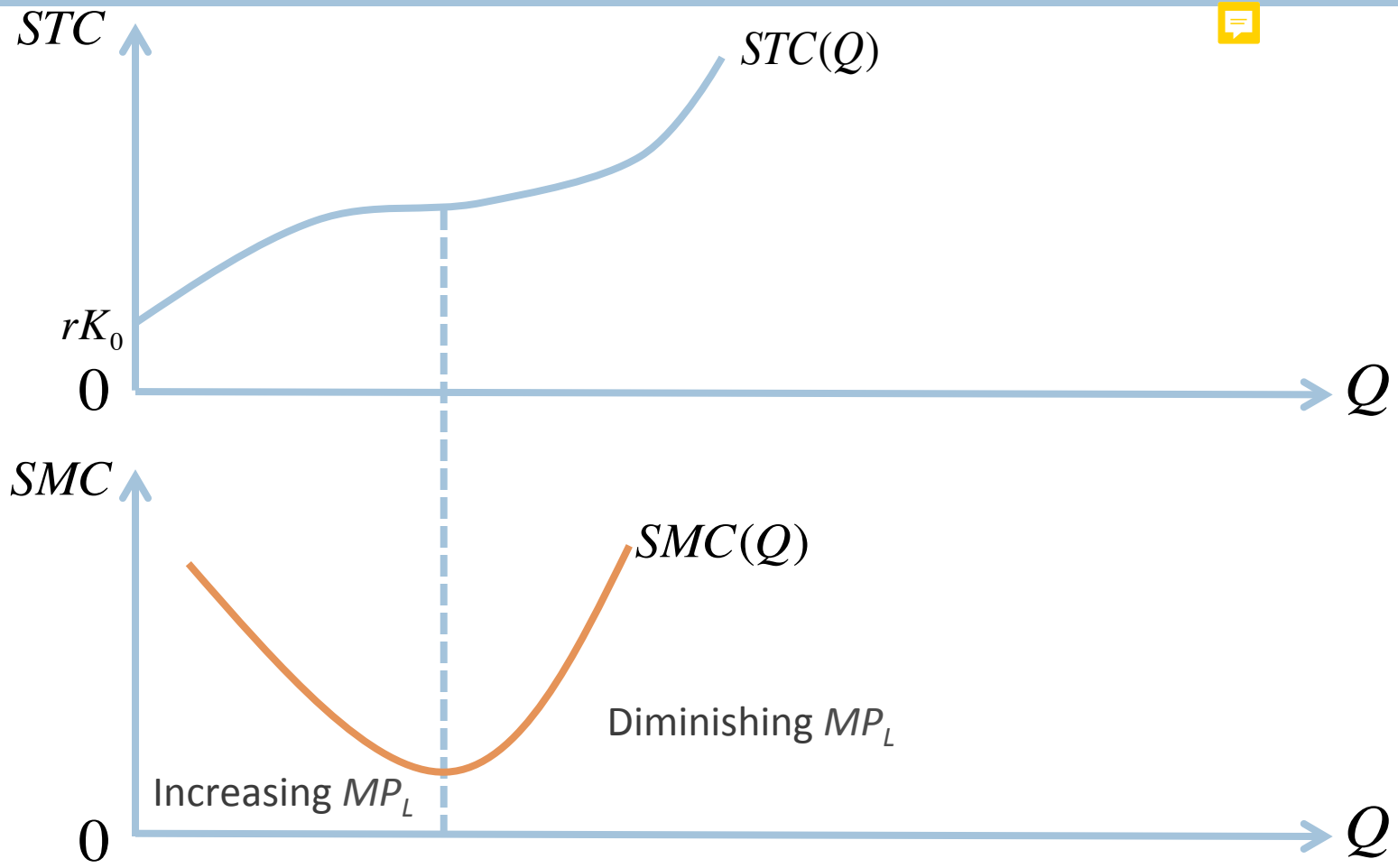
Diminishing Marginal Return (of Labor) and Short-Run Marginal Cost

- Rewriting short-run marginal cost

$$SMC = \frac{\Delta VC}{\Delta Q} = \frac{w\Delta L}{\Delta Q} = \frac{w}{MP_L}$$

- Recall diminishing marginal returns
  - MP_L decreases as L increases
- If we have diminishing marginal returns (assuming marginal product of labor is positive) then
  - SMC increases as Q increases

