Education Quality and Development Accounting: An Alternative Approach

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Abstract

This short note follows up on Schoellman (2012). It presents an alternative and simpler way to conduct development accounting with education quality. The key insight is that the original paper's assumptions about the aggregate production function are sufficient for deriving development accounting results given the available data. The results from implementing this approach are quantitatively similar to those in the paper. This suggests that the additional assumptions in the original paper are useful for describing an equilibrium environment that gives rise to the observed schooling levels and returns to schooling, but do not contribute to the pure development accounting results. I post it here in case it is useful for researchers who want to focus on development accounting or for teaching and expository purposes. A companion Stata program that works through this analysis is available in the "code and instructions" supplementary material from my website. Much of this work arises out of an extended exchange with Antonio Ciccone, who suggested the equations used below, pushed me to re-think the role of the other assumptions, and offered helpful comments on this draft. He is of course blameless for any errors.

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1 Derivation of Equations

This section derives the equations that allow one to undertake development accounting using only the aggregate production function. Start with the same aggregate production function in the original draft, equation (3), and the human capital production function (4), repeated here:

$$h(S_j, Q_j) = \exp\left[\frac{(S_j Q_j)^\eta}{\eta}\right]. \tag{1}$$

In order to construct country-specific aggregate human capital stocks, we need data on S_j, a measure of the quality of schooling in country j, Q_j, and an estimate of η. As we directly observe only S_j, we need to infer Q_j and η.

I start with deriving a theory-consistent measure of Q_j. The derivation exploits that we can estimate the Mincerian return to schooling of individuals educated in country j in two labor markets: the U.S. (M^j_{US}) and country j (M_j). Given the usual development accounting assumptions (aggregate production function, perfect substitutes among labor types, perfectly competitive labor markets), the Mincerian return to schooling of individuals educated in country j in the U.S. labor market is simply the derivative of log human capital in (1) with respect to schooling:

$$M^j_{US} = \frac{\partial \log[h(S^j_{US}, Q^j_{US})]}{\partial S^j_{US}} = (Q^j_{US})^\eta (S^j_{US})^{\eta-1}.$$

Given an estimate of M^j_{US}, this equation can be inverted to measure education quality as a (non-linear) function of the returns to schooling of immigrants,

$$Q^j_{US} = (S^j_{US})^{\frac{1-\eta}{\eta}} (M^j_{US})^{\frac{1}{\eta}}. \tag{2}$$

This method of retrieving Q^j_{US} reads it off of the production function, given observed schooling and Mincer returns. It takes the place of the equations at the bottom of p. 19 in the original draft, which use equilibrium relationships to find an alternative expression for the same object.

Now we need an estimate of η. To find this, we compare the returns to schooling of immigrants to the returns to schooling of non-migrants from the same country. Given the usual development accounting assumptions, the Mincerian return to schooling of individuals

educated in country j in the country j labor market is:

$$M_j = \frac{\partial \log[h(S_j^j, Q_j^j)]}{\partial S_j} = (Q_j)^{\eta}(S_j)^{\eta-1}.$$

Taking the ratio of the returns to schooling of non-migrants and immigrants cancels out the (common) education quality and yields:

$$\frac{M_{US}^j}{M_j} = \left(\frac{S_{US}^j}{S_j}\right)^{\eta-1} \tag{3}$$

This equation has four known variables (schooling levels and returns to schooling for migrants and non-migrants) and one unknown parameter, η. Thus, it can be used to estimate η. Essentially, it exploits the fact that immigrants and non-migrants have very different levels of schooling but common education quality. Given the structure of the production function, I can estimate the η that is jointly consistent with the relative schooling levels and relative returns to schooling of immigrants and non-migrants.

2 Estimation and Results

In this section I carry out the estimation suggested above, working in reverse order. First, I estimate η using the (log) of equation 3.[1] The data on M_{US}^j and S_{US}^j come from the immigrant sample and estimated returns to schooling used throughout the paper. Data for S_j come from Barro and Lee (2001). I explore two different estimates for M_j; first, I try the estimates from Banerjee and Duflo (2005); second, I try imposing the mean value in the sample for all countries.

Table 1 gives the results. The estimates with either actual or imputed returns to schooling are almost identical at -0.33, although only the latter are statistically significant. Since the regression coefficient actually captures $\eta - 1$, the implied η is 0.67, somewhat higher than the range of η considered in the paper (where 0.50 was used as the baseline).

Given η, I then use equation (2) to construct the education quality of all countries. In Figure 1 I plot these estimates of Q_j against the estimates produced in the paper. The estimates produced using only the production function line up well with those in the

[1] It is of course somewhat arbitrary how one specifies the equilibrium relationship in (3) for estimation. My view is that returns to schooling are measured with much greater noise than mean years of schooling. Thus, I prefer to specify the equation with relative returns to schooling as the dependent variable because this reduces concerns about attenuation bias.

