Long-Run Economic Growth, Part 2

Agenda
• Fundamental Determinants of Living Standards.
• Policies to Raise Long-Run Living Standards.

The Solow Model
• Fundamental determinants of living standards:
  ➢ The saving rate.
  ➢ Population growth.
  ➢ Productivity growth.

The Solow Model
• Fundamental determinants of living standards:
  ➢ Increasing the saving rate:
Effect of an increase in the saving rate

\[ Y/N = A^* \alpha(K/N) \]

\[ (S/N)_A = (I_p/N)_A \]

\[ S/N = s^*A^* \alpha(K/N) \]

\[ Y/N = (n + d)K/N \]

\[ Y/N = \alpha^*(K/N) \]

The Solow Model

• The adjustment mechanism:
  
  ➢ A higher saving rate shifts the saving function up.
  
  ➢ At the original \( K/N \), at \( (K/N)_A \), \( S/N \) is now greater than \( I_p/N \).
  
  ➢ Consequently, \( K/N \) will increase, causing:
    • \( Y/N \) to increase along the production function,
    • \( S/N \) to increase along the new saving function, and
    • \( I_p/N \) to increase along the balanced investment function.

The Solow Model

• The adjustment mechanism (continued):
  
  ➢ Because of diminishing marginal product of capital, the increase in \( S/N \) is smaller than the increase in \( I_p/N \) for every increase in \( K/N \).
  
  ➢ Eventually \( S/N \) will equal \( I_p/N \) at a new, higher steady state at B.

The Solow Model

• The adjustment mechanism (continued):
  
  ➢ At B, \( Y/N \) has increased, \( K/N \) has increased, \( S/N \) has increased, and \( I_p/N \) has increased.
  
  ➢ At steady state B, \( \Delta Y/Y = \Delta N/N = \Delta K/K \).
  
  ➢ During the transition period from steady state A to steady state B:
    • \( \Delta Y/Y > \Delta N/N \) because \( Y/N \) was increasing, and
    • \( \Delta K/K > \Delta N/N \) because \( K/N \) was increasing.
The Solow Model

• Fundamental determinants of living standards:
  - Increasing the saving rate means:
    - A higher capital-labor ratio, $K/N$,
    - A higher output per worker, $Y/N$, and
    - A higher consumption per worker, $C/N$.

• Should raising the saving rate be a policy goal?
  - Not necessarily.
    » There is a trade-off between present and future consumption.
    » The cost is lower consumption in the short run.

Effect of a faster population growth rate

\[
\begin{align*}
S/N = sA^*(K/N) \\
I/N &= (x + d)K/N \\
Y/N &= A^*(K/N) \\
(Y/N)_A &= (I/N)_A \\
(S/N)_A &= (I/N)_A
\end{align*}
\]
The Solow Model

• The adjustment mechanism:
  ➢ A slower population growth rate rotates the balanced investment function down.
  ➢ At the original $K/N$, at $(K/N)_A$, $S/N$ is now greater than $I_b/N$.
  ➢ Consequently, $K/N$ will increase, causing:
    • $Y/N$ to increase along the production function,
    • $S/N$ to increase along the saving function, and
    • $I_b/N$ to increase along the new $I_b/N$ function.

The Solow Model

• The adjustment mechanism (continued):
  ➢ Because of diminishing marginal product of capital, the increase in $S/N$ is smaller than the increase in $I_b/N$ for every increase in $K/N$.
  ➢ Eventually $S/N$ will equal $I_b/N$ at a new, higher steady state at B.

The Solow Model

• Fundamental determinants of living standards:
  ➢ Slowing the population growth rate means:
    • A higher capital-labor ratio, $K/N$,
    • A higher output per worker, $Y/N$, and
    • A higher consumption per worker, $C/N$. 

The Solow Model

• The adjustment mechanism (continued):
  ➢ At B, $Y/N$ has increased, $K/N$ has increased, $S/N$ has increased, and $I_b/N$ has increased.
  ➢ At steady state B, $\Delta Y/Y = \Delta N/N = \Delta K/K$.
  ➢ During the transition period from steady state A to steady state B:
    • $\Delta Y/Y > \Delta N/N$ because $Y/N$ was increasing, and
    • $\Delta K/K > \Delta N/N$ because $K/N$ was increasing.
The Solow Model

• Fundamental determinants of living standards:
  - Slowing the population growth rate:
    - Should reducing population growth be a policy goal?
      - Doing so will raise consumption per worker but it will reduce total output and consumption.
      - We have also assumed that the proportion of the population of working age is fixed which may not be true.
  - Increasing the productivity growth rate:

Effect of a productivity improvement

\[ \frac{Y}{N} = A \cdot f(\frac{K}{N}) \]

\[ \frac{(S/N)}{N} = \frac{(I/N)}{N} \]

\[ \frac{I/N}{N} = (n + d) \cdot \frac{K}{N} \]

\[ \frac{S/N}{N} = s \cdot A \cdot f(\frac{K}{N}) \]

The Solow Model

• The adjustment mechanism:
  - An improvement in productivity shifts both the production and saving functions up.
  - At the original \( K/N \), \( Y/N \) is now higher.
  - Also at the original \( K/N \), \( S/N \) is now greater than \( I/N \).
The Solow Model

• The adjustment mechanism:
  ➢ Consequently, $K/N$ will increase, causing:
    • $Y/N$ to increase along the new production function,
    • $S/N$ to increase along the new saving function, and
    • $I_b/N$ to increase along the balanced investment function.

