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# International Studies & AAE 374

## Growth and Development of Nations

Lecture 18  
10 November 2009

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### **I. Introduction to Lecture**

#### **A. Beyond Exogenous "A" in the Solow Model**

1. Recall  $Y = A * F(K, L, H)$  as our basic output function with A being the measure of technology.
2. We called A a measure of our ignorance because after accounting for accumulation of K, L, and H, it turns out that changes in A (technology or whatever) explain a lot of growth.
3. Now we are moving away from formal model to get inside of A in various ways.

#### **B. Start with another quick look at the early American Industrial Success**

1. Argue that there might have been a nice connection between A, K, and natural resource abundance in US that made for highly productive industries.
2. See a strong tie between what US exports and technologies that use a lot of natural resources that US had in abundance relative to discoveries in the rest of world at that time.

#### **C. Move onto Increasing Returns to Scale (internal to firm and external in sectors)**

1. Increasing returns to scale breaks away from the Solow view of diminishing returns to inputs (esp. capital) and argues that there may be opportunities for firms or sectors of the economy to become more efficient by growing larger or learning over time.
2. Implications for convergence/divergence should be obvious. Head start or positive feedback loops could lead to even more rapid growth for those who can get into position to exploits IRS and achieve endogenous growth of fall into traps.

#### **D. Learning-by-doing model (modifying Solow world to show how technology can mitigate diminishing marginal returns)**

### **II. Origins of American Industrial Success Redux (Wright)**

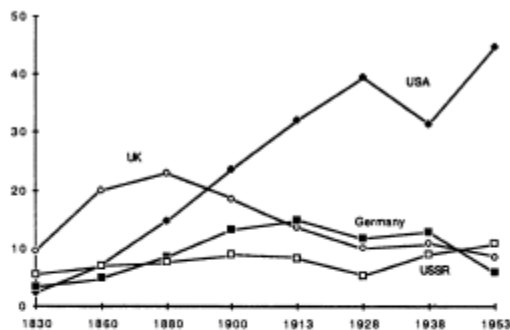
#### **A. Revisiting of the 1879-1940 American manufacturing export "success" – Basic Idea**

1. Derived from congruence between US abundance in natural resources and technological congruence of advancing industries that were resource-intensive. Made for lower cost production in US of a range of export products
2. Leadership was not based on skill-intensive or capital-intensive exports.

### B. Initial Evidence

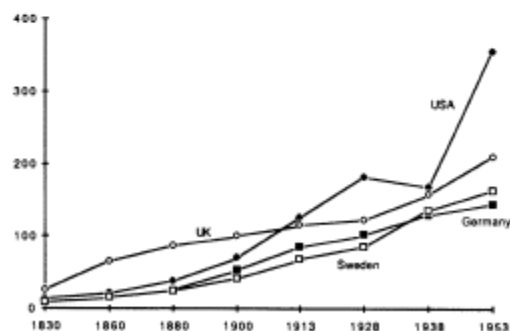
1. Charts 1 and 2 show the takeoff in US industrial performance after 1890.
2. Leading exports in 1890s were US shoes, machine tools, and engineering goods. Steel, machine tools, and cars in early 20<sup>th</sup> century.
3. Rise in late 19<sup>th</sup> early 20<sup>th</sup> century coincided with period when: US was the world's leading producer of:
  - (a) Coal
  - (b) Copper
  - (c) Petroleum
  - (d) Iron ore
  - (e) Zinc
  - (f) Phosphate, and so on

CHART 1. SHARES OF WORLD INDUSTRIAL OUTPUT, 1830-1953



Source: Bairoch (1982, pp. 296, 304).

CHART 2. INDUSTRIAL OUTPUT PER CAPITA



Source: Bairoch (1982, pp. 294, 302).

### C. Deeper Look at the Evidence

What is Wright looking for?

Factor intensity of trade and how it shifts as US export boom occurs.

1. Table 1 – Capital Labor Ratios

- (a) American exports are more capital intensive from 1879-1928 but export surge in early 20<sup>th</sup> century is not marked by a shift toward capital intensive manufactured exports.
- (b) Decline in food processing exports actually behind some of downward trend in K/L ratio in X/M.

