Lecture 4: Labor Demand

Labor Economics, Fall 2025

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Introduction

Introduction

- **Labor demand** is *how firms respond to changes in costs for employees*.
- **Question:** *How is labor different from the goods and services that consumers demand?*
  - ***Answer:*** Labor is a derived demand(引致需求).
- **Question:** *In what ways does labor differ from other factors of production?*
- **Answer:** Many!
  - *Firms can't own a worker!* Rather, firms can only rent a worker's services.
  - *Workers need motivation!* Office supplies don't get bored/tired, but people do.
  - *Workers care about working conditions!* Most robots can handle a 95-degree warehouse, but many people would struggle in such extreme heat.

Introduction: Why Labor Demand Matters?

- Labor demand directly affects two critical outcomes in the labor market:
  - Employment and unemployment levels
  - Wage and income inequality
- The static theory of the firm's labor demand will mostly focus on issues of substitution among inputs into production: capital vs. labor, low-skilled vs. high-skilled labor

Introduction: Empirical Studies

- Historically, labor demand has received somewhat less attention in the academic literature compared to labor supply.
- This trend has been partly reversed with:
  - The availability of *employer-employee linked databases*, as well as *employer-based surveys* (though still scarce in China)
- The growth of theoretical and empirical studies of the dynamic adjustment of employment and hours (job creation and destruction from firms's birth and death)

Introduction: Government Interventions

- Increased government interventions that directly affect firms' employment decisions:
  - Minimum wage policies — setting wage floors
  - Overtime regulations — affecting the cost of hours vs. workers
  - Subsidized training programs — encouraging skill development
  - Hiring subsidies — directly reducing employment costs
  - Social insurance contributions — adding to labor costs

Introduction: Technological Change

- An increased interest in technological change, especially skill-biased technological change or routine-biased technological change
- These substitution effects are at the heart of the theory of the skill premium, which has been paramount in explaining the growth in wage inequality
- Key questions:
  - How does technology affect demand for different worker types?
  - Why has wage inequality increased so dramatically?
  - What role does automation play in labor market outcomes?

Micro Review

Micro Review: Firm Production

- Question: *What is the most optimal decision of the quantity of product to be produced for a firm?*
- Answer: 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 here is $C(q)$

Micro Review: Firm Production

- Profit function with respect to q (the number of products) is:

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

- So we can 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, optimal q occurs where marginal revenue equals marginal cost (边际收益=边际成本)

Micro Review: Firm Production

Several key concepts 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:

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

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

$$f'(L) > 0 \text{ and } f''(L) < 0$$

- where MP_L is the additional output obtained from one more unit of labor, thus, marginal product of labor (边际产品)

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

Micro Review: Firm Production

- Marginal Revenue (边际收益) is the additional revenue from producing one more unit of product, thus MR_q
- For example, if
  - $MP_L = 10$ and $MR_q = 50$,
  - $MRP_L = MP_L \cdot MR_q = 10 \cdot 50 = 500$

Micro Review

- So when the product market is perfectly competitive, the price of the product is the market price (P), and an individual firm cannot change it:

$$MR_q = p$$

- Marginal revenue product (边际产品收益):

$$MRP_L = MR_p \times MP_L = p \times MP_L = VMP_L$$

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

Micro Review: Short Run vs. Long Run

- Short Run: $q = f(\bar{K}, L) = f(L)$ — only labor can be adjusted dynamically, and capital is assumed to be fixed
- Long Run: $q = f(K, L)$ — both capital and labor can be adjusted dynamically by the firm

Micro Review: Short Run

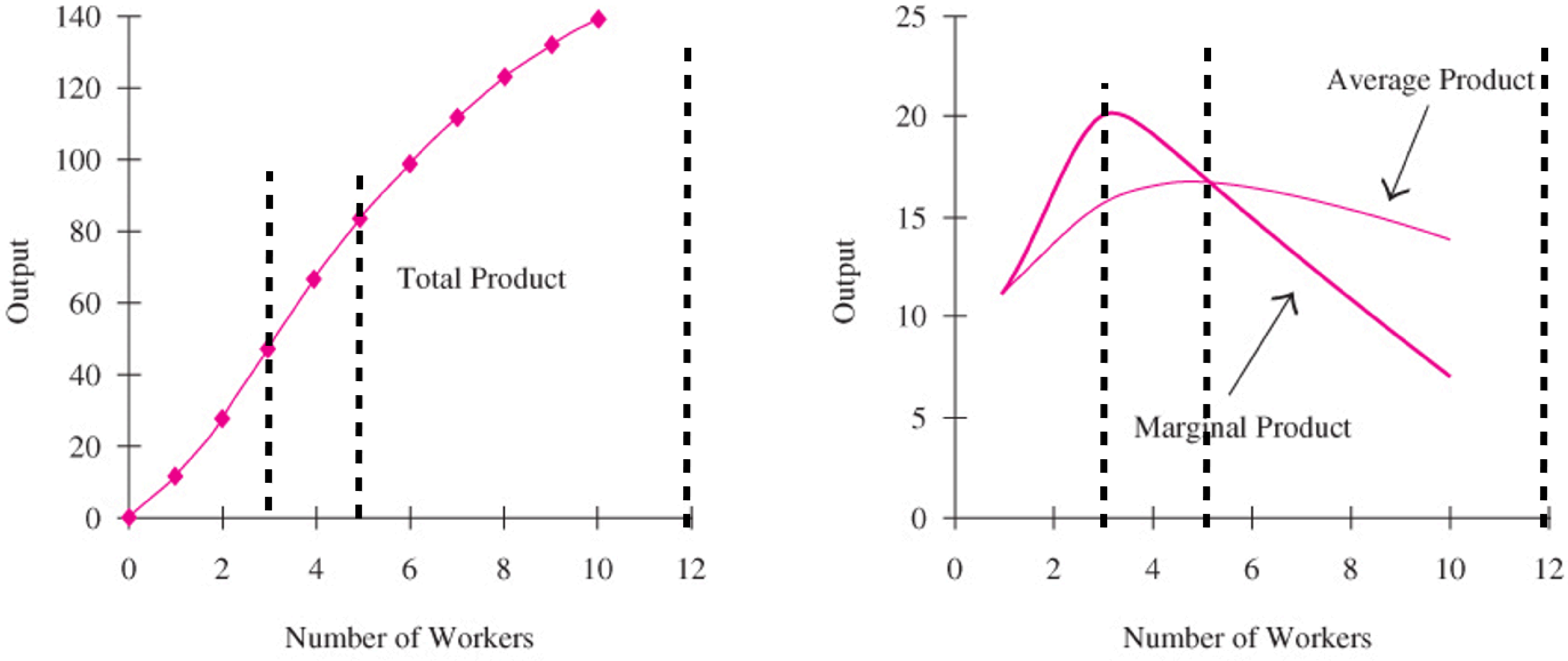
In the short run with capital fixed:

