

# Lec4: Labor Demand

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# Introduction

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# Introduction

- Labor demand is how firms respond to changes in costs for employees.
- It is a derived demand(引致需求), thus firms hire the labor as to their optimal production decisions.
- Important topic since it affects:
  - Employment and unemployment levels
  - Wage and income inequality
- By comparison to labour supply, it occupied a less voluminous part of the field of labour.

- This trend has been partly reversed with
  - An increased theoretical interest for the firm's internal labour market or personnel economics.
  - The availability of employer-employee linked data-bases, as well as employer based surveys(though still be scarce in China)
  - The growth of theoretical and empirical studies of the dynamic adjustment of employment and hours (job creation and destruction from the firms' birth and death).

# Introduction

- Increased government interventions that change the incentives facing employers making decisions about employment and hours, such as
  - minimum wages
  - overtime pay
  - subsidized training
  - hiring subsidies
- An increased interest in technological change, especially skill-biased technological change or routine-biased technological change.

# Introduction

- An increased interest in technological change, especially **skill-biased technological change** or **routine-biased technological change**.
- the static theory of the firm's labour demand will mostly focus on issues of substitution among inputs into production: capital vs. labour, low skilled vs. high skilled labour.
- These substitution effects are at the heart of the theory of the **skill premia**, that has been paramount in explaining the growth in wage inequality

## Micro Review

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## Micro Review: Firm Production

- **What is the most optimal decision of the quantity of product to be produced for a firm?**
- Total Revenue( $TR$ ) is

$$TR = p \times q$$

- where  $p$  is the price of the product,  $q$  is the quantity of the product,
- The Cost function is  $C(q)$



## Micro Review: Firm Production

- Profit Function as to  $q$  (the number of products) is

$$\pi(q) = p \cdot q - c(q) = TR - c(q)$$

- So we could obtain the optimal production by F.O.C

$$\frac{d\pi(q)}{dq} = 0 \Rightarrow \frac{d(TR)}{dq} = c'(q) \Rightarrow MR = MC$$

- Thus 边际收益 = 边际成本时的  $q$ .

- Several Concept in Production Theory
  - Marginal Product(边际产品)
  - Marginal Revenue(边际收益)
  - Marginal Revenue Product (边际产品收益)

## Micro Review: Firm Production

- If the firm's production function is given by

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

- $f()$  is a strictly increasing and concave function, then

$$MP_L = \frac{\partial f(K, L)}{\partial L} > 0$$

- where  $MP_L$  is the additional output obtained from one more unit of labor, thus, **Marginal Product(边际产品) of labor.**

- Marginal Revenue (边际收益) is the addition revenue from producing one more unit of product, thus  $MR_q$
- Marginal revenue product(边际产品收益) is the addition revenue obtained from one more unit of labor, thus  $MP_L$  multiple  $MR_q$

$$MRP_L = MP_L \cdot MR_q$$

- So when the market of product is perfect **competitive**, **thus** the price of product is market price(**P**), individual firm can't change it.
- Marginal revenue product(边际产品收益)

$$MRP_L = MR_p * MP_L = p * MP_L = VMPL$$

- VMPL is also called the **value of marginal product**(边际产品价值)

## Micro Review: Firm Production

- **Short Run:**  $q = f(\bar{K}, L) = f(L)$  thus only labor can be adjusted dynamically and the capital is assumed in a fix amount.
- **Long Run:**  $q = f(K, L)$   $K$  and  $L$  thus both capital and labor can be adjusted dynamically by firm.

