Where has all the education gone?

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Abstract:

Cross national data show no association between the increases in human capital attributable to rising educational attainment of the labor force and the rate of growth of output per worker. This implies the association of educational capital growth with conventional measures of TFP is large, strongly statistically significant, and *negative*. While these are the results "on average"--from imposing a constant coefficient--the economic impact of education has not been the same in every country. Three causes could explain why the impact of education varied widely across countries and fell short of what was hoped. First, the institutional/governance environment could have been sufficiently perverse that the educational capital accumulation *lowered* economic growth. Second, perhaps the marginal returns to education fell rapidly as the supply expanded while demand for educated labor was stagnant. Third, educational quality could have been so low that "years of schooling" have created no human capital. The extent and mix of these three phenomena vary from country to country in explaining the actual economic impact of education.

Where has all the education gone?[1]

To be a successful pirate one needs to know a great deal about naval warfare, the trade routes of commercial shipping; the armament, rigging, and crew size of potential victims; and the market for booty.

To be a successful chemical manufacturer in early twentieth century United States required knowledge of chemistry, potential uses of chemicals in different intermediate and final products, markets, and problems of large scale organization.

If the basic institutional framework makes income redistribution (piracy) the preferred economic opportunity, we can expect a very different development of knowledge and skills than a productivity increasing (a twentieth century chemical manufacturer) economic opportunity would entail. The incentives that are built into the institutional framework play the decisive role in shaping the kinds of skills and knowledge that pay off.

Douglas North (1990)

People with more education have higher wages. This is probably the second (after Engel's law) most well established fact in economics. Naively, it would seem to follow naturally that if more individuals were educated average income should rise: and if there are positive externalities to education average income should rise by even more than the sum of the individual effects. The belief that expanding education promotes economic growth has been a fundamental tenet of development strategy for at least forty years.[2] The post WW II period has seen a rapid, historically unprecedented, expansion in educational enrollments. Since 1960 average developing country (gross) primary enrollments have risen from 66 to 100 percent and (gross) secondary enrollments from 14 to 40 percent.

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[2] The idea that either the "new" growth theory or the "neo-classical revival" have "discovered" the importance of human capital is belied by even a casual reading of Kuznets (1960), Lewis (1956), Schultz (1963) or Dennison (1967). Gunnar Myrdal's *Asian Drama*, written in the late 1950s already treats the importance of human

How has this experiment of massive expansions in education turned out? Is there now strong evidence of the growth promoting externalities to education? This is an area where the growth theory and empirical estimates are potentially important. Positive externalities should mean that the impact of education on aggregate output is greater than the aggregation of the individual impacts. To test for externalities we need macroeconomic and microeconomic models of educations impacts that are consistent. The augmented Solow model is just such a model because it predicts the "no externality" impact of education should be the share of educational capital in factor income. This can be estimated from microeconomic evidence on the wage increments to capital. Within the augmented Solow model the estimated growth impact of education, rather than being more, is consistently *less* than would be expected from the individual impacts. The cross-national data suggests *negative* externalities and present something of a "micro-macro" paradox.

The path to the resolution of this paradox begins with the acknowledgement that the impact of education on growth has not been the same in all countries (Temple, 1999). I discuss three possibilities for reconciling the macro and micro evidence and explaining the differences across countries in the growth impact of education. The first possibility is North's (metaphorical) piracy: education has raised productivity, and there has been sufficient demand for this more productive educated labor to maintain (or increase) private returns, but the demand for educated labor comes (at least in part) from individually remunerative yet socially wasteful or counter-productive activities. In this case the relative wage of each individual could rise with education (producing the micro evidence) even while increases in average education would cause aggregate

capital in development as the settled conventional wisdom.

output to stagnate, or even fall (producing the macro evidence). The second possibility is that the expansion of the supply of educated labor when demand was stagnant could cause the rate of return of education to fall rapidly. In this case the average Mincer returns estimated in the 1960s and 1970s overstated the actual marginal contribution to output from expansion of education in those instances in which there was not sufficiently rapid expansion in the demand for educated labor. Third, schooling quality may have been so low it did not raise cognitive skills or productivity. This could even be consistent with higher private wages if education serves as a signal to employers of some positive characteristics like ambition or innate ability.

I) Expansion of education and growth accounting regressions

A) How much should education matter? The Augmented Solow model

Mankiw, Romer and Weil (1992) extend the Solow aggregate production function framework to include educational capital:

1) $Y_t = A(t) * K_t^{\alpha_k} * H_t^{\alpha_h} * L_t^{\alpha_l}$

Assuming constant returns to scale $(\alpha_k + \alpha_h + \alpha_l = 1)$, normalizing by the labor force, and taking natural logs produces a linear equation in levels. But this "linear in log-levels" specification can also be expressed in rates of growth. Since estimation in levels raises numerous problems (to which I return below) I focus on the relationship between percent per annum growth of output per worker ($\hat{y} = d\ln(Y/L)/dt$), growth of physical capital per worker and educational capital per worker:[3]

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[3] Growth for each variable is calculated as the logarithmic least squares growth rates over the entire period

2) $\hat{y} = \hat{a} + \alpha_k * \hat{k} + \alpha_h * \hat{h}$

In the context of this model, $\hat{a}$ is the growth rate of growth accounting residual—and I will reluctantly follow convention and call this TFP (even though it is not, Pritchett 2000):

(3) $\hat{TFP} = \hat{y} - \alpha_k * \hat{k} - \alpha_h * \hat{h}$

The extended Solow approach facilitates simple non-regression based estimates of how much the expansion of educational capital "ought" to matter. Since the weights in the aggregate Cobb-Douglas production function represent the factor shares of national income, the coefficient on educational capital in a growth accounting regression ought to be equal to the share of educational capital in GDP which can be estimated based on microeconomic data.

