Various Human Capital Issues

David N. Weil

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Ben Jones, “The Knowledge Trap”

- Paper has two relatively disjoint parts
  - Critique of standard “Mincerian” treatment in development accounting
  - Model to explain differences in quality of human capital between rich and poor countries
- Putting these together, he concludes that differences in human capital can explain a lot of the gap in income between rich and poor countries.
- This is in contrast to the usual development accounting finding that human capital is not so important
- Related issue: the Lucas (1988) model puts human capital at the center of growth and income differences. Like Lucas, Jones stresses the “ideas” aspect of human capital in contrast to the “training” aspect.
We usually look at the *quantity* of human capital, measured in years, possibly quality adjusted.

He stresses a different aspect: degree of specialization

- examples: you can be a “general engineer” of a specialist in a very narrow area
- Getting a project done requires many skills. It is better for many specialists to each do their own thing, but in many developing countries, one person has to do them all. And for some types of projects, there is no way that one person could even have all the relevant skills.
- We observe that specialist training is much more available in rich countries (course catalogues from MIT vs University of Khartoum).
Production requires two skills: A and B
Two choices in training: generalist or specialist
- generalist gets $H_A = H_B = 1$
- specialist gets $m > 1$ at one task and 0 at the other

NOTE: his notation is messed up. In the below, $H$ suddenly becomes the time input by each type of human capital. Each individual is endowed with one unit if time.

- Generalist production is $Y = \sqrt{H_A H_B}$
  - output per worker is $1/2$ (generalist devotes $1/2$ of his time to each task)

- Specialist production is $Y = c\sqrt{H_A H_B}$
  - $c < 1$ is the coordination penalty
  - output per worker is $\frac{1}{2}mc$ (two specialists work together, each devoting one unit of time)

if $mc > 1$ then specialization raises output
Specialist vs. Generalist

- generalist: $1/2$
- specialist: $\frac{1}{2} mc$ where $c < 1$ and $m > 1$
- which is bigger will depend on values of $m$ and $c$
- Maybe in poor countries values of $m$ and $c$ are such that there is no specialization
- $m$ might be small
  - in poor countries, specialist training may not be available or be of low quality
    - This is certainly true, but note that this comes close to just saying that human capital production is poor in poor countries, in which case we didn’t need this whole model.
- $c$ might be small
  - bad institutions could lead to frictions in processes that involve many workers (analogous to poor capital markets).
More interesting possibility is that two equilibria can exist

Consider the problem of a someone deciding on training in a country where all human capital is generalist

- as a generalist she would earn $1/2$
- As a specialist, she would team with a generalist to do the other task
  - she would pay the generalist $1/2$, which is his opportunity cost
  - specialist income would be $c\sqrt{m} \times 1 - \frac{1}{2}$ [NOTE: this is not what it says in his paper, but I think that his notation is messed up – it doesn’t matter for the story.]
  - so if $c\sqrt{m} - \frac{1}{2} < \frac{1}{2}$ then individual will not choose to specialize.
  - It is possible that $c\sqrt{m} < 1 < cm$ in which case an inefficient generalist equilibrium is stable
Even if we don’t believe the multiple equilibrium story, the mechanism here can be viewed as a multiplier that will exacerbate the effects of other factors.

These could be differences in $c$ and $m$ among countries or they could be things not related to human capital at all (general productivity, capital market imperfections, etc.).

Second part of the paper, we will just assume that human capital in poor country is not as productive as in a rich country, without worrying whether it is through the generalist/specialist channel or some other reason.
Mincerian return \( r_m \) comparing two levels of schooling \( s' > s \)

\[
w(s) = w(s') e^{r_m(s-s')}
\]

This can be re-written as

\[
e^{r_m(s'-s)} = \frac{w(s')}{w(s)}
\]

and

\[
r_m(s'-s) = \ln(w(s')) - \ln(w(s)) \approx \frac{w(s') - w(s)}{w(s)} \approx \frac{w'(s)}{w(s)}(s' - s)
\]

\[
r_m \approx \frac{w'(s)}{w(s)}
\]

\( r_m \) is the percentage increase in wages from an additional year of schooling.
Suppose that there is infinite elasticity of substitution among different types of human capital.

Let $w$ be the wage per unit of human capital (which will vary across countries).

Let $h(s)$ be the function that gives human capital as a function of schooling.

$w(s) = w \times h(s)$

$$\frac{w'(s)}{w(s)} = \frac{h'(s)}{h(s)}$$

The Mincerian return informs us about the slope of the $h(s)$ function.