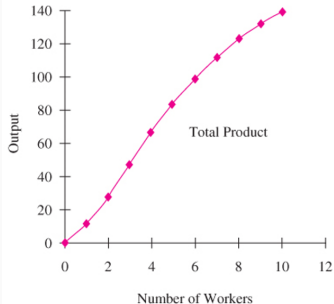
## Micro Review: Short run

- 总产量:  $TP = Q = f(L)$
- 平均产量:  $AP = \frac{Q}{L} = \frac{f(L)}{L}$
- 边际产量:  $MP = \frac{dQ}{dL} = \frac{df(L)}{dL}$
- 合理生产区间:
  - 边际产量  $>$  平均产量
  - 边际产量  $<$  平均产量

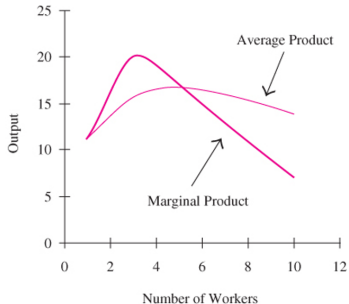
## ■ 总产量、平均产量和边际产量

**FIGURE 3-1** The Total Product, the Marginal Product, and the Average Product Curves

(a) The total product curve gives the relationship between output and the number of workers hired by the firm (holding capital fixed). (b) The marginal product curve gives the output produced by each additional worker, and the average product curve gives the output per worker.



(a)



(b)

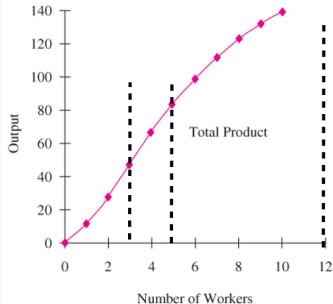


# Micro Review

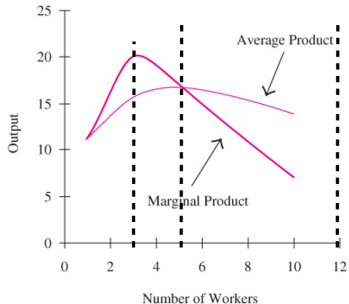
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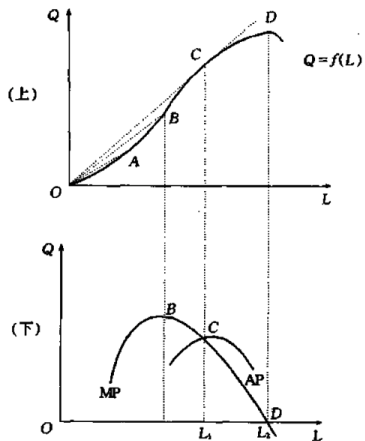


图 6.6 总产量(Q)、平均产量(AP)与边际产量(MP)

## Short-Run Labor Demand

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## Short-Run Labor Demand

- In a perfect **competition** market of product and labor market, the firm's profit function is

$$\Pi(L) = P * f(L) - wL$$

- Profit maximization implies

$$\Pi'(L)_L = 0 \Rightarrow PF'(L) - wL = 0$$

## Short-Run Labor Demand

- Thus

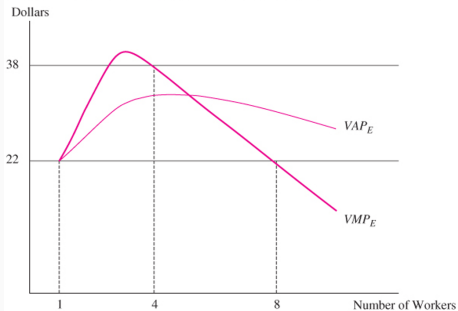
$$PF'(L) = P \cdot MP_L = VMPL = w$$

- Then ,the optimal condition  $VMPL = w$  thus, the value of marginal product(边际产品价值) equals to wage rate.
- Similar  $VAPL = P * AP_L$

# Short-Run Labor Demand

**FIGURE 3-2** The Firm's Hiring Decision in the Short Run

A profit-maximizing firm hires workers up to the point where the wage rate equals the value of marginal product of labor. If the wage is \$22, the firm hires eight workers.