- Total Product: $TP = Q = f(L)$
- Average Product: $AP = \frac{Q}{L} = \frac{f(L)}{L}$
- Marginal Product: $MP = \frac{dQ}{dL} = \frac{df(L)}{dL}$
- Rational production region:
- Marginal product > Average product
- Marginal product < Average product

Micro Review: Firm Production

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.



Short-Run Labor Demand

Short-Run Labor Demand

- In a perfect competitive market for both products and labor, the firm's profit function is:

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

- Profit maximization implies:

$$\Pi'(L) = 0 \Rightarrow P \cdot f'(L) - w = 0$$

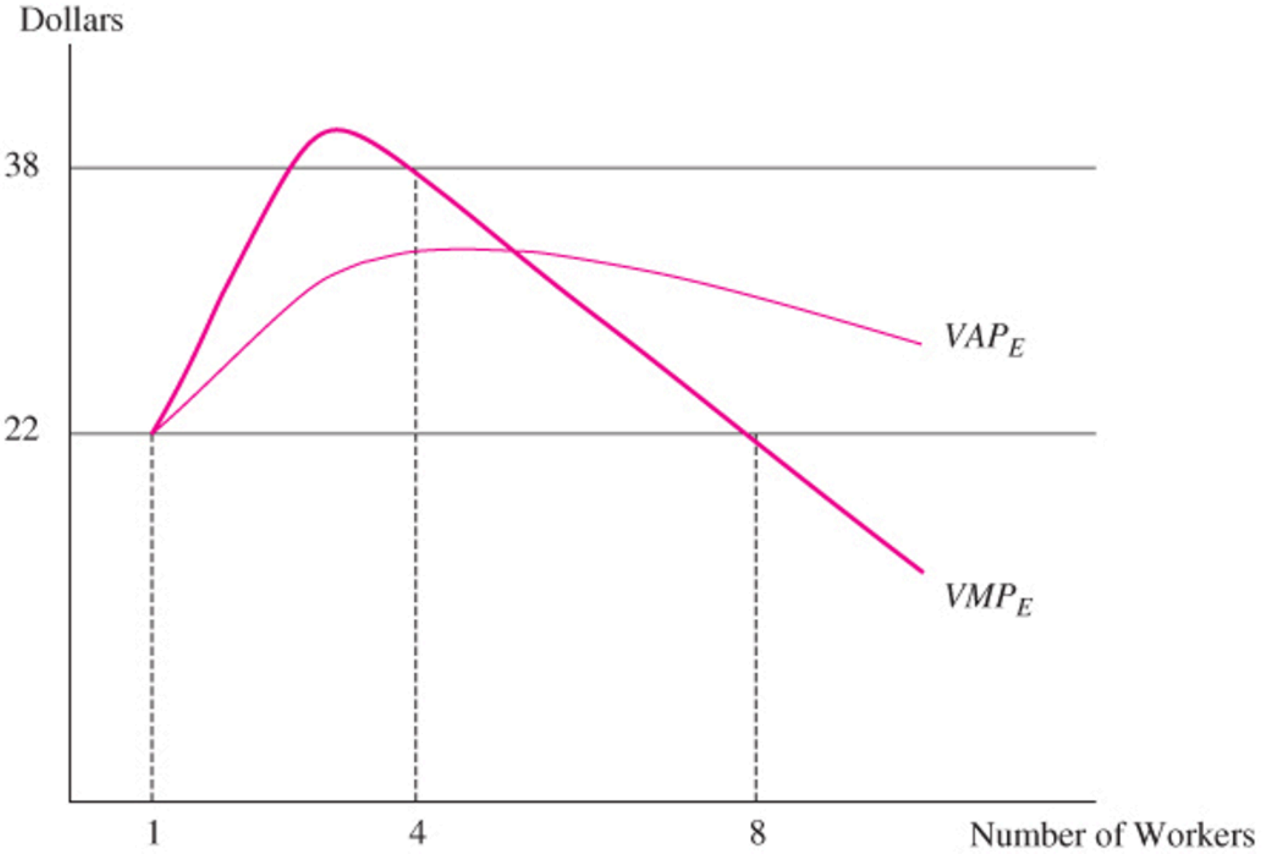
$$P \cdot f'(L) = P \cdot MP_L = VMP_L = w$$

- Then, the optimal condition is $VMP_L = w$ — the value of marginal product (边际产品价值) equals the wage rate
- Similarly, $VAP_L = P \times AP_L$

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.



