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REDISCOVERING EDUCATION IN GROWTH REGRESSIONS

by

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PREFACE

The OECD Development Centre's programme of work for 2001-02 stresses the importance of human capital in economic development. Together with Daniel Cohen, Marcelo Soto has contributed to the subject in a series of papers from the Centre.

A number of influential papers have challenged the view that education is important for development. In reviewing this controversial literature, Soto argues that the critics have failed to evaluate properly the effects of education on national income, and this for a number of reasons. Among them is the need to cope with measurement error problems and to deal adequately with the strong relationship between physical and human capital stocks. Indeed, collinearity, which describes this strong link, has made the task of identifying the benefits from education at a national level difficult. Using previously constructed indicators on education available in Development Centre Technical Paper # 179, Soto here shows that the macroeconomic gains from expanding education are at least as high as those observed at a microeconomic level.

Policies that may lead a country to higher educational attainment, however, are another question. In this regard, Development Centre Technical Paper # 197 stresses that a key element in maximising gains to development from education is life expectancy. In this context, policies oriented towards improvement in health standards and thus extending life expectancy have the potential for promoting economic growth in a longer horizon.

This Technical Paper makes a significant contribution to the tools available to decision makers making choices about resource allocation and is complementary to work on maximising gains from human capital formation. It will be of interest to policy makers and those who advise them in both developing and OECD-Member countries.

Jorge Braga de Macedo
President
OECD Development Centre
20 November 2002

RÉSUMÉ

Ce Document technique examine la curieuse absence de corrélation entre le revenu et la scolarisation que l'on observe dans les régressions macro-économiques. Ce phénomène a trois origines. En premier lieu, un problème de définition de la manière d'intégrer les années de scolarisation dans une fonction de production. En deuxième lieu, l'existence de colinéarités entre les stocks de capital humain et physique affecte grandement la signification des indicateurs d'éducation dans les régressions de croissance. En troisième lieu, la difficulté à corriger les erreurs de mesure et l'endogénéité introduit des biais dans les estimations. Une fois ces problèmes résolus, il apparaît que les données corroborent largement l'approche néoclassique du capital humain.

SUMMARY

This paper studies the puzzling lack of correlation between income and schooling in macro regressions. It is argued that the root of the puzzle is threefold. First, there is a problem of a proper definition of the way in which years of schooling should enter into a production function. Second, collinearity between physical and human capital stocks seriously undermines the ability of educational indicators to display any significance in growth regressions. Third, failure to cope with measurement error and endogeneity produces biased estimates. After dealing with these problems, the neoclassical approach to human capital is strongly supported by the data.

I. INTRODUCTION

A recurrent question that has characterised the debate on economic growth during the last decade refers to the puzzling lack of correlation between changes in years of schooling and changes in the level of income. This evidence has led to different examinations and reinterpretations of the role of education. Benhabib and Spiegel (1994) have suggested that the level of education should not be seen as a factor of production, but as a determinant of changes in total factor productivity. On the other hand, in successive versions of an influential paper, Pritchett (2001) has argued that the poor institutional framework, low quality and excess supply of schooling in developing countries are responsible for the lack of empirical link between changes in educational attainment and economic growth. This is the so-called "Pritchett hypothesis" — a term stamped by Temple (2001) in reference to the idea that the environment where increases in education have taken place has hindered the impact of schooling on growth. More recently, Krueger and Lindahl (2001) have stressed that measurement error in years of schooling is the central cause behind the lack of correlation between schooling and income.

