Does Learning to Add up Add up?

Lant Pritchett
Presentation to Growth Commission
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Five Issues, Some with Evidence

I) Why aggregate data at all?
II) Education and long-run growth: Can Jones be escaped?
III) Education and medium/short run growth: Is education part of the explanation?
IV) Education and ‘externalities’: Does macro-mincer exceed macro-mincer?
V) What explains variations in macro-mincer?
I) Why aggregate data?

• Aggregate data is messy, our behavioral theories are about micro behavior, why bother?

• The micro-Mincer literature is perfect(ly useless) for policy

• The *policy* question (if we take it seriously) is about the *difference* between social and private returns not the *level* of either
II) Can the Jones critique be escaped?

- First, models with only level (or change on change) effects (Solow Swan)
- Then “first generation” endogenous growth models in which steady state growth rates are affected by the levels of stuff (R&D, scale, education, etc.)
- The Jones critique: extraordinary stability of growth of the leaders over the very long-run.
Long-run growth acceleration (almost none) versus change in levels of education (orders of magnitude)
Do we need something “extra” to explain the residual?

• The frustration with Solow was that TFP was, of necessity, exogenous in the theory but TFP was large as a fraction of growth
• “Endogenous” growth helped reduce the fraction of growth unexplained
• But the real problem in most developing world is that the residual is too small not too large—the addition of human capital deepens not resolves puzzles
TFP growth (ppa, 1960-1992) calculated in the standard HK augmented) Solow sort of way—all regions (except for China) TFP growth is less than industrial countries.
III) Does Education Help Explain the Basic Empirical Features of Cross-national Growth?

- Divergence? Nope.
- The big slow down? Nope.
- The volatility? Nope.
- The cross-national differences? Much more complicated, but nope.
Output per worker *diverged* while schooling per worker *converged* sharply
(90/10 ratios comparing 1960 to 1995)

Source: Calculations with PWT6.0 and Barro-Lee
Figure 1a: Schooling and GDP per person in Venezuela

Source: Calculations with PWT6.0 and Barro-Lee
Figure 2: Schooling and GDP per person in Brazil
Education and the “big slow down”—Schooling per worker growth accelerated across decades while growth of output per worker collapsed in 80’s, 90s.
Figure 4: Schooling and GDP per person in Indonesia
Figure 5: Schooling and GDP per person in Argentina
Given the volatility of growth rates and persistence of schooling, schooling cannot help explain growth except at very long frequencies

<table>
<thead>
<tr>
<th>Description</th>
<th>R2</th>
<th>30 year</th>
<th>10 year</th>
<th>5 year</th>
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<tbody>
<tr>
<td>Growth of CUDIE per worker (K/W)</td>
<td>.461</td>
<td>.424</td>
<td>.287</td>
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<tr>
<td>Growth K/W, lagged output, initial infant mortality rate, period dummies</td>
<td>.647</td>
<td>.530</td>
<td>.390</td>
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</tr>
<tr>
<td>Initial S/W, final S/W, squares of initial and final S/W, initial and final 1/(S/W)</td>
<td>R2</td>
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<td>.400</td>
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<tr>
<td>Incremental</td>
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<td>.033</td>
<td>.01</td>
<td></td>
</tr>
<tr>
<td>All except K/W</td>
<td>R2</td>
<td>.515</td>
<td>.329</td>
<td>.200</td>
</tr>
<tr>
<td>Incremental of K/W growth</td>
<td>.199</td>
<td>.232</td>
<td>.200</td>
<td></td>
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</table>
Back to the fundamental empirical problem/question—can variation in SK explain growth?

Figure 11a: Growth (ppa) of Y/W and SK($\psi=.58, \phi=0$) with initial GDP/W (upper case Y/W, lower case SK/W)
Same figure for CUDIE

Figure 11b: Growth (ppa) of Y/W and K/W with initial GDP/W
(upper case Y/W, lower case K/W)
Summary: Does the introduction of human capital into growth models help us understand the basic facts about developing country growth? No.

Fact 1: TFP growth is lower in poor than rich countries—introducing schooling increases the difference.

Fact 2: Divergence of rich/poor schooling converged.

Fact 3: The big slow-down of 80s, 90s schooling accelerated.

Fact 4: Growth is volatile over time schooling (and its growth) is stable, cannot predict turning points or high frequency.

Fact 5: Huge cross-national differences in growth small cross-national differences in growth of SK, Everybody did schooling, even those that did not grow.
III) Does macro-mincer exceed micro-mincer?

- That there is a wage increment associated with higher levels of education is probably, after Engel’s law, the most widely replicated fact in economics.
- Huge amount of attention to the question of whether this is “causal” (twins, mandatory attendance, etc.)
- The rough rule is about 10 percent per year of schooling (median is 8.5 in a complete sample)
Hundreds of Mincer regressions in many many countries....
Are there output externalities? Two interests in the question

- First, the WB presentations of the ‘rate of return’ to schooling always reported private and social—with social always lower, by construction.
- But if the policy of zero fee publicly provided schooling were to be justified because of “externalities” the social return (inclusive of all benefits) would have to be much larger than the private return (between 2 and 6 percentage points)—the question is not zero the question is magnitude.
Interest in the question

• The ‘first generation’ growth regressions (e.g. Benhabib and Spiegel) found that in regressions on growth (a) the change in S didn’t matter but (b) the lagged level did.

