9 Productivity and Economic Growth

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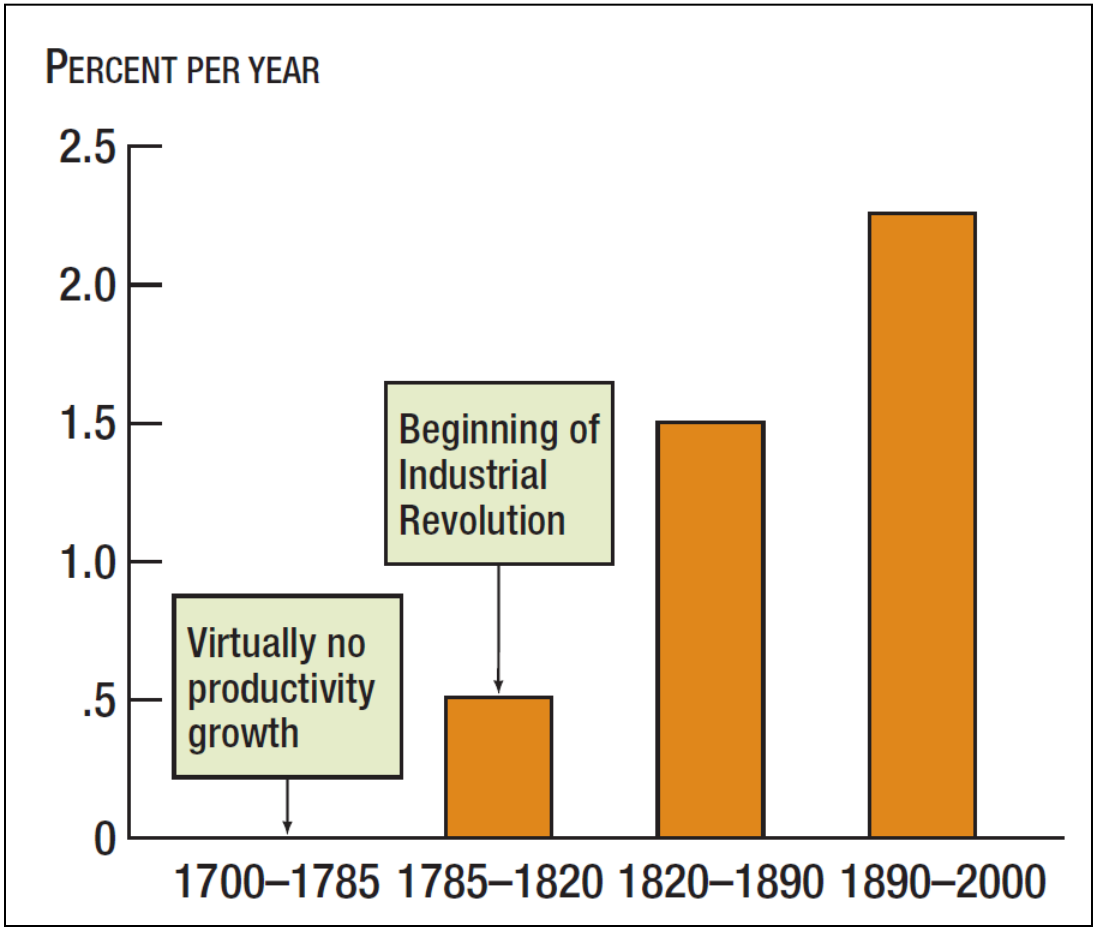
Productivity and Economic Growth

Productivity: output per hour of work.

Productivity growth: the percentage increase in productivity from one year to the next.

