

macro

Topic 5:
Economic Growth II
 (Chapter 8)

macroeconomics
fifth edition

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PowerPoint® Slides
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Learning objectives

- Technological progress in the Solow model
- Policies to promote growth
- Growth empirics:
 Confronting the theory with facts
- Endogenous growth:
 (covered in section)

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Introduction

In the Solow model of Chapter 7,

- _____
- _____

Neither point is true in the real world:

- 1929-2001: U.S. real GDP per person grew by a factor of 4.8, or 2.2% per year.
- examples of technological progress abound (see next slide)

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Examples of technological progress

- 1970: 50,000 computers in the world
2000: 51% of U.S. households have 1 or more computers
- The real price of computer power has fallen an average of 30% per year over the past three decades.
- The average car built in 1996 contained more computer processing power than the first lunar landing craft in 1969.
- Modems are 22 times faster today than two decades ago.
- Since 1980, semiconductor usage per unit of GDP has increased by a factor of 3500.
- 1981: 213 computers connected to the Internet
2000: 60 million computers connected to the Internet

Tech. progress in the Solow model

- A new variable: $E =$ _____
- Assume:
Technological progress is **labor-augmenting**:
it increases labor efficiency at the exogenous rate g :

$$g = \text{_____}$$

Tech. progress in the Solow model

- We now write the production function as:

$$Y = F(K, L \times E)$$

- where $L \times E =$ the number of _____
_____.
– Hence, increases in labor efficiency have the same effect on output as increases in the labor force.

Tech. progress in the Solow model

- Notation:

$$y = \frac{Y}{N} = \frac{Y}{N}$$

$$k = \frac{K}{N} = \frac{K}{N}$$

- Production function per effective worker:

$$y = f(k)$$

- Saving and investment per effective worker:

$$s y = s f(k)$$

Tech. progress in the Solow model

_____ = break-even investment:
the amount of investment necessary
to keep k constant.

Consists of:

- to replace depreciating capital
- to provide capital for new workers
- to provide capital for the new
"effective" workers created by
technological progress

Tech. progress in the Solow model

Investment,
break-even
investment

Capital per
worker, k

Steady-State Growth Rates in the Solow Model with Tech. Progress

Variable	Symbol	Steady-state growth rate
Capital per effective worker	$\mathbf{k} = \mathbf{K}/(\mathbf{L} \times \mathbf{E})$	
Output per effective worker	$\mathbf{y} = \mathbf{Y}/(\mathbf{L} \times \mathbf{E})$	
Output per worker	$(\mathbf{Y}/\mathbf{L}) = \mathbf{y} \times \mathbf{E}$	
Total output	$\mathbf{Y} = \mathbf{y} \times \mathbf{E} \times \mathbf{L}$	

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The Golden Rule

To find the Golden Rule capital stock, express \mathbf{c}^* in terms of \mathbf{k}^* :

$$\mathbf{c}^* = \mathbf{y}^* - \mathbf{i}^*$$

$$= \mathbf{f}(\mathbf{k}^*) - \underline{\hspace{2cm}}$$

\mathbf{c}^* is maximized when
 $\text{MPK} = d + n + g$
 or equivalently,

In the Golden Rule Steady State, the marginal product of capital net of depreciation equals the pop. growth rate

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Policies to promote growth

Four policy questions:

1. Are we saving enough? Too much?
2. What policies might change the saving rate?
3. How should we allocate our investment between privately owned physical capital, public infrastructure, and "human capital"?
4. What policies might encourage faster technological progress?

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1. Evaluating the Rate of Saving

- Use the Golden Rule to determine whether our saving rate and capital stock are too high, too low, or about right.
- To do this, we need to compare $(MPK - d)$ to $(n + g)$.
- If $(MPK - d) > (n + g)$, then we are _____ the Golden Rule steady state and should _____ **s**.
- If $(MPK - d) < (n + g)$, then we are _____ the Golden Rule steady state and should _____ **s**.