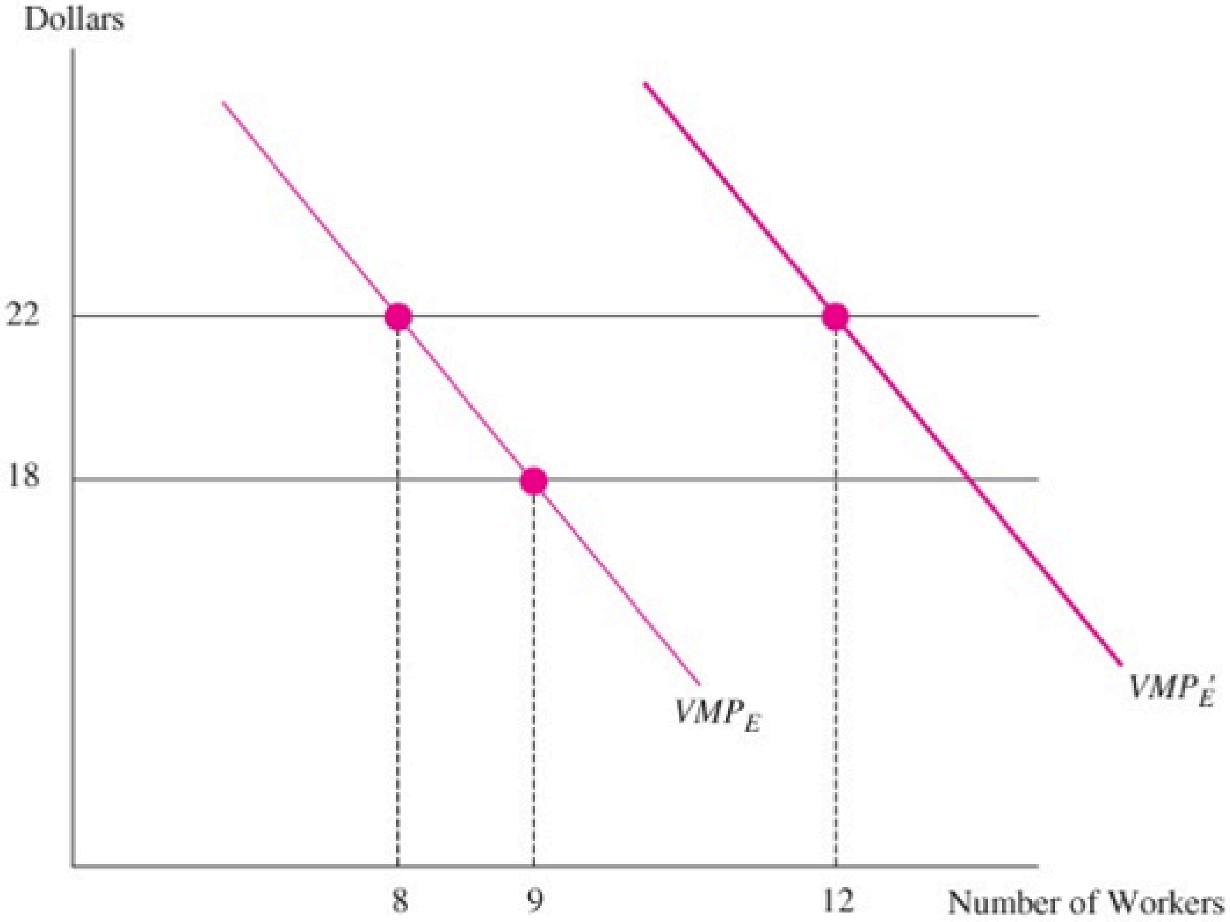
Short-Run Labor Demand

- The intersection of wage and VMP_L is the firm's short-run labor demand curve
  - If the wage were to rise, the firm would move up its VMP curve to hire fewer workers
  - If the wage were to fall, the firm would move down its VMP curve to hire more workers
- Therefore, VMP_L is the firm's short-run labor demand curve

Short-Run Labor Demand

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.



$$VMP_L = MP_L \times P$$

Factors Affecting 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 for the product

Long-Run Labor Demand

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

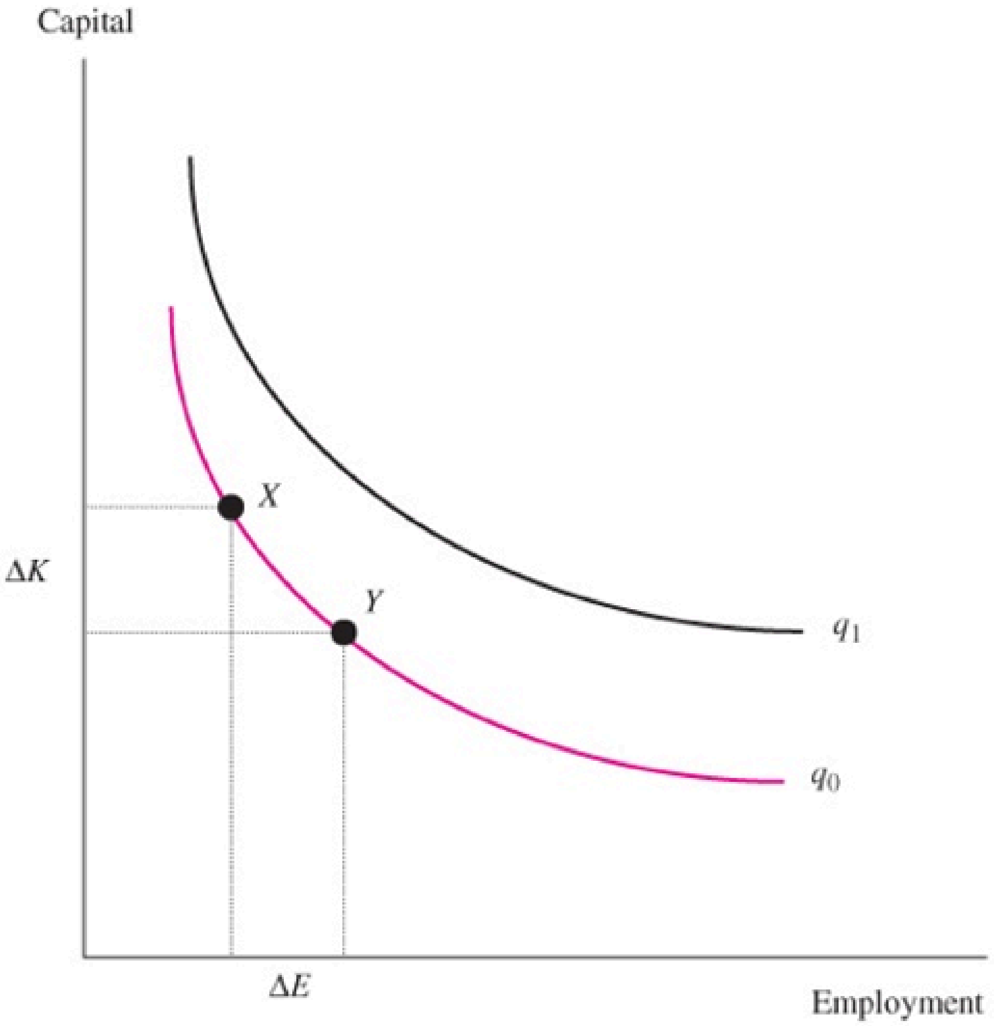
This added flexibility has important implications for labor demand. In the short run, with capital fixed, the only way to increase output is to hire more workers. But in the long run, the firm can increase output either by hiring more workers or by investing in more capital—or some combination of both.

