1 Long-Run Economic Growth

• Goal: to understand factors that affect long-term performance of an economy.

• long-term → usually 20-30 years. Fixed vs. variable factors. Long run: all factors of production including capital stock etc. are variable.

• Trend vs blips. Ignore blips.

• Why should we care about the long-run?

• “Rule of 72”: 72 divided by the rate of growth of an economy will approximately give the number of years it takes for an economy to double in size. E.g., an economy growing at 4% per year doubles in size in 18 years.
• Wide disparity in cross country growth rates

• GDP per capita: The dollar value of a country’s final output of goods and services in a year (its GDP), divided by its population. It reflects the average income of a country’s citizens.

• GDP or GDP per capita?

• Countries with a GDP per capita in 2003$ of $9,386 or more are classified as “high income”, between $3036 and $9,385 as higher-middle income, between $761 and $3,035 as lower-middle income, and $765 or less as low income.

• Caveats with GDP per capita: purchasing power (PPP), fulfilling? Index of human development.
- US real GDP per capita grew at 3.7 % p.a from 1947-1973 (size doubled in 19.5 years); from 1974-1992 grew at 2.2 % p.a (32.7 years); since 1890, US GDP per capita has increased by a factor of 25.

- **Cross-Section** versus **Time-Series** view of data

- cross-section: large disparities in per capita income across countries

- Nigeria’s per capita income is about 5% that of the US! Not always like this.

- The example of the Philippines and Korea. GDP per-capita $640 in 1975 US$; 28 million people in Philippines versus 25 million in Korea, 27% of Filipinos lived in Manila versus 28% in Seoul; all boys of primary school age were in school in both nations; 1960-1988 → Philippines grew at 1.8% per year while Korea grew at 6.2% per year.
Crucial to understand what constitutes an economy’s physical capacity to produce goods and services.

1.1 Growth Accounting

Output is produced by “factors of production”; e.g. capital goods, people, land, energy...more of all these factors translates into more output.

How effectively are these used?

This is summarized in a mathematical relationship called the production function:

\[ Y_t = AF(K_t, N_t) \]  

where \( Y \) = real output produced at time \( t \), \( A \) = a measure of productivity, \( K_t \) = capital stock at time \( t \), \( N \) = number of workers employed at time \( t \) (usually assumed to be the size of the adult work force).
• Connecting \( K, N, A \) with \( Y \) is a function \( F \).

• Assume that there is only firm in the economy and all households rent their capital and labor services to this one firm; then (1) measures the \textit{maximum} amount of output (GDP) this firm can produce at any given date \( t \).

• For the US, the relationship is

\[
Y_t = AK_t^{\frac{1}{3}}N_t^{\frac{2}{3}}.
\]

• \( A \) is called “total factor productivity”.

• The “missing ingredient”

• What does (1) look like?
• To draw a picture showing how $Y$ changes with change in both $K$ and $N$ would require a 3-D picture. Instead we will hold $N$ fixed and see how $Y$ changes with $K$.

• For example: Fix $N = 129.6$ million workers; and $A = 16.45$. Then

$$Y_t = AK_t^{\frac{1}{3}}N_t^{\frac{2}{3}} = Y_t = 16.45K_t^{\frac{1}{3}}(129.6)^{\frac{2}{3}} = (495.4)K_t^{\frac{1}{3}}.$$

• Two important features:

1. Slopes upward from left to the right

2. Slope becomes flatter from left to right.
• Notion of marginal product of capital $MPK$.

• $MPK = \text{increase in output (}\Delta Y\text{) resulting from a one-unit increase in the capital stock (holding labor fixed)}$

• $MPK$ at a point $= \left(\frac{\Delta Y}{\Delta K}\right)$ at that point $= \text{slope of the production function at that point} = \text{derivative of the function } F \text{ with respect to } K \text{ at that point}$.

• Diminishing marginal productivity of capital; example

• Marginal product of labor (same as $MPK$)

• $MPK = \left(\frac{\Delta Y}{\Delta K}\right) \Rightarrow \Delta Y = MPK \times \Delta K$
• Example: suppose labor is fixed and $MPK = 1/5$. If we increase $K$ by 10 units, i.e. $\Delta K = 10$, we can calculate $\Delta Y$ by

$$\Delta Y = MPK \times \Delta K = \frac{1}{5} \times 10 = 2$$

• We use the $MPK$ to convert changes in $K$ to changes in output.

• Similarly, holding capital $K$ (and $A$) fixed, we use the $MPN$ to convert changes in $N$ to changes in output.

• If we allow both $N$ and $K$ to change, then combined change in $K$ and $N$ adds up to produce final change in output:

$$\Delta Y = (MPN \times \Delta N) + (MPK \times \Delta K)$$
More generally:

\[ \frac{\Delta Y}{Y} = \frac{\Delta A}{A} + a_N \frac{\Delta N}{N} + a_K \frac{\Delta K}{K} \]  \hspace{1cm} (2)

- \[ \frac{\Delta N}{N} \] = growth rate of labor

- \[ \frac{\Delta K}{K} \] = growth rate of capital

- \[ a_N \] = percentage change in output resulting from a 1% change in labor use = elasticity of output with respect to labor

- Called “growth accounting equation”. Breaks up output growth into its components.

- Contribution of capital to output growth: \[ a_K \frac{\Delta K}{K} \]

- For the US, \[ a_K = 0.3, \] \[ a_N = 0.7. \]
• Example: Suppose $\Delta N \over N = \Delta K \over K = 0$ and $\Delta A \over A = 10\%$. Then (2) says that $\Delta Y \over Y = 10\%$.

• Example: Suppose $\Delta A \over A = \Delta K \over K = 0$ and $\Delta N \over N = 10\%$. Then (2) says that $\Delta Y \over Y = (a_N) \times 10\% = (0.7) \times 10\% = 7\%$

• Thus, a 10\% increase in labor use, with capital and productivity unchanged, leads to only a 7\% increase in output. Why?

• Table

• Note the small or even negative contribution of productivity in recent decad