

## CHAPTER 25

## Production and Growth

PRINCIPLES OF  
Economics  
N. Gregory Mankiw

*A typical family with all their possessions  
in the U.K., an advanced economy*



GDP per capita:	\$35,580
Life expectancy:	79 years
Adult literacy:	99%

***A typical family with all their possessions in Mexico, a middle income country***



GDP per capita:	\$11,410
Life expectancy:	76 years
Adult literacy:	92%

***A typical family with all their possessions in Mali, a poor country***



GDP per capita:	\$1,130
Life expectancy:	50 years
Adult literacy:	46%

*Incomes  
and Growth  
Around the  
World*

**FACT 1:**

There are vast differences in living standards around the world.

	<i><b>GDP per capita, 2005</b></i>	<i><b>Growth rate, 1960-2005</b></i>
China	\$6,572	5.8%
Singapore	29,921	5.4%
Japan	30,821	3.8%
Spain	26,125	3.2%
India	3,486	2.7%
Israel	25,670	2.7%
United States	41,854	2.2%
Canada	32,886	2.1%
Colombia	7,769	1.8%
New Zealand	22,511	1.4%
Philippines	4,920	1.4%
Argentina	14,421	1.0%
Saudi Arabia	14,729	0.8%
Rwanda	1,333	0.3%
Haiti	1,836	-1.2%

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*Incomes  
and Growth  
Around the  
World*

**FACT 2:**

There is also great variation in growth rates across countries.

	<i><b>GDP per capita, 2005</b></i>	<i><b>Growth rate, 1960-2005</b></i>
China	\$6,572	5.8%
Singapore	29,921	5.4%
Japan	30,821	3.8%
Spain	26,125	3.2%
India	3,486	2.7%
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## Incomes and Growth Around the World

Since growth rates vary, the country rankings can change over time:

- Poor countries are not necessarily doomed to poverty forever – *e.g.*, Singapore, incomes were low in 1960 and are quite high now.
- Rich countries can't take their status for granted: They may be overtaken by poorer but faster-growing countries.

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## Incomes and Growth Around the World

Questions:

- Why are some countries richer than others?
- Why do some countries grow quickly while others seem stuck in a poverty trap?
- What policies may help raise growth rates and long-run living standards?

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## Productivity

- Recall one of the Ten Principles from Chap. 1:  
***A country's standard of living depends on its ability to produce g&s.***
- This ability depends on  
(                    ), the average quantity of g&s produced per unit of labor input.
- $Y$  = real GDP = quantity of output produced  
 $L$  = quantity of labor  
so productivity =  $Y/L$  (output per worker)

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## Why Productivity Is So Important

- When a nation's workers are very productive, real GDP is large and incomes are high.
- When productivity grows rapidly, so do living standards.
- What, then, determines productivity and its growth rate?

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## Physical Capital Per Worker

- Recall: The stock of equipment and structures used to produce g&s is called **[physical] capital**, denoted **K**.
- ( ) = capital per worker.
- Productivity is higher when the average worker has more capital (machines, equipment, etc.).
- *i.e.*,  
an increase in **K/L** causes an increase in **Y/L**.

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## Human Capital Per Worker

- ( ) (**H**):  
the knowledge and skills workers acquire through education, training, and experience
- **H/L** = the average worker's human capital
- Productivity is higher when the average worker has more human capital (education, skills, etc.).
- *i.e.*,  
an increase in **H/L** causes an increase in **Y/L**.

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## Natural Resources Per Worker

- ( **N** ) (**N**): the inputs into production that nature provides, e.g., land, mineral deposits
- Other things equal, more **N** allows a country to produce more **Y**.  
In per-worker terms, an increase in **N/L** causes an increase in **Y/L**.
- Some countries are rich because they have abundant natural resources (e.g., Saudi Arabia has lots of oil).
- But countries need not have much **N** to be rich (e.g., Japan imports the **N** it needs).

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## Technological Knowledge

- ( **knowledge** ) **knowledge**: society's understanding of the best ways to produce g&s
- Technological progress does not only mean a faster computer, a higher-definition TV, or a smaller cell phone.
- It means any advance in knowledge that boosts productivity (allows society to get more output from its resources).
  - E.g., Henry Ford and the assembly line.