TABLE 1—CAPITAL-LABOR RATIOS FOR MANUFACTURED GOODS, 1879–1940  
(\$000 PER EMPLOYEE IN 1909 DOLLARS)

|                 | A. 1899 Coefficients |       |       |       |       |       |
|-----------------|----------------------|-------|-------|-------|-------|-------|
|                 | 1879                 | 1899  | 1909  | 1914  | 1928  | 1940  |
| Exports         | 4.186                | 4.059 | 4.052 | 3.961 | 3.946 | 3.374 |
| Imports         | 2.608                | 2.886 | 2.785 | 2.850 | 2.907 | 3.221 |
| Exports/Imports | 1.61                 | 1.41  | 1.46  | 1.39  | 1.36  | 1.05  |
|                 | B. 1909 Coefficients |       |       |       |       |       |
|                 | 1879                 | 1899  | 1909  | 1914  | 1928  | 1940  |
| Exports         | 5.405                | 4.877 | 4.967 | 4.811 | 4.959 | 4.193 |
| Imports         | 2.999                | 3.079 | 3.020 | 3.073 | 3.486 | 4.444 |
| Exports/Imports | 1.80                 | 1.58  | 1.64  | 1.57  | 1.42  | 0.94  |
|                 | C. 1947 Coefficients |       |       |       |       |       |
|                 | 1879                 | 1899  | 1909  | 1914  | 1928  | 1940  |
| Exports         | 4.725                | 5.170 | 6.350 | 6.790 | 6.330 | 5.265 |
| Imports         | 2.910                | 3.440 | 3.420 | 3.690 | 4.325 | 5.850 |
| Exports/Imports | 1.62                 | 1.50  | 1.86  | 1.84  | 1.46  | 0.90  |

Sources: 1899 coefficients from Mary Locke Eysenbach, *American Manufactured Exports, 1897–1914*, New York: Arno Press, 1976, pp. 302–306; 1909 coefficients from U.S. Census of Manufactures; 1947 coefficients from Wassily Leontief, “Factor Proportions and the Structure of American Trade,” *Review of Economics and Statistics*, November 1956, 38, 403–407.

Trade Figures: for 1879, 1899, 1914 from Eysenbach, pp. 271–275; 1909, 1928, 1940 from U.S. Commerce Department, *Foreign Commerce and Navigation of the United States*. Exact industry groupings available on request.

2. Table 2 – Skill Intensity

- (a) Again, no discernible upward trend in high wage L or average wage in X sector, suggesting that skill not behind X surge of first half of 20<sup>th</sup> century.
- (b) Post WWII data probably would not look the same.

TABLE 2—MEASURES OF SKILL INTENSITY OF MANUFACTURED GOODS, 1879–1940

|                 | A. Percentage Earning More than \$12/Week in 1890 |       |       |       |       |       |
|-----------------|---|-------|-------|-------|-------|-------|
|                 | 1879  | 1899  | 1909  | 1914  | 1928  | 1940  |
| Exports         | 52.3  | 48.7  | 48.2  | 45.9  | 46.6  | 42.9  |
| Imports         | 48.5  | 45.7  | 47.1  | 44.1  | 42.3  | 41.3  |
| Exports/Imports | 1.08  | 1.07  | 1.02  | 1.04  | 1.10  | 1.04  |
|                 | B. Average Wage (1909)                            |       |       |       |       |       |
|                 | 1879  | 1899  | 1909  | 1914  | 1928  | 1940  |
| Exports         | 0.467   | 0.482 | 0.487 | 0.502 | 0.504 | 0.541 |
| Imports         | 0.431   | 0.433 | 0.460 | 0.426 | 0.463 | 0.471 |
| Exports/Imports | 1.09  | 1.11  | 1.06  | 1.18  | 1.09  | 1.15  |
|                 | C. Percentage Women and Child Labor (1909)        |       |       |       |       |       |
|                 | 1879  | 1899  | 1909  | 1914  | 1928  | 1940  |
| Exports         | 10.1  | 10.7  | 9.9   | 11.0  | 11.2  | 10.4  |
| Imports         | 30.6  | 29.0  | 30.2  | 27.8  | 24.2  | 21.1  |
| Exports/Imports | 0.33  | 0.37  | 0.33  | 0.40  | 0.46  | 0.49  |

Sources: Percent \$/week from Eysenbach, pp. 307–311; average wage from 1909 Census of Manufactures (wage bill divided by labor force); women and child labor from 1909 Census of Manufactures (females aged 16 and over, under 16, and males under 16, divided by labor force).

