8. Technology and Efficiency.

References: Weil Chapter 10

Consider:

- technological progress explains productivity *growth* in developed countries (the leading edge).
- But does it also explain the productivity difference across rich and poor countries *at any given time*?
- in other words: are poor country "just" lagging behind or do they suffer from a deeper problem?

$\rightarrow$ Weil's spoon parable.

Efficiency:

- "umbrella concept" for anything that accounts for productivity differences other than technology.
- strictly speaking: degrees of inefficiency (inside the PPF).

one natural possibility: structural change. But there are others, less natural...

Decomposition of productivity: technology $\times$ efficiency:

$$A = T \cdot E$$

$\rightarrow$ Weil's 2 farmers.

How much can we reasonably expect to be explained by efficiency and technology?

- Recall our 2 country innovation–imitation model (for example U.S. vs. India).
- Let g be the productivity growth rate in the U.S.
- Suppose India is lagging G years behind technologically:

$$T_{t,US} = T_{t-G,US} \cdot (1+g)^G = T_{t,India} \cdot (1+g)^G.$$

Implied technology ratio:

$$\frac{T_{India}}{T_{US}} = (1+g)^{-G}.$$

(we dropped the t since g is assumed constant, i.e. the equation holds at all times t)

Consider:

- productivity growth in the U.S: 0.81% annually.
- India is 10 years behind.

$$\frac{T_{India}}{T_{US}} = (1.0081)^{-10} = 0.92.$$

Conclude: India would have 92% of the U.S. technology level.

Now, with the possibility of efficiency differences...

$$A_{India} = T_{India} \cdot E_{India}, \qquad A_{US} = T_{US} \cdot E_{US} \qquad \Rightarrow \qquad \frac{A_{India}}{A_{US}} = \frac{T_{India}}{T_{US}} \cdot \frac{E_{India}}{E_{US}}.$$

Thus:

$$\frac{E_{India}}{E_{US}} = \frac{\frac{A_{India}}{A_{US}}}{\frac{T_{India}}{T_{US}}}.$$

Recall: the productivity differential between India and the US was 35%. Implying:

$$\frac{E_{India}}{E_{US}} = \frac{0.35}{0.92} = 0.38.$$

Conclude:

- the example suggests an efficiency differential of 38%.
- if India had all the production factors of the U.S. *and* all U.S. technology it would produce 38% of US output!

Yet, maybe India lags farther behind? $\rightarrow$ let's do the calculations more thoroughly...

Decomposition of the Productivity Gap between India and the US

G	T-ratio	E-ratio
10	0.92	0.38
20	0.85	0.41
30	0.79	0.45
40	0.72	0.48
50	0.67	0.52
65	0.59	0.59
75	0.55	0.64
100	0.45	0.78

Recall:

- most patents run out after 20 years (or less)
- technology is then world-wide freely available.

i.e. it is quite unrealistic that India is 50 years or more behind.

Conclude: the bulk of cross-country productivity differences is explained by different degrees of (in-) efficiency of technology use.

What about the most developed nations?

- these are "leading-edge" countries.
- they should operated about the same technology.
- if there are productivity differences they most likely reflect efficiency differences.

Productivity in Selected Industries in the Early 1990

	US	Japan	Germany
Automobiles	100	127	84
Steel	100	110	100
Food Processing	100	42	84
Telecommunication	100	51	42
Aggregate	100	67	89

Where do these differences come from?

- labor market regulations (breaks, shift work, firing costs)
- holidays, working hours
- governance, regulation, incentives

or what ?

Other causes:

- rent seeking (lawyers, special interest groups)
- bureaucracy, corruption
- the "allocation of talent"
- kleptocratic rulers, uncertainty
- geography (geographic barriers, heat)
- culture, religion, work ethic.

We'll come back to these issues in Part III (Deep Determinants). Here, we discuss only 1 aspect:

Misallocation of Factors among Sectors

- The economy's resources are (at at given time) used to produce the wrong things (in different regions of the country)
- Note the difference to the mechanism and consequences of Structural Change!

Consider:

- 2 Sectors produce 1 good each using labor (fixed capital stock)
- there are positive, decreasing returns to labor input.

[Efficient Allocation between Sectors]

Conclude (as in Micro I): efficient allocation where the marginal products of labor are equalized.

[Overallocation of Labor in Sector 1]

In a perfectly functioning market economy factors would be efficiently allocated "automatically"

- through the market mechanism
- labor mobility and flexible wages.

$\rightarrow$ 2 possible explanations for inefficiency.

1. Immobility: people cannot freely move from one sector to another
   - institutional barriers (e.g. taxes, tariffs)
   - family ties
   - geographic barriers (from country-side to city, or back?)

2. Inflexible wages
   - minimum wages in the high-wage (manufacturing) sector
   - one particular form of insufficient wage flexibility arises almost naturally…

Family farms:

- members of the (extended) family work together
- on their own (fixed) piece of land
- they don't receive a formal wage

output is divided among family members $\rightarrow$ L is paid according to its *average* product.

Production (land normalized to one):

$$Y = AL^{\alpha} \qquad \Rightarrow \qquad \frac{Y}{L} = AL^{\alpha-1} > w = \alpha AL^{\alpha-1}$$

Conclude: there are inefficiently many workers on family farms:

[Overallocation of Labor in Family Farms]