光华管理学院
Guanghua School of Management

## Chapter 12

# Factor Input Demand

Hui Wang, Dept. of Applied Economics, GSM, Peking University

# Outline

1. **Input Demand for Profit-maximizing Firms**
2. **Substitution among Factor Inputs**
3. **Firm's and Market's Factor Demand**

# Outline

1. **Input Demand for Profit-maximizing Firms**

# 1.1 Marginal Revenue Product

- ***Marginal Revenue Product (MRP)*** of input A is the additional revenue produced by an additional unit of input A
- Calculation:
  - Adding another unit of input (labor) increase firm's production by $MP_i$
  - Sale of each addition unit of output increase firm's revenue by MR
  - Therefore: $MRP = MP_i \times MR$

| Market Structure | Marginal Revenue (MR) | Marginal Revenue Product (MRP) |
|---|---|---|
| Perfect Competition | MR=P | $MRP = MP_i \times P$ |
| Imperfect Competition | MR(q) depends on the specific output level | $MRP = MP_i \times MR$ |

# 1.2 Input Demand for Profit-maximizing Firms

- Adding another unit of input is a "marginal change"
- According to the marginal principle, as long as

  "benefit of adding the unit of input i" > "cost of adding the unit of input i"

  i.e. $MRP_i = MP_i \times MR >$ Price of factor i

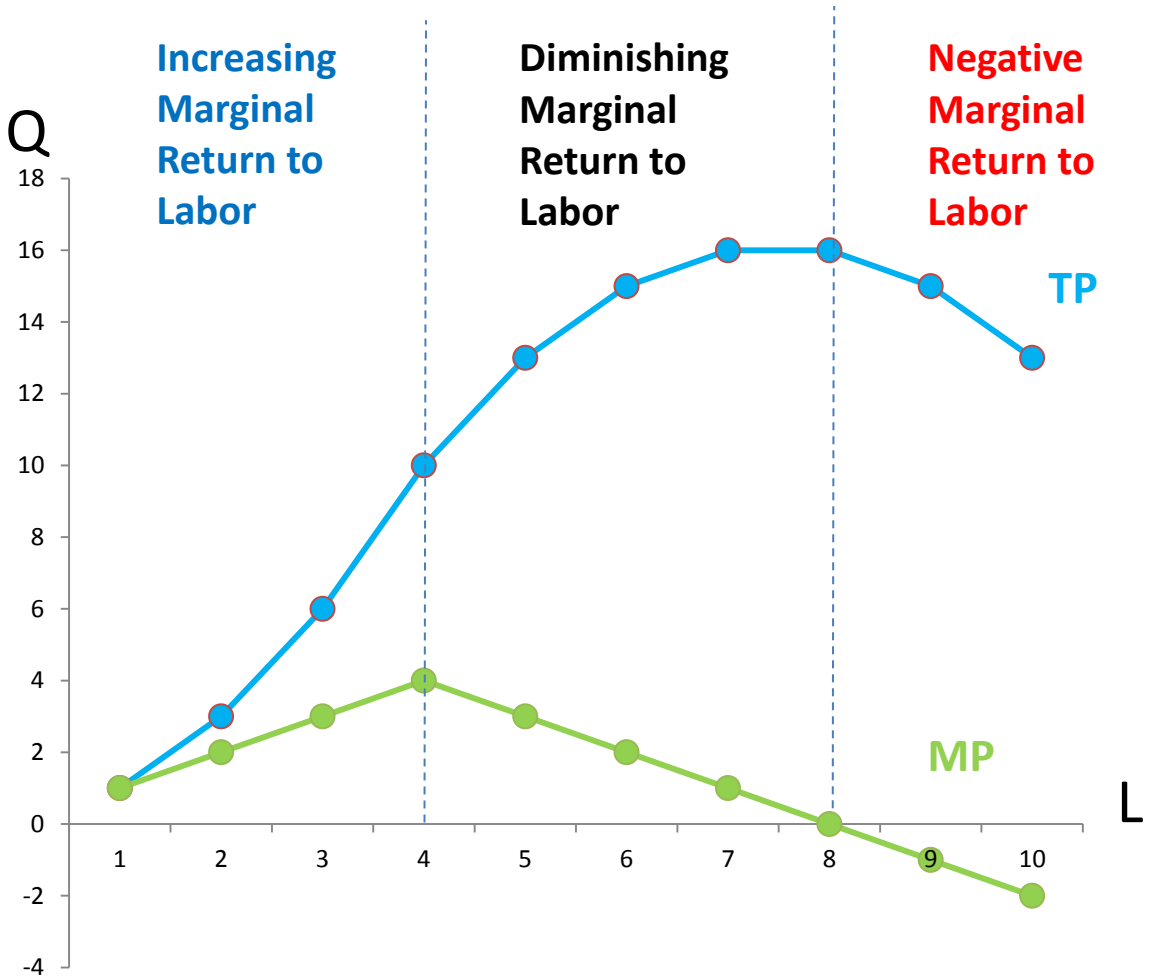
  the firm should increase additional unit of *factor input*
- As factor input↑, marginal productivity ↓, eventually