### 3. Table 3 – Nonrenewable Natural Resources Coefficients

- US exports had a substantially higher natural resource content than imports, “and this trend was growing both absolutely and relatively over precisely the historical period when the country was moving into a position of world industrial preeminence.”
- Resource intensity of imports growing, too, and trend is reversed after 1928 and gone by 1943.
- Regression analysis in Tables 4 and 5 confirms this descriptive evidence and also illustrates the complementary nature of capital and natural resources, especially in the years 1914 and 1928.

TABLE 3—NONRENEWABLE NATURAL RESOURCE COEFFICIENTS IN MANUFACTURING GOODS, 1879–1940 (1947 COEFFICIENTS)

|                 | A. Direct Use              |        |        |        |         |        |
|-----------------|----------------------------|--------|--------|--------|---------|--------|
|                 | 1879                       | 1899   | 1909   | 1914   | 1928    | 1940   |
| Exports         | 0.0742                     | 0.0677 | 0.0918 | 0.0988 | 0.09984 | 0.0564 |
| Imports         | 0.0131                     | 0.0194 | 0.0170 | 0.0133 | 0.0290  | 0.0369 |
| Exports/Imports | 5.66                       | 3.49   | 5.40   | 7.43   | 3.39    | 1.53   |
|                 | B. Direct and Indirect Use |        |        |        |         |        |
|                 | 1879                       | 1899   | 1909   | 1914   | 1928    | 1940   |
| Exports         | 0.1107                     | 0.1239 | 0.1647 | 0.1800 | 0.1635  | 0.1240 |
| Imports         | 0.0565                     | 0.0747 | 0.0766 | 0.0749 | 0.0934  | 0.1127 |
| Exports/Imports | 1.96                       | 1.66   | 2.15   | 2.40   | 1.75    | 1.10   |

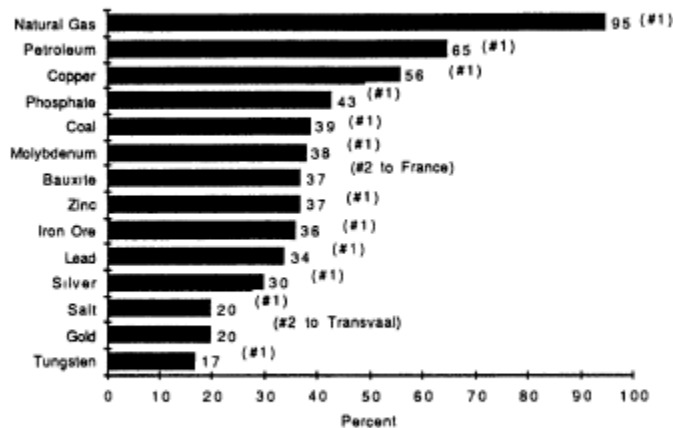
Sources: Coefficients from Eysenbach, pp. 297–301; trade figures, see Table 1.

### 4. Natural Resources and American Industrial Success

- Chart 3 – US leading share of mineral output worldwide in 1913. Important because of high transport cost era made US uniquely situated with respect to major minerals.
- Allowed the US to take advantage of the high throughput of mass production factories where these abundant and low-cost resources could have been especially advantageous for competitiveness of US manufacturers.

- (c) US Manufacturing Exports led by Iron and Steel, Machinery, and Autos, add in petroleum products, and have 50% of US manufactured exports. All of these had a strong reliance on raw materials. Ford UK, for example, paid 50% more for their steel inputs than the parent company. About half of cars value came from metal inputs.
- (d) US firms' high productivity and high wages may have been associated with the high throughput, low cost materials that allowed them to look more productive, not based necessarily on skill/technology but rather on complementarity between input needs of products and costs of those inputs.

CHART 3. U.S. MINERAL OUTPUT, 1913:  
PERCENTAGE OF WORLD TOTAL



Source: Smith (1919), using data from U.S. Geological Survey (1913).