## Short-Run Labor Demand

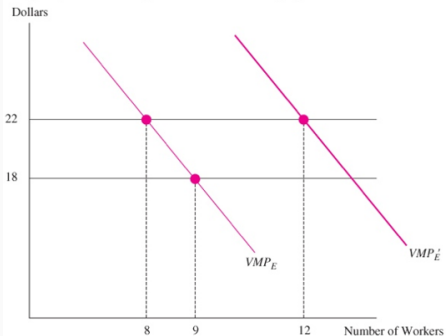
- The intersection of wage and  $VMP_L$  is the curve of firm's labor demand in a short run.
  - If the wage were to rise, the firm would move up its VMP curve to hire the labors.
  - If the wage were to fall, the firm would move down its VMP cure to hire the labors.
- Therefore,  $VMP_L$  is the curve of firm's labor demand in a short run.

# Short-Run Labor Demand

- $VMP_L = MP_L * P$

**FIGURE 3-3** The Short-Run Demand Curve for Labor

Because marginal product eventually declines, the short-run demand curve for labor is downward sloping. A drop in the wage from \$22 to \$18 increases the firm's employment. An increase in the price of the output shifts the value of marginal product curve upward and increases employment.





## Monopoly in Product Market

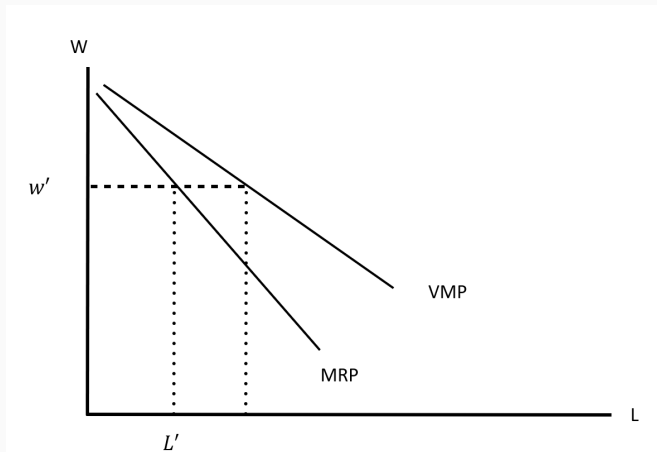
- Monopoly: A market with only a seller. So the firm is the price maker in the product market.
- Then the optimal condition is

$$MRP_L = MR_P * MP_L = w$$

- Because  $MR_P \leq P$

$$MRP_L \leq VMP_L$$

# Monopoly in Product Market



# Monopoly in Product Market

- $MRP_L$  is the curve of firm's labor demand in a short run. And is steeper or more inelastic than that in perfect competitive market.
  - The labor demand of a monopoly firm is relatively less than firms in perfect competitive market.
  - The demand is also unresponsive to changes in the wage rate.

## Factors affect Labor Demand

- $MP_L$  or  $f'(L)$  represents the marginal labor productivity.
- $W$  represents the real wage rate
- The  $MR$  or the price of product, which is determined by the demand of the product.

## Criticisms of Marginal Productivity Theory

- It seems to bear little relation to the way employers actually make hiring decisions.
- Employers in a competitive labor market must act as if they know and obey the implications of marginal productivity theory.

## Long-Run Labor Demand

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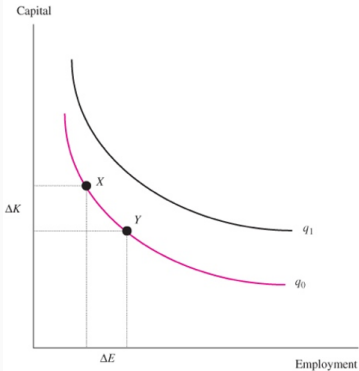
# Long-Run Labor Demand

- In the long run, the firm's capital stock is not fixed.
- The firm can choose both how many workers to hire and how much plant and equipment to invest in.
- **Isoquants(等产量线)**: describes the possible combinations of labor and capital that produce the same level of output.