- **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)

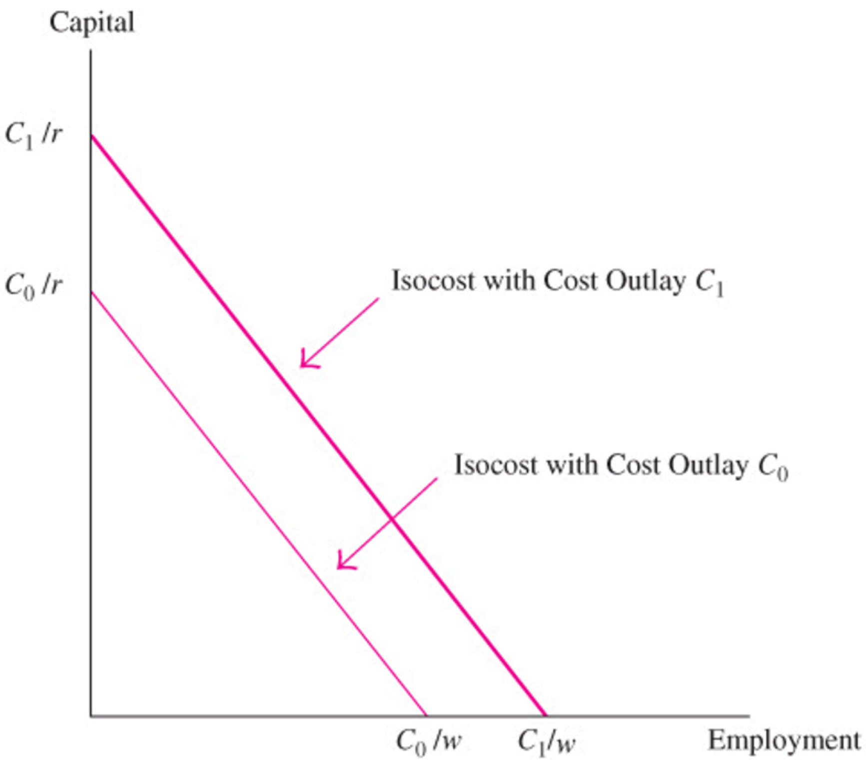
FIGURE 3-6 **Isoquant Curves**

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 ($-w/r$).