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1. Evaluating the Rate of Saving

To estimate $(MPK - d)$, we use three facts about the U.S. economy:

1. $k = 2.5y$
The capital stock is about 2.5 times one year's GDP.
2. $d k = 0.1y$
About 10% of GDP is used to replace depreciating capital.
3. $MPK \times k = 0.3y$
Capital income is about 30% of GDP

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1. Evaluating the Rate of Saving

1. $k = 2.5 y$
2. $d k = 0.1 y$
3. $MPK \times k = 0.3 y$

To determine d , divided 2 by 1:

$$\frac{d k = 0.1 y}{k = 2.5 y} \Rightarrow d = \frac{0.1}{2.5} = 0.04$$

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1. Evaluating the Rate of Saving

1. $k = 2.5 \text{ y}$
2. $d k = 0.1 \text{ y}$
3. $MPK \times k = 0.3 \text{ y}$

To determine MPK, divided 3 by 1:

$$\frac{0.3}{2.5} \Rightarrow MPK = \frac{0.3}{2.5} = 0.12$$

Hence, $MPK - d = 0.12 - 0.04 = 0.08$

1. Evaluating the Rate of Saving

- From the last slide: $MPK - d = 0.08$
- U.S. real GDP grows an average of 3%/year, so $n + g = 0.03$
- Thus, in the U.S.,
 $MPK - d = 0.08 > 0.03 = n + g$
- Conclusion:

The U.S. is _____ the Golden Rule steady state: if we _____ our saving rate, we will have faster growth until we get to a new steady state with higher consumption per capita.

2. Policies to increase the saving rate

- Reduce the _____
(or increase the budget surplus)
- Increase incentives for _____:
 - reduce capital gains tax, corporate income tax, estate tax as they discourage saving
 - replace federal income tax with a consumption tax
 - expand tax incentives for IRAs (individual retirement accounts) and other retirement savings accounts

3. Allocating the economy's investment

- In the Solow model, there's one type of capital.
- In the real world, there are many types, which we can divide into three categories:
 - _____
 - _____
 - _____: the knowledge and skills that workers acquire through education
- How should we allocate investment among these types?

Allocating the economy's investment: *two viewpoints*

1. Equalize tax treatment of all types of capital in all industries, then let the _____.
2. _____: Govt should actively encourage investment in capital of certain types or in certain industries, because they may have positive externalities (by-products) that private investors don't consider.

Possible problems with industrial policy

- Does the gov't have the ability to "pick winners" (choose industries with the highest return to capital or biggest externalities)?
- Would politics (e.g. campaign contributions) rather than economics influence which industries get preferential treatment?

4. Encouraging technological progress

- _____:
encourage innovation by granting temporary monopolies to inventors of new products
- _____ for R&D
- Grants to fund _____ at universities
- Industrial policy:
encourage specific industries that are key for rapid tech. progress
(subject to the concerns on the preceding slide)

CASE STUDY:

The Productivity Slowdown

	Growth in output per person (percent per year)	
	1948-72	1972-95
Canada	2.9	1.8
France	4.3	1.6
Germany	5.7	2.0
Italy	4.9	2.3
Japan	8.2	2.6
U.K.	2.4	1.8
U.S.	2.2	1.5

Explanations?

- _____
Increases in productivity not fully measured.
– But: Why would measurement problems be worse after 1972 than before?
- _____
Oil shocks occurred about when productivity slowdown began.
– But: Then why didn't productivity speed up when oil prices fell in the mid-1980s?

Explanations?

- 1970s - large influx of new entrants into labor force (baby boomers, women). New workers are less productive than experienced workers.
- Perhaps the slow growth of 1972-1995 is normal and the true anomaly was the rapid growth from 1948-1972.

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The bottom line:

We don't know which of these is the true explanation, it's probably a combination of several of them.

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CASE STUDY: I.T. and the "new economy"

	Growth in output per person (percent per year)		
	1948-72	1972-95	1995-2000
Canada	2.9	1.8	2.7
France	4.3	1.6	2.2
Germany	5.7	2.0	1.7
Italy	4.9	2.3	4.7
Japan	8.2	2.6	1.1
U.K.	2.4	1.8	2.5
U.S.	2.2	1.5	2.9

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CASE STUDY: I.T. and the “new economy”

Apparently, the computer revolution didn't affect aggregate productivity until the mid-1990s.

Two reasons:

1. Computer industry's share of GDP much bigger in late 1990s than earlier.
2. Takes time for firms to determine how to utilize new technology most effectively

The big questions:

- Will the growth spurt of the late 1990s continue?
- Will I.T. remain an engine of growth?

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Growth empirics: Confronting the Solow model with the facts

Solow model's steady state exhibits

_____ -

- Solow model predicts Y/L and K/L grow at same rate (g), so that _____.

This is _____ in the real world.

- Solow model predicts

_____.

Also _____ in the real world.

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Convergence

- Solow model predicts that, other things equal, “poor” countries (with lower Y/L and K/L) should _____ than “rich” ones.
- If true, then the income gap between rich & poor countries would _____, and living standards “converge.”
- In real world, many poor countries do NOT grow faster than rich ones. Does this mean the Solow model fails?

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