Chapter 18
Economic Growth

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上課時間/地點: 週三上午9:10-12:00/海3006
Learning Objectives

1. Show how small differences in growth rates can lead to large differences in living standards

2. Explain why GDP per capita is the product of average labor productivity times the proportion of the population employed and use this decomposition to discuss the sources of growth

3. Discuss the determinants of average labor productivity within a particular country and use these concepts to analyze per capita GDP differences across countries

4. Discuss and evaluate government policies that promote economic growth

5. Compare and contrast the benefits of economic growth with its costs
Economic Growth

- Real GDP per Capita
- Share of Population Employed
- Average Labor Productivity

- Economic Growth
  - Standard of Living
    - 6 Determinants of Average Labor Productivity
  - Compound Growth Rates
  - Pro-Growth Policies
Learning Objective 1

複利率成長: 微小差異可使結果大不同
Benefits of Growth

• In the late 18\textsuperscript{th} and early 19\textsuperscript{th} century
  – Life expectancy was 40 years
    • Most families had 2 or 3 children die
  – \underline{Nothing} moved faster than the speed of a horse
  – The best highway was from Boston to New York

• Pace of technical change is accelerating
  – Inventions are not sufficient to create growth
  – Products must be commercialized and sold
Living Standards

• Use an economic model to study the remarkable rise in living standards
  – Real GDP per person is a measure of the goods available to a typical person

• One clue to growing prosperity in the 20th century – Real GDP per person today is five times greater than it was in 1929
## Real GDP per person, 1870 - 2008

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>US</td>
<td>$2,445</td>
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<td>3,881</td>
<td>13,993</td>
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<td>Japan</td>
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<td>448</td>
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<td>619</td>
<td>895</td>
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<td>781</td>
<td>1,122</td>
<td>1,210</td>
<td>1,062</td>
<td>1,650</td>
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Growth of Real GDP per person, 1870 - 2008

<table>
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<tr>
<th></th>
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<tbody>
<tr>
<td>US</td>
<td>1.9%</td>
<td>2.1%</td>
<td>1.8%</td>
</tr>
<tr>
<td>UK</td>
<td>1.5</td>
<td>2.1</td>
<td>2.1</td>
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<td>Germany</td>
<td>1.8</td>
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<tr>
<td>Japan</td>
<td>2.5</td>
<td>4.4</td>
<td>1.9</td>
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<tr>
<td>China</td>
<td>1.9</td>
<td>4.8</td>
<td>6.7</td>
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<tr>
<td>Brazil</td>
<td>1.6</td>
<td>2.3</td>
<td>0.9</td>
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<tr>
<td>India</td>
<td>1.3</td>
<td>2.7</td>
<td>4.2</td>
</tr>
<tr>
<td>Ghana</td>
<td>1.0</td>
<td>0.7</td>
<td>1.1</td>
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Real GDP per Person, 1870-2008
Compound Interest Rates

• **Compound interest** pays interest on the original deposit and all previously accumulated interest
  – Interest paid in year 1 earns interest in year 2
  – Example 18.1
    $10 deposited at 4% interest in 1800 is $37,757.33 in 2010
    - $10 \times (1.04)^{210} = \$37,757.33
  – Example 18.2
    <見課本>
  – 七二法則: 72/利率(如:2%就放2)=本金翻倍所需年數
Learning Objective 2

人均實質GDP=平均勞動生產力*就業人口比例
Real GDP per Capita

• Notation
  – \( Y = \) real total GDP
  – \( N = \) number of people employed
  – POP = population

\[
\frac{Y}{\text{POP}} = \frac{Y}{N} \times \frac{N}{\text{POP}}
\]

• (Real) GDP per capita is the product of output per worker and the share of the total population that is working

• Real GDP per person depends on
  – How much each worker produces and
  – The share of people working
Understanding Growth

• (以下省略 Real) GDP per capita increases when
  – Output per worker (Y / N) increases
  – The share of the population employed (N / POP) increases

• Between 1960 and 2009,
  – GDP per capita increased because both output per worker and the share of the population employed increased
  – The share of the population employed increased due to
    • Larger working age population
    • Increase in female labor force participation
Y / POP and Y / N, 1960 - 2009
Understanding Growth

In the long run, increases in output per person arise primarily from increases in average labor productivity.
Learning Objective 3

影響平均勞動生產力之因素
Production function (生産函數)