Typical Short-Run Total and Marginal Cost Curves



Short-Run Average Costs

- Definition 8.6 *Short-run average total cost* (*SAC*)

$$SAC(Q) = \frac{STC(Q)}{Q}$$

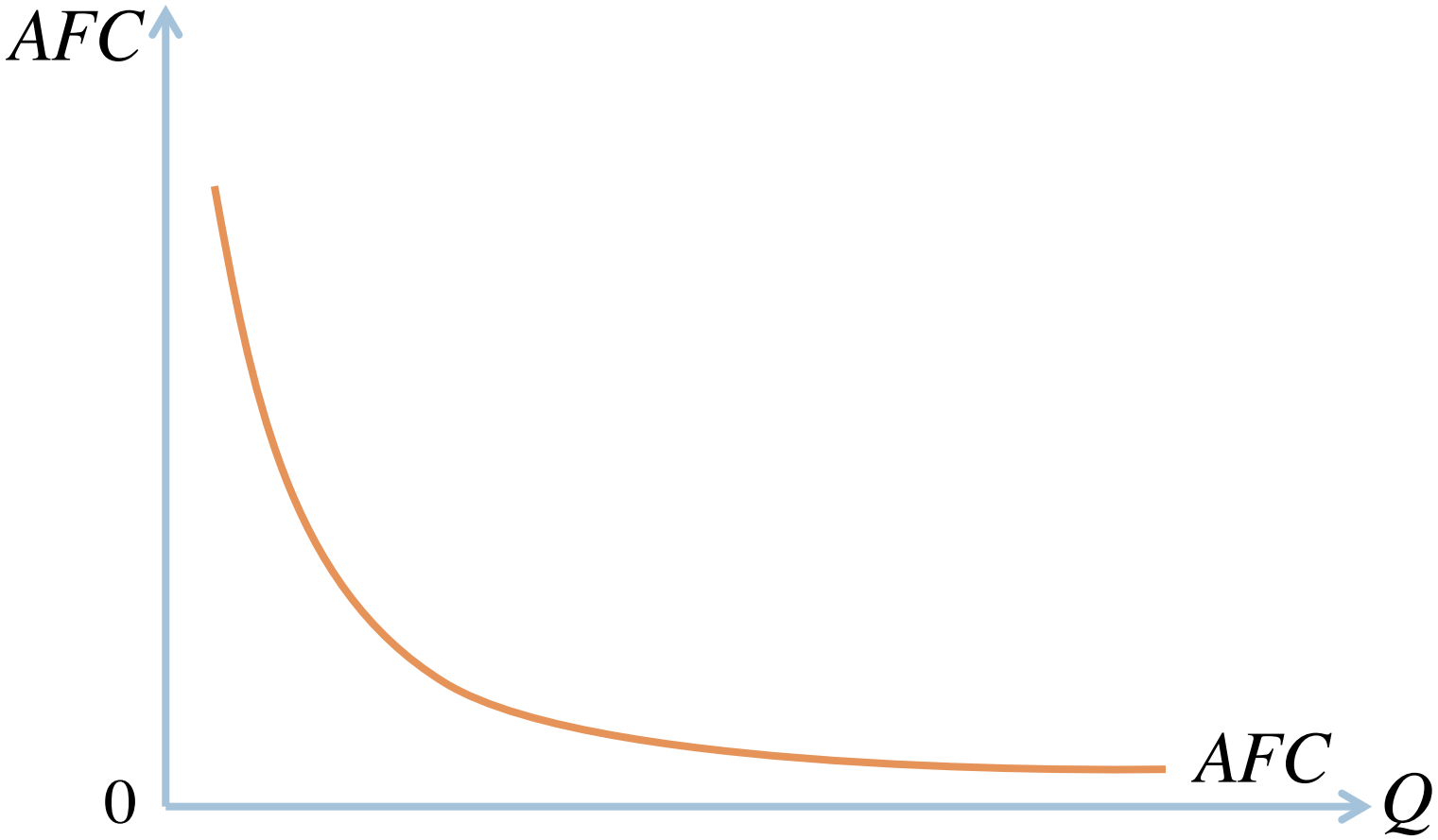
- Definition 8.7 *Average variable cost* (*AVC*)

