Discussion 7

1 Review

1.1 Topics

- Graphing TPk, MPk, and APk
- Technology Choice
- Cost Curves and equilibrium production levels
- Profit Maximization

1.2 The Production Function

- A **production function** gives us the relationship between the quantity of inputs a firm uses and the quantity of output it produces. A firm can use **fixed inputs**, which are inputs whose quantities cannot be changed; and **variable inputs**, which are inputs that the firm can decide to use more or less of.
- The firm makes decisions about production in the **short run**, the time period in which at least one input is fixed, and in the **long run**, the time period in which all inputs can be varied.
- The **total product curve** shows how the quantity produced by the firm depends on the quantity of the variable input, for a given quantity of the fixed input.
- The **marginal product** of an input is the change in quantity of output produced by one additional unit of that input: $MPL = \frac{\text{change in quantity of output}}{\text{change in quantity of input}}$

1.3 Cost of Production

- A **fixed cost** is a cost that does not depend on the quantity of the output produced. This relates to the cost of the fixed input.
- A **variable cost** is a cost that depends on the quantity of the output produced. This relates to the cost of the variable input.
- The **total cost** of producing a given quantity of output is the sum of the fixed cost and the variable cost: $TC = FC + TVC$
- The **marginal cost** is the change in total cost generated by one additional unit of output: $MC = \frac{\text{change in total cost}}{\text{change in quantity of output}}$
- **Average total cost**, or **average cost**, is the total cost divided by the quantity of output produced: $ATC = \frac{TC}{Q}$

- **Average fixed cost** is the fixed cost per unit of outpout: $AFC = \frac{FC}{Q}$
- **Average variable cost** is the variable cost per unit of output: $AVC = \frac{VC}{Q}$
- Combining all of these, when the average total cost curve is U-shaped, average total cost is at its minimum at the bottom of the U. We call this point the **minimum-cost output**. In this point:
  - 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.
  - At output greater than the minimum-cost output, marginal cost is greater than average total cot and average total cost is rising.

***Looking forward: Our 'golden rule' for profit maximization in a competitive market is Marginal Revenue = Marginal Cost... a little rhyme "MR=MC gives me the Price and Quantity to produce most profitably"

2 Exercises

2.1 Graphing TPk, MPk, and APk

Nile, an online shopping company, has completely automated their shipping process and only uses robots to fill orders. The following table shows how many orders each robot can fulfill

Number of Robots	Number of Orders Filled	Marginal Product of Capital	Average Product of Capital
0	0	-	-
1	100		
2	400		
3	750		
5	1500		
10	3300		
15	4500		
25	4000		

1. Fill in the MPk and APk columns of the table.
2. Below, graph the Total Product of Capital Curve on the top graph. On the second graph, graph both the Marginal Product of Capital curve and the Average Product of Capital curve.

3. Over what number of robots are there increasing returns to capital? Diminishing returns to capital? Negative returns to capital?

4. General question: Given a typical production process, when average product (AP) increases, the marginal product (MP) _____.

2.2 Firm Choice of Technology

Suppose Babcock Dairy Factory has the following three technologies available to produce banana milk. All three produce the same amount of banana milk and combine labor and capital price in the proportions displayed in the table below:

Technology	Labor	Capital
A	4	3
B	2	5
C	4	4

1. Is there a technology that will never be used?(hint: which one will for sure require more input cost than another)

2. If the unit price of labor is \$3 and the unit price of capital is \$4, which technology would be used?

3. If the unit price of labor is \$4 and the unit price of capital is \$2, which technology would be used?

2.3 Firm cost functions and profit maximization

You are working in a small construction company in a perfectly competitive housing market. You accidentally spilled coffee on an important file below, which summarizes the company's costs.

Q	TC	VC	FC	ATC	AVC	AFC	MC
0				–	–	–	–
1							50
2		200					
3				600			
4					600		
5	5000					120	

1. Restore the file by filling all the blanks.

2. Suppose your construction company is in a perfectly competitive market where the price is P=1200. What quantity should the firm produce in order to maximize its profit? What is the firm's profit at that price and quantity? (hint: what is our 'golden rule' for competitive markets)

2.4 Changes in Costs

Consider McKinsey & Company, a global consulting firm. Assume that McKinsey owns an office in NYC and produces strategic consulting papers by hiring Econ graduates. The market for consulting papers is perfectly competitive.

1. Suppose property taxes in NYC increase. Do total costs for McKinsey increase, decrease, or stay the same? What about variable costs?

2. Will McKinsey exit the market and shutdown production immediately? Why or why not?

3. Will the number of consulting papers produced by McKinsey increase, decrease, or stay the same?

Suppose that the rent prices are back to normal, and disregard any change that might have happened in the previous part. Now, the wage of Econ graduates employed in McKinsey has increased. After this change:

1. Do total costs for McKinsey increase, decrease, or stay the same? What about variable costs?

2. Do we have enough information to decide whether McKinsey will shutdown in the short-run? Why or why not?

3 Multiple Choice Questions (Very Challenging)

3.1

A producer has 4 identical machines and is employing 9 identical workers, where each worker is paired with a single machine. It is known that the producer does not work herself (therefore, K=4 and L=9), and she is producing using all the machines and all the workers.

The total production per week **for each one of the machines** as a function of the number of workers is presented in the following table:

Number of workers	Total output
1	70
2	120
3	150
4	160
5	162

I. The marginal product of the ninth worker is 30 units per week.

II. The total production of the producer will increase by 50 units per week if she will get one more machine.

III. The producer should give up 1 machine in exchange for a compensation of 70 units.

Which of the above statements are true?

a. Only I.

b. I and III.

c. II and III.

d. I and II.

3.2

Teslon is a profit-maximizing automobile firm with the following curves for its total product (TP), marginal product of labor, (MP_L), and marginal product of capital (MP_K):

$$MP_L = 2 + \frac{2}{\sqrt{L}},\ L > 0$$
$$MP_K = 1 + \frac{1}{\sqrt{K}},\ K > 0$$

1. Which of the following statements is **false**?
   a. The firm never experiences negative returns to labor or capital
   b. The firm never experiences diminishing marginal returns to labor or capital
   c. The firm never experiences increasing marginal returns to labor or capital
   d. The total production curve never slopes downward
2. Firms typically cannot control their capital in the short run, and Teslon is no different. Suppose the firm currently employs 3 units of labor and 1 unit of capital. If it wanted to increase output by 3 automobiles, what should it do? (hint: remember we are given MP equations)
   a. Fire 1 worker
   b. Hire 1 worker
   c. Hire 2 workers
   d. Hire 3 workers

3.3

Given the following total cost function, derive the fixed cost.

$$TC = \frac{5}{q+1} + 5 + 5q + q^2$$

a. $4

b. $5

c. $8

d. $10

3.4

Elise and Ling decide to start a tutoring business. To start their business, they need to invest in buying 2 units of the most recent version of MacBook Pro which costs $2,500 for one unit. The cost of hiring tutors will be $25,000 per year, cost of office supplies $1,000 per year, and the cost for advertising their business will be $4,000 per year. Assume that all costs are paid at the end of the year.

1. What is the least amount of revenue they can make in their first year so they do not shut down? (hint: ignore OC and assume only one of those expenses is a fixed cost)

   a. $30,000

   b. $31,000

   c. $35,000

   d. $36,000