• 生產函數為描述生產要素轉換為產出的效率

• $Y = \tilde{F}(K, L, \text{自然資源, } A, \ldots) = A*F(K, L, \text{自然資源, } \ldots)$
  – K: physical capital 實體資本(設備建物)
  – L: labor 勞動或人力資本
  – A: total factor productivity, TFP 總要素生產力

• 影響一國長期經濟成長之近似因素為
  – 生產要素如K & L的累積
  – TFP的高低
Production function (生產函數)

- TFP衡量除了生產要素以外所有影響產值高低的因素
- TFP可進一步分解為
  - 技術水準
    - 和商業化的知識技能有關
  - 生產效率
    - 取決於制度、組織、管理、法律規章與執行、行政效率等
- TFP深受政府行為的影響
  - 制定政策鼓勵研發，以促進技術進步
  - 建立好的制度與規則，以幫助廠商提升效率
Determinants of Average Labor Productivity (Y/POP)

- U.S. average labor productivity is
  - 24 times that of Indonesia
  - 100 times that of Bangladesh

- Six factors determine average labor productivity
  1. Human capital  人力資本 (L)
  2. Physical capital  實體資本 (K)
  3. Land and other natural resources  土地與其他自然資源
  4. Technology  技術
  5. Entrepreneurship and management  企業家精神與管理
  6. Political and legal environment  政治與法律環境

(4.~6. 為影響TFP的因素)
#1 Human Capital

- Human capital comprises the talents, education, training, and skills of workers
  - Human capital increases workers' productivity
- Germany and Japan used human capital to rebuild after World War II
  - Professional scientists and engineers
  - Apprentice and on-the-job training emphasized
  - Japanese increased emphasis on early education
- *Cost – Benefit Principle* applies to building human capital
  - Premium paid to skilled workers
#2 Physical Capital

- More and better capital increases worker productivity
- Factory owner employs two people and adds capital
  - Each machine requires one dedicated operator (Ex. 18.5)

<table>
<thead>
<tr>
<th>Number of Machines</th>
<th>Output per Week</th>
<th>Hours Worked per Week</th>
<th>Output per Hour Worked</th>
<th>Marginal product of capital (MPK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>16,000</td>
<td>80</td>
<td>200</td>
<td></td>
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<tr>
<td>1</td>
<td>32,000</td>
<td>80</td>
<td>400</td>
<td>16,000</td>
</tr>
<tr>
<td>2</td>
<td>40,000</td>
<td>80</td>
<td>500</td>
<td>8,000</td>
</tr>
<tr>
<td>3</td>
<td>40,000</td>
<td>80</td>
<td>500</td>
<td>0</td>
</tr>
</tbody>
</table>

- 當機器數目逐漸增加，平均勞動生產力(每小時工人生產的糖果數目)剛開始會增加，但不會一直上升
- 因資本邊際產量(每多一台機器所多生產的糖果)會遞減
Diminishing Returns to Capital

- **Diminishing returns to capital** (或 diminishing marginal product of capital，資本邊際產量遞減) occurs if an addition of capital with other inputs held constant increases output by less than the previous increment of capital
  - Assumption: all inputs except capital are held constant
  - Result: output increases at a decreasing rate
- When a firm has many machines, the most productive uses have already been filled
  - The increment in capital will necessarily be assigned to a less productive use than the previous increment
Growth and Diminishing Returns to Capital

- Implications of diminishing returns
  - Increasing capital will increase labor productivity and output
  - Positive contribution to growth
  - There are limits to increasing productivity by adding capital because of diminishing returns
Capital and Output per Worker, 1990 (See Figure 18.5)
#3 Land and Other Natural Resources

- Inputs other than capital increase worker productivity
  - Land for farming
    - Farmers are less than 3% of the population and they supply the US and export the surplus
    - Manufacturing requires raw materials and energy
  - Resources can be obtained through international markets
    - Japan, Hong Kong, Singapore and Switzerland have high levels of GDP per capita with a limited resource base
# Technology

- New technologies are the **single most important source** of productivity improvement
- Technical change can affect industries beyond the primary application
  - Transportation expanded markets for farm produce
  - Medicine
  - Communications
  - Electronics and computers