• Their interpretation—’all spillover’ (the ‘level on growth’ effect is an effect on TFP).

• But this complete ignores the micro evidence—we know there are wage increments…so
“Where has all the education gone?”

- Written in 1996, published in 2000, finds that the output impact of education is much less than what would have been expected from the micro
- An arithmetic trick to make this not a “failure to reject”—calculate TFP subtracting off the growth accounting “schooling capital share” and then add education to the regression
- Schooling is strongly negative and significant on conventionally measured TFP
- Emphasized the conditional and contextual transmission of wage increments to outputs (North’s pirates)
Other studies

- Fixed effect panel studies all tend to negative impacts—but as seen above identifying the impact this way is dubious.
- Temple finds that the zero finding is not “robust” functional form is not the issue.
- Most who do level on level find positive impacts (but small)—but reverse causation a big issue in level on level.
Krueger-Lindahl in JEL

- Point out problem of huge measurement error in short period panels
- Claim to take micro-macro seriously
- Find that, with instruments, they can get a coefficient that is as large as the micro estimates (but it is not statistically significant)
What accounts for the differing results?

• It is *not* measurement error in long-period changes on changes (Pritchett 1996).
• It is *not* differences in data—everyone is using Barro-Lee education data and Summers-Heston PWT GDP per capita data.
• Turns out, the key lies is mapping from “years of schooling” to “schooling capital”
• If change in $\Delta \ln(S/W)$ (percentage changes) one finds negative or zero coefficients, if one uses $\Delta SW$ (absolute changes) then one finds positive.
Percentage vs. absolute growth of S/W makes a big difference in the relationship between initial level and growth

Figure 7: Initial schooling and the absolute versus percentage change in years of schooling
Bils Klenow on S to SK—a parametric encompassing to the question

\[ H(t) = \int_a^T h(a, t) L(a, t) \, da \]

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

\[ f(s) = \frac{\theta}{1 - \psi} s^{1 - \psi} \]
Variations in assumptions about $\Psi$ encompass the “log” changes and “level” changes approaches.
How about psi?

- If $\psi=0$ then (K-L and others)

$$SK = e^{rs}$$

- But $\Psi$ is estimated as the slope in the Mincer coefficient wrt $S$—and the t-test of $\psi=0$ is over 6
Partial scatter plot (conditioning out K/W)—with my preferred specification (because it is based on evidence)

Figure 10c: Partial scatter plot, growth output per worker and growth in schooling capatial ($\psi=.58, \varphi=0$)
Same regression, assumption $\Psi=0$—note that for same observations on S people with low initial S have less “growth” in SK (e.g. Haiti, Niger) while those with more initial S have more SK (e.g. Canada)

Figure 10d: Partial scatter plot, growth output per worker and growth in schooling captial ($\psi=0, \varphi=0$)
Ψ=0 (zero slope in the S-r graph) is rejected with a t-statistic of over 6!

Figure 6: Estimates of the return to schooling and years of schooling (Observations identified with country code and year of study)
Three empirical issues

• Little variation in SK/W growth—huge variations in Y/W growth
• Even w/o any attribution to SK the residual is “too small” (e.g. growth is low)
• Therefore if, in a linear fashion one attempts to attribute a big effect of SK/W on Y/W then TFP is *massively* negative in most developing countries

(same problem inter-temporally as too little variation in SK to explain Y/W—if big effect then TFP falls are huge)
V) New Frontiers: the way forward is interactive?

- Obviously the variance has to be increased to explain much—but how?
- Quality of schooling? But Mincer?
- Openness—some evidence, not strong yet.
- Growth in manufacturing?
- Government policy on absorption of educated labor (e.g. Egypt)—negatively
- General “institutional” climate?
V) New Frontiers opened up

• Positive models of schooling—why does government own and operate all schools
  – “normative as positive” is a silly model—especially when the factual premises are dubious

• Models of the selection aspect of the education system in a world of “super-star” economic production

• More of “where did all the education go?”
  – Just deepen the puzzle?
  – Play some role in not digging out of crisis?
Figure 1a: Schooling and GDP per person in Venezuela
## Possibilities

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<th>Closed elite (Oligarchs/socially stratified)</th>
<th>Open elite (Meritocratic selection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rent seeking economy</td>
<td>Central America (when closed)</td>
<td></td>
</tr>
<tr>
<td>(Pirates)</td>
<td></td>
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</tr>
<tr>
<td>Non-rent seeking</td>
<td></td>
<td>Korea</td>
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<tr>
<td>economy (Engineers)</td>
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