The purpose of this paper is to review these findings. It is argued that, although the Pritchett hypothesis may apply to some specific countries, it cannot explain why cross-country or panel regressions result in null or even negative coefficients for years of schooling. It is shown that the root of the puzzle is threefold. First, there is a problem of a proper definition of the way in which years of schooling should enter into a production function. The underlying question is how to relate the number of years of schooling to human capital. Put simply, this is a discussion on whether the macro-return to education should be evaluated in a log-log or log-linear formulation. This question can be settled empirically and has already been addressed elsewhere (Bils and Klenow, 2000). A second issue refers to the appropriate functional form to be estimated. As is shown later, a simple statistical problem of collinearity between physical and human capital stocks, a point surprisingly neglected in the earlier literature may be seriously undermining educational indicators' ability to display any significance in growth regressions. The third point refers to the consistency of the estimates. Growth regressions usually rely on OLS or fixed-effect estimates and therefore overlook endogeneity and measurement error problems, an omission that certainly leads to inconsistent estimates.

As many authors have noted, the discussion on why education fails to display positive effects in growth regressions is more an academic issue than one pertinent for policy decisions. The policy relevant question is whether schooling presents social returns that are higher than the private ones, which could provide empirical support for orienting decisions on public spending in education. The paper offers a range of values for the social return to years of schooling. It will be seen that social returns exceed the standard private returns found in micro studies only if physical capital is assumed to respond to changes in human capital.

The paper is organised as follows: the next section highlights the most influential results and the current state of the literature on the macro-returns to schooling. Section III shows the roots underlying the schooling-income dilemma and presents new empirical results. Section IV explores the effects of alternative definitions of human capital. The conclusions are presented in Section V.

II. LITERATURE

The empirical literature on macro returns to education comprises two broad sets of studies. The first, based on endogenous growth models, suggests that the level of education affects the income growth rate, as in Benhabib and Spiegel (1994). In these models the level of human capital is not characterised as an input of the production function, but as a determinant of domestic innovation and of absorption capacity of foreign technologies. Benhabib and Spiegel show that the change in years of schooling, whether measured by Kyriacou (1991) or Barro and Lee (1993) data, provides non-significant and sometimes even negative coefficients, when entered in a growth regression. On the other hand, they find that the level of schooling is positively — though not always significantly — correlated with growth. Undoubtedly, these results are the first to have questioned empirically the view that human capital is to be treated as an additional factor of production.

Informal Barro growth regressions, which are closer to the neoclassical framework since they imply the existence of a steady state in income level, also postulate a growth-on-level formulation. In these regressions the educational level is sometimes seen as a state variable, i.e. a variable measuring the proximity to the steady state (Barro and Sala-i-Martin, 1995) and sometimes as a determinant of the steady-state itself (Barro, 1997).

The second tradition is based on the neoclassical model "revived" by Mankiw, Romer and Weil (MRW, 1992)[1]. In this tradition, human capital is represented as a factor of production in an extended version of the Solow model:

$$Y = A\,K^{\alpha}H^{\beta}L^{1-\alpha-\beta} \qquad (1)$$

Here Y represents total output, K and H are total physical and human capital respectively, and L is the labour force. From equation (1) and standard laws of motion for K and H, MRW show that both the output level and growth may be related to the investment rate in physical and human capital. These two equations represent, respectively, the steady state and convergence path of income. Then, in their empirical analysis, MRW show that human capital investment is significant in both equations. For human capital investment, MRW use the secondary enrolment rate multiplied by the fraction of population aged 15 to 19 in the working age population.

The empirical results of this influential paper are nevertheless overshadowed by the fact that MRW fail to control for the endogeneity of the investment rates and by the murkiness of their measure of human capital investment. Examples of papers that have tackled the endogeneity problem for testing the MRW model are Caselli *et al.* (1996) and Islam (1995). In both papers the schooling variable appears with the wrong sign.

The availability of data on both physical and human capital stocks has made possible the direct estimation of level-on-level or change-on-change regressions. Pritchett (2001) follows this last option. Based on Mincer (1974) wage equations, Pritchett builds a human capital index given by:

$$h = \exp(r \times S) - 1 \tag{2}$$

where h is human capital per worker, r is the Return to education (which Pritchett sets at 0.1) and S is the average number of years of schooling taken from Barro and Lee (1993). He then uses OLS and IV methods to estimate the following cross-section regression,

$$\hat{y}_i = \hat{A}_i + \alpha \hat{k}_i + \beta \hat{h}_i + \varepsilon_i \tag{3}$$