With constant returns to scale labor share is one minus the physical capital share. A physical capital share of around .4 is somewhat high, but is consistent with a variety of evidence: the estimates from national accounts, the estimates from regression parameters, and with capital output ratios (if the capital-output ratio (K/Y) is 2.5 and the rate of return to capital is 16 percent then the share of capital, rK/Y, is 40 percent). This implies the labor share is .6.

How much of the labor share is due to human (or educational) capital? One simple way of estimating the share of the wage bill attributable to human capital uses the ratio of the unskilled-or "zero human capital"--wage w_0 to the average wage *w*:

4) $\textit{Human captial share (from wages)} = 1 - w_0 / w$

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for which the data is available. This makes the estimates of growth rates much less sensitive to the particular endpoints than simply calculating the beginning period to end period changes. However, this means the time period over which I calculate the growth rate does not always correspond exactly to the time period for the education data, but since both are per annum growth rates this difference does not matter much.

A calculation based on the distribution of wages in Latin America estimates a human capital share of wages between 50 and 75 percent. Mankiw, Romer, Weil (1992) use the historical ratio of average to minimum wages in the US to estimate that half of wages are due to human capital[4]. Either of these calculations suggest a human capital coefficient (α_h) of at least .3.

Another approach to estimating the educational capital share is to assume a wage increment to education (taking the micro evidence discussed below at face value) and then use data on the fraction of the labor force in each educational attainment category to derive the educational capital share. Table 1 shows the results of two calculations. The top half shows the fraction of the labor force in various educational attainment categories in various regions. One can calculate the share of the wage bill due to educational attainment by assuming a wage premia for each attainment category and applying equation 5:

$$(5)\quad \textit{Educational capital share of wage bill} = \frac{\sum_{i=0}^{K}(w_i - w_0)*\gamma_i}{wL}$$

where i represents each of the seven educational attainment categories and γ_i are the shares of the labor force in each educational attainment category.

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[4] Using data on the distribution of worker's earnings (World Bank, 1993) we take the ratio of the average wage only of wages up to the 90th percentile (to exclude the effect of the very long tails of the earnings distribution) to the wage of those workers in either the 20th or 30th percentile (to proxy for the wage of a person with "no" human capital). The estimates of human capital share of the wage bill are 62 and 47 percent respectively. If the top tenth percentile is included (so I take the ratio of average wages to 20th or 30th percentile) the estimates of human capital share are even higher, 74 and 63 percent respectively. While these are considerably higher that other estimates, these are estimates of all human capital, not just educational capital. In the US ratio of the average to the minimum wage (taken as a proxy for "unkilled" wage) has hovered around 2.

Table 1: Share of educational capital in wage bill							
	Wage premia by educational attainment under assumption set:		Share of work force by educational attainment, 1985				
	A	B	Developing Countries	Sub-Saharan Africa	Latin American and Caribbean	South Asia	OECD
No Schooling	1.00	1.00	49.7%	48.1%	22.4%	69.0%	3.3%
Some Primary	1.40	1.56	21.3%	33.2%	43.4%	8.9%	19.4%
Primary Complete	1.97	2.44	10.1%	8.5%	13.2%	4.8%	18.3%
Some Secondary	2.77	3.42	8.7%	7.7%	8.4%	8.8%	20.7%
Secondary	3.90	4.81	5.9%	1.6%	5.5%	5.3%	20.1%
Some Tertiary	5.47	6.06	1.4%	0.2%	2.5%	0.9%	7.7%
Tertiary	7.69	7.63	3.0%	0.8%	4.6%	2.3%	10.5%
Average years of schooling			3.56	2.67	4.47	2.81	8.88
Calculated share of wage bill due to educational capital across regions under various assumptions:							
Assumption set A) Assuming that the wage increment is constant at 10%			36%	26%	43%	30%	62%
Assumption set B) Assuming the wage increments are: primary 16%, secondary 12% and tertiary 8 %.			49%	38%	56%	42%	73%
Sources: Data on educational attainment by region from Barro and Lee (1993).							

Under assumption set A (of a constant wage increment 10 percent per year of schooling) the educational share of the wage bill varies across regions from 26.3 percent (in SSA) to 62.1 percent in OECD and is 36.4 percent for the developing countries as an aggregate. Under assumption set B (a year of primary has a higher proportionate wage increment (16%) than secondary (12%), and secondary than tertiary (8%)) the share of educational capital in total wage bill is almost exactly half on average, 49 percent, for all developing countries and varies from 38 percent (in SSA) to 73 percent (in the OECD). Both of these methods suggest that the educational capital share of the wage bill should be between .35 and .7. Hence the growth accounting regression coefficient on educational capital (α_h) ought to be between .21 and .42—with .3 in the middle of the range.

B) Data and specification for physical and educational capital

Using two recently created cross national, time series data sets I create estimates of the growth rate of per worker *educational* capital. The two data sets use different methods to estimate the educational attainment of the labor force. Barro and Lee (1993) (BL) estimate the educational attainment of the population aged 25 and above using census or labor force data where available and create a full panel of five yearly observations over the period 1960-85 for a large number of countries by filling in the missing data using enrollment rates. Nehru, Swanson and Dubey (1994) (NSD) use a perpetual inventory method to cumulate enrollment rates into annual estimates of the stock of schooling of the labor force aged population, creating annual observations for 1960-1987.