# Isoquant Curves (等产量线)

**FIGURE 3-6** Isoquant Curves

All capital-labor combinations that lie along a single isoquant produce the same level of output. The input combinations at points  $X$  and  $Y$  produce  $q_0$  units of output. Input combinations that lie on higher isoquants produce more output.

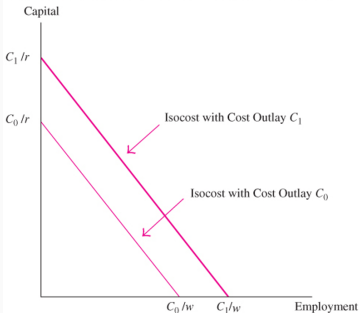




# Isocost Lines(等成本线)

**FIGURE 3-7 Isocost Lines**

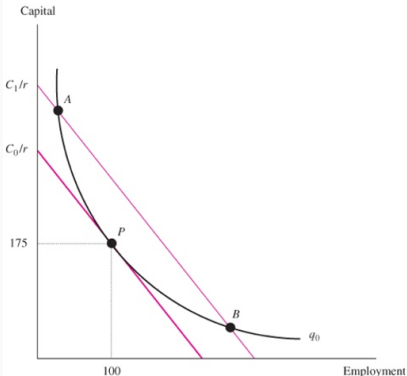
All capital-labor combinations that lie along a single isocost curve are equally costly. Capital-labor combinations that lie on a higher isocost curve are more costly. The slope of an isoquant equals the ratio of input prices ( $-w/r$ ).



# The Optimal Inputs

**FIGURE 3-8 The Firm's Optimal Combination of Inputs**

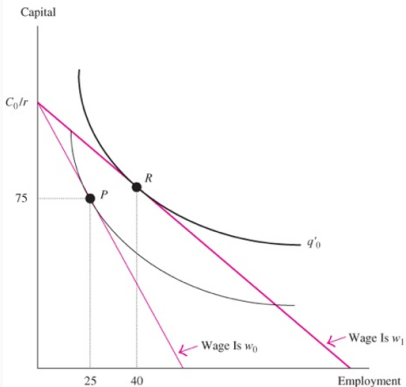
A firm minimizes the costs of producing  $q_0$  units of output by using the capital-labor combination at point  $P$ , where the isoquant is tangent to the isocost. All other capital-labor combinations (such as those given by points  $A$  and  $B$ ) lie on a higher isocost curve.



# Labor Demand: Wage Reduction

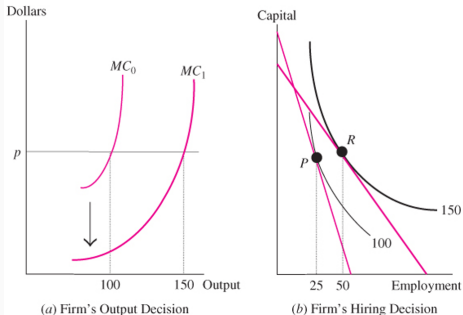
**FIGURE 3-9** The Impact of a Wage Reduction, Holding Constant Initial Cost Outlay at  $C_0$

A wage reduction flattens the isocost curve. If the firm were to hold the initial cost outlay constant at  $C_0$  dollars, the isocost would rotate around  $C_0$  and the firm would move from point  $P$  to point  $R$ . A profit-maximizing firm, however, will not generally want to hold the cost outlay constant when the wage changes.



# Labor Demand: Wage Reduction

**FIGURE 3-10** The Impact of a Wage Reduction on the Output and Employment of a Profit-Maximizing Firm  
(a) A wage cut reduces the marginal cost of production and encourages the firm to expand (from producing 100 to 150 units). (b) The firm moves from point *P* to point *R*, increasing the number of workers hired from 25 to 50.