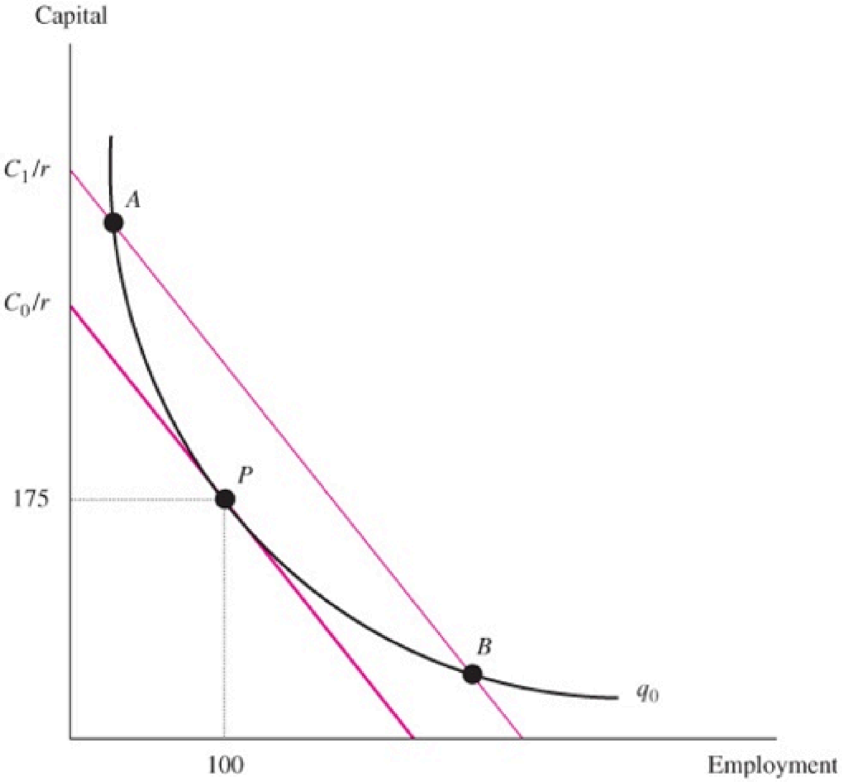


$$C = wL + rK$$

The Optimal Inputs

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

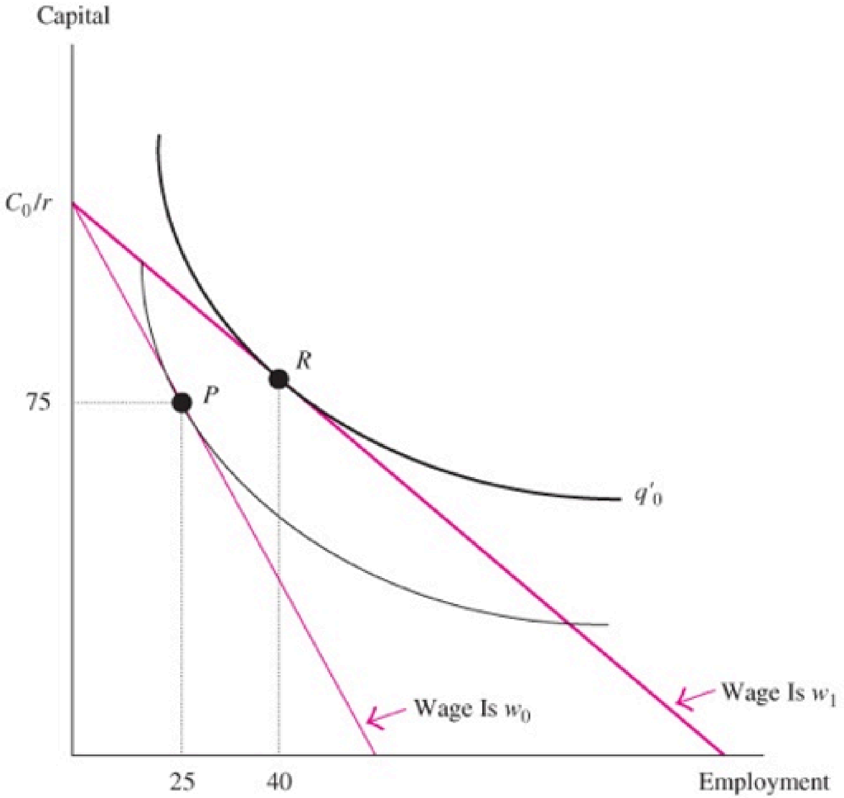
A firm minimizes the costs of producing q_0 units of output by using the capital-labor combination at point P, where the isoquant is tangent to the isocost. All other capital-labor combinations (such as those given by points A and B) lie on a higher isocost curve.



Labor Demand: Wage Reduction

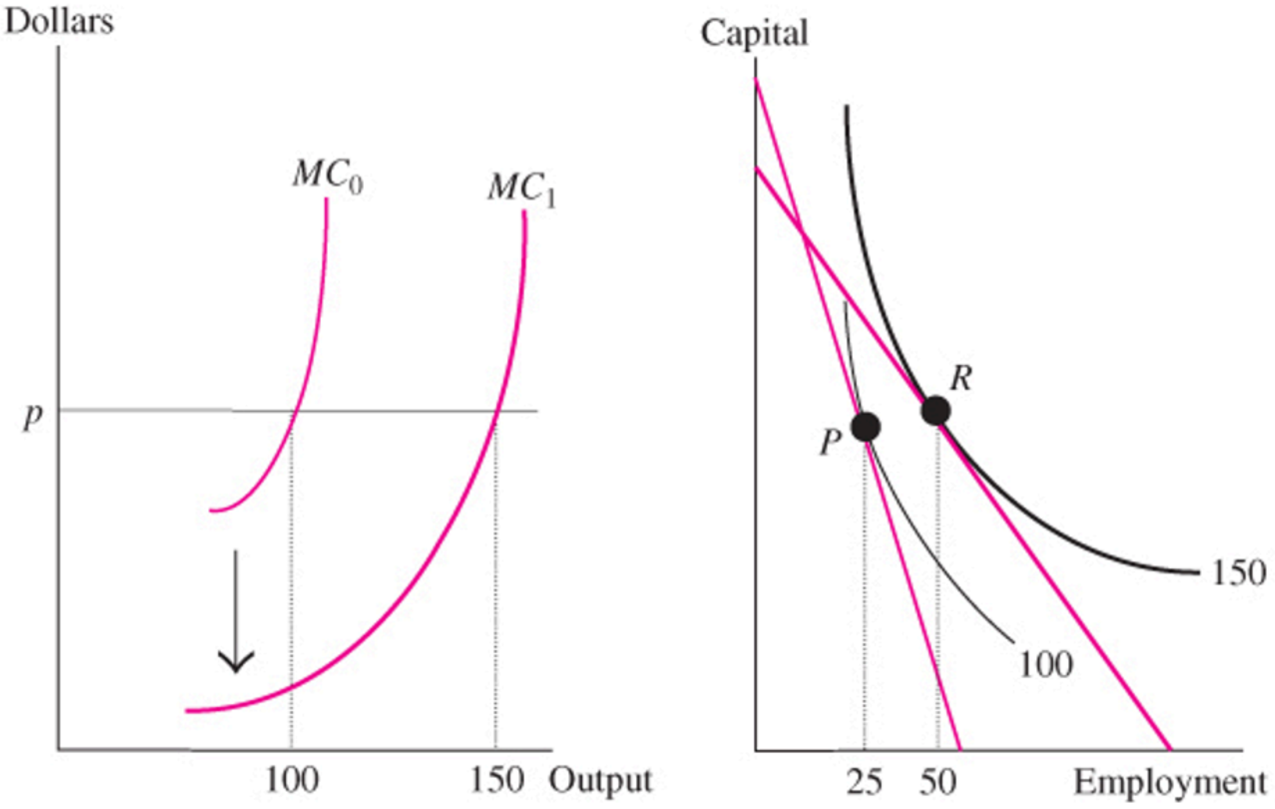
FIGURE 3-9 The Impact of a Wage Reduction, Holding Constant Initial Cost Outlay at C_0

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.