The fact that Mincerian returns look “sort of the same” across countries implies that production of human capital is sort of the same across countries and that $h(s)$ function looks sort of the same.
Aside: Caselli and Ciccone (2013)

- They think about $w(s)$ function (without worrying about production of human capital varying across countries.
- Suppose that high and low skill people are not perfect substitutes. Then $w'(s)$ should fall with the level of schooling.
- The standard development accounting exercise asks “what would happen if we raised schooling, holding the return to schooling constant”
  - if high and low skill are not perfect substitutes, raising school would lower the return to skill (see Bils and Klenow).
- One picture (that I made!) summarizes their paper (next slide).
- Bottom line: standard development accounting overstates the contribution of human capital differences to income differences.
Fig. 1. Change in income from change in schooling.
Suppose that the worker chooses schooling optimally. He is trying to maximize PDV of lifetime earnings

- only cost of schooling is opportunity cost
- for convenience, infinite horizon
- discounts future cash flows at some rate $r$

\[
y(s) = \int_s^\infty w(s)e^{-rt}dt
\]

Solving the integral (which is easy when we note that it is just the infinite PDV discounted from time $s$)

\[
y(s) = \frac{w(s)e^{-rs}}{r}
\]
Taking the derivative of the expression on the last page w.r.t. \( s \)

\[
0 = \frac{w'(s)e^{-rs} - w(s)re^{-rs}}{r}
\]

implying:

\[
\frac{w'(s)}{w(s)} = r
\]

in words: “Stop schooling when the rate of growth of the wage is equal to the discount rate”

This is the standard condition from the Mincer model of schooling
Optimality Condition and Mincerian Return

Optimality condition:

\[ \frac{w'(s)}{w(s)} = r \]

Mincerian return:

\[ \frac{w'(s)}{w(s)} = r_m \]

- If an individual is indifferent between choosing \( s' \) or \( s \), then the Mincerian return \( r_m \) will be equal to the discount factor \( r \).
- If countries have the same \( r \), then they will have the same Mincerian return even if
  - they have differently shaped \( h(s) \) functions (i.e. one produces human capital from schooling more efficiently than the other)
  - The assumption of infinite elasticity of substitution among levels of human capital doesn't hold
What is $r$? Presumably, it is not the safe interest rate (which is like 2%), since the Mincerian return is like 10%.

So $r$ is the effective discount rate, which can take into account risk, liquidity constraints, etc.

We would expect $r$ to be higher in developing countries, which would explain their having higher Mincerian returns.

Big point: Mincerian return does not tell us about the $h(s)$ function or how $w'(h)$ varies.

Big issue: how is number of years of schooling actually determined?

- Jones: unconstrained optimization
- Alternative view: variation among families in $r$ or liquidity constraints, variation in availability of schooling, etc.

I think that the alternative view is closer to being right, but I don’t really know.

Also: All this assumes that we are measuring $r_m$ purged of ability bias!!!!!!
Other Issues with Using the Mincerian Return

- **Sorting and signalling:** to the extent that these are reflected in Mincerian return, it overstates the importance of education for income differences
  - labor economists use quarter of birth, etc. to identify Mincerian return in rich countries, but we generally don’t have this in poor countries.

- **Directed technological change**
  - Technology not really factor neutral. Different technologies complement different factors (skilled vs. unskilled labor; labor vs. capital)
  - What technology is developed is (partially) market driven: use most abundant factors
  - This (partially or fully) un-does the effect of imperfect substitution, so that a rise in the skill ratio can either not lower skill premium much, or even raise it!
Does schooling cause growth or the other way around?

Motivation: regress growth on initial schooling, get a big coefficient

- We think that this is horribly identified, but still (maybe) useful as a starting point for thinking about magnitudes

- They try to think through how big the magnitudes should be for two effects:
  - higher schooling raises human capital, which causes growth
  - future growth raises investment in human capital

I will just look at two pieces of the paper
They start with a dataset of estimates of Mincerian returns from a large sample of countries mostly from Psacharopolous (who compiles these)

Allow Mincerian return to vary with level of schooling. Functional form is:

$$\phi(s) = \frac{\theta}{1 - \psi} s^{1 - \psi}$$

implying

$$\phi'(s) = \theta s^{-\psi}$$

taking logs:

$$\ln(\phi'(s)) = \ln(\theta) - \psi \ln(s)$$

This doesn’t come from theory - the idea is just to have a functional form that allows us to see how the Mincerian return varies with level of schooling.
\[ \ln(\phi'(s)) = \ln(\theta) - \psi \ln(s) \]