From these estimates of the years of schooling of the labor force, I create a measure of *educational* capital from the microeconomic specification of earnings used by Mincer. I assume the natural log of the wage (or more generally, earnings per hour) is a linear function of the years of schooling:

$$(6)\quad \ln(w_N) = \ln(w_0) + r * N$$

where w_N is the wage with N years of schooling, N is the number of years of schooling and r is the wage increment to a year's schooling. The value of the *stock* of educational capital at any given time t can then be defined as the discounted value of the wage premia due to education:

$$(7)\quad HK(t) = \sum_t^T \delta^t * (w_N - w_0)$$

where w_0 is the wage of labor with no education. Substituting in the formula for the educational wage premia (eqn. 6) into the definition of the stock (eqn. 7) and taking the natural log gives equation 8 for the log of the stock of educational capital:

$$(8)\quad \ln(HK(t)) = \ln(\sum_{t=0}^{T}\delta^{t}) + \ln(w_0(t)) + \ln(e^{rN} - 1)$$

Therefore the proportional rate of growth of the stock of educational capital is approximately:[5]

$$(9)\quad h\dot{k}(t) \cong d\ln(\exp^{rN(t)} - 1)/\,dt$$

Based on existing surveys of the large number of micro studies[6] I calculate the growth of educational capital using equation 9, the data on years of schooling from either BL or NSD, and using an assumed r of 10 percent constant across all years of schooling.[7]

In addition to the measures of educational capital I use two series created by a perpetual

[5] There are two reasons this formula is only an approximation. First, the discount factor is assumed constant and hence is factored out in the time rate of change. However, it does depend on the average age of the labor force (since the discount is only until time T (retirement)) which certainly varies systematically across countries, but I am assuming that changes in this quantity over time are small. The second, potentially more serious problem is that I dropped out the growth rate of the ln ($w_{0(t)}$)—the evolution of the unskilled wage term. This means my growth rate of human capital is really that component of the growth of human capital due to changes in years of schooling. For instance. Mulligan and Sala-I-Matin (1994) estimate a human capital stock in which rises in unskilled wages reduce human capital, which is technically correct, but counter-intuitive.

[6] A survey by Psacharopulus (1993) shows wage increments by region of: SSA 13.4 percent, Asia 9.6 percent, Europe, Middle East and North Africa, 8.2 percent, Latin America 12.4 percent, OECD 6.8 percent, an unweighted average of 10.1. In any case, the cross national differences in the growth rate of educational capital is very robust to variations in the value of r.

[7] One (of the many) confusions in this literature is between the wage increment and the rate of return to education. The often repeated assertion that "returns are higher to primary schooling" (such as those reported by Psacharopolous (1993)) is not because the increment to wages from a year of primary school are *higher* than other levels, but because the opportunity cost of a year of primary schooling is much *lower*. This is because the typical foregone wage attributed to a primary age, unschooled,child is very low (Bennell, 1994). What is relevant to growth accounting is the increment to wages, not the cost inclusive return.

inventory accumulation of investment and an initial estimate of the "capital" stock (based on an estimate of the initial capital-output ratio)—King and Levine (1994) and Nehru and Dhareshwar (1993). As I have argued elsewhere, these cannot be treated as estimates of the physical capital stock relevant to the production function as there is no underlying theoretical or empirical justification for doing so when governments are the main investors and hence should be called by a purely descriptive acronym: CUDIE (CUmulated, Depreciated, Investment Effort) (Pritchett 2000). The two series are highly correlated and give similar results with the principal difference in the two CUDIE series is that the King and Levine data use the Penn World Tables, Mark 5 (Summers and Heston, 1991) investment data while Nehru and Dhareshewar data use World Bank investment data.

The dependent variable is growth of GDP per worker from PWT5. This is conceptually more appropriate in growth accounting regressions than GDP per person or per labor force aged person (but as argued below the findings are robust).[8]

C) Regression results for growth and TFP

The results for estimating the growth accounting equation (2) for the entire sample of countries[9] are reported in column 1 of table 2. The partial scatter plot is displayed as figure 1.

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[8] This output variable does raise one problem. My estimates of human capital are based on estimates of the educational capital of the labor force aged population, while my output is output per estimated labor force (although not corrected for unemployment) so that systematic differences in the evolution of the labor force versus the labor force aged population (say through differential female labor force participation) could affect the results. Addressing the question of whether or not *changes* in female labor force participation (cross national level differences would not affect the results) are an important part of the story is beyond the scope of this paper. With the currently available gender disaggregated data this is an active current research question, with some arguing female education is more important for growth (Klasen 1999) and some less (Barro 1999).

[9] Four countries are dropped from all regressions because of obvious data problems. Kuwait, because PWT5 GDP data is bizarre, Gabon, because labor force data (larger than population) is clearly wrong, Ireland because the NSD

The estimates for cumulated physical investment (CUDIE) correspond reasonably well to national accounts based estimates of the capital share (although .52 is somewhat on the high side) and are strongly significant (t=12.8). *Very much* on the other hand, the estimate of the impact of growth in educational capital on growth of per worker GDP is *negative (-.049)* and insignificant (t=1.07). Adding the initial level of GDP per worker (column 2) has no impact on the negative estimates of the effect of education (-.038).

Columns 9 and 10 of Table 1 show the results of regressing TFP growth on the growth of physical CUDIE and educational capital. In column 9 the assumed factor shares used in creating TFP are .4 (physical) and .3 (educational). The growth of educational capital shows a large, statistically very significant (t=6.91), and *negative* (-.338) effect on TFP growth. In column 10 I make the educational capital share as small as is consistent with growth accounting by assuming the physical capital share is on the high side at .5 and that the share of educational capital in the wage bill is on the low side, at $.\overline{3}\overline{3}$ so that the educational capital share is as low as it can reasonably be (1/2 * 1/3=.167). It is still the case that educational capital accumulation is strongly and statistically significantly *negatively* related to TFP growth. Of course, except for fixing the "physical capital" share, this TFP regression is equivalent to a t-test that the estimated human capital share is equal to .167. Using the results of column 1 this hypothesis is easily rejected (t=(-.049-.167)/.046=4.72).

These TFP results are a simple arithmetic trick, but this simple trick is useful because it changes a typically uninteresting "failure to reject" to a convincing rejection of an interesting and

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data report an average of 16 years of schooling (immigration wreaks havoc with their numbers), and Norway because BL reports an impossible increase of 5 years in schooling over a period of 5 years.

policy relevant hypotheses. The findings are not a "low powered" failure to reject zero—they are a "high power" failure to reject as while the data do not reject zero, it does in fact reject a wide range of interesting hypothesis—including the hypothesis that the growth impact is as large as the microeconomic data would have suggested. After all, the primary reason to use aggregate data to estimate the impact of schooling is to find out if the impact is higher (or lower) than what would have expected from the microeconomic data and hence provide some indication of the presence (or absence) of externalities. But to speak to this question, growth regressions using aggregate data must demonstrate not only that the educational capital coefficient is not zero but it is higher than the value that is "expected" given the microeconomic evidence applied to the same growth model. This is a seemingly modest standard but one that has never been met.