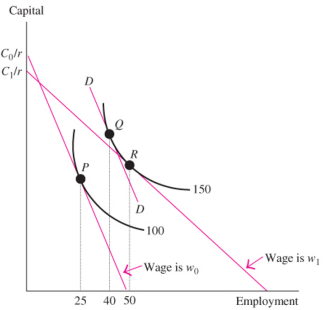
## Substitution and Scale Effects

- **Substitution effect:** Because labour is now more cheaper relative to capital, and because labour and capital are substitutes in production, firms will change their input mix to use more labour and less capital to produce any level of output.
- **Scale effect:** more cheaper to produce any level of output, the firm will increase output (and hence increase use of labour (and probably capital too))

# Substitution and Scale Effects

**FIGURE 3-12** Substitution and Scale Effects

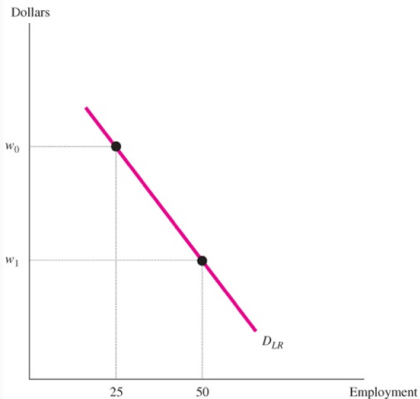
A wage cut generates substitution and scale effects. The scale effect (the move from point  $P$  to point  $Q$ ) encourages the firm to expand, increasing the firm's employment. The substitution effect (from  $Q$  to  $R$ ) encourages the firm to use a more labor-intensive method of production, further increasing employment.



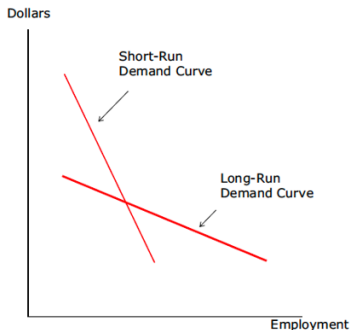
# The Long-Run Demand Curve

**FIGURE 3-11** The Long-Run Demand Curve for Labor

The long-run demand curve for labor gives the firm's employment at a given wage and is downward sloping.



# The Long-Run Demand Curve



In the long run, the firm can take full advantage of the economic opportunities introduced by a change in the wage. As a result, the long-run demand curve is more elastic than the short-run demand curve.



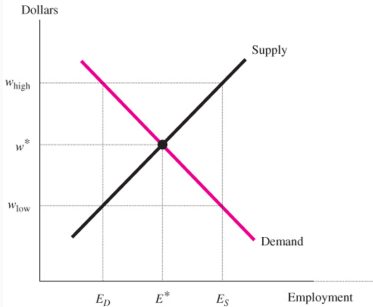
# Labor Market Equilibrium

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# Labor Market Equilibrium

**FIGURE 3-17 Wage and Employment Determination in a Competitive Market**

In a competitive labor market, equilibrium is attained at the point where supply equals demand. The “going wage” is  $w^*$  and  $E^*$  workers are employed.



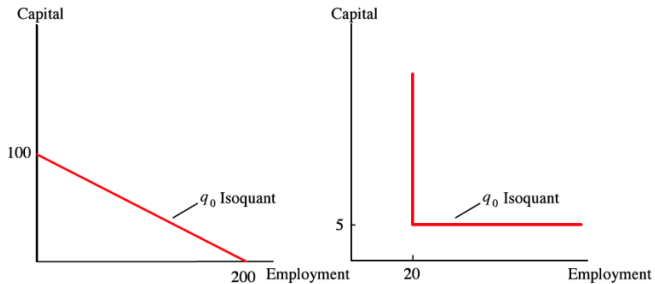
## Elasticity of Substitution

- The elasticity of substitution

$$\sigma = \left[ \frac{\Delta K/E}{K/E} \right] / \left[ \frac{\Delta w/r}{w/r} \right]$$

- The percentage change in the capital to labor ratio given a percentage change in the price ratio (wages to real interest).
- Example: If the elasticity of substitution is 5, then a 10% increase in the ratio of wages to the price of capital would result in the firm increasing its capital-to-labor ratio by 50%.