(*a*) Firm's Output Decision (*b*) Firm's Hiring Decision

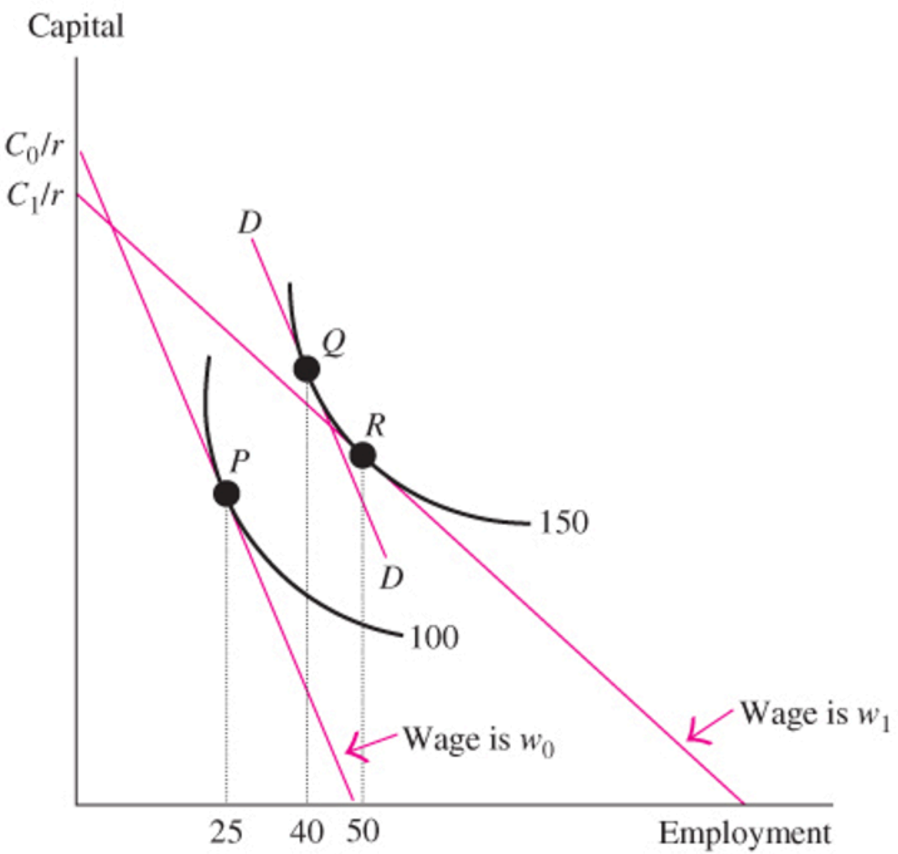
Substitution and Scale Effects

- **Substitution effect**: Because labor is now cheaper relative to capital, and because labor and capital are substitutes in production, firms will change their input mix to use more labor and less capital to produce any level of output

Substitution and Scale Effects

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

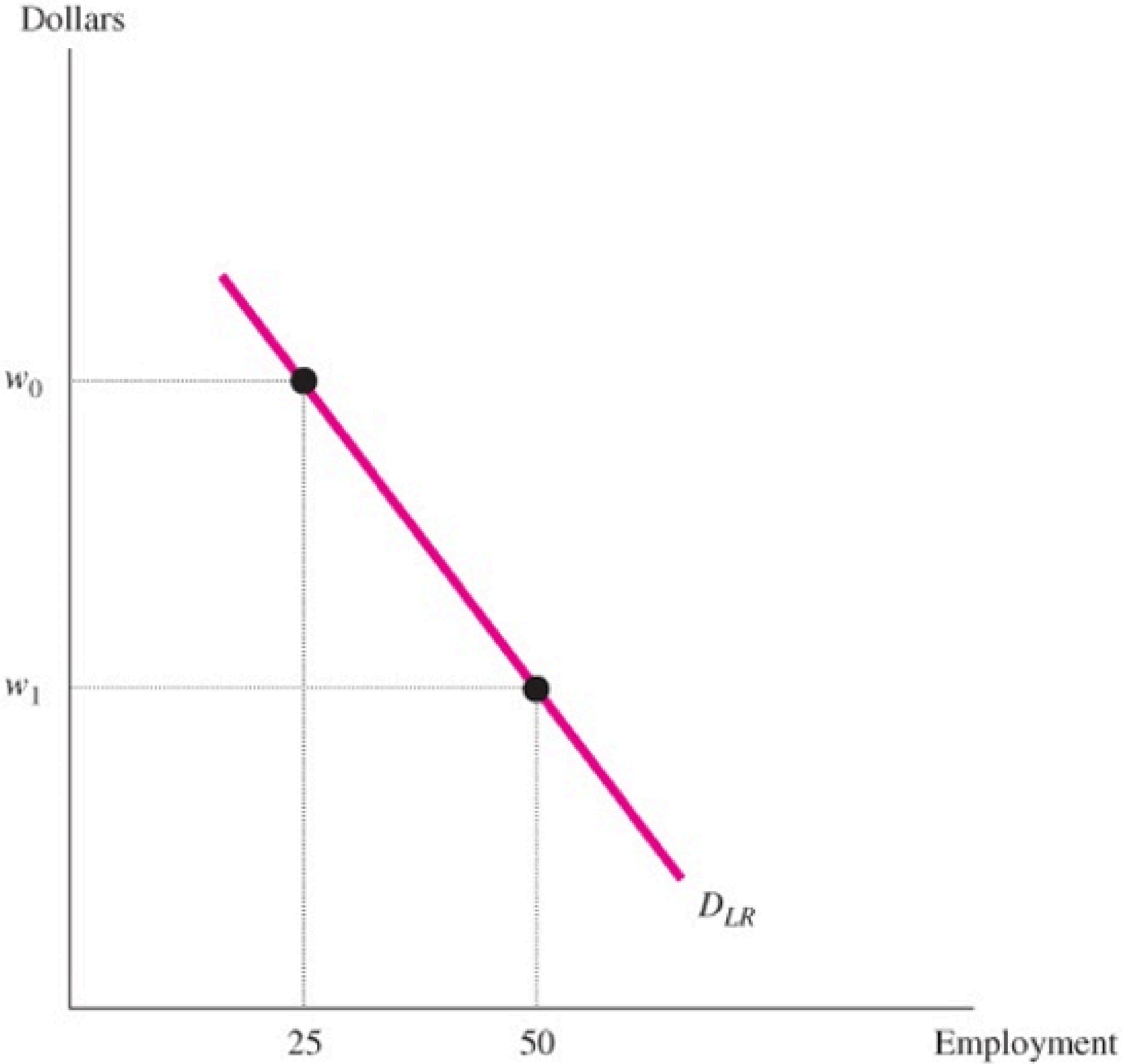
A wage cut generates substitution and scale effects. The scale effect (the move from point *P* to point *Q*) encourages the firm to expand, increasing the firm's employment. The substitution effect (from *Q* to *R*) encourages the firm to use a more labor-intensive method of production, further increasing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