where y = Y/L, k = K/L for each country i and $\hat{g}$ stands for growth rate of variable g, over the period 1960-85. As in Benhabib and Spiegel (1994), Pritchett finds a non-significant β, implying that changes in schooling have had no impact on economic growth. Furthermore, when the income level y_i is regressed on physical and human capital stocks, the significance of β is also rejected. The interpretation of this result is however radically different from the one given by Benhabib and Spiegel. Pritchett bases it on the institutional characteristics where increases in education have taken place. The main arguments provided by Pritchett are: *i)* education has been of low quality and so it has not generated increases in human capital; *ii)* the expansion in supply of educated labour has surpassed demand, leading to a decrease in the return of education; and *iii)* educated workers may have gone to privately lucrative but socially unproductive activities.

Even if all these phenomena might be actually taking place, they can hardly be the reason behind the apparent lack of productivity of education in macro empirical studies. First, it is difficult to believe that the provision of education has been of such a low quality in some countries that on average the world return is zero. Moreover, as shown later, if countries with higher levels of schooling benefit from better quality and productivity of schooling, then standard methods of estimation would provide world average returns biased upwards, not downwards. Second, even assuming that the supply of education has increased more rapidly than demand, this cannot by itself imply that one additional year of schooling leads to a null increase in production. Otherwise, why would education take place? Besides, in Pritchett's argument is implicit the idea that shifts in demand or supply would alter a technical parameter, which is a rather unconventional assumption. Third, the hypothesis that most of the increases in education have been devoted to socially unproductive activities around the world — an hypothesis necessary to explain a null global return — is simply at odds with reality. We do observe that more educated people are employed in better-paid activities, as reflected in the national accounts. Again, this simple observation does not mean that all skilled workers are devoted to socially productive activities, but neither is the opposite true.

More recently, Temple (2001) has revisited Pritchett's results. He has explored the effects of estimating the MRW production function (1) by assuming different formulations for human capital. With the same database as Benhabib and Spiegel (1994), Temple estimates the following cross-section regressions:

$$\Delta\log(Y_i) = C_0 + \alpha\,\Delta\log(K_i) + \beta\,\Delta f(S_i) + \gamma\,\Delta\log(L_i) + \Delta\varepsilon_I \qquad (4)$$

where $f(S_i)$ is a function of the number of years of schooling. In particular, Temple reports results for $f(S_i) = rS_i$ and for $f(S) = c_0 + c_1\log(S_i) + c_2(1/S_i)$. None of these yielded significant coefficients at standard levels. Temple concludes that "[…] the *aggregate* evidence on education and growth, for a large sample of countries, continues to be clouded with uncertainty".

The systematic failure of cross-country regressions to display positive effects from education has led some researchers to question the quality of the education data. Topel (1999), and Krueger and Lindahl (2001) argue that measurement error in the number of years of schooling is a major cause of the apparent lack of significance of ΔS in growth regressions. In both papers, the authors report panel data results for the following equation for country i in year t:

$$\Delta\log(y_{it}) = \pi_1\,S_{it-1} + \pi_2\,\Delta S_{it} + \pi_3\,\log(y_{it-1}) + \Delta\tau_t + \Delta\varepsilon_{jt} \qquad (5)$$

where τ_t represents a time-specific effect. The years-of-schooling variable is taken from Barro and Lee (1993), who according to Krueger and Lindahl, have less measurement error than Kyriacou's (1991) data. Topel and Krueger and Lindahl estimate (5) by using different data frequencies. They find that in high frequency regressions (i.e. panel data with five-year observations) ΔS is not significant, while in lower frequency regressions (ten or twenty-year observations), ΔS becomes significant. The authors argue that in short periods of time ΔS has a low informational content relative to the measurement error and this is why in five-year data regressions the significance of ΔS is rejected. But in longer periods of time true changes in S are more likely to predominate over measurement errors. Furthermore, Krueger and Lindahl show that if the estimate of π_2 (in the regressions with twenty-year observations) is adjusted by taking into account the downwards bias induced by the measurement error in S, its magnitude shoots from 0.18 to 0.30. Topel finds a non-adjusted π_2 as high as 0.25 in a similar regression. These values suggest huge returns to education and, if taken at face value, they would imply large positive externalities.