Before proposing explanations of this apparent micro-macro paradox of negative externalities, I first show this result is robust to sample, data, technique, and is not the result of "pure" measurement error or failure to account for school quality[10].

The estimated coefficient is not the result of a peculiar sample or a few extreme or atypical observations. To ensure robustness against outliers, individual observations identified as influential were sequentially deleted up to 10 percent of the sample size with no qualitative change in results.[11] The negative coefficient on schooling growth persists if: (a) only developing

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[10] One thing I do not do is show the results are robust to the introduction of other covariates (Levine and Renelt, 1992). This is because I am interested in growth accounting within a specific model of growth which takes a production function approach. There is no scope to then introduce other covariates arbitrarily, as in the "reduced form" literature.

[11] Observations are identified as influential based on the difference in the estimates with and without the observation included (Belsley, Kuh, and Welch, 1980). Temple (1999) working on a different data set finds substantial parameter homogeneity and finds that a significant fraction the sample must be dropped to recover a significant positive coefficient on education. I take this to indicate not a lack of robustness, but substantial parameter heterogeneity—a point we return to below.

countries are used, (b) all the observations from Sub-Saharan Africa are excluded or (c) regional dummies are included.

The results are also robust to variations in the data used for education, CUDIE, or GDP. All the regressions in table 2 were also estimated using the NSD estimates of educational capital and the educational capital coefficient estimates were similar: consistently negative.[12] Changing the data on growth and using World Bank local currency, constant price, GDP growth rates instead of the PWT5 GDP data gave similar results. Using growth of GDP per person or per labor force aged population produces an even larger negative estimate for education. Relaxing the assumption of constant returns to scale does not alter the negative estimate on educational capital. Using weighted least squares with either (log of) population, GDP per capita, or total GDP as the weights also gives nearly identical results.

The finding using *levels* on *levels* specification of the augmented Solow equation in column 6 of table 2 shows a coefficient of .13 (t=1.97)—which continues to reject $H_0 : \alpha_h = .3$, t=2.37. However, there are good reasons to believe levels on level coefficients will be biased upward. If this education capital coefficient is biased upward by as much as the CUDIE results appear to be (by about .1) then the small negative coefficient in the "growth on growth" regressions are consistent with the small positive coefficients in the "level on level" regressions.

While both sets of educational attainment data have been roundly criticized on a number of legitimate grounds (Behrman and Rosenzweig, 1993,1994) I use two different instruments to

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[12] These are reported in the working paper version Pritchett (1996). The basic OLS regression using the other data set was $\hat{y} = c + \underset{(15.4)}{.501}\hat{k} - \underset{(2.07)}{.104}\hat{h}, n = 79, r^2 = .557$ ($t-statistics\ in\ paentheses$)

show this particular result on educational capital is not the result of pure measurement error in the estimates of years of schooling. Using the growth of the NSD educational capital as an instrument for BL educational capital (the correlation of the growth rates of the two series is .67) the coefficient becomes slightly more negative -.12 (column 4 of table 1) versus -.091 for OLS on the same sample (column 3). In addition I also matched each country with a "similar" country, usually picking the geographically closest neighbor, on the idea that educational capital growth rates in similar countries are likely correlated (the actual correlation was ρ=.316) while the pure measurement error in similar countries' reported enrollment and attainment rates is plausibly uncorrelated (and certainly less than perfectly correlated). This IV coefficient in column 5 of table 2 is also negative (-.088). Correcting for pure measurement error makes the estimates more negative (which is to expected as measurement error produces attenuation bias) and hence only deepens the puzzle[13].

Recently Krueger and Lindahl 2000 (K&L) have criticized Benhabib and Spiegel (1994) which is based on older estimates of educational stocks. K&L claim that the findings of B&S are not robust to pure measurement error. However, this criticism is not relevant to the present work (which was written several years before the K&L paper) for three reasons. First, I use newer data sets, not the Kyriacou (1990) data used in B&S. Second, my use of IV to correct to measurement error is exactly the same conceptual approach as K&L and I do not find IV reverses any findings. Third, they focus particularly on the measurement error of growth rates over short periods—such as five years and argue, rightly, measurement error is a larger concern in differenced data. In any

[13] Using instruments for the physical CUDIE and educational capital simultaneously so as to correct for measurement error in both had very little impact on the estimates on educational capital.

case the results in table 5, column 5 of K&L that are the most similar to those presented here (in that they control for physical capital with an unconstrained coefficient and instrument for the education variable) find an empirically modest impact of schooling but which is statistically insignificant (t=.41). The two standard deviation bound on K&L's estimate of the aggregate equivalent of the Mincerian rate of return ranges from *negative* 44 percent to *positive* 67 percent. The major difference between our results is that I use the percentage rate of growth in the value of educational capital (which is essentially a logarithmic specification eqns 6-9) while they use absolute change in the years of schooling.

A different, deeper, notion of measurement error is that while the years of schooling are correctly measured, the true problem with measurement error is that years of schooling do not reflect learning. However, while differences in educational quality can account for *heterogeneity* in the impact of schooling (see below) it should not explain a low *average* impact. In fact, due to the "general underlying positive covariance between quantity and quality of schooling" (Schultz, 1988) one would expect that excluding quality would bias the estimated return *upwards*, as more schooling is accumulated where quality is high[14]. In order for lack of quality adjustment to explain the results or quantities in the aggregate there would have to be a very strong inverse cross-national relationship between quality and the expansion of quantity, a relationship for which there is no evidence.