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## Tech. Knowledge vs. Human Capital

- Technological knowledge refers to society's understanding of how to produce g&s.
- Human capital results from the effort people expend to acquire this knowledge.
- Both are important for productivity.

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## The Production Function

- The production function is a graph or equation showing the relation between output and inputs:

$$Y = A F(L, K, H, N)$$

**F( )** – a function that shows how inputs are combined to produce output

**"A"** – the level of technology

- **"A"** multiplies the function **F( )**, so improvements in technology (increases in **"A"**) allow more output (**Y**) to be produced from any given combination of inputs.

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## The Production Function

$$Y = A F(L, K, H, N)$$

- The production function has the property ( ) **returns to scale**: Changing all inputs by the same percentage causes output to change by that percentage. For example,
- Doubling all inputs (multiplying each by 2) causes output to double:

$$2Y = A F(2L, 2K, 2H, 2N)$$

- Increasing all inputs 10% (multiplying each by 1.1) causes output to increase by 10%:

$$1.1Y = A F(1.1L, 1.1K, 1.1H, 1.1N)$$

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## The Production Function

$$Y = A F(L, K, H, N)$$

- If we multiply each input by  $1/L$ , then output is multiplied by  $1/L$ :

$$Y/L = A F(1, K/L, H/L, N/L)$$

- This equation shows that productivity (output per worker) depends on:
  - the level of technology (**A**)
  - physical capital per worker
  - human capital per worker
  - natural resources per worker

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## ECONOMIC GROWTH AND PUBLIC POLICY

Next, we look at the ways  
public policy can affect  
long-run growth in productivity  
and living standards.

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### Saving and Investment

- We can boost productivity by increasing **K**, which requires investment.
- Since resources scarce, producing more capital requires producing fewer consumption goods.
- Reducing consumption = increasing saving. This extra saving funds the production of investment goods. *(More details in the next chapter.)*
- Hence, a tradeoff between current and future consumption.

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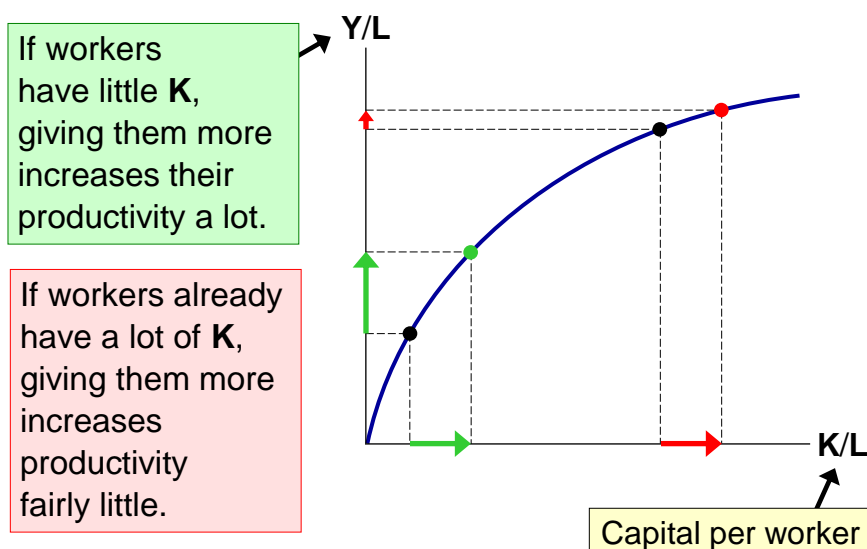
## Diminishing Returns and the Catch-Up Effect

- The govt can implement policies that raise saving and investment. (*Details in next chapter.*)  
 Then  $K$  will rise, causing productivity and living standards to rise.
- But this faster growth is temporary, due to ( ) **returns to capital**:  
 As  $K$  rises, the extra output from an additional unit of  $K$  falls....