Yet, these findings must be looked at with some caution for three reasons. First, the regressions are not based on a specific growth model. The use of lagged income suggests that equation (5) represents a convergence path towards steady state but, in that case, it is hard to justify the presence of both the change and the level of schooling simultaneously. The MRW augmented model states that, in a convergence path, income growth depends on the investment rate of human capital (not on its level or its change).

Second, in almost all the regressions reported, the endogeneity of years of schooling is completely neglected. This variable is likely to be endogenous since richer countries can afford more spending on education, and hence reach a higher level of education. Not dealing with the endogeneity of S means that its coefficient is likely to be biased upwards. The few regressions reported by Krueger and Lindahl that were estimated with instrumental variable methods make use of Kyriacou's series as instruments (as a solution to the measurement error problem). However, this instrument does not represent a solution to endogeneity since it is itself an endogenous variable. Krueger and Lindahl argue that the attenuation bias introduced by measurement error is higher than the upwards bias inherent to the endogeneity of S. But this argument, by itself, does not justify not using suitable instruments — like lagged values of endogenous variables — to overcome the measurement error or endogeneity problems. A straightforward estimation method that deals with both sorts of biases looks as a much more natural method of estimation.

A third reason to be cautious about these results is that ΔS is significant only when the change in the stock of physical capital is omitted from the regressions. When Krueger and Lindahl include $\Delta\log(k)$, ΔS loses its explanatory power, while physical capital growth gets a coefficient as high as 0.8. This is much higher than the standard share of physical capital in total income — which is thought to have a ceiling at around 0.5 (see Gollin, 2002) — and consequently is a clear sign of endogeneity problems. Only when the coefficient associated to $\Delta\log(k)$ is constrained to 0.35, does ΔS recover its significance. Krueger and Lindahl conclude that: "Overall, unless measurement error problems in schooling are overcome, we doubt that cross-country growth equations that control for capital growth will be very informative insofar as the benefit of education is concerned". Again, IV (instrumental variable) estimation by using lagged variables as instruments seems the natural way to proceed in the presence of both measurement errors and endogenous regressors.

To illustrate the effects entailed in the omission of physical capital, consider Table 1. Columns (1) and (2) reproduce the estimates of equation (5) reported by Krueger and Lindahl (2001) and Topel (1999) for the regressions based on ten-year observations (over the period 1960-90). Series for GDP per capita and per worker are from Penn World Table Mark 5.6 [an updated version of Summers and Heston (1991) data set] and years of schooling are from Barro and Lee (1993). These results show that both the change and the initial level of years of schooling have a positive effect on economic growth. The differences in point estimates are due to the different method of estimation used. Krueger and Lindahl's results are obtained by OLS, while Topel uses the Within estimator, hence the large downward bias of lagged income. From these results the authors conclude that schooling has an effect on growth. Columns (3) and (4) replicate these regressions by using the Cohen and Soto (2001) series on years of schooling for 83 countries. The results are very close to those of Krueger and Lindahl, whether GDP per capita or per worker is used. However, when the change in capital stock is included[2] in column (5) the coefficient on the change in years of schooling falls dramatically and becomes insignificant. The further inclusion of the initial level of physical capital stock causes the initial level of schooling to lose its significance as well. On the other hand, the large coefficient on physical capital reflects that endogeneity is biasing this coefficient upwards. Yet, endogeneity of k by itself may not be the cause behind the vanishing effect of schooling. Moreover, if countries invest more on education as they become richer, schooling would also be affected by an upward simultaneity bias.