**18th century transport**
- Horse power

**19th century transport**
- Steam engine
  - Rail
  - River

**20th century transport**
- Road network
- Air
Productivity Puzzle

• U.S. labor productivity grew 2.8% from 1947 – 1973
  – Slowed to 1.4% from 1973 – 1995
  – Resurgence to 3% since 1995
• Productivity slow-down remains a mystery
• Growth since 1995 is largely attributed to information and communications technologies making workers more productive
  – Growth seen in industries that produce these technologies and industries that use them
  – Slower growth in sectors that do not use much information and communications technologies
#5 Entrepreneurship and Management

- **Entrepreneurs** create new economic enterprises
  - Essential to a dynamic, healthy, growing economy
- Examples
  - Henry Ford and mass production
  - Bill Gates and standardized graphical user interface operating system
  - Larry Page and Sergey Brin and Google's search
- Policies should channel entrepreneurship in productive ways
  - Taxation policy and regulatory regime
  - Value innovation
#6 Political and Legal Environment

- Encourage people to be economically productive
- Well-defined property rights are essential
  - Who owns what and how those things can be used
  - Reliable recourse through courts
- Maintain political stability
- Promote free and open exchange of ideas
Medieval China

- Sung period (960 – 1270 AD) was technically sophisticated
  - Paper
  - Water wheels
  - Gunpowder
  - Compass?

- Economic stagnation followed
  - Social system limited entrepreneurship
  - Emperor retained property rights to business
    - Seizure possible without notice

- Scientific advances alone do not ensure technical change and growth
Communism Failed

• Output per person in the Soviet Union was probably less than one-seventh the US rate in 1991
• The Soviet Union had ingredients for growth – human capital, physical capital, natural resources, technology
• Two main flaws
  – Communal ownership of capital stock
    • General absence of private property rights
    • *Incentive Principle* could not work
  – Government planning replaced market system
    • Abundant unexploited opportunities
• Political instability and appropriate legal framework
Learning Objective 4

促進經濟成長之政策
Promote Growth with Human Capital

• Governments support education and training programs
  – U.S. public education support extends from kindergarten through institutions of higher learning
  – Head Start program for pre-school children
  – Job training and retraining programs

• Government pays because education has externalities
  – A democracy works better with educated voters
  – Progressive taxes capture some of the higher income
  – Increases chances of technical innovation
  – Poor families could not pay
Promote Growth with Savings and Investment

- Government policies can encourage new capital formation and saving in the private sector
  - Individual Retirement Accounts (IRAs) are an incentive for individuals to save
  - Government periodically offers investment tax credits

- Government can invest directly in capital formation
  - Construction of infrastructure such as roads, bridges, airports, and dams
  - US interstate highway system reduced costs of transporting goods, making markets more efficient
Promote Growth with R & D Support

• Research and development promotes innovation
  – Some types of research, such as basic science, create **externalities** that a private firm cannot capture
    • Silicon chip
      – Fund basic science with National Science Foundation (NSF) and other government grants
• Government sponsors research for military and space applications
• Maintain political and legal framework to support growth
Promoting Economic Growth in Least Developed Countries

- Prescription for more human and physical capital is broadly correct
  - Appropriate technology and education
- Most countries need *institutions* to support growth
  - Corruption creates uncertainty about property rights and drains financial resources out of the country
  - Regulation discourages entrepreneurship
  - Markets do not function efficiently
  - Lack of political stability discourages foreign investment
Learning Objective 5

追求經濟成長所付出的成本
The Costs of Economic Growth

• Increasing the capital stock will increase GDP
• Opportunity cost of producing more capital goods is
  – Fewer consumer goods
    • People may be willing to forego present consumption to have more in the future
  – Reduced leisure time
  – Possible risks of health and safety from rapid capital production
• Pursue growth only if the benefits > costs
Mexico City Air Quality

• Research indicates that pollution increases up to a point with increased GDP per person
  – After A, air pollution decreases and air quality improves
  – Estimates suggest Mexico is close to point A

• Beyond a certain level of income, citizens value a cleaner environment and they are willing and able to pay for it
Limits to Growth

• Can growth be sustained?
  – Depletion of some natural resources
  – Environmental damage and global warming

• Computer models suggested growth is not sustainable
  – Did not adequately treat new and better products
  – Greater income can pay for better environmental quality
  – Ignored the market's response to increasing scarcity
    • High prices trigger a response
    • Strong response to energy crisis in mid 1970s

• Government action needed in case of externalities