The quality of schooling across countries is impossible to measure without internationally comparable test examinations of comparable groups of students and these, unfortunately, exist

[14] For instance, Behrman and Birdsall (1983) show that not controlling for school quality leads the impact of years of schooling to be *overestimated* by factor of 2 in Brazil.

for very few countries.[15] Hanushek and Kim (1996) use test score data to show test score performance has positive and statistically significant coefficient as an independent variable in a growth regression[16]. However, in this case the interest is in the impact of an increase in educational capital and the expected functional form when schooling quality matters would be an interactive effect: the impact of an additional unit of educational capital is higher when higher the quality of schooling. I estimate this functional form using a single observation on test scores for each of the 25 countries used by Hanushek and Kim 1996 (normalized to a mean of one) to interact with the growth of the educational capital stock. As shown in column 7 of table 1 while the estimated impact of education is higher with higher quality (although the interactive coefficient is statistically insignificant) it is still the case that, evaluated at the average level of quality (test score=1), the education impact is still substantially less than zero (.06-.48=-.42)—suggesting that, as expected, the lack of control for quality causes the an *upward* bias so the negative estimates which do not control for quality are not negative enough.

D) Relationship to other empirical results on schooling

As surprising as these negative results may seem, they are similar to what other researchers have found when they have examined the growth/education relationship using either

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[15] One possible way out of the lack of quality measures is to use proxies for quality. However, there is no particular reason to believe that physical indicators (such as teacher per pupil) or resources expended per student will adequately proxy quality, and many reasons to believe they will not. Hanushek and Kim (1996) explore the connections between these indicators and test scores in order to be able to extrapolate a quality when it is not available, but with little success. Since schooling is typically publicly provided there is no reason to believe that dollars spent will be closely associated with output (that is, one cannot apply the usual theory about the relationships between inputs and outputs derived from production theory of profit maximizers). There is a huge literature on the impact of various physical and financial measures of resources expended per student on achievement, with generally ambiguous results (Filmer and Pritchett, 1997).

[16] However, one could easily suspect that any variable, like test scores, on which countries like Singapore (the

growth on growth or level on level regressions. Benhabib and Spiegel (1994) and Spiegel (1994) use a standard growth accounting framework which includes initial per capita income and estimates of years of schooling from Kryiacou, 1990 and find the coefficient on growth of years of schooling was negative.[17] Lau, Jamison and Louat (1991) estimated the effects of education by level of schooling (primary versus secondary) for five regions and found that primary education had an estimated negative effect in Africa and MENA, insignificant effects in South Asia and Latin America, and was only positive and significant in East Asia. Jovanovic, Lach and Lavy (1992) use annual data on a different set of capital stocks and the NSD education data and find negative coefficients on education in a non-OECD sample. Behrman (1987) and Dasgupta and Weale (1992) find that changes in adult literacy are not significantly correlated with changes in output. The World Bank's World Development Report on labor also reports the lack of a (partial) correlation between growth and education expansion (World Bank, 1995, figure 2.4). Newer studies using panels to allow for country specific effects consistently find *negative* signs on schooling variables (Islam 1995, Casselli, et. al. 1998, Hoeffler, 1999)[18].

Some very early papers used enrollment rates in growth regressions (Barro, 1991, Mankiw, Romer, Weil, 1992) but this approach has two deep problems. First, especially in MRW secondary enrollment rates alone were used—but without any clear or compelling reasoning as to why both primary and tertiary enrollment rates should be excluded. Second,

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highest, 72.1) and Hong Kong (71.8) do well and countries like Nigeria (38.9) and Mozambique (27.9) do badly might well be capturing more in a growth regression than just labor force quality.

[17] Spiegel (1994) shows the finding of a negative effect of educational growth is robust to the inclusion of a wide variety of ancillary variables (i.e. dummies for SSA and Latin America, size of the middle class, political instability, share of machinery investment, inward orientation) and samples.

[18] However, these studies are susceptible to the Krueger and Lindahl (2000) critique about exacerbation of measurement error in short (five year) panels. Morever, the dynamic properties of the educational series are unlikely

enrollment rates are a worse than terrible proxy for growth in years of schooling[19]. The assumption that current (or average) enrollment rates adequately proxy a country's steady state stock is true only if enrollment rates are constant over time across countries—but this contradicts the massive recent expansion of schooling in developing countries (Schultz, 1988). The correlation between the growth of educational capital and secondary enrollment rates is -.41. This is because the *growth* of educational attainment depends not on the current enrollment rate but on the *difference* in the enrollment rate between the cohort leaving the labor force and the cohort entering the labor force[20].

Another strand of the literature uses the initial *level* of the stock of education to explain *growth* of output per capita. Behabib and Spiegel (1994) show that if the initial *level* of education is added to a growth accounting regression, the initial *level* of education is positive while the mildly negative impact of the *growth* of educational capital persists. This finding of a level effect is actually much more puzzling than is generally acknowledged as the "spillover" effects of knowledge that might be captured by an effect of the level of education in the

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to be able to identify impacts of education in any case (Pritchett, 2000a).

[19] This does raise something of a puzzle as to why, if they are not a valid proxy for accumulation of schooling, initial secondary enrollment rates are a reasonably robust correlate of subsequent growth rates. My conjecture is the nature of "conditional convergence" regressions that both the initial level of income and initial secondary enrollment rate are on the rhs of the equation with growth on the lhs. It is not unreasonable that having high secondary enrollment rates conditional on income level is not a signal of something "good" about a country's growth prospects (e.g. governments are providing good schools which might mean they do other things well, that income is temporarily low, the country has a substnantial "middle class", people anticipate the country will do well, etc.) quite independently of the impact via accumulation of educational capital.