The Solow Model

• The adjustment mechanism (continued):
  ➢ Because of diminishing marginal product of capital, the increase in $S/N$ is smaller than the increase in $I_b/N$ for every increase in $K/N$.
  ➢ Eventually $S/N$ will equal $I_b/N$ at a new, higher steady state at B.

The Solow Model

• The adjustment mechanism (continued):
  ➢ At B, $Y/N$ has increased, $K/N$ has increased, $S/N$ has increased, and $I_b/N$ has increased.
  ➢ At steady state B, $\Delta Y/Y = \Delta N/N = \Delta K/K$.
  ➢ During the transition period from steady state A to steady state B:
    • $\Delta Y/Y > \Delta N/N$ because $Y/N$ was increasing, and
    • $\Delta K/K > \Delta N/N$ because $K/N$ was increasing.

The Solow Model

• Fundamental determinants of living standards:
  ➢ An improvement in productivity means:
    • A higher capital-labor ratio, $K/N$,
    • Higher output per worker, $Y/N$, and
    • Higher consumption per worker, $C/N$. 
The Solow Model

- Fundamental determinants of living standards:
  - An improvement in productivity means:
    - Productivity improvement directly improves the amount that can be produced at any capital-labor ratio.
    - The increase in output per worker also increases the supply of saving, and indirectly causes the long-run capital-labor ratio to rise.

The Solow Model

- Fundamental determinants of living standards:
  - Can consumption per worker grow indefinitely?
    - The saving rate cannot rise forever.
    - The population growth rate cannot fall forever.
    - Productivity and innovation can always occur.

The Solow Model

- Fundamental determinants of living standards:
  - So living standards can rise continuously.
  - The rate of productivity improvement is the dominant factor determining how quickly living standards rise.

Application: The growth of China

- Population of 1.3 billion people.
  - A huge labor force with a comparative advantage in labor-intensive industries where wages are low.

- A low, but rapidly growing, level of GDP.
  - About 1/7 of US GDP per capita in 2007.
Real GDP growth in China and the US

Application: The growth of China

- Rapid output growth attributable to:
  - Saving is very high.
  - Current consumption is very low.
  - Huge increases in capital investment.
  - Productivity growth is very rapid.
    - Due in part from changing to a market economy.
    - Due to adopting foreign technologies through FDI, etc.
  - Population growth has slowed.

- Will China ever catch up to the U.S.?
  - Problems China faces:
    - Weak banking system.
    - Rapidly aging population.
    - Increasing income inequality.
    - Much unemployment in rural areas.
Policies to Raise Long-Run Living Standards

• Policies to increase the saving rate:
  ➢ If private markets are efficient, the government should not try to change the saving rate.
    • The private markets’ saving rate represents its optimal trade-off of present for future consumption.
    • However, if tax laws or myopia cause an inefficiently low level of saving, government policy to raise the saving rate may be justified.

Policies to Raise Long-Run Living Standards

• Policies to increase the saving rate:
  ➢ Increase private saving.
    • Raise the real interest rate to encourage saving.
      – The response of saving to changes in the real interest rate seems to be small.
    • Provide tax incentives to encourage saving.
      – The response of saving to changes in tax incentives also seems to be small.

Policies to Raise Long-Run Living Standards

• Policies to increase the saving rate:
  ➢ Increase government saving.
    • Reduce the government deficit or run a surplus.
      – Through reduced government purchases or higher taxes.
        » But under Ricardian equivalence, tax increases to reduce the deficit won’t affect national saving.

Policies to Raise Long-Run Living Standards

• Policies to raise the productivity growth rate:
  ➢ Improve the infrastructure:
    • Infrastructure is the highways, bridges, utilities, dams, airports, etc.
      – Research suggests a link between the amount and quality of infrastructure and productivity growth.
Policies to Raise Long-Run Living Standards

• Policies to raise the **productivity growth rate**:
  ➢ Build human capital:
    • Research shows a strong connection between productivity and human capital.
    • Government can encourage human capital formation through educational policies, worker training and relocation programs, and health programs.
    • Another form of human capital is entrepreneurial skill.
      – Government could help by removing barriers like red tape.

Encourage research and development:
  • Encourage R & D through direct and/or indirect means:
    – Government funding of R & D efforts.
    – Government tax incentives for R & D activities.
    – Enforcement of patents, trademarks, etc.

Summary

• Fundamental determinants of living standards:
  ➢ The saving rate,
  ➢ The population growth rate, and
  ➢ Productivity growth.

• The productivity growth rate is the **dominant factor** in determining how quickly living standards increase.

• Government can influence living standards with policies designed to:
  ➢ Increase the saving rate,
  ➢ Slow the population growth rate, and/or
  ➢ Raise the productivity growth rate.