

Production and Growth in the Long Run

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Outline: Unit II, Section RE1

- I. Sources of Economic Growth
- II. Productivity: Key to Rising Living Standards
- III. Growth across the World

I. Sources of Economic Growth

Determinants of real GDP or output

1. K = Amount of physical capital
2. L = Amount of labor
3. Technology level
4. H = Human capital or education
5. Quality of management/entrepreneurship
6. N = Natural resources

A = Total Factor Productivity = Intangible factors

Simplified Long-Run Production Model

$$Y = AK^{\alpha}L^{1-\alpha}$$

Y = real GDP

A = TFP

K = Physical capital

L = Labor

α = Share of output going to owners of K = 0.30

Growth Accounting Equation

$$Y = AK^{\alpha}L^{1-\alpha}$$

$$\ln Y = \ln A + \alpha \ln K + (1 - \alpha) \ln L$$

$$\frac{d}{dt} [\ln Y = \ln A + \alpha \ln K + (1 - \alpha) \ln L]$$

Growth Accounting Equation:

$$(* 1) \quad \% \Delta Y = \% \Delta A + \alpha \% \Delta K + (1 - \alpha) \% \Delta L$$



TFP Growth Capital Growth Labor Growth

Handout 2 – Table 1
Sources of Growth for the U.S. Economy
 (average percent increase per year)

Years		Sources of Growth			
	Output Growth	Total Factor Productivity Growth	Capital Growth	Labor Growth	
	$\% \Delta Y$	$=$	$\% \Delta A$	$+ \alpha \% \Delta K$	$+ (1 - \alpha) \% \Delta L$
1950-1960	3.3		1.3	1.0	1.0
1960-1970	4.4		1.8	1.4	1.2
1970-1980	3.6		1.0	1.4	1.2
1980-1990	3.4		0.6	1.2	1.6
1990-1999	3.7		0.9	1.2	1.6
1995-2002	3.7		1.1	1.7	0.9
1948-2007	3.6		1.2	1.2	1.2
1948-1972	4.0		1.9	1.2	0.9
1972-1995	3.4		0.6	1.3	1.5
1995-2007	3.5		1.3	1.3	1.0

This table assumes that capital has a 30% share in production ($\alpha = 0.3$) and labor has a 70% share ($(1 - \alpha) = 0.7$). This table is taken from *Macroeconomics*, Seventh Edition (2010), by N. Gregory Mankiw.

Notes

II. Productivity: Key to Rising Living Standards

“Consumption is the sole end and purpose of all production.” Adam Smith

Key variable: $\frac{C}{pop}$ = Consumption per capita

C = Consumption

$\frac{L}{pop}$ = Labor force participation rate

$\frac{Y}{L}$ = Output/worker or Labor productivity

Basic Solow Growth Model

$$C = (1 - s)Y$$

where s = savings rate

$$\frac{C}{pop} = (1 - s) \frac{Y}{pop}$$

Solow equation:

$$(* 3) \quad \frac{C}{pop} = (1 - s) \left(\frac{Y}{L} \right) \left(\frac{L}{pop} \right)$$

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Consumption per capita:

$$1. \quad s \downarrow \Rightarrow \frac{C}{pop} \uparrow$$

– Trade-off: Investment \downarrow in future $\Rightarrow K \downarrow$ the future

$$2. \quad \frac{L}{pop} \uparrow \Rightarrow \frac{C}{pop} \uparrow$$

– Labor force participation rate ‘

– Hours worked \uparrow

$$3. \quad \frac{Y}{L} \uparrow \Rightarrow \frac{C}{pop} \uparrow$$

Percent Change Formulas

- Useful formulas for problem set 2
- $\% \Delta \left(\frac{A}{B} \right) = \% \Delta A - \% \Delta B$
- $\% \Delta (A * B) = \% \Delta A + \% \Delta B$

Output per worker: $\frac{Y}{L}$

$$(* 1) \quad \% \Delta Y = \% \Delta A + \alpha \% \Delta K + (1 - \alpha) \% \Delta L$$

$$\% \Delta Y - \% \Delta L = \% \Delta A + \alpha (\% \Delta K - \% \Delta L)$$

Productivity Equation:

$$(* 2) \quad \% \Delta \left(\frac{Y}{L} \right) = \% \Delta A + \alpha \% \Delta \left(\frac{K}{L} \right)$$

Growth of $\frac{Y}{L}$ determined by two factors:

- Growth of A , or TFP: $\% \Delta A$
- Growth of $\frac{K}{L}$, or Capital per worker: $\% \Delta \left(\frac{K}{L} \right)$

Handout 2 – Table 2
Sources of Productivity Growth for the U.S. Economy
 (average percent increase per year)