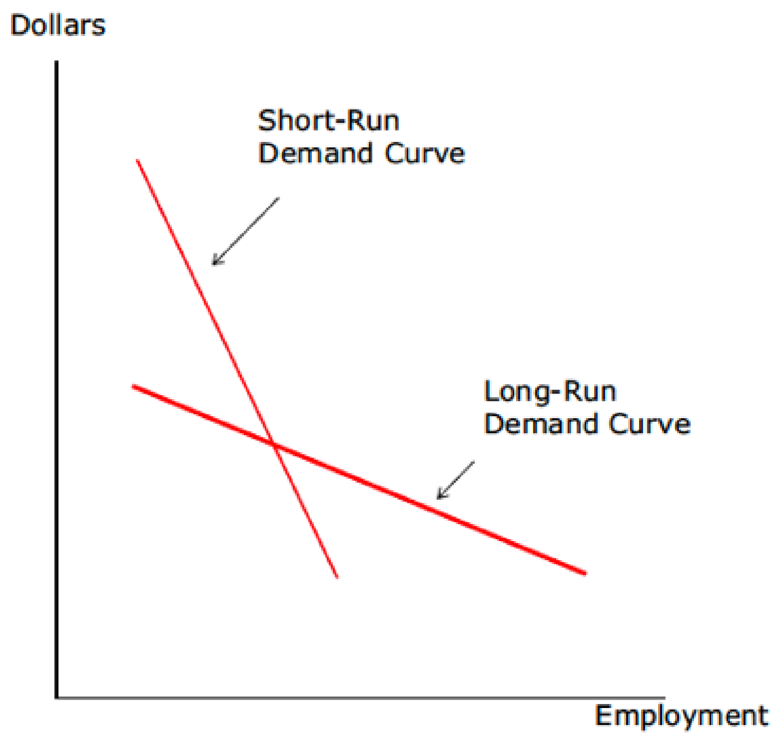
The Long-Run Demand Curve

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.

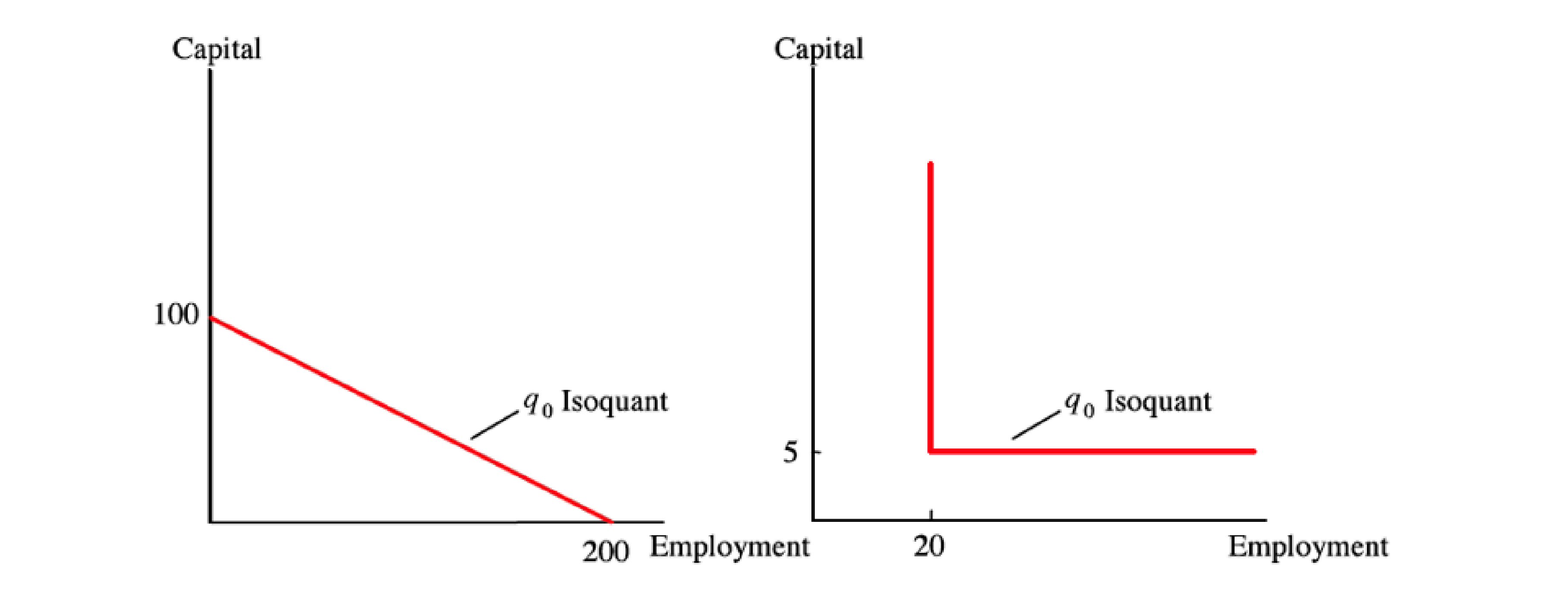


The Long-Run Demand Curve



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.