Table 1. **The Fading Effect of Schooling on Growth**
Dependent Variable: Annualised Change in Log(y_{it})

	K-L (per capita) (1)	Topel (per worker) (2)	This Paper (per capita) (3)	This Paper (per worker) (4)	This Paper (per worker) (5)	This Paper (per worker) (6)
Observations	292	290	230	230	230	230
ΔS_t	0.086	0.058	0.081	0.093	0.028	0.008
	(0.024)	(2.15)	(0.036)	(0.041)	(0.023)	(0.022)
S_{t-1}	0.004	0.009	0.003	0.003	1.6e-3	2.4e-4
	(0.001)	(2.35)	(0.001)	(0.001)	(0.6e-3)	6.7e-4)
$\log(y_{t-1})$	-0.005	-0.050	-0.005	-0.006	-0.004	-0.016
	(0.003)	(6.45)	(0.004)	(0.003)	(0.002)	(0.004)
$\Delta\log(k_{it})$					0.574	0.607
					(0.042)	(0.041)
$\log(k_{it-1})$						0.011
						(0.003)
R^2	0.284	0.481	0.268	0.287	0.634	0.666

Notes: Time dummies included (not reported). Columns (1) and (2) are from Krueger and Lindahl (2001) and Topel (1999), respectively. OLS estimates, except for Topel, who reports fixed-effect estimates. Standard errors in parenthesis, except for Topel who reports t-statistics. Ten-year observations for the period 1960-90. Variables in changes are annualised. y_{it} is GDP per capita or per worker, from Summers and Heston, PWT 5.6; S_{it} is years of schooling from Barro and Lee (1993) in columns (1) and (2) and from Cohen and Soto (2001) in columns (3) to (6); k_{it} is stock of physical capital per worker from Easterly-Levine (2001).

Krueger and Lindahl argue that measurement error in S is exacerbated by the inclusion of physical capital, hence the lack of significance of schooling in the regression with $\Delta\log(k)$. However, the next section shows that rather than a consequence of measurement error, the fading effect of years of schooling is a sign of collinearity between physical capital and years of schooling. This hypothesis is explored below, in the framework of a more standard growth model.

III. REDISCOVERING EDUCATION

New Evidence

Acknowledging the measurement error problem, Cohen and Soto (2001) have built new series on years of schooling for a large number of countries. The data for almost half the countries in the sample are built from the OECD database on schooling. This database has the advantage of presenting standardised information across countries; thus the measurement error introduced by differences in classification in each country is minimised. Data for countries not covered in the OECD database are constructed from the latest surveys or census published by UNESCO. For a number of low-income countries with no census or survey information, years of schooling are built from historical enrolment rates and tables of population by age. The measurement error in this last group of countries is not likely to be large since the true value of S in low-income countries is low and so the error of measure is limited to small magnitudes. When all countries are included, Cohen and Soto report a reliability ratio of 0.58 for the first-differences of their series over the period 1960-90, while the reliability ratio for Barro and Lee (2000) data is 0.37[3]. When De la Fuente and Doménech (2000) data are used as a benchmark for OECD countries, the reliability ratios for series in levels are 0.95 and 0.93 for Cohen-Soto and Barro-Lee data, respectively. The corresponding ratios for series in first differences fall to 0.56 and 0.04 respectively. From these simple checks, the Cohen-Soto series seems to be less affected by measurement error than Barro and Lee's series.

Assuming constant returns on K and H, and setting log(h) = r S [4], equation (1) yields the following testable system of equations:

$$\log(y_{it}) = \alpha\log(k_{it}) + (1-\alpha)rS_{it} + \eta_i + \tau_t + \varepsilon_{it} \qquad (6a)$$

$$\Delta\log(y_{it}) = \alpha\Delta\log(k_{it}) + (1-\alpha)r\Delta S_{it} + \Delta\tau_{it} + \Delta\varepsilon_{it} \qquad (6b)$$

The assumption of constant returns on K and H (i.e. $\alpha + \beta = 1$) allows the identification of r and has no implication on the results that are presented below. This hypothesis is tested later.

