Macroeconomics

MECN 450
Winter 2004

Topic 2: Long Run Growth
the Solow Growth Model
Long-run Growth

We started with diagnostics: What are the Sources of Growth?
- Growth Accounting
  - Investment and Capital Accumulation
  - Productivity Growth

Prescriptions: What determines whether countries grow or stagnate?
- The Solow growth model

The Solow Growth Model

- Solow models economic growth as a process of capital accumulation
- Capital is accumulated through savings
- Solow shows that an equilibrium balances savings and capital accumulation
Start from a production function:

\[ Y = \text{output}, \]
\[ \text{produced using capital and labor} \]
\[ K = \text{capital} \]
\[ N = \text{labor} \]

The production function is \( f(K,N) \):

\[ Y = f(K,N) \]

We are interested in output per worker

Divide output by labor:

\[ Y/N = y = f(K/N, N/N) = f(k,1) = f(k) \]

so output per worker = \( y = f(k) \),

a function of capital per worker
output per worker = \( y = f(k) \), is a function of capital per worker

Workers save a share, \( s \), of their income, so total savings = \( sY \)

Savings per worker is then \( \frac{S}{N} \), or

\[ \frac{sY}{N} = sf(k) \]

a share, \( s \), of output per worker
Savings per worker = \( sf(k) \)

This gives savings per worker. Now, what should investment be?

In a “steady state” equilibrium output per worker should be constant (for given productivity) that is, you can’t grow more just by accumulating capital.
In “steady state”, you need just enough investment to replace depreciation and keep up with population growth.

So Investment = depreciation + (population growth × capital per worker)

Investment = depreciation + (new workers × capital per worker) = (d × K) + (n × N) × (K/N)

where d = depreciation rate
n = population growth rate

Simplifying, Investment = (d+n)K

or investment per worker = (d+n)k
Steady state investment per worker

\[ (d+n)k \]

In equilibrium, savings must equal steady state investment per worker

\[ sf(k) = (n+d)k \]

Steady state savings = investment

\[ k^* \]

Savings per worker, \( sf(k) \)

Investment per worker, \( (n+d)k \)

Capital per worker, \( k \)
Out of equilibrium, are there forces that move the economy toward $k^*$?

The growth process stops when the capital stock reaches steady state, $k^*$, since savings & investment are now just high enough to maintain the steady state, but not to grow.

What do output and consumption look like in the steady state?

Steady state savings = investment

Steady state output per worker

Steady state consumption per worker
At what point do we see maximum consumption per worker?

What does the model tell us?

- High savings promotes growth through capital accumulation
- Productivity growth promotes growth
  - Since output is higher for given inputs, and
  - The steady state capital stock will also be higher
- Population growth inhibits economic development
  - By diluting resources
What does the model tell us?

- Even without productivity growth, economies can grow via capital accumulation
- With decreasing returns to capital, there are limits to this process
- An economy can become “too capital intensive”
  - There is no evidence that this has happened

What is missing from the model?

- How is the savings rate, s, determined?
  - If this can vary, an economy would probably reduce its savings before exceeding the “golden rule” capital stock
- International capital flows
  - Countries can borrow abroad to finance capital accumulation
  - In practice, savings and investment are closely (but not perfectly) tied even in open economies
- Institutions
  - Capital accumulation relies on markets to allocate capital
  - … and institutions to enforce these allocations
    - For example, property rights
    - Corruption is highly correlated with economic stagnation
What do we know about Long-run Growth?

From Solow:
- Countries with low capital can grow by accumulating capital
  - Investment is fostered by high savings
- Countries that are already capital-intensive can grow further by investing, but this can go too far (and even be counter-productive)
- Growth is always enhanced by productivity gains

What do we know about Long-run Growth?

From Growth Accounting:
- Productivity growth is central to improved output per capita in developed economies
- This may take the form of improved labor and/or capital, or technological improvements
- Factor accumulation (labor & capital) is also an important part of the story, especially for developing economies
Open Questions

For developed economies: how does one foster technological progress?
- Capital markets - micro
- Incentives (like taxes)

For developing economies: how to achieve investment and productivity growth?
- capital markets and taxes - macro
- education

For both - what is the role of institutions?
- Micro: incentives and liquidity
- Macro: Property rights, stability, and credibility
- Government: “Macro-fundamentals”