  $MRP_i$ = Price of factor i

  when firm's profit is maximized
- For labor, this means that

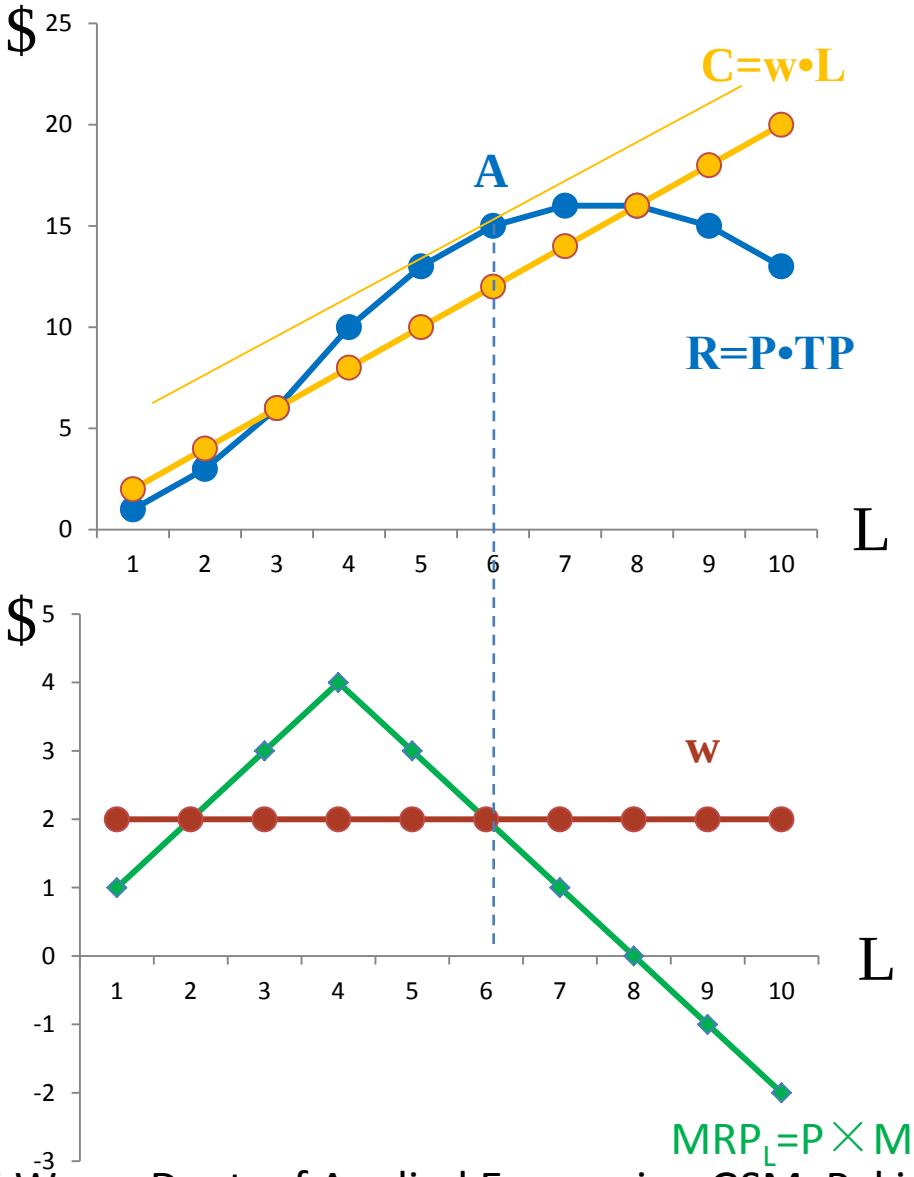
  $MRP_L = MP_L \times MR$ = wage

实例：一个工厂装配汽车。4台机器：车轮，底盘，内饰，外壳。应该雇佣多少工人?




| # Worker | Total Product（TP） | Marginal Product（MP） |
|---|---|---|
| 1 | 1 | 1 |
| 2 | 3 | 2 |
| 3 | 6 | 3 |
| 4 | 10 | 4 |
| 5 | 13 | 3 |
| 6 | 15 | 2 |
| 7 | 16 | 1 |
| 8 | 16 | 0 |
| 9 | 15 | -1 |
| 10 | 13 | -2 |

# Optimal Labor Input




1. P=1， w=2
2. Π = R-C = P·TP-w·L
3. When L=6, Π is maximized (Vertical distance between R and C)
4. At this point, slope of R = Slope of C (point A)。
5. i.e. $MRP_L$=w