[20] Comparing Korea and Great Britain provides a simple illustration. Korea's secondary enrollment rate in 1960 was 27 percent while Great Britain's was 66 percent. But the level of schooling of Great Britain's labor force in 1960 was 7.7 years while the level of Korea's was 3.2 years. Subsequently Great Britain's enrollment rate increased to 83 percent by 1975 and then remained relatively constant, while Korea's enrollment rate also increased from 27 to 87 percent by 1983. Given these differences in initial stocks and the large changes in enrollment rates, Korea's average years of schooling expanded massively from 3.2 to 7.8 by 1985 while Great Britain's expanded only modestly from 7.7 to 8.6, even though Great Britain enrollment rate was higher than Korea's for most of the period.

endogenous growth literature should be *in addition to* rather than *instead of* the usual direct productivity effects. Finding *only* a spillover impact is grossly inconsistent with the micro data: if the entire return to education at the aggregate level is spillover effects then why is the wage premium observed at the individual level?

Moreover, a regression with growth rates on the lhs and level of education on the rhs is either mis-specified or a complicated way of imposing parameter restrictions. The obvious fact that growth rates are stationary (without drift) while the stock of education is non-stationary and secularly increasing implies there cannot be a stable relationship between the *growth* of output and the *level* of education (Jones, 1997).[21] Growth regressions that include initial levels of both education and output are only justified if education levels (non-stationary) are co-integrated with the level of income (non-stationary). But in that case this specification still begs the original question as to fully implement the error correction model as one must still estimate the co-integrating relationship.

II) Why (and where) has schooling contributed to growth?

There is an apparent micro-macro contradiction. The microeconomic evidence is commonly (if naively) taken to provide evidence that substantial wage increments from additional schooling are nearly universal and that additional schooling will lead to growth. The macroeconomic data in an entirely standard growth accounting model suggests education has not uniformly had the growth impact the microeconomic data would suggest. The obvious resolution

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[21] Pappell and Ben David (1995) use Maddison's historical data and find that growth rates are stationary after allowing for one structural break. This is a criticism that applies to all endogenous growth models that make growth rates a function of any variable (such as the magnitude of R&D or the stock of knowledge) that are non-stationary while growth rates are stationary (Jones, 1997).

is that the impact of education has varied widely across the countries (Temple, 1999)[22]--the question is why? In those countries which have had substantial improvements in the educational attainment of the labor force and yet still face declining real wages and slow economic growth the question must be asked: where *has* all the education gone?

I do not propose a single answer but put forward three possibilities which could account for the results:

- The newly created educational capital went into piracy: privately remunerative, but socially unproductive activities.
- Slow growth in the demand for educated labor so that supply of educational capital has outstripped demand and the returns to schooling declined rapidly, and
- Failures in the *educational system* so that a year of schooling provided few (or no) skills.

These possibilities are not mutually exclusive options. All three are likely present to a varying extent in every country. I will discuss each briefly, with some indication of the evidence that would be supportive or contradict each of the three approaches in any given country (for a more extensive discussion see Pritchett, 1996).

A) Are cognitive skills applied to socially productive activities?

> *Rent seeking in our [African] economies is not a more or less important phenomenon as would be the case in most economies. It is the center-piece of our economies. It is what defines and characterizes our economic life.*

[22] Not at all surprisingly, when unconstrained, the data do not say that schooling has contributed to output in exactly the same degree in Korea, Zaire, Paraguay, and Hungary. Parameter homogeneity does not change the fact that the unconstrained estimates are well below the expected level on average. Hence there must be number of countries for which education appears to have had less than the expected "standard augmented Solow model no externality" growth impact if wage increments were on the order of 10 percent.

One way to reconcile high wage increments to schooling with a small (and differential) macroeconomic impact of education is that social and private rates of return to education diverge due to distortions in the economy. North's (1990) powerful metaphorical comparison of piracy and chemical manufacturing in the introduction suggests the problem. Rent seeking and directly unproductive (DUP) activities can be privately remunerative but socially dysfunctional and reduce overall growth. If the improved cognitive skills acquired through education are applied to "piracy" this could explain both the micro returns (rich pirates) and small macro impact (poor countries). Several pieces of evidence suggest that this is at least part of the puzzle.

In many developing countries the public sector has often accounted for a large share of the expansion of wage employment in the 60's and 70's (see table 3). This is not to equate government, or the magnitude or growth of government employment, with the magnitude of rent seeking, nor am I saying that the expansion of education in government is necessarily unproductive. On the contrary, the most successful of developing countries have had strong and active governments and highly educated civil servants hired through a very competitive process (World Bank, 1994).[23] The question is not whether the educated labor flows into the government, but *why* the government hires them (actual need versus employment guarantee) and *what* the educated labor does once in the government (productive versus unproductive or rent seeking activities).

[23] Wade (1990) asserts that college graduates were as likely to enter government service in Korea and Taiwan as in African economies.

Table 3: Fraction of wage employment growth accounted for by public sector growth in selected developing countries.

Country:	Period:	Average growth (% per annum) of wage employment			Public sector % of total increase
		Public	Private	Total	
Public sector employment growth positive, private wage employment growth zero or less					
Ghana	1960-78	3.4	-5.9	-0.6	
Zambia	1966-80	7.2	-6.2	0.9	418
Tanzania	1962-76	6.1	-3.8	1.6	190
Peru	1970-84	6.1	-0.6	1.1	140
Egypt	1966-76	2.5	-0.5	2.2	103
Brazil	1973-83	1.4	0	0.3	100
Public sector employment growth more than half of total wage employment growth					
Sri Lanka	1971-83	8	0.9	3.9	87
India	1960-80	4.2	2.1	3.2	71
Kenya	1963-81	6.4	2	3.7	67
Public sector growth faster, but less than half of total wage employment growth					
Panama	1963-82	7.5	1.8	2.7	45
Costa Rica	1973-83	7.6	2.8	3.5	34
Thailand	1963-83	6.3	5.5	5.7	33
Venezuela	1967-82	5.1	3.4	3.7	27
Unweighted mean		5.5	0.3	2.4	

Source: Derived from Gelb, Knight, and Sabot, 1991, table 1.

