We have…

- Measured the quantity of goods and services an economy produces;
- The living standard

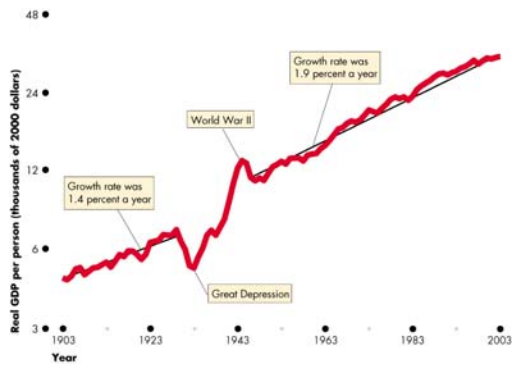
Now, we observe

- Some economies are producing more than others;
- Some economies have higher living standards;
- Even for the same economy, it tends to produce more and more, and with higher and higher living standard.

Road map for the rest of the quarter

We explore what determine the producing power and purchasing power of an economy;

- In the long run ----- Growth
- In the short run ----- Business Cycles



25 Production and Growth

PRINCIPLES OF
ECONOMICS
FOURTH EDITION

N. GREGORY MANKIW

PowerPoint® Slides
by Ron Cronovich

In this chapter, look for the answers to these questions:

- What are the facts about living standards and growth rates around the world?
- Why does productivity matter for living standards?
- What determines productivity and its growth rate?
- How can public policy affect growth and living standards?

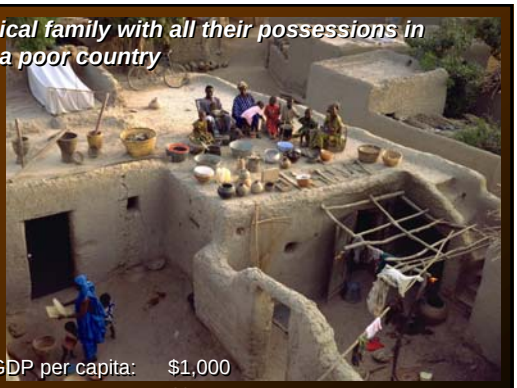
A typical family with all their possessions in the U.K., an advanced economy

Real GDP per capita: $30,800
Life expectancy: 78 years
Adult literacy: 99%

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

Real GDP per capita: $9,800
Life expectancy: 74 years
Adult literacy: 92%

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



Real GDP per capita: $1,000
Life expectancy: 41 years
Adult literacy: 46%

Incomes and Growth Around the World

FACT 1:

There are vast differences in **living standards** around the world.

	GDP per capita, 2004	*Growth rate, 1960-2004*
China	$5,495	5.6%
Singapore	27,273	5.4%
Japan	29,539	3.9%
Spain	25,341	3.2%
Israel	24,082	2.6%
India	3,115	2.5%
United States	39,618	2.2%
Canada	31,129	2.1%
Colombia	7,121	1.8%
New Zealand	22,912	1.4%
Philippines	4,558	1.3%
Argentina	12,723	0.8%
Saudi Arabia	14,022	0.8%
Rwanda	1,326	0.2%
Haiti	1,685	–1.3%

Incomes and Growth Around the World

FACT 2:

There is also great variation in growth rates across countries.

	GDP per capita, 2004	*Growth rate, 1960-2004*
China	$5,495	5.6%
Singapore	27,273	5.4%
Japan	29,539	3.9%
Spain	25,341	3.2%
Israel	24,082	2.6%
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Rwanda	1,326	0.2%
Haiti	1,685	–1.3%

Why do we care about the Growth?