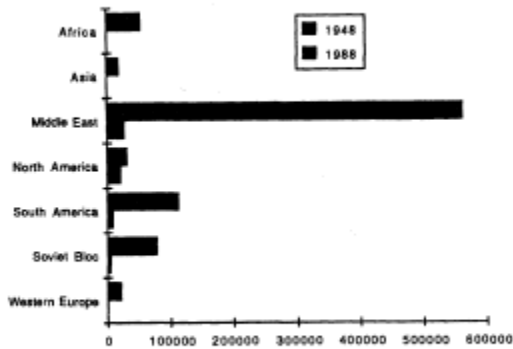
## 5. End of this era

- (a) Starting in 1920s, US becomes net importer of most minerals (nonferrous metals, bauxite, lead, zinc, copper, iron ore, and petroleum) which means that no longer in a preferred position. Chart 3

What happened? Lots of discoveries elsewhere (Chart 6). US had been heavily explored in late 19<sup>th</sup> century. Rest of world push in early 20<sup>th</sup> century. Notice especially Mideastern oil.

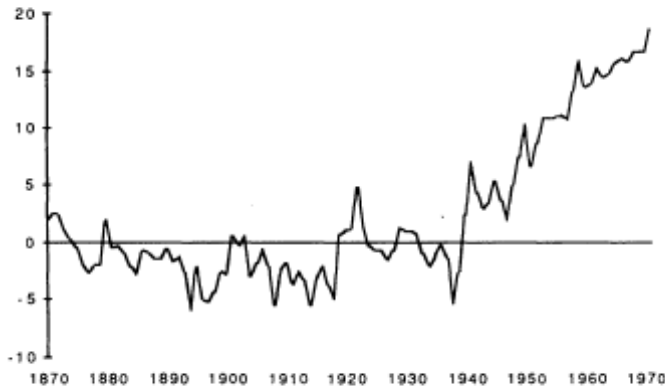
- (b) Development of “abundance” in US was related to large size and integrated national transport system linking for example Mesabi ore in Minnesota to Pennsylvania coal.
- (c) Since that time, the globalization of resource industries has served to erode the national advantage of natural resources that played a key role in US in that era.

CHART 6. WORLD CRUDE OIL RESERVES, 1948 AND 1988



Source: American Petroleum Institute (1988, Section II, Table 1): "Estimated Proved Reserves of Crude Oil Annually as of January 1 (millions of barrels)."

CHART 4. U. S. NET MINERAL IMPORTS AS A PERCENTAGE OF CONSUMPTION



Source: Manthy (1978, Tables MC1 and MC2).

*D. Value of this argument to our class*

1. Gives one solid historical example of an endogenous technology story that was crucial to the long-term US economic success and suggests how it can match up with other key resource endowments.
2. Also, shows the ephemeral nature of "success" and leadership.

