Discussion 10

1 Topics

- Input Market
- Pareto Efficiency

2 Review: Input Markets

- **Marginal Product of Labor ($\mathbf{MP}_L$):** The additional output produced by one additional unit of labor.
- **Marginal Revenue Product of Labor ($\mathbf{MRP}_L$):** The additional revenue a firm earns from employing one additional unit of labor.
- In a competitive environment, if MP_L is the marginal product of labor and P_x is the price of output, then the marginal revenue product of labor is given by

$$MRP_L = MP_L \times P_x$$

- A profit maximizing firm in a competitive environment will hire workers as long as $MRP_L \geq w$, where w is the wage rate i.e. the cost to the firm of hiring each additional worker.
- More generally, at equilibrium in factor markets (i.e. labor or capital markets), we have

$$MRP_f = P_f$$

  where MRP_f is the marginal revenue product of input f and P_f is the price of the input f.
- Thus, for a firm that uses two inputs Labor(L) and Capital (K), the equilibrium condition is then

$$\left.\begin{array}{l} MRP_L = P_L \\ MRP_K = P_K \end{array}\right\} \implies \boxed{\frac{MP_L}{P_L} = \frac{MP_K}{P_K}}$$

  Use the conditions on the left whenever possible as the condition on the right is not always enough (sufficient) to characterize the equilibrium.
- **Shifts in Input Demand:** recall $MRP_L = MP_L \times P_x$
  - if demand for output increases (decreases) $\implies P_x \uparrow (\downarrow) \implies MRP_L$ shifts to the right (left)

- if inputs are complements (substitutes), then when $K \uparrow (\downarrow) \implies MPL \uparrow (\downarrow) \implies MRP_L$ shifts to the right (left)
- if prices of other inputs change, for example, suppose that $P_K \uparrow$, then
  1. Factor substitution effect: $K \downarrow \implies$ complementary factors $\downarrow$, substitutable factors $\uparrow$
  2. Output effect: cost of producing output $\uparrow \implies$ less production $\implies$ use less of all inputs

  Thus, effect of $P_K \uparrow \implies K \downarrow, L \downarrow$ if K, L are complements; whereas, the effect on L is uncertain if K, L are substitutes.

Pareto Efficiency

- Definition: A condition in which no change is possible that will make some members of the society better off without making some other members of the society worse off.
- A change is said to be *efficient* when it makes someone better off without making anyone else worse off.

3 Input Market Exercises

Exercise 1

Consider the following information for a T-shirt manufacturing firm that can sell as many T-shirts as it wants for $3 per shirt.

Number of Workers	Quantity of Shirts	MPL	TR	MRPL
0	0			
1	30			
2	80			
3	110			
4	135			
5		20		
6	170			
7				30
8				15

1. Fill in all the blanks in the table.
2. Verify that MRPL for this firm can be calculated in two ways: (1) change in the TR from adding another worker and (2) MPL times the price of the output.

3. If this firm must pay a wage rate of $45 per worker per day, how many workers should be hired now? Why?

4. Suppose the wage rate rises to $60 per worker. How many workers should be hired now?

5. Suppose the firm adopts a new technology that doubles output at each level of employment and the price of shirts remains at $3. What is the effect of this new technology on MPL and MRPL? At a wage of $50, how many workers should the firm hire now?

Exercise 2

Willy Wonka's Chocolate factory produces chocolate bars by using labor and boats that float down the chocolate river (capital). Assume that Willy Wonka is a price taker in the markets for chocolate bars, labor and boats.

1. Suppose the price of a chocolate bar is \$5 and at the current level of labor and capital $MP_L = 10$, $MP_K = 100$, the price of labor is \$40 and the rental price of a boat is \$600. Assuming the chocolate factory exhibits diminishing marginal returns to both labor and capital, what should Willy Wonka do to improve his profits?

2. Charlie eventually takes over the chocolate factory and ensures that it always maximizes profits. Years later the price of a chocolate bar is \$6 and the wage of a worker is \$72. Calculate the MP_L under Charlie's management.

Exercise 3

Consider the retail gasoline market, which is perfectly competitive. Market demand and supply for gasoline are represented by the following:

$$Supply : P = 0.2Q$$

$$Demand : P = 400 - 0.2Q$$

P is the price of gasoline and Q is barrels of gasoline. There are 100 identical firms in the market. Each gas station hires workers in a perfectly competitive labor market. The supply and demand for labor are represented by:

$$Supply : W = 0.03L$$

$$Demand : W = 50 - 0.02L$$

W is the price of labor (wage) and L is the quantity of workers.