- Two countries: Country A and Country B.
- Individuals in both countries earn $2500 per year and their income has been growing by 1.5% per year. Each country has a choice:
  - Choice 1: take a year off from work and have a year-long party. Resume work at the end of the year and continue to enjoy the 1.5% annual increase in income per person for year to come;
  - Choice 2: spend that year investing in things that increase productivity, such as clearing land, building factories, and improving machinery, so that income per person can rise to 2.5% per year. In exchange, that country must give up the year-long party.
- Country A goes for Choice 1 and Country B goes for Choice 2.
  - Country A gets a year-long party and individuals in Country A earn $2500*(1+1.5%)=$2537.5 in the year that follows;
  - Country B gives up the party and individuals in Country B earn $2500*(1+2.5%)=$2562.5 in the year that follows.
- However, after 100 years:
  - Individuals in Country A earn on average $2500*(1+1.5%)^100=11,000;
  - Individuals in Country B earn on average $2500*(1+2.5%)^100=30,000;
- France and Argentina had roughly equal income per person in 1900, but over the next 100 years economic growth per person was about 2.2% per year in France and about 1.1 percent per year in Argentina. Today, income per person in France is $24000, compared with only $8000 in Argentina.

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.

Long-Term Growth Trends

	Levels of Real GDP per Capita (1995 U.S. dollars)				Annual Growth Rate
Country	1870	1913	1950	1996	1870–1996
Australia	3,123	4,523	5,931	15,076	1.3
Canada	1,347	3,560	6,113	17,453	2.1
France	1,571	2,734	4,149	14,631	1.8
Germany	1,300	2,606	3,339	15,313	2.0
Japan	618	1,114	1,563	17,346	2.7
Sweden	1,316	2,450	5,331	14,912	1.9
United Kingdom	2,610	4,024	5,651	14,440	1.4
United States	2,247	4,854	8,611	19,638	1.7

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?

Robinson-Crusoe Economy

Robinson-Crusoe Economy

- Robinson Crusoe lives alone on an island;
- He makes a living by fishing.
- The amount of fish he catches everyday is the total product, total income and total expenditure of the Robinson-crusoe economy.
- What makes this economy grow? Or, what gives Robinson higher level of living standard?

Productivity

- *A country's standard of living depends on its ability to produce g & s.*
  - Robinson's living standard depends on his fish-catching ability.

- This ability depends on **productivity**: the average quantity of g&s produced per unit of labor input.
  - How much fish can Robinson catch every hour?
- **Y** = real GDP = quantity of output produced
  L = quantity of labor

  productivity = Y/**L** (output per worker)

Productivity Is Important!

- When a nation's workers are very productive, real GDP is large and incomes are high.
  - If Robinson is very productive, he catches a lot of fish everyday.
- When productivity grows rapidly, so do living standards.
  - Robinson becomes more and more productive so that he enjoys more and more fish everyday. Or, he will even have some time to build himself a house.
- What, then, determines productivity and its growth rate?
  - What helps Robinson to be more productive?

Physical Capital Per Worker

- Recall: The stock of equipment and structures used to produce g&s is called **[physical] capital**, denoted **K**.
- **K/L** = 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**.
- Robinson gets more/better fishing nets! That helps him to catch more fish.

Human Capital Per Worker

- **Human capital** (**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**.
- A smarter and more experienced Robinson.

Natural Resources Per Worker

- **Natural resources** (**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).
- Robinson lives on an island where there is a lot of fish nearby.

Technological Knowledge

- **Technological 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.

Things that improve productivity

- Physical Capital per worker
  - The stock of equipment and structure used to produce goods and services. Robinson gets more/better fishing nets.
- Human Capital per worker
  - the knowledge and skills workers acquire through education, training, and experience
  - A smarter and more experienced Robinson.
- Natural Resources per worker
  - the inputs into production that nature provides, *e.g.,* land, mineral deposits
  - Robinson lives on an island where there is a lot of fish nearby.
- Technological Knowledge
  - society's understanding of the best ways to produce g&s
  - Robinson used to catch fish by hand, now he use fishing nets, he will use fishing boats.