# Elasticity of Substitution: The Extreme Cases



# Policy Application

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## Policy Application: Affirmative Action

- **Affirmative Action**: describes policies that support members of a disadvantaged group that has previously suffered **discrimination** (and may continue to) in such areas as education, employment, or housing.
- These programs typically "encourage" firms to alter the race, ethnicity, or gender of their workforce by hiring relatively more of those workers who have been underrepresented in the firm's hiring in the past.

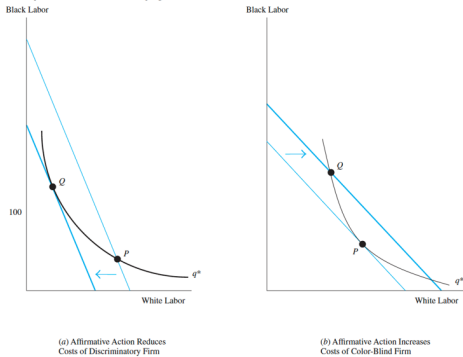
## Policy Application: Affirmative Action

- To simplify the discussion, suppose there are two inputs in the production process: black workers and white workers.
- Suppose further that black and white workers are not perfect substitutes.
- The two groups of workers might have different productivities.

# Policy Application: Affirmative Action

**FIGURE 3-15** Affirmative Action and the Costs of Production

(a) The discriminatory firm chooses the input mix at point  $P$ , ignoring the cost-minimizing rule that the isoquant be tangent to the isocost. An affirmative action program can force the firm to move to point  $Q$ , resulting in more efficient production and lower costs. (b) A color-blind firm is at point  $P$ , hiring relatively more whites because of the shape of the isoquants. An affirmative action program increases this firm's costs.





## Policy Application: Affirmative Action

- Our perception about the "real world" can greatly influence the position that we take in the debate over the labor market impacts of affirmative action.
- The empirical evidence about the existence and prevalence of labor market discrimination is very crucial.

## Discussions

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# Discussions: Robots v.s Workers

*Table 1*  
**Annual Robot Sales in China and the World**

<i>Year</i>	<i>World (1,000 units)</i>	<i>China (1,000 units)</i>	<i>China's share in the world (%)</i>
1995	69.3	0.0	0.0
2000	98.7	0.4	0.4
2005	120.1	4.5	3.7
2010	120.6	15.0	12.4
2011	166.0	22.6	13.6
2012	159.3	23.0	14.4
2013	178.1	36.6	20.5
2014	220.6	57.1	25.9
2015	253.7	68.6	27.0
2016	294.3	87.0	29.6

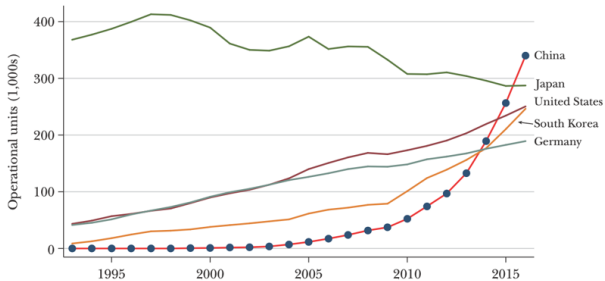
*Source:* International Federation of Robotics (2017).

*Notes:* This table shows the rise of China in the world robot market, especially after 2013.

# Discussions: Robots v.s Workers

Figure 1

Stock of Operational Robots in Major Countries 2016



Source: Data is from International Federation of Robotics (2017).

Notes: This figure plots the operational stock of robots in the five major markets. China exceeded Japan and became the country with the largest operational robot stock in 2016.

- Chinese government has launched one of the largest program in the world to subsidize heavily the firm which would like to take place workers with robots since 2015.
- **What are your opinions on the policy?**
  - Pro
  - Con
  - And consider what is your benchmark for evaluating a public policy?