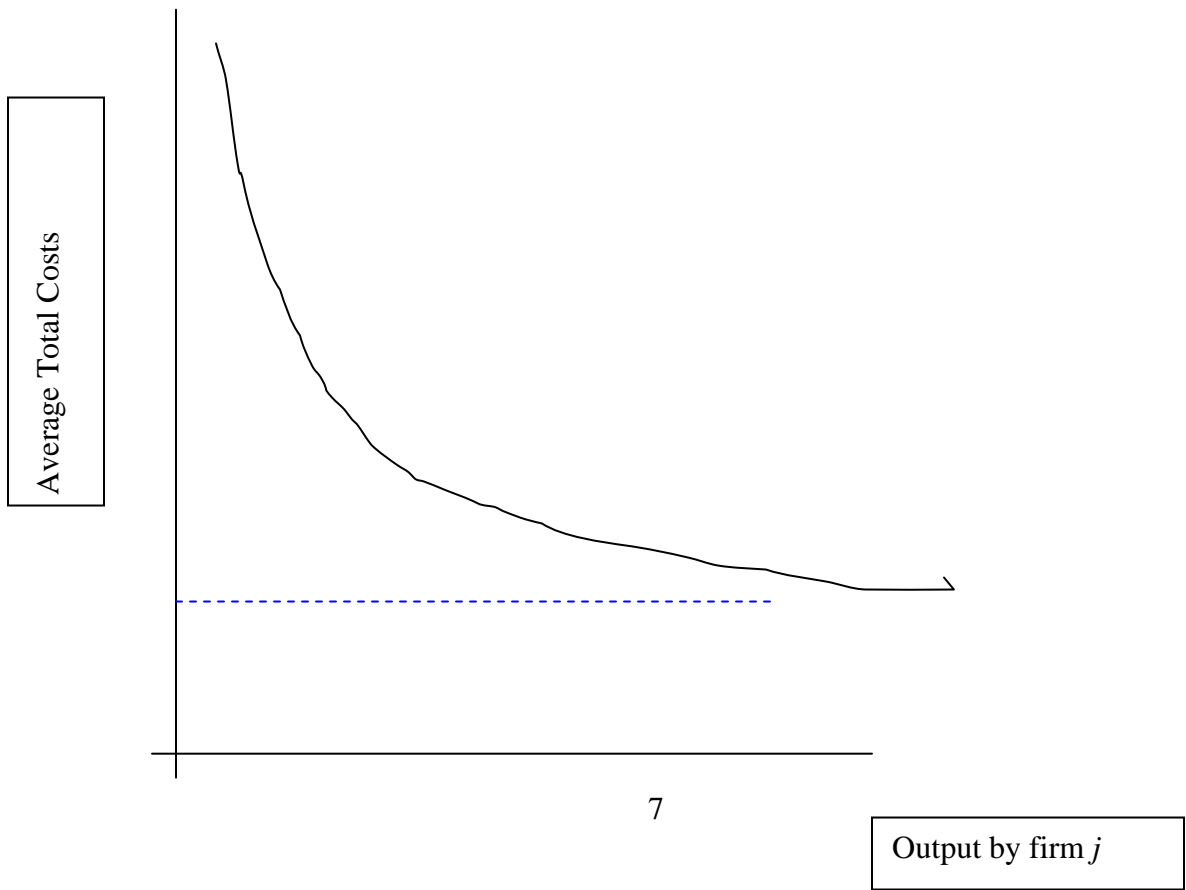
### III. Increasing Returns to SCALE, or Why Size Matters?

#### A. Dim Returns and Back again

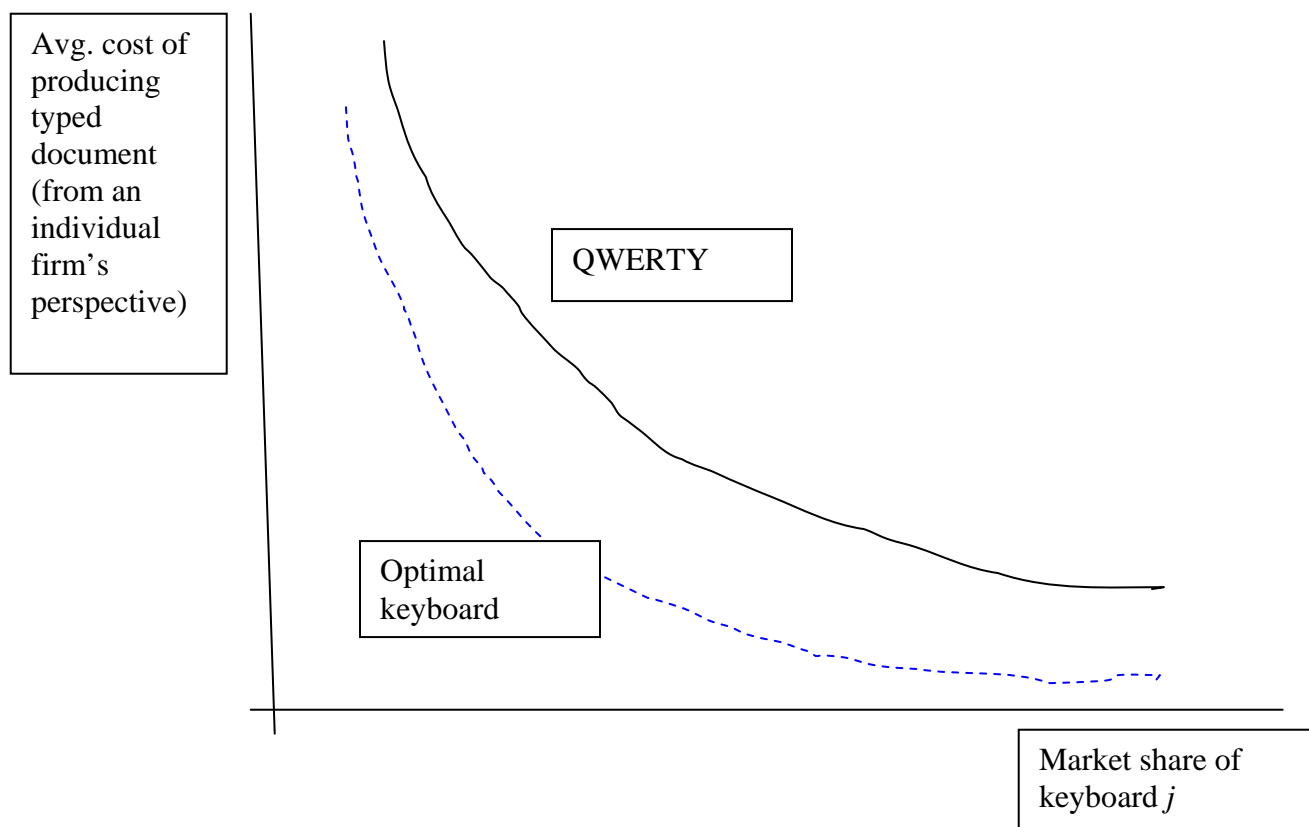
1. Diminishing returns – more capital, lower marginal return or productivity.
2. Crucial to convergence outcomes because justifies why capital would move to more productive and poorer places. But, what if the returns are not diminishing?
3. Explore two types of increasing returns examples.