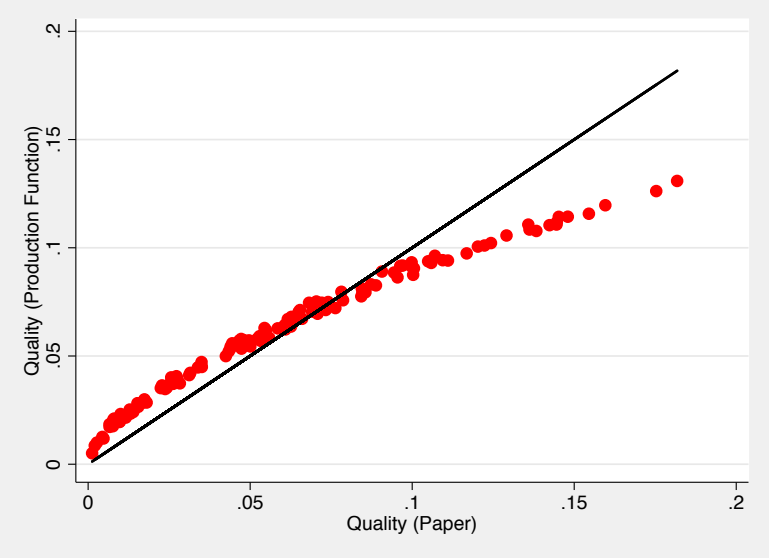
Table 1: Estimates of η

	Source for Returns to Schooling of Non-Migrants	
	Banerjee and Duflo (2005)	Common Return (10 percent)
Estimate	-0.330	-0.330
	(0.201)	(0.098)
Implied η	0.67	0.67
N	65	89

Table notes: Each column gives one estimate from a regression on equation (3) (in logarithms) and the corresponding implied value of η. Standard errors are in parentheses.

paper. Since they use information on $\eta < 1$, they build in some curvature that the baseline estimates do not, dampening somewhat the implied variation in Q_j.

Figure 1: Education Quality



Finally, given η and Q_j, I use equation (1) to construct the human capital stock of all countries. Again in Figure 2 I plot these estimates of the human capital stock against the estimates produced in the paper. In each case I have normalized the human capital stock of the U.S. to be 1 to provide a comparable scale. We can see that the two estimates are highly correlated (0.89 in logs), although the exact ordering of countries changes somewhat depending on which method one uses.

Because the resulting human capital stocks are fairly similar, the implications for development accounting are also similar. This is shown in Table 2. The 90-10 ratio of human

Figure 2: Human Capital Stocks Relative to U.S.

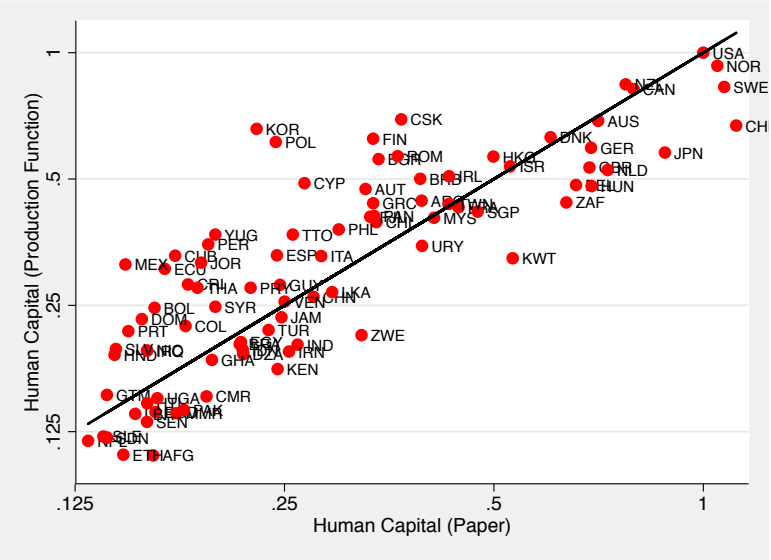


Table 2: Development Accounting with Both Human Capital Stocks

	Paper	Production Function
h_{90}/h_{10}	4.71	4.74
$\frac{h_{90}/h_{10}}{y_{90}/y_{10}}$	0.21	0.34
$\frac{\text{var}[\log(h)]}{\text{var}[\log(y)]}$	0.26	0.34
$\varepsilon_{\log(h),\log(y)}$	0.42	0.42

capital stocks is almost identical between the two measures. The development accounting implications in terms of fraction of the 90-10 ratio or fraction of the log variance of output accounted for is modestly higher for the new measure. This arises purely because of a change in the countries in the sample; the figures are quite close in a balanced sample. The elasticity of log human capital with respect to log GDP per worker is nearly identical between the two samples.

3 Conclusion

Given the structure of the production function, which features only one unknown parameter, it is actually possible to use observed data on years of schooling and returns to schooling of immigrants and non-migrants to pin down that parameter and back out implied education quality by country. The resulting estimates of education quality, human capital stocks, and

the importance of human capital for development accounting are quantitatively similar to those in the Schoellman (2012), but rely on fewer assumptions.

References

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