**Rule: Profit-maximization labor input**

Manager should keep hiring labor, until $MRP_L$=w in the *diminishing marginal return* region

# 1.3 Least Cost Rule (1)

- Profit maximizing problem can be thought as to
  1. *minimize the cost* of producing a given level of output
  2. Chose a output level that maximize profit
- Condition of achieving ***cost minimization*** $\frac{MP_L}{wage} = \frac{MP_K}{interest}$
  - Suppose that $\frac{MP_L}{wage} < \frac{MP_K}{interest}$
  - Now consider to shift $1 spent on labor to the capital
    - $1 decrease in labor spending decreases labor input by 1/wage units
    - Decreases production by MPL/wage units of output
    - $1 increase in capital spending increase capital by 1/interest units
    - Increases production by MPK/interest units of output
    - Since (MPL/wage) < (MPK/interest), we can increase output while keeping the same level of total cost
    - *Put in another way, we can maintain the same level of output while reducing the total cost*

# Least Cost Rule (2)

- As we shift expenditure from labor to capital
  - MPL is increasing (diminishing marginal productivity of labor)
  - MPK is decreasing (diminishing marginal productivity of capital)
  - We should stop the shifting until $\frac{MP_L}{wage} = \frac{MP_K}{interest}$
  - At this point, production cost of a given level of output is minimized
- When $\frac{MP_L}{wage} = \frac{MP_K}{interest}$, this ratio give us the amount of output being generated if we spend $1 in factor inputs; it does not matter we spend the extra $1 on labor or capital. Therefore

$$\frac{MP_L}{wage} = \frac{MP_K}{interest} = \frac{\Delta Q}{\Delta C} = \frac{1}{MC}$$

- Now, we should chose a output level that can maximize profit
  - MR=MC
  - Therefore $\frac{MP_L}{wage} = \frac{MP_K}{interest} = \frac{1}{MR}$
  - This is equivalent with the condition obtained from maximizing profit directly

    $MRP_i = MP_i \times MR$ = Price of factor i

# 2. Substitution among Factor Inputs

- Optimization requires:

$$\frac{MP_L}{wage} = \frac{MP_K}{interest} = \ldots = \frac{1}{MR}$$

- What if the interest rate increases while wage remain fixed ?

$$\frac{MP_L}{wage} > \frac{MP_K}{interest}$$

  - Keeping the same level of capital use will increase production cost without increase in output
  - Reduce the use of capital and use more labor for cost minimization
  - MPA↑ and MPL↓ until the above equation is balanced again
- ***Substitution Rule***: If the price of one factor rises while other factor prices remain fixed, the firm will profit form substituting more of the other inputs for the more expensive factor.
- What if $MP_K$ increases due to technological changes?

# 3. Firm's and Market's Factor Demand

- The MRP schedule for each input gives the demand schedule of the firm for that input

- As with all demand curves, the competitive market demand curve is the horizontal summation of demand curves of all the firms

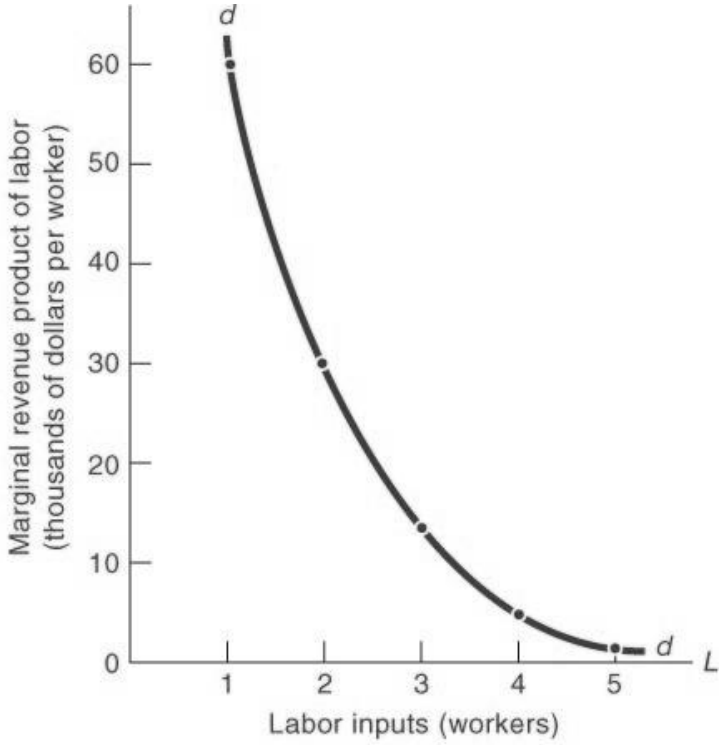



**FIGURE 12-3. Demand for Inputs Derived through Marginal Revenue Products**