#### B. Internal scale economy example <do a CRTS example first> scale of firm j's production

|                                 |  |        |
|---------------------------------|--|--------|
| Fixed Costs                     | 0  | 1000   |
| Variable Unit Costs             | 10   | 10     |
| Total Average Costs if produce: | $TAC = (VUC * N\_units + FC) / (N\_units)$ |        |
| 10 units                        | 10   | 110    |
| 100 units                       | 10   | 20     |
| 1000 units                      | 10   | 11     |
| 1,000,000 units                 | 10   | 10.001 |



C. *External/pecuniary QWERTY Example—stress complementarities/coordination side of story;*



D. *Other examples of pecuniary externalities*

1. Supplier networks
2. Labor markets
3. Innovation (as in Nelson & Wright)

E. *Why these are all positive feedback examples*

1. Result in arbitrary outcomes (could have been betamax, not VHS)
2. Traps (QWERTY and VHS)

## IV. Leaks, Matches and Traps

A. Setup: At this point in his book, Easterly is reviewing that “Neither aid no investment nor education nor population control nor adjustment lending nor debt forgiveness proved to be the panacea for growth.” Now we’ll start looking for other things...

B. Basics of leak story:<sup>1</sup>

1. Dosh garments opens in Bangladesh, 1980 (43,000 shirts at \$1.28 each ~ \$55k)
2. \$2b in short time (later as 54% of total exports)
3. 130 workers trained by Daewoo in 1979 (& why did Daewoo do this in 1<sup>st</sup> place?)
4. 6/30/81 Cancel agreement with Daewoo
5. 115 of 130 exited Dosh to start own firms (over 700 by 1985)

C. *Leaks and Matches: Elements from Dosh shirt making example:*

1. Knowledge non-rivalrous (Daewoo to Dosh) & leaks
2. Knowledge spills over/knowledge begets knowledge and know-how
  - (1) Note huge growth that could not be stopped even after Daewoo left
  - (2) Note also that Daewoo could not privately capture all returns (nor ultimately could Dosh)
  - (3) Note unanticipated ‘public’ returns to Daewoo investments made in the 1960s.
3. Agglomeration (Dosh versus rival, Mohammadi Apparel)
  - (1) Pre-Dosh, would have been unprofitable to invest
  - (2) After Dosh, investment became profitable

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<sup>1</sup> From [doshgroup.com](http://doshgroup.com): “The Chairman and CEO of the Group, Mr. M. Noorul Quader, by education an economist, with honors from the university of Dhaka and higher education from Cambridge university, England, was until 1974, a career civil servant. As Secretary to the Government of Bangladesh, he headed several ministries like the Establishment Division of Cabinet Affairs, Communication, Railways, Shippings, Water Ways, Airways etc. He Was also the founder Chairman of Bangladesh Parjatan Corporation, the Tourism Corporation.”