They estimate \( \psi = 0.58 \) (standard error 0.15)

They choose \( \theta = 0.32 \) to match the average Mincerian return in their sample (9.9%) 

Implies that the return to schooling is 

21% if \( s=2 \), 11.4% if \( s=6 \), 8.5% if \( s=10 \)

- Note that they are assuming that there is always only a single Mincerian return in a country, and that this varies with average level of schooling
- In principle, if people with different \( s \) are imperfect substitutes, the whole shape of the \( \phi(s) \) curve should vary with the shape of the education distribution (except is Jones is right).
- One might be able to estimate such a thing in the data underlying what is reported in Psacharopoulos
- great glory in this – but again, identification is a big problem.
Bils and Klenow use this estimate (and a whole lot of other structure) to ask whether it makes sense to think that differences in education caused differences in growth.

They decide that the answer is no. Magnitude of education→growth channel too small.

They then look at causation running in the other direction: from expected growth to education
\[ Y = K^\alpha (AH)^{1-\alpha} \]

Open economy, factors paid their marginal products, world interest rate \( r \)

\[ \alpha Y = (r + \delta)K \]

\[ (1 - \alpha)Y = wH \]

- Notice that because of the open capital market assumption (and Mincerian model of all human capital being the same input), raising \( H \) will not lower \( w \)
- Thus \( w \sim A \) (wage is just proportional to technology)
Individual born at time zero maximizes

\[ \int_0^T e^{\rho t} \frac{c(t)^{1-1/\sigma}}{1 - 1/\sigma} dt + \int_0^s e^{-\rho s} \zeta dt \]

where \( \zeta \) is the flow utility from going to school (relative to working – there seems to be no leisure here)

Subject to budget constraint:

\[ \int_s^T e^{-rt} w(t)h(t) dt = \int_0^T e^{-rt} c(t) dt + \int_0^S e^{-rt} \mu w(t)h(t) dt \]

where \( \mu \) is the ratio of tuition to the opportunity cost of student time.
Human capital production (simplified):

\[ h(a, t) = h(a + n, t)^\phi e^{f(s)} \]

where \( a \) is age and \( n \) is the generation length, so the first term is human capital of the teacher generation (see my paper?)

\( f(s) \) is the sort of function that we saw before

[Note: this is all a bit of a cheat: their model says that when \( s \) is high, years of schooling are converted to fewer units of human capital. But really we should think that in such a case, schooling is converted to the same thing, but it is worth less in the market. They are stuck doing it this way because they assume that there is only one kind of human capital. ]

This can be solved for a somewhat messy first order condition
If we set $\zeta = 0$ then we get:

- higher growth rate of $A$ raises optimal quantity of schooling
  [Reason: schooling has low opportunity cost in relation to high future wages]
- Level of $A$ does not affect optimal schooling choice
- Note: Galor and Weil (2000) have these same two results, but with a different mechanism for the first. In their case it is because of the effect that higher $A$ growth raises the return to education – story from TW Schultz.
- teacher generation human capital doesn’t affect optimal choice (because it shifts down costs and benefits of educational proportionally)
  - again, that leans heavily on the “one type of human capital” assumption. If raw labor earned a return, this result would not hold
Results – continued

- if $\zeta > 0$ (school is fun), then higher $A$ raises schooling. This is an income effect.
  - really? Hard to believe that higher $A$ doesn’t raise optimal schooling for other reasons. Gets into appropriate technology issue.
Conclusion from second part

- if there is exogenous variation in $A$ growth rates, and if enough of that variation is anticipated, then that can explain ability of schooling to predict growth

- I’m very skeptical of that model of education:
  - what about liquidity constraints, government policy, etc?
Does higher life expectancy raise schooling?

This could be considered a health→growth topic, but since the model is the same as what we just saw, I will do it here.