Murphy, Shliefer and Vishny (1991) present a simple model of the allocation of talent in which, if returns to ability are the greatest in rent seeking, then economic growth is inhibited by drawing the most talented people away from productive sectors into rent seeking. Anecdotal evidence that rent seeking attracts educated labor abounds. There is the possibly apocryphal, but nevertheless instructive, story of one West African nation with an employment guarantee for all university graduates. In a year in which the exchange rate was heavily overvalued (and hence there was a large premia on evading import controls) 60 percent of university graduates in all fields designated the Customs service as their preferred government branch for employment.

Government explicit or implicit guarantees of employment for the educated were common and have led to large distortions in the labor market. In Egypt, government employment guarantees led to legendarily over staffed enterprises and bureaucracies. In 1998 the government or public enterprises employed 70 percent of all university graduates and 63 percent of those with education at the intermediate level and above (Assad, 1997). Gersovitz and Paxson (1995) calculate that in 1986-88 in Cote d' Ivoire, 50 percent of all workers between 25 and 55 that had completed *even one grade* of post-primary education worked in the public sector. Gelb, Knight, and Sabot (1991) build a dynamic general equilibrium model in which government responds to political pressures from potentially unemployed educated job seekers and becomes the employer of last resort of educated labor force entrants. They show that when both employment pressures are strong and the government is highly responsive to those pressures, the employment of "surplus" educated labor in the public sector can reduce growth of output per worker by as much as 2 percentage points a year (from a base case growth of 2.5 percent).

B) Stagnant demand for educated labor

A second explanation for smaller growth returns from expanding education than the wage increments would have suggested is that the *marginal* return to adding an additional year of schooling economy-wide can be dramatically different from the *average* returns estimated from a cross sectional Mincer regression on wage employment at a single point in time. Depending on the shift in the demand for and supply of educated labor, and the mechanism of labor market adjustment, the wage premia can rise or fall. In different countries there is evidence of rising, falling, stable or vacillating returns to schooling. Mincer coefficients in the US have increased (at the median) from .063 to .096 (Bushinksy 1994). The returns to schooling in Egypt fell significantly in the 1980s (Assad, 1997). Funkhouser (1994) shows quite stable Mincer returns for five Central American countries over several years. Montenegro (1995) shows that the Mincer coefficient in Chile varies between .095 to .167 between 1960 and 1993--falling then rising then falling again over this period.

There are two basic stories to explain demand for educated labor (including by the self-employed). One is that education conveys skills that make labor more productive. In this case the demand for educated labor will rise when the skill intensity of the economy rises. The second is that more educated individuals are able to adapt more quickly to disequilibrium (Schultz, 1975, Nelson and Phelps, 1977). In this case the demand for educated labor will rise when there are greater gains to adapting to disequilibrium. These two stories of the source of returns to education are difficult to distinguish empirically but both suggest impact of growth of educational capital would have a larger impact on output growth when policies are in place such that either sectoral shifts lead to higher skill intensity, the creation or assimilation of knowledge is higher (even within the same sector) or both.

One can easily imagine a scenario in which a Mincer regression based on wage employment showed very high returns and yet, in the absence of expansion of the wage employment sector (assume for know this is the “skill intensive” sector), these returns could fall very fast so that the marginal return to additional education is very small. Table 4 (adapted from Bennell 1994) shows that in many African countries the expansion of newly educated laborers has often exceeded the expansion of wage employment by more than an *order of magnitude*. In these conditions the returns to education could fall very fast.

Table 4: Growth of enrollments and of wage employment in selected Sub-Saharan African countries, from date of study estimating Mincerian return study to 1990 (or most recent).

Country	Change in enrollments ('000)	Change in wage employment ('000)	Ratio, expansion of enrollment to wage employment	Wage employment as percent of total labor force.
Enrollment growth positive, wage employment falling				
Zambia	446	-4.3	---	13.1
Cote d'Ivoire	323	-7.7	--	9
Enrollment growth exceeds wage employment growth by an ***order of magnitude***				
Sierra Leone	257	8.9	29	4.9
Uganda	225	13.2	17	4.7
Ghana	1312	80	16	3.8
Burkina Faso	351	35.4	10	3.8
Lesotho	142	14.9	10	5.4
Enrollment growth higher by factor of 4				
Senegal	180	45.4	4.0	5.5
Kenya	1709	436	3.9	14.1
Malawi	546	143	3.8	13.7
Rough equality of enrollment and wage sector growth				
Botswana	157	122	1.3	50.4
Zimbabwe	135	111.1	1.2	36.6

Source: Bennell, 1994, table 5.

Even without sectoral shifts the return to education would be higher where technological progress was rapid—requiring constant adaptation to the technologically induced "disquilibria." Schultz (1975) argues that in a technologically stagnant agricultural environment the production gains from education would be zero, as even the least educated could eventually reach the efficient allocation of factors. In this case only when new technologies and inputs are available does education pay off and then only in transition to the new equilibrium. Rosenzweig and Foster (1995) find the return to five years of primary schooling versus no schooling in the average Indian district studied was a modest 11 percent (446 rupees increase in average farm profits). However, returns to schooling were higher in those districts whose agricultural conditions were intrinsically conducive to the adoption of Green Revolution technologies (which they proxy by the exogenous increase in average farm profits). In a district with farm profits one standard deviation above the average due to technical progress, the return to primary schooling was 32 percent—almost three times higher. However, the converse of high returns with rapid progress is that the estimated returns to schooling were *negative* in those districts in which progress was low.[24]

Rosenzweig 1996 uses data across districts of India to show the pitfalls in cross sectional regressions when technological progress varies exogenously. In a cross section of Indian districts, education is correlated with economic growth. But Rosenzweig shows that once varying exogenous technical progress is introduced this technological progress explains both the higher economic growth and higher returns to education (and the higher returns leads to greater expansion in the amount of education). While schooling paid off handsomely in those areas in which the Green Revolution brought technological advances in technologically stable areas education was not an important determinant of local growth and the apparent impact of education from cross district regressions disappears.