Figure 9-1

Productivity Growth During the Past 300 Years



Labor Alone

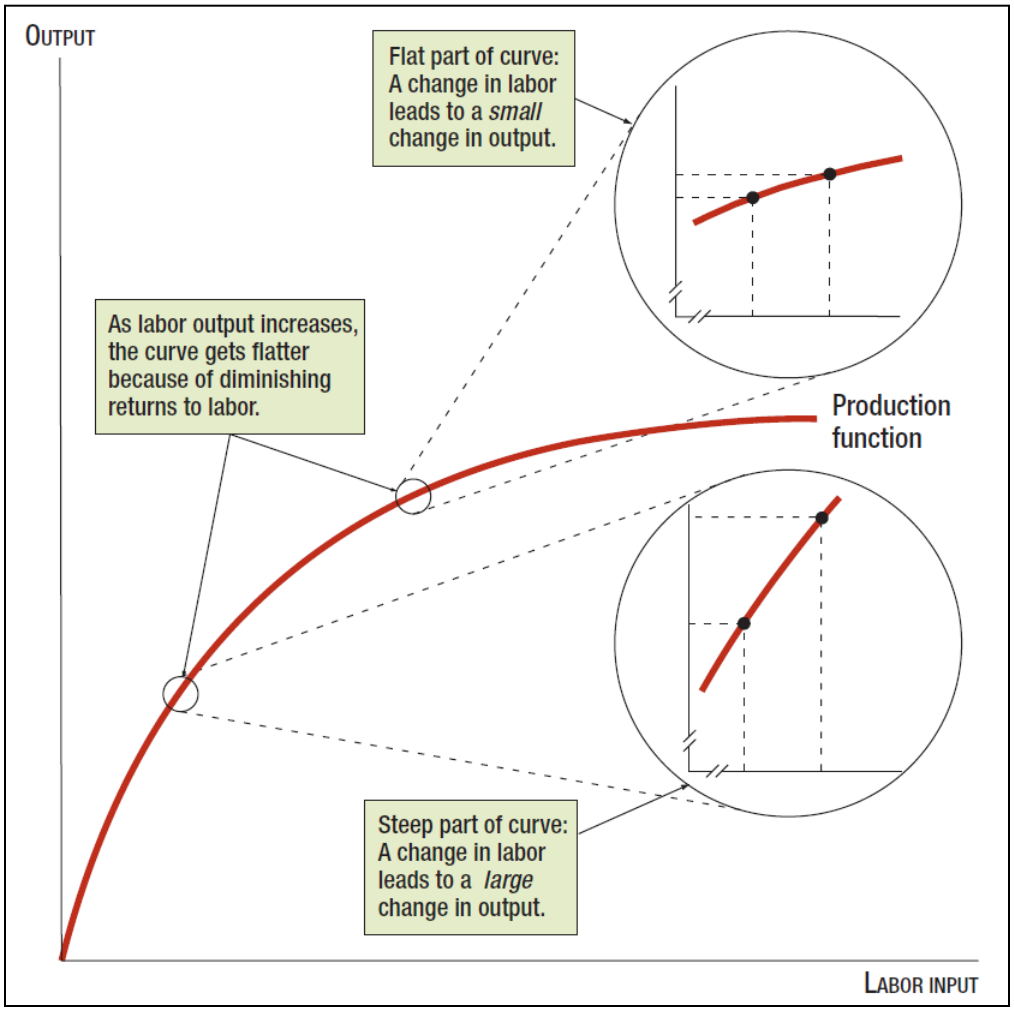
We start with a production that has only one input: labor. The production function is expressed as

$$Y = F(L)$$

Figure 9-2 illustrates the production function with labor but no capital inputs.

Only Changes in Labor Can Change Output

Figure 9-2



Labor Alone

Diminishing returns (to labor): a situation in which successive increases in the use of an input (labor), holding other inputs constant, will eventually cause a decline in the additional production derived from one more unit of that input.

Labor Alone

In **Figure 9-2**, the slope of the production function becomes flatter as more labor is hired. This illustrates diminishing returns to labor.

Adding Capital

Capital (physical capital): is all machines, factories, oil tankers, and other physical resources used in the production of goods and services.

Adding Capital

Depreciation: the amount by which physical capital wears out over a given period of time.

Net investment: gross investment minus depreciation.