Years	Sources of Productivity Growth		
	Productivity Growth	Total Factor Productivity Growth	Capital Per Worker Growth
	$\% \Delta (Y/L)$	$= \quad \% \Delta A$	$+ \quad \alpha \% \Delta (K/L)$
1950-1960	1.9	1.3	0.6
1960-1970	2.7	1.8	0.9
1970-1980	1.9	1.0	0.9
1980-1990	1.1	0.6	0.5
1990-1999	1.4	0.9	0.5
1948-2007	1.9	1.2	0.7
1948-1972	2.7	1.9	0.8
1972-1995	1.3	0.6	0.7
1995-2007	2.1	1.3	0.8

(Figures again taken from *Macroeconomics* by N. G. Mankiw (Seventh Edition, 2010).

Notes

Capital, TFP, & Growth

- K & Growth

$$s = 100\% \Rightarrow \frac{K}{L} = \text{high}, \quad \frac{C}{pop} = 0$$

$$s = 0\% \Rightarrow \frac{K}{L} = 0, \quad \frac{C}{pop} = \text{high (SR only)}$$

- TFP & Growth

– If TFP increases $\Rightarrow \frac{C}{pop}$ increases

IV. Growth across the World

- Data across countries
- Nominal exchange rate (nom e) = 10 pesos/ \$1

	US	Mexico
Avg income	\$30,000	100,000 pesos
Nom e	\$30,000	\$10,000
Price of dinner		
Real GDP (PPP)		

Growth Around the World

GROWTH IN OUTPUT PER PERSON (PERCENT PER YEAR)

Country	1948-1972	1972-1995	1995-2007
Canada	2.9	1.8	2.2
France	4.3	1.6	1.7
West Germany	5.7	2.0	
Germany			1.5
Italy	4.9	2.3	1.2
Japan	8.2	2.6	1.2
United Kingdom	2.4	1.8	2.6
United States	2.2	1.5	2.0

Source: Angus Maddison, *Phases of Capitalist Development* (Oxford: Oxford University Press, 1982); OECD *National Accounts*; and World Bank: *World Development Indicators*.

Handout 2 – Table 4

Real (PPP) Gross Domestic Product of Selected Countries, 1950 and 2000					
Country	Real (PPP) GDP per capita 1950		Real (PPP) GDP per capita 2000		Real (PPP) Avg. Growth rate
		Percentage of US		Percentage of US	Percentage per year
United States	10702.58	100	33292.99	100	2.27
Switzerland	10451.35	98	26413.68	79	1.85
Canada	9092.548	85	26904.5	81	2.17
France	5428.664	51	22357.69	67	2.83
United Kingdom	7524.621	70	22189.71	67	2.16
Germany	Na	Na	22855.57	69	2.03
Ireland	4265.51	40	26380.63	79	3.64
Italy	4042.976	38	21780.21	65	3.37
Japan	2226.743	21	24675.34	74	4.81
Spain	2829.696	26	18046.88	54	3.71
Sweden	Na	Na	23635.13	71	2.26
China	Na	Na	3747.298	11	3.87
India	705.2127	7	2478.919	7	2.51
Hong Kong	Na	Na	26698.51	80	5.39
Philippines	1343.127	13	3425.036	10	1.87
Argentina	6430.014	60	11006.46	33	1.08
Brazil	1655.055	15	7190.005	22	2.94
Chile	Na		9925.528	30	2.21
Mexico	2989.812	28	8762.336	26	2.15
Cote d'Ivor	Na	Na	1869.172	6	0.35
Egitto	1371.236	13	4183.969	13	2.23
Kenya	694.4228	6	1244.366	4	1.17
Nigeria	751.97	7	706.843	2	-0.12

Source: Penn World Tables

In 2000 US\$

Concept of Convergence

1. Developing countries have lower $\frac{K}{L}$
 - Assuming diminishing $MP_K \Rightarrow$ Additional K is more productive (relative to rich countries)
 - \Rightarrow Returns to K are higher
 - More foreign/domestic investors put K into poor countries
2. Developing countries free-ride off technological improvements

Evidence

- Catch up observed among advanced countries
 - US, Canada, Japan, Australia, Western Europe
- Catch up observed among some initially developing countries
 - Mostly East Asia, and Southeast Asia: South Korea, Taiwan, Hong Kong, Singapore, China
- Many developing countries have not caught up
 - Some Latin American, sub-Saharan African countries

Conditional Convergence

- Environmental Factors or Endowment View:
Geography, Natural resources, Disease (Sachs)
- International Trade:
Well integrated into world trading system, Learning-by-Doing (Ricardian Trade)
- Legal and Government Institutions:
Property rights, Corruption (Acemoglu, Johnson, Robinson)