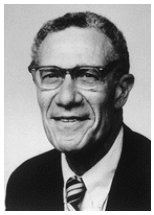
Tech. Knowledge vs. Human Capital

- 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.
- technological knowledge can easily be shared among infinitely many producers. Human capital is generally tied to the individuals that expend the effort to acquire it.

Tech. Knowledge vs. Physical Capital

- Technological knowledge is often embodied in physical capital.

Robert Solow: the winner of Nobel Memorial Prize in 1987



- Best Known for his work on Neoclassical growth models.
- He argues technological progress as the driving force for long-run growth.

Case Study: Henry Ford and the assembly line

- The first car of Ford Motor Company, Model T, was less expensive than most other cars, but it was still not attainable for the "multitude." Ford realized he'd need a more efficient way to produce the car in order to lower the price.
- Ford divided the labor by breaking the assembly of the Model T into 84 distinct steps. Each worker was trained to do just one of these steps.
- The production process was arranged so that as one task was finished, another began, with minimum time spent in set-up.

Creating cars at record-breaking rate!

Moving assembly line at Ford Motor Company's Michigan plant

Assembly line was Henry Ford's masterpiece.

- the Model T produced by the assembly line was inexpensive and could fit a family. It only was about $200.00 which even in 1924 was inexpensive.
- Without his creation, not many of us would have cars in fact none of us would probably have a car.

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.

The Production Function

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

- The production function has the property **constant 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:

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

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

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

Some Examples

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

F( ) is a function.

It can be linear:

$$Y=A\times(L+K+H+N)$$

Or not linear:

$$Y=A\times(L^{0.25})\times(K^{0.25})\times(H^{0.25})\times(N^{0.25})$$

Question: do these two production functions have the property of constant returns to scale?

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

Things that improve productivity

- Physical Capital per worker
  - The stock of equipment and structure used to produce goods and services. Robinson gets more/better fishing nets.
- Human Capital per worker
  - the knowledge and skills workers acquire through education, training, and experience
  - A smarter and more experienced Robinson.
- Natural Resources per worker
  - the inputs into production that nature provides, *e.g.,* land, mineral deposits
  - Robinson lives on an island where there is a lot of fish nearby.
- Technological Knowledge
  - society's understanding of the best ways to produce g&s
  - Robinson used to catch fish by hand, now he use fishing nets, he will use fishing boats.

ACTIVE LEARNING 1:
Discussion question

Which of the following policies do you think would be most effective at boosting growth and living standards in a poor country over the long run?

a. offer tax incentives for investment by local firms
b. …by foreign firms
c. give cash payments for good school attendance
d. crack down on govt corruption
e. restrict imports to protect domestic industries
f. allow free trade
g. give away condoms

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This coming Thursday, 1st Midterm

- No. 2 pencils
- Scantron form: Parscore form F-288-ERI-L
- Ink pens
- Non-programmable calculator
- Picture ID.
- 1 hour and 10 minutes.
- Regular lecture time and lecture room.

ECONOMIC GROWTH AND PUBLIC POLICY

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

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.

Case Study: Social Security Reform

- Question: does social security tax discourage or encourage saving?
- Pay-as-you-go system and fully-funded system.
- Additional Reading: "growing old expensively".

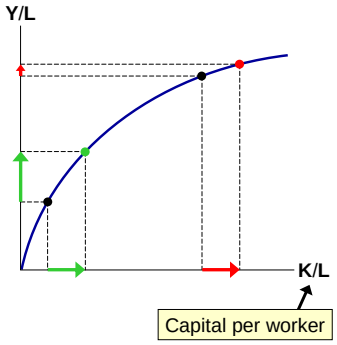
Diminishing Returns and the Catch-Up Effect

- 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 **diminishing returns to capital**: As **K** rises, the extra output from an additional unit of **K** falls….