Adding Capital

Relationship between capital and investment:

Capital at the end of this year	=	Capital at the end of last year	+	Net investment during this year

Adding Capital

Once we add capital, the new production function for the economy is

$$Y = F(K, L)$$

where Y = GDP

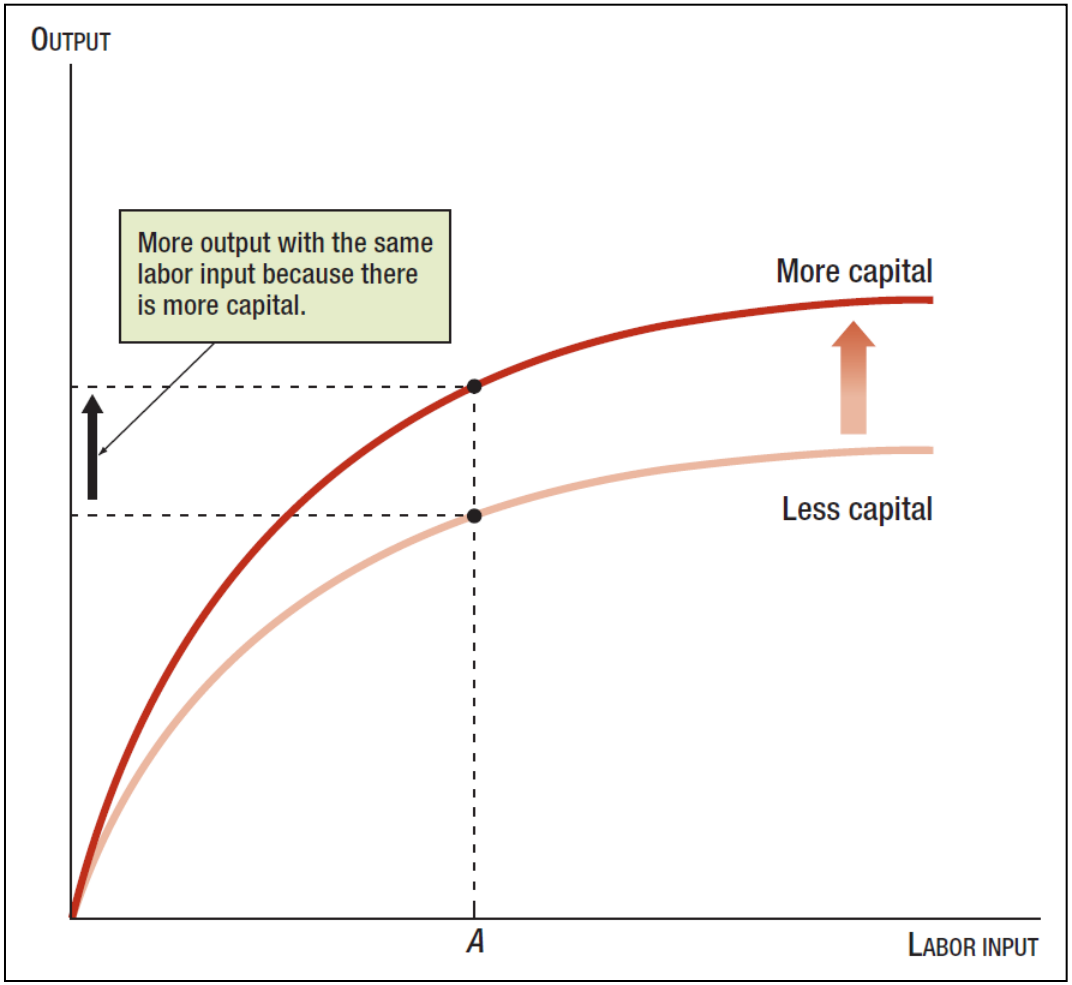
K = capital input

L = labor input

More capital in the economy will shift the production function upward.