Elasticity of Substitution: The Extreme Cases



Policy Application: Robots vs Workers Debate

Policy Application: Robots vs Workers Debate

Table 1

Annual Robot Sales in China and the World

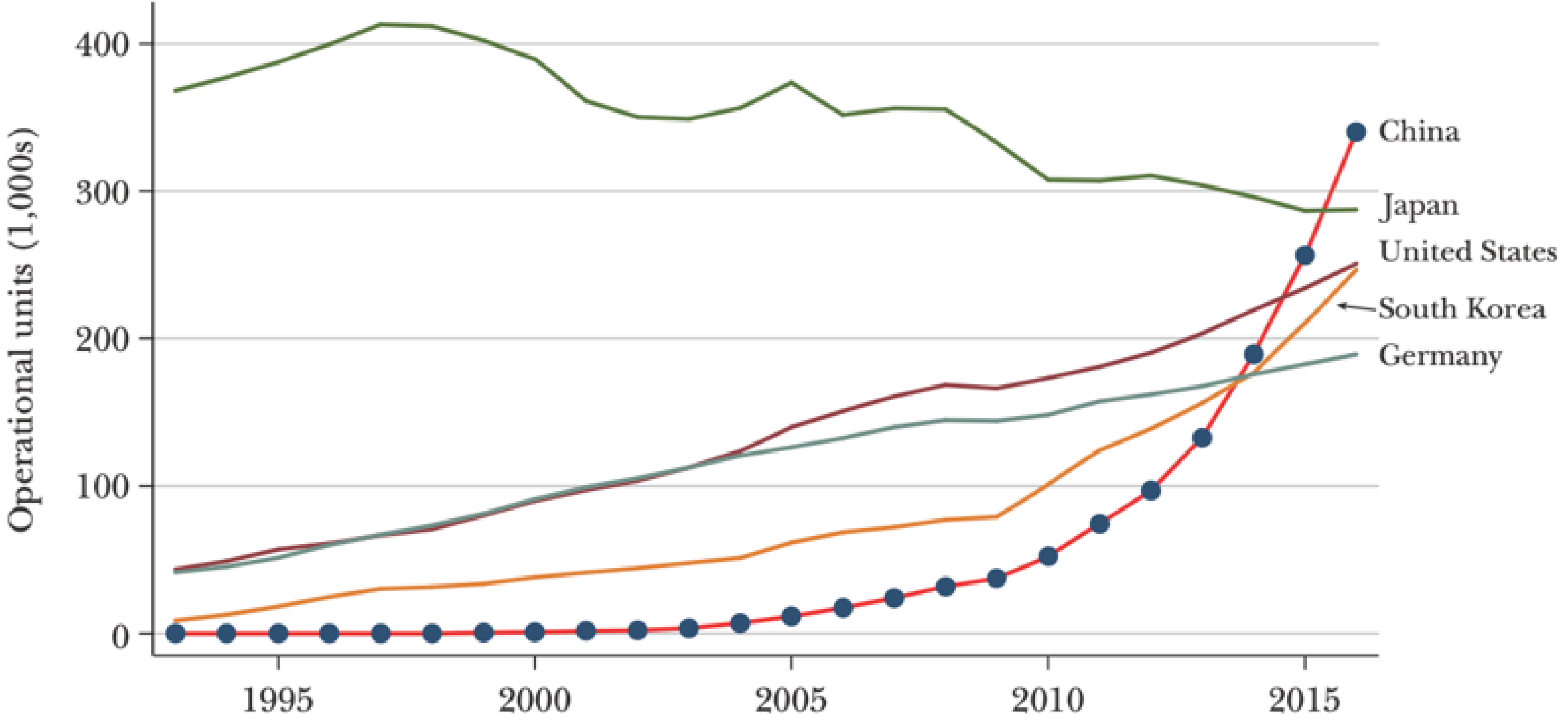
Year	World (1,000 units)	China (1,000 units)	China's share in the world (%)
1995	69.3	0.0	0.0
2000	98.7	0.4	0.4
2005	120.1	4.5	3.7
2010	120.6	15.0	12.4
2011	166.0	22.6	13.6
2012	159.3	23.0	14.4
2013	178.1	36.6	20.5
2014	220.6	57.1	25.9
2015	253.7	68.6	27.0
2016	294.3	87.0	29.6

Source: International Federation of Robotics (2017).
Notes: This table shows the rise of China in the world robot market, especially after 2013.

Discussions: Robots vs. 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.

Discussions: Pro Robots Subsides

- The Chinese government had launched one of the largest programs in the world to heavily subsidize firms willing to replace workers with robots since 2015.And the subsidy is still ongoing and enlarging for AI.
- The subsidy is still ongoing and even enlarging for AI for rural areas in recent years.

附件：

青浦区2024年蔬菜生产“机器换人”示范创建补贴资金表

序号	街镇	示范园艺场	实际播种亩次	补贴标准	补贴资金（元）	备注
		合 计	11781.82		1767273.0	
1	练塘镇	上海恒尚源农业种植专业合作社张联基地	868.08	150	130212.0	
2		上海绿椰农业种植专业合作社	2300.02	150	345003.0	
3	朱家角镇	上海世鑫蔬菜种植专业合作社	1540.49	150	231073.5	
4		上海郁香园蔬果专业合作社	2250.14	150	337521.0	
5	白鹤镇	上海弘阳农业有限公司杜村基地	1366.56	150	204984.0	
6	重固镇	上海春昌蔬果专业合作社	3456.53	150	518479.5	

Discussion: Pro Robots Taxes by Bill Gates

Discussions: Robots Taxes v.s. Subsides

- What are your opinions on Robots Taxes vs. Robots Subsides?
- Two possible arguments:
  - Pro: Robots Taxes, Con: Robots Subsides
  - Pro: Robots Subsides, Con: Robots Taxes
- *Please reading some articles on this topic and we will spend one class to discuss it.*