References:


The idea is obvious. Questions are:

- How big is the effect quantitatively?
- How much of the change in schooling during growth can it explain?

approaches: well-identified causal estimate or simple calculation

Empirical estimates require sharp, exogenous changes in expected mortality
Huntington Disease
- onset during adulthood, reducing life expectancy by 20 years and healthy life expectancy by 35 years (US data).
- 50% probability of one parent has it
- can take genetic test

- testing positive lowers probability of completing college by 30 percentage points
- extrapolated to cross-country data, implies that differences in mortality explain 10% of the observed variation in college enrollment
- so “horizon effects” matters some, but doesn’t explain most of the correlation of schooling with life expectancy.
- rapid reduction in maternal mortality in Sri Lanka over the period 1946-1953
- raised female life expectancy at age 15 (censored at 65) by 1.5 years, or 4%.
- Estimates, based on regional variation in maternal mortality as well as male-female differences, is that every extra year of life expectancy raised literacy by 0.7 percentage points and education by 0.11 years.
- 0.17 years of increased female schooling due to mortality reduction is small compared to the total increase of 1.5 years comparing women in the treated and untreated cohorts.
Simple Model

- earnings proportional to human capital, which is a function of schooling: \( h = f(s) \).
- Ignore trend growth in wages (Bils and Klenow); ignore how schooling is financed; ignore risk.
- Assume that the only cost of schooling is the opportunity cost of foregone wages.
- \( s \) is chosen to maximize

\[
\int_{s}^{\infty} S(a)f(s)e^{-ra}da
\]

where \( S(a) \) is the probability of survival to age \( a \).

- \( f(s) \) function from Bils and Klenow: \( f(s) = \frac{\Theta}{1-\Psi}s^{1-\Psi} \)
- \( \Theta = 0.32 \) and \( \Psi = 0.58 \).

(Why am I using this? General equilibrium, I guess. That might be lame, but the effect is small anyway)
time zero = age five.

This will be calibrated to match Hazan (2009) (next paper)
Start with $S(a)$ from age five for the cohort of males born in the
United States in 1850, when life expectancy at age five was 52.5
years. Hazan reports that this cohort received an average of 8.7
years of schooling.

I choose the real interest rate so that optimal schooling matches
this value.

The implied value of $r$ is 8.7%, which might be viewed as high.
However, given both that human capital investment carries risk,
and that the discount rate applied may reflect credit market
imperfections, I don’t think of this value as unreasonable.

I hold the other parameters constant and change the $S(a)$ function
to match that of the cohort born in 1930, for which life expectancy
at age five was 66.7 years. Optimal schooling rises to 9.6 years.

In fact, average years of schooling for this cohort was 13.3. Thus
the pure mortality effect explains roughly one-fifth of the increase.
Essence of the Ben-Porath mechanism is that an increase in survival that induces a rise in schooling must also induce a rise in lifetime labor supply.

measures expected total working hours (ETWH) over the lifetime for cohorts of American men born between 1850 and 1970.

In addition to mortality, ETWH is affected by labor supply along both the extensive margin (working or not working) and the intensive margin (hours per week).

declines in weekly hours, along with earlier retirement, have more than offset the decline in mortality.

For example, ETWH at age 20 fell from 112,199 for men born in 1850 to 81,411 for men born in 1930.
Figure 1.—Life expectancy at age 5 and average years of schooling by year of birth. Average years of schooling are our own estimates using IPUMS data and Margo’s (1986) methodology. For data sources on life expectancy, see Section 4.1.
FIGURE 2.—The probability of remaining alive, conditional on reaching age 20, for men born in 1840, 1880, and 1930: Cohort estimates.
Labor Force Participation

Figure 3.—Labor force participation for men born in 1840, 1880, and 1930: Cohort estimates.
Weekly hours worked by men, 1860–present

Figure 4.—Weekly hours worked by men, 1860–present.
Expected total working hours over the lifetime of consecutive cohorts of men born between 1840 and 1930. Individuals are assumed to enter the labor market at age 20; Cohort estimates are calculated at age 20.
Expected total working hours over the lifetime of consecutive cohorts of men born between 1840 and 1930. Individuals are assumed to enter the labor market at age 20: Cohort estimates are calculated at age 5.

Figure 8.
Expected total working hours and Average years of schooling

**Figure 10.**—Expected total working hours and average years of schooling of consecutive cohorts of men born in 1850–1970. Individuals are assumed to enter the labor market at age 20: Period estimates are calculated at age 5.
Critique of Hazan

- Good point, but....
- Does not show that reduced mortality did not raise schooling
  - Shows that even though falling mortality raised ETWH, other factors lowered ETWH by more
- We can still believe in the Ben Porath mechanism ($ETWH \rightarrow$ schooling) but that some other factor raised schooling
  - We already knew that even if ETWH had risen as much as declining mortality would imply (without changes in hours/retirement), “other factors” would still have to explain most of the rise in schooling
- Second critique: decline in workweek affects both benefit of schooling and opportunity cost
- Third critique: OK to assume such perfect expectations?