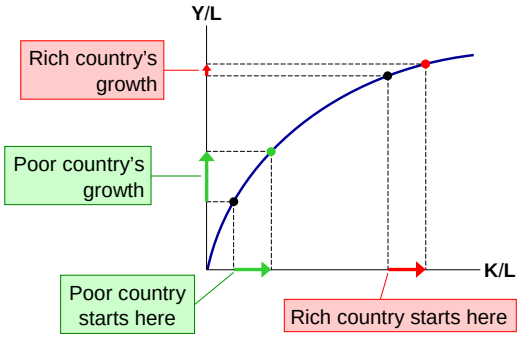
The Production Function & Diminishing Returns

If workers have little **K**, giving them more increases their productivity a lot.

If workers already have a lot of **K**, giving them more increases productivity fairly little.



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



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.

Investment from Abroad

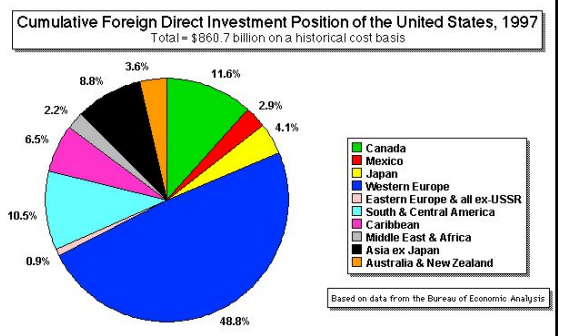
- To raise **K/L** and hence productivity, wages, and living standards, the govt can also encourage
  - **Foreign direct investment**: a capital investment (*e.g.*, factory) that is owned & operated by a foreign entity.
  - **Foreign portfolio investment**: a capital investment financed with foreign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

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.

Sizing Up Foreign Direct Investment

- **Of all the kinds of capital which flows into developing countries, foreign direct investment (FDI) is the most advantageous to the host country.**
- **When it comes to FDI, the developing country is under no obligation to keep up foreign currency payments for dividends — or pay off any debt.**



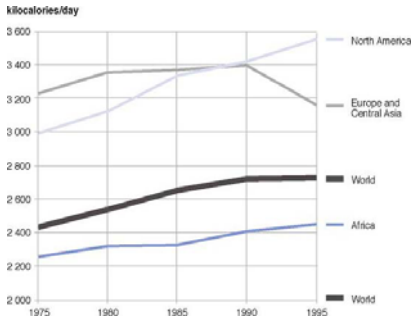
Education

- 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.

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.

caloric consumption



Nobel winner Robert Fogel

- 30% of Great Britain's growth from 1790-1980 was due to improved nutrition.

Property Rights and Political Stability

- Recall: *Markets are usually a good way to organize economic activity.* The price system allocates resources to their most efficient uses.
- This requires respect for **property rights**, the ability of people to exercise authority over the resources they own.

Property Rights and Political Stability

- In many poor countries, the justice system doesn't work very well:
  - contracts aren't always enforced
  - fraud, corruption often go unpunished
  - in some, firms must bribe govt officials for permits
- Political instability (*e.g.,* frequent coups) creates uncertainty over whether property rights will be protected in the future.

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.

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.
- The World Trade Organization is the only global international organization dealing with the rules of trade between nations. At its heart are the WTO agreements, negotiated and signed by the bulk of the world's trading nations and ratified in their parliaments.

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.

Now, the key

" I am looking for a lot of men who have infinite capacity to not know what can't be done."

-- Henry Ford

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

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.

Population Growth

2. Diluting the capital stock

- more 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.

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

Population Growth

3. Promoting tech. progress

- More people
  = more scientists, inventors, engineers
  = more frequent discoveries
  = faster tech. progress & economic growth
- Over the course of human history,
  - growth rates increased as the world's population increased
  - more populated regions grew faster than less populated ones

ACTIVE LEARNING 2:
Productivity

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

ACTIVE LEARNING 2: Answers

Determinants of productivity:

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

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:

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

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.
- In the next chapter, we will learn how saving and investment are determined, and how policies can affect them.

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.