$$AVC(Q) = \frac{VC(Q)}{Q}$$

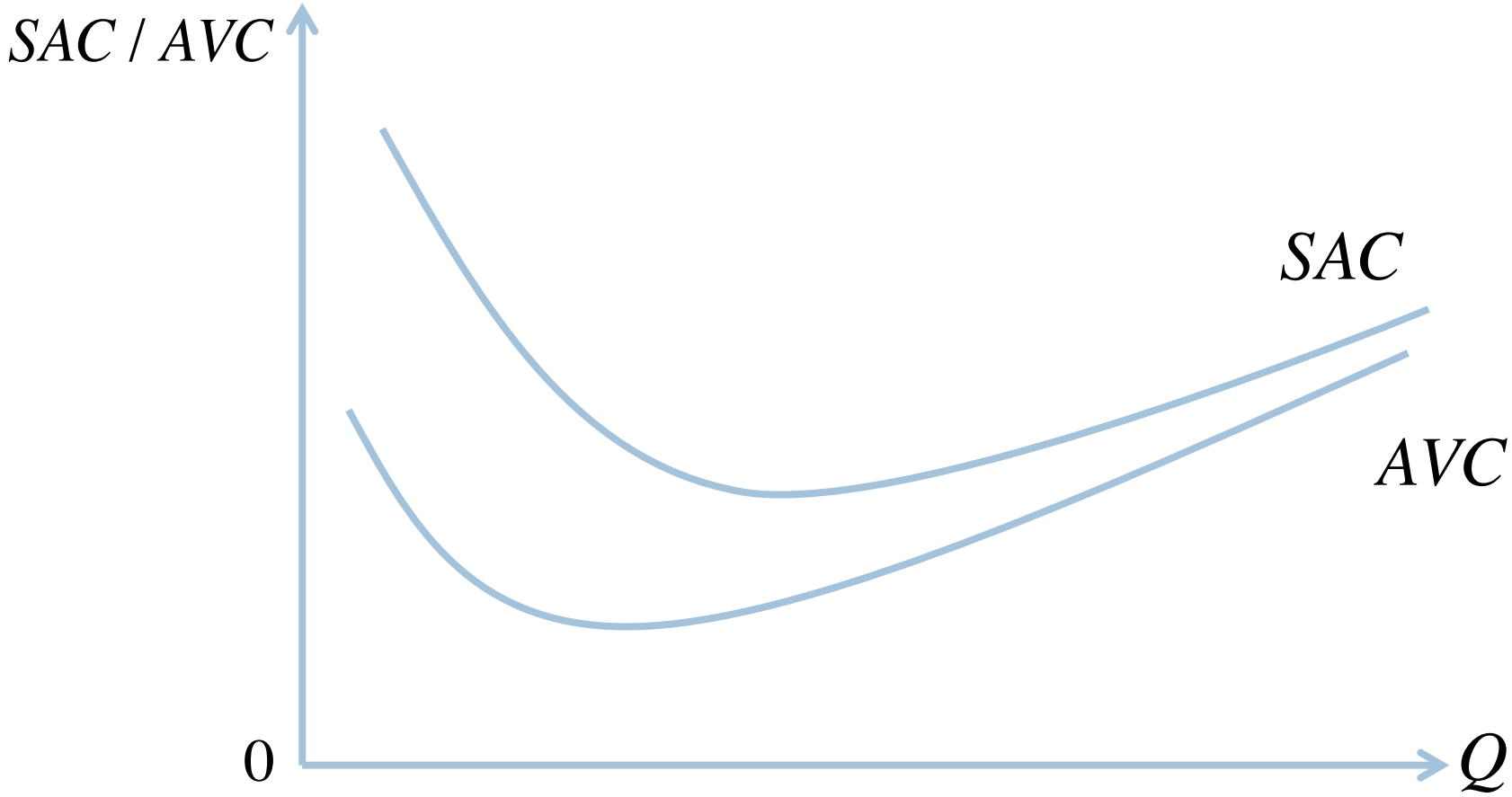
- Definition 8.8 *Average fixed cost* (*AFC*)

$$AFC(Q) = \frac{FC}{Q}$$

Average Fixed Cost Curve



Typical Short-Run Average Cost Curves



Relationship between *AC* and *MC*

- When *AC* is falling
  - As output increases, average cost goes down
  - The cost of an extra unit of output is pulling down the average
  - *MC<AC*
- When *AC* is rising
  - As output increases, average cost goes up
  - The cost of an extra unit of output is pulling up the average
  - *MC>AC*

SMC crosses *SAC* and *AVC* at the minimum points of *SAC* and *AVC*