If some country's policies are more conducive to the creation or assimilation of technical

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[24] When district average farm profits were more than 2/3 of a standard deviation below the country average the point estimate of education was *negative*. This explanation of the interaction of demand and supply for education due to different rates of technological progress might suggest that the reason education appears not to have paid off in places like Sub-Saharan Africa. Several recent studies have found very little return to education in farming in Africa (Gurgand, 1995, Joliffe, 1995). If there has been little exogenous change in the technical production functions appropriate to African agriculture for more educated farmers to adopt, as the Green Revolution innovations were not adaptable to African conditions.

progress or to development patterns that are skill intensive then one could expect that the output impact of a given expansion of schooling could be higher or lower. For instance, many argue that more open trade regimes in developing countries facilitate “catch-up” and lead to more rapid technical progress and that the returns to education would depend, at least in part, on complementary policies like reasonable outward orientation (World Bank 1994).

C) Did schooling create skills?

Direct evidence from internationally comparable exams shows substantial variation in schooling quality—and children in some developing countries lag far behind the OECD and East Asian countries (TIMSS, 1998). Low quality of schooling is consistent with the macroeconomic evidence and is obviously consistent with the household evidence of little or no wage increment from additional schooling.

However, in countries in which there is a reliably demonstrated microeconomic return but no apparent macroeconomic impact of schooling more sophisticated “low quality” explanation of the paradox is needed. A signaling model of the labor market is consistent with schooling that creates few skills and yet substantial observed wage impacts. If workers with high initial (or innate) ability have an easier time staying in school than workers with low initial ability, employers will pay more for “schooled” workers even though schooling has no impact on skills or productivity (Spence, 1974).

There is mixed evidence of a signaling function of schooling. “Sheepskin” effects—in which the completion of a level of education has substantially more labor market impact than would be expected from the skills acquired in that level—are common and can be taken as indication of schooling as a filter. However, there are at least three sources of evidence against an argument that the *entire* wage impact of schooling is signaling. First, at least three studies from developing countries with data on ability, skills, and schooling suggest that signaling effects are small (Knight and Sabot 1991 (Kenya and Tanzania), Glewwe 1991 (Ghana), Alderman, Behrman, Ross and Sabot 1996, Pakistan). Second, the limited evidence about the impact of education on productivity of farmers (Jamison and Lau, 1982) or the self-employed is harder to explain from signaling. Finally, even in data from Sub-Saharan African countries, where one might suspect educational quality is quite low, Demographic and Health Survey (DHS) show women with primary education have 24 percent lower child mortality than women with no education (Hobcraft, 1993)--which is hard to explain if schooling has no impact on knowledge[25].

Conclusion

In the decades since 1960 nearly all developing countries have already seen education attainment grow rapidly. The cross national data show that--on average--education contributed much less to growth than would have been expected in the standard augmented Solow model. Where did all they education go?

There are three possible explanations for the differences across countries in the impact of schooling on growth in economic output:

- In some countries schooling has created cognitive skills and these skills were in demand, but to do the wrong thing. In some countries institutional environment was sufficiently bad that the bulk of newly acquired skills were devoted to privately remunerative but socially

[25] But not impossible as the education-health linkage might be entirely the result of intergenerationally correlated endowments or preferences.

wasteful, or even counter-productive, activities—in some countries the expansion of schooling meant the country just had better educated pirates.

- The rate of growth of demand for educated labor (in part due to different sectoral shifts, in part due to policies, in part due to exogenous differences in technological progress) has varied widely across countries so that countries with the same initial individual returns and equal subsequent expansions in the supply of educated labor could have seen the marginal return to education fall dramatically, stay constant, or rise.
- Schooling has in some countries been enormously effective in transmitting knowledge and skills while in other countries it has been essentially worthless and created no skills.

No two countries follow exactly the same mold and each of these explanations contributes different amounts to explaining the overall impact of schooling on growth in different countries.

None of the arguments in this paper suggest that governments should invest less in basic schooling, for many reasons. First, most, if not all, societies believe that at least basic education is a *merit* good so that its provision is not, and need not be, justified on economic grounds at all—a position I strongly share. To deny a child an education because the expected economic growth impact is small would be a moral travesty. Second, schooling has a large number of direct beneficial effects beyond raising economic output, such as lower child mortality. Third, education can raise cognitive skills. The implication of a poor past aggregate payoff from increased cognitive skills in a perverse policy environment is not "don't educate" but rather "reform *now* so that investments (past and present) in cognitive skills will pay off."

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Table 2: Growth Accounting Regressions of GDP per worker growth with educational capital and CUDIE per worker growth

Dependent Variable:	Per annum growth of GDP per worker (GPDPW)						Level GDPPW	TFP as defined in text	
	1 OLS (entire sample)	2 OLS With initial GDPPW	3 OLS (on just IV sample)	4 IV (w/ NSD educ. capital data)	5 IV (w/ similar country)	7 OLS (sample of countries with test scores)	8 OLS (on level in 1985, whole sample)	9 OLS (factor shares, α_K=.4, α_H =.3)	10 OLS (factor shares, α_K=.5, α_H=.167)
Growth of educ. capital per worker[a]	-.049 (1.07)	-.038 (.795)	-.091 (1.61)	-.120 (1.42)	-.088 (.593)	.058 (.229)	.136 (1.97)	-.338 (6.91)	-.205 (4.19)
Growth of CUDIE per worker[a]	.524 (12.8)	.526 (12.8)	.458 (10.19)	.460 (10.18)	.527 (12.42)	.592 (6.78)	.612 (14.88)	.126 (3.08)	.026 (.651)
Ln (initial GDP per worker)		.0009 (.625)						.0009 (.625)	.0009 (.625
Test Score (normalized, mean=1)						.014 (1.31)			
Test Score* EK						-.485 (1.27)			
Number of countries	91	91	70	70	77	25	96	91	91
R-Squared	0.653	0.655	.611	--	--	.71	.909	.419	.205

Notes: t-statistics in parenthesis.

a) except in column six, which uses levels.