- (a) Knowledge plus
- (b) One dozen trained workers from Deseh
- (3) Labor (and other supplier) side of story

- 4. 'Traps' of History: vicious or virtuous circles?
  - (1) Why not do it everywhere?
  - (2) Incentive issues
  - (3) Ironies in Deseh story (& more contemporary Africa Growth with Opportunity Act, AGOA preferential treatment, maybe Daewoo story again).
  - (4) Domestic examples?

*D. Complementarities and Expectations*

- 1. Are skills substitutes (diminishing returns) or complements (returns increasing with number of other skilled folk)?
- 2. Easterly's examples of star chefs in Morocco (goes to France) and Indian surgeons (go to the West)
- 3. More serious examples
  - (1) Brain Drain (54% of World gdp on 10% of land area)
  - (2) Urban pull (and prices!) (2% of land in US produces 50% of GDP)
- 4. Traps of Expectations

*E. So what are implications for public policy???*

- 1. Educated Indian 14 times more likely to emigrate than uneducated
- 2. Gunsham and Bhutibai at Donutland: Why not more Gunshams?

*F. Now go forward to look at a model of matching, expectations and traps*

## V. *A Learning-by-doing Model of Endogenous Growth & Traps of History*

A. *Let's now use our standard technological specification, but look at it from the perspective of an individual firm 'j' that take same technological specification:*

$$Y_j(t) = A(t)K(t)_j^\alpha L(t)_j^{1-\alpha}$$

*where the 'j' subscripts indicates inputs for firm j. Note, however, that the technology multiplier is economy wide. This creates the sort of interdependence between firms and business emphasized by Easerly.*

B. *Now assume that (recall  $k(t)=K(t)/L(t)$ )*

$$A(t) = ak(t)^\beta$$

1. *How does this make sense??*
2. *Label this as a "learning by doing" specification of technological change. Strong elements of this in both Nelson/Wright & Easterly.*

### C. Analysis of Endogenous Technical Change

1. Lets consider the special case where  $\beta = (1-\alpha)$  that

$$A(t) = ak(t)^{(1-\alpha)} = a(K(t) / L(t))^{1-\alpha}$$

2. If we now combine this assumption with our usual economy-wide production function (ignore  $j$  now), we find the following:

$$\begin{aligned} Y(t) &= [ak(t)^{(1-\alpha)}]K(t)^\alpha L(t)^{1-\alpha} \\ &= aK(t)\left(\frac{L(t)}{L(t)}\right)^{1-\alpha} = aK(t) \end{aligned}$$

3. Note that by doing this, we have effectively eliminated diminishing returns to capital at the economy-wide level. That is even though increasing investment at the firm level brings diminished returns to further capital accumulation, the spillover in increased in productivity just off-sets the diminished returns. (the fact that the increase in productivity “just” off-sets the diminished returns is an reflection of our rather special assumption—but this special assumption very nicely illustrates the idea.

4. To see this even more clearly, assume that the economy has one unit of labor (e.g., one “country’s worth of people). In this case, we can write output per unit of labor as:

$$y(t) = ak(t)$$

5. That is, per-capita output is linear (non-diminishing) in capital, exactly as in the Harrod-Domar model (with  $a = \frac{1}{\theta}$ )!

6. *Note that we arrive at this NOT by abrogating the appealing idea that returns diminish, but by saying that although returns diminish, new learning offsets the diminishing returns. In this case, growth in already countries need not slow down, explaining the lack of convergence.*

D. *See how this can create a trap of history: history matters, which ever country grows first will tend to grow fastest ... .*

E. *Next class we will look at an expectational trap story. Key addition is going to be to add in two sectors, with different prospects for endogenous tech change. Please look at Weil 9.3. <<also look at Pack and Saggi>>*