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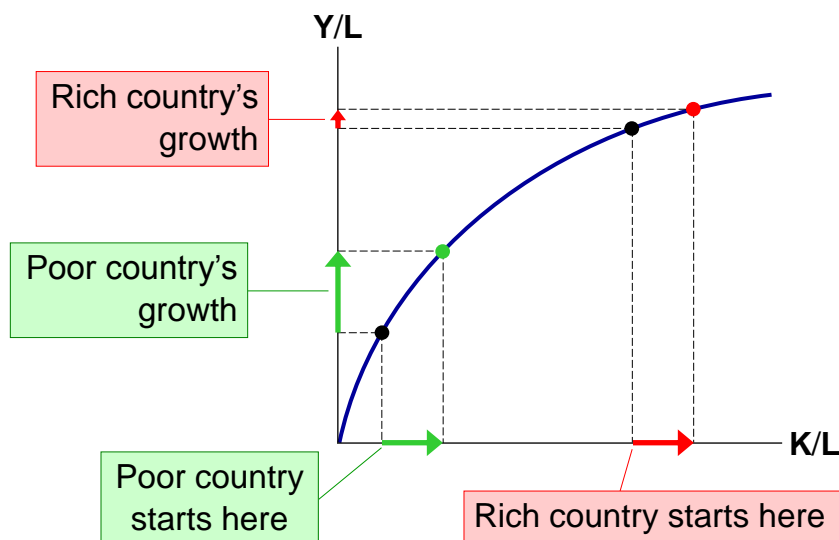
## The Production Function & Diminishing Returns



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**The catch-up effect:** the property whereby poor countries tend to grow more rapidly than rich ones



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## Example of the Catch-Up Effect

- Over 1960-1990, the U.S. and S. Korea devoted a similar share of GDP to investment, so you might expect they would have similar growth performance.
- But growth was >6% in Korea and only 2% in the U.S.
- Explanation: the catch-up effect.  
In 1960,  $K/L$  was far smaller in Korea than in the U.S., hence Korea grew faster.

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## Investment from Abroad

- To raise **K/L** and hence productivity, wages, and living standards, the govt can also encourage
  - **foreign ( ) investment:**  
a capital investment (e.g., factory) that is owned & operated by a foreign entity
  - **foreign ( ) investment:**  
a capital investment financed with foreign money but operated by domestic residents
- Some of the returns from these investments flow back to the foreign countries that supplied the funds.

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## Investment from Abroad

- Especially beneficial in poor countries that cannot generate enough saving to fund investment projects themselves.
- Also helps poor countries learn state-of-the-art technologies developed in other countries.

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## Education

- Govt can increase productivity by promoting education—investment in human capital (**H**).
  - Public schools, subsidized loans for college
- Education has significant effects: In the U.S., each year of schooling raises a worker's wage by 10%.
- But investing in **H** also involves a tradeoff between the present & future:  
Spending a year in school requires sacrificing a year's wages now to have higher wages later.

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## Health and Nutrition

- Health care expenditure is a type of investment in human capital – healthier workers are more productive.
- In countries with significant malnourishment, raising workers' caloric intake raises productivity:
  - Over 1962-95, caloric consumption rose 44% in S. Korea, and economic growth was spectacular.
  - Nobel winner Robert Fogel:  
30% of Great Britain's growth from 1790-1980 was due to improved nutrition.

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## Property Rights and Political Stability

- When people fear their capital may be stolen by criminals or confiscated by a corrupt govt, there is less investment, including from abroad, and the economy functions less efficiently.  
Result: lower living standards.
- Economic stability, efficiency, and healthy growth require law enforcement, effective courts, a stable constitution, and honest govt officials.

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## Free Trade

- **Inward-oriented policies** (e.g., tariffs, limits on investment from abroad) aim to raise living standards by avoiding interaction with other countries.
- **Outward-oriented policies** (e.g., the elimination of restrictions on trade or foreign investment) promote integration with the world economy.

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## Free Trade

- Recall: *Trade can make everyone better off.*
- Trade has similar effects as discovering new technologies – it improves productivity and living standards.
- Countries with inward-oriented policies have generally failed to create growth.
  - *E.g., Argentina during the 20th century.*
- Countries with outward-oriented policies have often succeeded.
  - *E.g., South Korea, Singapore, Taiwan after 1960.*

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## Research and Development

- Technological progress is the main reason why living standards rise over the long run.
- One reason is that knowledge is a **public good**: Ideas can be shared freely, increasing the productivity of many.
- Policies to promote tech. progress:
  - Patent laws
  - Tax incentives or direct support for private sector R&D
  - Grants for basic research at universities

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## Population Growth

...may affect living standards in 3 different ways:

### 1. Stretching natural resources

- 200 years ago, Malthus argued that pop. growth would strain society's ability to provide for itself.
- Since then, the world population has increased sixfold. If Malthus was right, living standards would have fallen. Instead, they've risen.
- Malthus failed to account for technological progress and productivity growth.