1. How many workers will be hired by each firm in equilibrium?

2. What is the market equilibrium wage?

3. What is the market equilibrium price of gasoline?

4. Calculate the marginal product of labor for each firm.

Exercise 4

Suppose Dr. Wells owns a running machine company called STAR. He hires technicians (called Cisco, capital) and normal workers (called Barry, labor) to produce treadmills. The marginal product of Cisco is $MP_K = 30 + 3L$ and marginal product of Barry is $MP_L = 20 - L$. L is the amount of labor.

1. In equilibrium, wage of Cisco is three times as much as wage of Barry. How many Barry workers will be hired?

2. When the number of Barry workers increases, what happens to MP_K? Increase or decrease? What is the relationship between these two inputs?

3. If the wage of Cisco increases, does Dr.Wells hire more Barry workers? Or fewer Barry workers? Why? [Hint: Consider both output effect and factor substitution effect!]

4 Pareto Efficiency Exercises

Exercise 5

Hurley and Leonard pool their money to buy a lottery ticket and manage to win one million dollars. Which of the following is a Pareto efficient division of the winnings, assuming Hurley and Leonard both want as much money as possible?

1. Hurley and Leonard split the money fifty-fifty.

2. Hurley gets all the money and Leonard gets nothing.

3. Leonard gets $400,000, Hurley gets $300,000, and the other $300,000 is burned.

5 Multiple Choice Exercises

Exercise 6

Suppose the marginal product of labor for a coffee producer is given by the equation $MP_L = 15 - L$, where L is the amount of labor. Let the price of a bag of coffee be \$10. What is the equation for MRP_L?

(a) $MRP_L = 15 - 10L$

(b) $MRP_L = 150 - 10L$

(c) $MRP_L = 150 - L$

(d) $MRP_L = 10$

Exercise 7

Continuing from exercise 6, let the market wage be \$20. How much labor should the firm hire?

(a) 2 workers

(b) 0 workers

(c) 13 workers

(d) 15 workers

Professor Hansen needs to decide how many research assistants to hire. Each paper produced is worth of$20. Use the following table to answer the next two questions.

Total number of papers produced	Research assistants hired
10	1
18	2
24	3
28	4
30	5

Exercise 8

What is the marginal revenue product of the 5th research assistant hired?

(a) $20

(b) $40

(c) 2

(d) $600

Exercise 9

Continuing from the previous exercise, suppose the salary of research assistant is $80. How many research assistants should Professor Hansen hire?

(a) 5

(b) 2

(c) 3

(d) 4

Exercise 10

An economy contains two people and two goods, apples and bananas. Person 1 likes apples and dislikes bananas (the more bananas she has, the worse off she is), and person 2 likes bananas and dislikes apples. There are 100 apples and 100 bananas available. Which of the following allocations is Pareto efficient?

(a) person 1 has all the apples and person 2 has all the bananas

(b) person 1 has all the apples and all the bananas

(c) person 2 has all the apples and all the bananas.

(d) Person 1 has 50 apples and 50 bananas. Person 2 also has 50 apples and 50 bananas.

Exercise 11

An economy contains two people and two goods, apples and bananas. Person 1 likes apples and doesn't care about bananas (she is indifferent between any bundles (a,b) and (a,b'), where a is some number of apples and b and b' are numbers of bananas). Person 2 likes bananas and doesn't care about apples. There are 100 apples and 100 bananas available. Which of the following allocations is Pareto efficient?

(a) person 1 has all the apples and person 2 has all the bananas

(b) person 1 has all the apples and all the bananas

(c) person 2 has all the apples and all the bananas.

(d) Person 1 has 50 apples and 50 bananas. Person 2 also has 50 apples and 50 bananas.

Exercise 12

An economy contains two people and two goods, apples and bananas. Both people like both goods, but value them differently. For person 1, 1 apple is exactly equivalent to 2 bananas: she is indifferent between any bundles (a, b) and (a-n, b+2n), where a is some number of apples, b is some number of bananas, and n is some number). For person 2, 2 apples are exactly equivalent to 1 banana. Which of the following allocations is Pareto efficient?

(a) person 1 has all the apples and person 2 has all the bananas

(b) person 1 has all the apples and all the bananas

(c) person 2 has all the apples and all the bananas.

(d) All of the above