Capital Is Also a Factor of Production

Figure 9-3



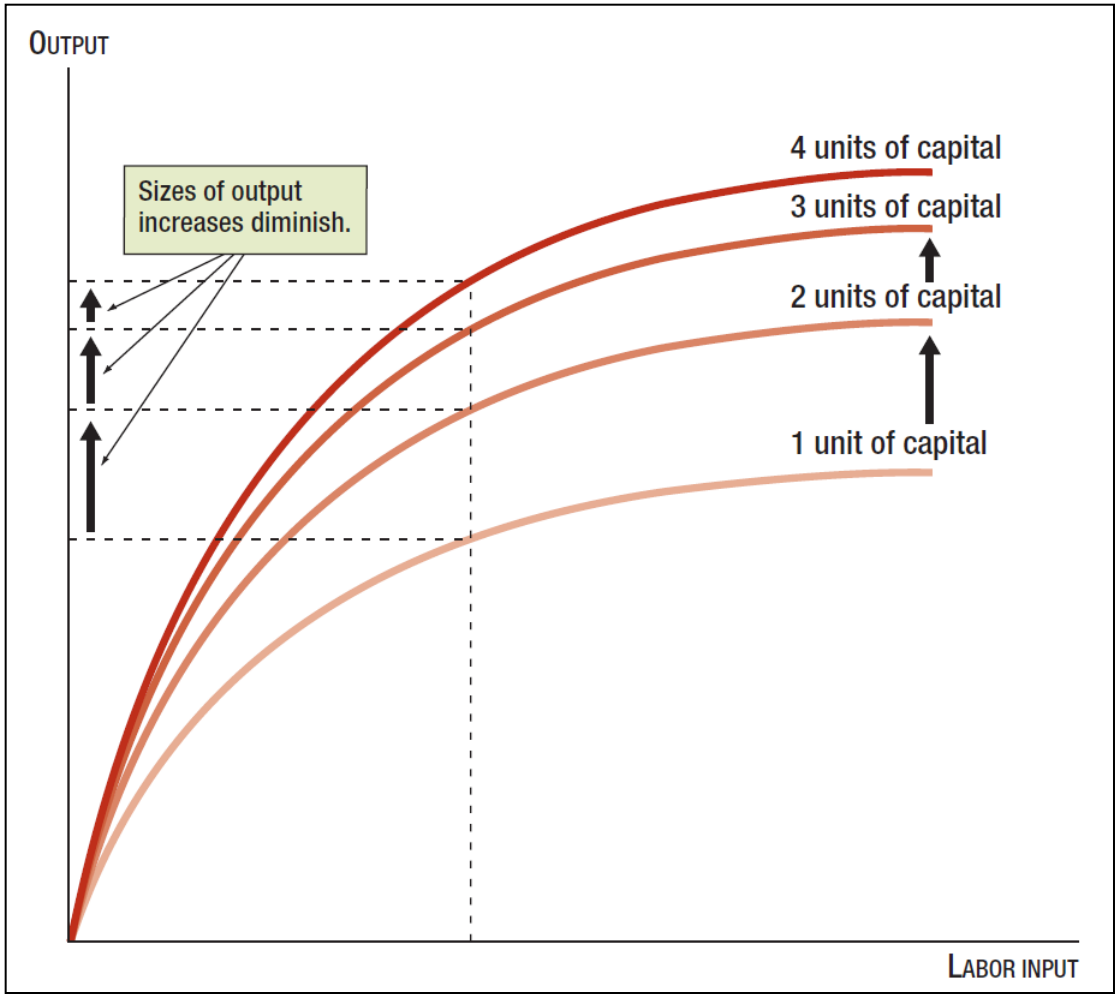
Adding Capital

Diminishing Returns to Capital: additional units of capital result in an increase in output, but the increase becomes smaller and smaller.

From **Figure 9-4**, increases in capital (holding the quantity of labor constant) will shift the production function higher. However, subsequent increases in capital shift the production function by a smaller and smaller vertical distance.

Capital Has Diminishing Returns Also

Figure 9-4



Technology

Technology: anything that raises the amount of the output that can be produced with a given amount of labor and capital.

Technology

Production function with technology:

$$Y = F(L, K, T)$$

where T = technology

Y = GDP

K = capital input

L = labor input

Technology

Technological change: improvements in technology over time; also referred to as technological progress.

Invention: a discovery of new knowledge.

Technology

Innovation: the application of new knowledge in a way that creates new products or significantly changes old products.

Diffusion: spreading of an innovation throughout the economy.

Technology

Labor-saving technological change: fewer workers are needed to produce the same output.

Example:

- A steam-powered tractor replaces a horse-drawn plow.

Technology

Capital-saving technological change: fewer machines are needed to produce the same output.

Example:

- Implementation of a night shift, where adding two more sets of crew will increase the productivity of an assembly plant

Technology

Learning-by-doing: a situation in which workers become more proficient by doing a particular task many times.

