EDUCATION (II)

How Large is the Contribution of Human Capital Accumulation to Income Growth?

1. The Model

2. Growth Decomposition

THE MODEL

- More educated workers are more productive.
- If a country has more educated people, it will enjoy faster economic growth.
- How do we measure the contribution from "more education"?
- Recall:

• Fact: Micro data show that 1 more year in schooling causes roughly 10% wage increase.

- Let's reconcile this fact.
- ASSPT: **Human capital** is accumulated by schooling.

  (Just as physical capital is accumulated by investment.)

THE MODEL

- Model: $Y_t = A_t(K_t)^{0.32}(L_t)^{1-0.32}$ is now replaced by

$$Y_t = A_t(K_t)^{0.32}(h_t L_t)^{1-0.32}.$$

- Here,
- h_t: Human capital holding of an average worker.

  A worker with $h_t = 2$ is as productive as two workers with $h_t = 1$.

  If more education, then $h_t \uparrow$.
- A_t: Everything else
- Problem: How do we relate the years of schooling to h_t?

THE MODEL

- Let's think:

Worker A	Worker B
10-year schooling	9-year schooling
Notation: $S_A = 10$	Notation: $S_B = 9$
Salary is 10% higher. That is, A is like 1.1 people of B's.	
$h_A = f(S_A) = f(10)$	$h_B = f(S_B) = f(9)$

- Want: $\frac{f(10)}{f(9)} = 1.1$.
- This can be done by $f(S) = e^{0.1S} \approx 2.718^{0.1S}$ where e is "Euler's number."
- An Excel command for $e^{0.1\times10}$ is =exp(0.1*10).

THE MODEL

- $f(10) = e^{0.1\times10} = 2.72$.
- $f(9) = e^{0.1\times9} = 2.46$.
- So we do have $\frac{f(10)}{f(9)} = \frac{2.72}{2.46} = 1.105$, which is what we want.
- $f(S) = e^{0.1S}$ is good.

- $\frac{f(2)}{f(1)} = \frac{1.22}{1.11} = 1.105$
- $\frac{f(3)}{f(2)} = \frac{1.35}{1.22} = 1.105$
- …
- $\frac{f(10)}{f(9)} = \frac{2.72}{2.46} = 1.105$

EDUCATION (II)

What is the Contribution of Human Capital Accumulation to Income Growth?

1. The Model
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GROWTH DECOMPOSITION

- **Question**: How large is the contribution of education in the U.S. economic growth?
- Assumption: Every person is identical (with same S).
- According to Barro-Lee data (at http://www.cid.harvard.edu/ciddata/ciddata.html), average schooling years for 25 years old and above:
  - 1960: 8.66 years, 2000: 12.25 years

GROWTH DECOMPOSITION

- So $h_{1960} = f(S_{1960}) = f(8.66) = e^{0.1\times 8.66} = 2.38$
  (Again, the Excel command is =exp(0.1*8.66).)
- And $h_{2000} = f(S_{2000}) = f(12.25) = e^{0.1\times 12.25} = 3.40$
- Go back to our growth accounting:
- Let's do it with per-capita GDP (This is the second version of growth accounting that we tried for physical capital accumulation):
  - Before: $Y_t = A_t(K_t)^{0.32}(L_t)^{1-0.32}$
  - Now: $Y_t = A_t(K_t)^{0.32}(h_tL_t)^{1-0.32}$

GROWTH DECOMPOSITION

- Before: $\frac{Y_t}{L_t} = \frac{A_t(K_t)^{0.32}(L_t)^{1-0.32}}{L_t} = A_t(K_t)^{0.32}(L_t)^{-0.32} = A_t\left(\frac{K_t}{L_t}\right)^{0.32}$
- Now: $\frac{Y_t}{L_t} = \frac{A_t(K_t)^{0.32}(h_tL_t)^{1-0.32}}{L_t} = A_t(K_t)^{0.32}(h_t)^{1-0.32}(L_t)^{-0.32} =$

  $A_t(h_t)^{1-0.32}\left(\frac{K_t}{L_t}\right)^{0.32}$
- Before: $\log\left(\frac{Y_t}{L_t}\right) = \log\left(A_t\left(\frac{K_t}{L_t}\right)^{0.32}\right)$
- Now: $\log\left(\frac{Y_t}{L_t}\right) = \log\left(A_t(h_t)^{1-0.32}\left(\frac{K_t}{L_t}\right)^{0.32}\right)$

GROWTH DECOMPOSITION

- $\log(Y_t) - \log(L_t) = \log(A_t) + \log((h_t)^{1-0.32}) + \log\left(\left(\frac{K_t}{L_t}\right)^{0.32}\right)$
- $\log(Y_t) - \log(L_t) = \log(A_t) + 0.68\log(h_t) + 0.32\log\left(\frac{K_t}{L_t}\right)$
- $\log(Y_t) - \log(L_t) = \log(A_t) + 0.68\log(h_t) + 0.32(\log(K_t) - \log(L_t))$
- $\log(Y_{t+1}) - \log(L_{t+1}) =$

  $\log(A_{t+1}) + 0.68\log(h_{t+1}) + 0.32(\log(K_{t+1}) - \log(L_{t+1}))$
- $g_Y - g_L = g_A + 0.68g_h + 0.32(g_K - g_L)$

GROWTH DECOMPOSITION

- Now the growth of real per-capita GDP (LHS) is decomposed into (i) a contribution from productivity growth and (ii) a contribution from educational improvements and (iii) the growth of per-capita physical capital stock.
- So how big is (ii)?
- We are looking for g_h in

$$h_{1960}(1+g_h)^{2000-1960} = h_{2000}$$

- So

• $2.38(1+g_h)^{2000-1960} = 3.40$

• $(1+g_h)^{2000-1960} = \frac{3.40}{2.38}$

GROWTH DECOMPOSITION

• $1+g_h = \left(\frac{3.40}{2.38}\right)^{\frac{1}{2000-1960}} = 1.009$

- So $g_h = 0.009$.
- Therefore,

$$g_Y - g_L = g_A + 0.68g_h + 0.32(g_K - g_L)$$

2.2% 0.6%

- Contribution from improvements in educational attainment is

$$\frac{0.6\%}{2.2\%} = 27\%$$

of per-capita GDP growth in the U.S.

GROWTH DECOMPOSITION

- REMARK: But is this a correct way?

- Using a cross-sectional result (10% returns to schooling) for a time-series analysis (assuming everyone is the same)?
- Other sources of human capital accumulation: On-the-job training? In-home training with parents?
- Human capital externalities are missing.