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## Population Growth

### 2. Diluting the capital stock

- Bigger population = higher **L** = lower **K/L**  
= lower productivity & living standards.
- This applies to **H** as well as **K**:  
fast pop. growth = more children  
= greater strain on educational system.
- Countries with fast pop. growth tend to have lower educational attainment.

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## Population Growth

### 2. Diluting the capital stock

To combat this, many developing countries use policy to control population growth.

- China's one child per family laws
- Contraception education & availability
- Promote female literacy to raise opportunity cost of having babies

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## Population Growth

### 3. Promoting tech. progress

- More people
  - = more scientists, inventors, engineers
  - = more frequent discoveries
  - = faster tech. progress & economic growth
- Evidence from Michael Kremer:
 

Over the course of human history,

  - growth rates increased as the world's population increased
  - more populated regions grew faster than less populated ones

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## ACTIVE LEARNING 2

### Review productivity concepts

- List the determinants of productivity.
- List three policies that attempt to raise living standards by increasing one of the determinants of productivity.

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## ACTIVE LEARNING 2

### Answers

#### Determinants of productivity:

**K/L**, physical capital per worker

**H/L**, human capital per worker

**N/L**, natural resources per worker

**A**, technological knowledge

#### Policies to boost productivity:

- Encourage saving and investment, to raise **K/L**
- Encourage investment from abroad, to raise **K/L**
- Provide public education, to raise **H/L**

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## ACTIVE LEARNING 2

### Answers

#### Determinants of productivity:

- K/L**, physical capital per worker
- H/L**, human capital per worker
- N/L**, natural resources per worker
- A**, technological knowledge

#### Policies to boost productivity:

- Patent laws or grants, to increase **A**
- Control population growth, to increase **K/L**

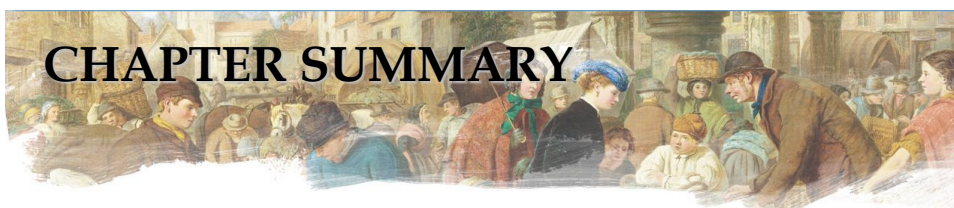
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## Are Natural Resources a Limit to Growth?

- Some argue that population growth is depleting the Earth's non-renewable resources, and thus will limit growth in living standards.
- But technological progress often yields ways to avoid these limits:
  - Hybrid cars use less gas.
  - Better insulation in homes reduces the energy required to heat or cool them.
- As a resource becomes scarcer, its market price rises, which increases the incentive to conserve it and develop alternatives.

## CONCLUSION

- In the long run, living standards are determined by productivity.
- Policies that affect the determinants of productivity will therefore affect the next generation's living standards.
- One of these determinants is saving and investment.



## CHAPTER SUMMARY

- There are great differences across countries in living standards and growth rates.
- Productivity (output per unit of labor) is the main determinant of living standards in the long run.
- Productivity depends on physical and human capital per worker, natural resources per worker, and technological knowledge.
- Growth in these factors – especially technological progress – causes growth in living standards over the long run.



## CHAPTER SUMMARY

- Policies can affect the following, each of which has important effects on growth:
  - Saving and investment
  - International trade
  - Education, health & nutrition
  - Property rights and political stability
  - Research and development
  - Population growth
- Because of diminishing returns to capital, growth from investment eventually slows down, and poor countries may “catch up” to rich ones.

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