Example:

- As the number of Boeing 777 airplanes produced increases, workers become more skilled at producing the aircraft.

Technology

Human capital: a person's accumulated knowledge and skills.

The decision to invest in human capital is similar to the decision to invest in physical capital. We should invest in human capital as long as the net present value of the benefits outweighs the net present value of the costs.

The Production of Technology: The Invention Factory

Patent: recognition that an invention is original and that gives the inventor exclusive rights to use the invention until the patent expires.

The number of patents is an indicator of how much technological progress is occurring.

The Production of Technology: The Invention Factory

More and more technological change is attributable to large expenditures for research and development funds by the industry and the government.

The supply of technology depends on the cost of producing the new technology and the benefits of the new technology.

Special Features of Technology

Nonrivalry: one person's use of the technology does not reduce the amount of that technology that another person can use.

There is no rivalry with technology. When a new TV with a clearer picture is invented, someone else's enjoyment of the new technology does not diminish your own enjoyment of the same technology.

Special Features of Technology

Nonexcludability: the inventor or the owner of the technology cannot exclude other people from using it.

Spill-over: the invention of a technology results in more technology that is invented.

Fundamental Causes of Economic Growth

Institutions: systems people in the country have created of adopted to govern themselves.

Geography: climate, terrain, even the shape of a continent can all influence the economic growth of an area

Willingness to be open to trade: being open to interactions with the rest of the world

Measuring Technology

Growth accounting formula: an equation stating that the growth rate of productivity equals capital's share of income multiplied by the growth rate of capital per hour of work plus the growth rate of technology.

Robert Solow proposed the following rule-of-thumb for growth accounting:

Measuring Technology

$$\left(\begin{array}{l}\text{Growth}\\ \text{rate of}\\ \text{productivity}\end{array}\right) = \frac{1}{3}\left(\begin{array}{l}\text{Growth rate of}\\ \text{capital per hour of}\\ \text{work}\end{array}\right) + \left(\begin{array}{l}\text{Growth rate}\\ \text{of technology}\end{array}\right)$$

Why 1/3? It is an estimate of how much capital contributes to output. It is an estimate and could vary over time. Remember, this is a rule-of-thumb.

Measuring Technology

Suppose the growth rate of real GDP per hour of work is 2 percent per year and the growth rate of capital per hour of work is 3 percent per year. Then the growth rate of technology is

$$\left(\text{Growth rate of technology}\right) = \left(\text{Growth rate of productivity}\right) - \frac{1}{3}\left(\text{Growth rate of capital per hour of work}\right)$$

Measuring Technology

$$\left(\begin{array}{l}\text{Growth rate of}\\ \text{technology}\end{array}\right) = \left(\begin{array}{l}\text{Growth}\\ \text{rate of}\\ \text{productivity}\end{array}\right) - \frac{1}{3}\left(\begin{array}{l}\text{Growth rate of}\\ \text{capital per hour}\\ \text{of work}\end{array}\right)$$

$$\begin{array}{l}\text{Growth rate}\\ \text{of technology}\end{array} = 0.02 - \frac{1}{3}(0.03) = 0.01$$

The growth rate of technology = 0.01 or 1 percent.

Technology Policy

Policies to improve technological progress:

- Policy to encourage investment in human capital (higher standards, incentives for good teaching, increased funding for education)

- Policy to encourage research and innovation (increased funding for R&D, tax credits for research)

Technology Policy

Policies to improve technological progress:

- Increased investment in new capital, especially if technology is embodied in new capital

Technology Embodied in New Capital

Embodied technological change means that the new technology is inseparable from the capital.

Example:

- A new bagel machine. To take advantage of the new technology, you need to buy the bagel machine.

Technology Embodied in New Capital

Disembodied technological change means taking advantage of new technology without using new capital.

Example:

- A new way to forecast demand for bagels in the morning

Is Government Intervention Appropriate?

To answer whether government intervention is appropriate in the production of technology, we must ask two questions:

- Is the private market providing the right incentives?
- Can the government do better without a large risk of government failure?

Is Government Intervention Appropriate?

If the answer to question 1 is “no” and the answer to question 2 is “yes,” then government intervention is appropriate.