Table 2 reports estimates for α and $(1 - \alpha)r$ resulting from different methods of estimation. The first column shows the estimates obtained by OLS for the equation in levels (6*a*). The physical capital variable is highly significant and its share in total income is estimated at 0.60, larger than the "conventional wisdom" on this variable. Conversely, years of schooling turns out to be not significant. Column (2) shows the results for the equation in differences (6*b*), which are similar to those obtained for the equation in levels. Namely, years of schooling are not significant, as the studies cited above have already found[5]. Surprisingly, the Within estimator yields a significant coefficient for years of schooling. From the estimated share of physical capital, the implicit r is equal to 0.066/(1-0.555) = 0.15. However, the large coefficient obtained for the physical capital share suggests that these results are biased upwards. As for the GMM estimates, none of them resulted in a significant coefficient for years of schooling. What is more, the standard Arellano-Bond (1991) difference GMM estimator provides a negative coefficient — although not significant — for ΔS and an excessively high α. Blundell and Bond (1998) and Blundell *et al.* (2000) have shown that in finite samples the difference GMM estimator has a large bias and low precision in series with a strong autoregressive component. This is certainly the case of the physical and human capital series. When the variables are strongly autoregressive, the authors show that the system GMM estimator, which estimates simultaneously the equation in levels and in first differences, provides more precise estimates and lower biases in finite samples. Yet, system GMM estimates do not result in a significant coefficient for years of schooling.

Table 2. **The Effect of Schooling in a Standard Production Function**

Equation Estimated: $\log(y_{it}) = \alpha \log(k_{it}) + (1-\alpha) r S_{it} + \eta_i + \tau_t + \varepsilon_{it}$

Panel A. **With Physical Capital**

	OLS (Levels)	OLS (Differences)	Within (Levels)	GMM (Differences)	GMM (System)
Observations	313	230	230	230	313
$\text{Log}(k_{it})$	0.604	0.585	0.555	0.707	0.490
	(0.047)	(0.043)	(0.041)	(0.171)	(0.132)
S_{it}	0.010	0.024	0.066	-0.018	0.054
	(0.018)	(0.022)	(0.024)	(0.108)	(0.057)
Sargan	–	–	–	0.219	0.352
2nd order serial correlation	–	–	–	0.551	0.760

Panel B. **Without Physical Capital** (α=0)

	OLS (Levels)	OLS (Differences)	Within (Levels)	GMM (Differences)	GMM (System)
Observations	313	230	230	230	313
S_{it}	0.249	0.088	0.158	-0.095	0.257
	(0.018)	(0.041)	(0.046)	(0.169)	(0.030)
Sargan	–	–	–	0.015	0.039
2nd order serial correlation	–	–	–	0.030	0.809

Notes: Time dummies included (not reported). Robust standard errors in parenthesis. Sargan and serial correlation tests show probability values. One-step results for GMM estimates. Ten-year observations for the period 1960-90. y_{it} is GDP per worker, from Summers and Heston, PWT 5.6; S_{it} is years of schooling from Cohen and Soto (2001); k_{it} is stock of physical capital per worker from Easterly-Levine (2001).The fact that none of the regressions making use of instrumental variables produces significant estimates for years of schooling strongly suggests that the measurement error problem is not the only reason causing insignificant coefficients. Another econometric problem that may be behind this result is collinearity between physical capital stocks and years of schooling.

The upper scatter of points in Figure 1 displays years of schooling (S) plotted against the logarithm of physical capital per worker (k). The correlation between both variables is considerable, as is shown by the large R^2 (=0.71) obtained from an OLS regression. A simple check that the high collinearity between log(k) and S is undermining the precision of the estimates can be made by regressing equations (6*a*) and (6*b*) without the physical capital variable. The results are shown in the second panel of Table 2. There, all the methods of estimation — except for the difference GMM estimator — result in significant coefficients for S. Even the equation in differences, when estimated by OLS, provides a non-null coefficient. Of course, these results are plagued by inconsistency problems arising from the omission of physical capital. This is patent from the implicit high return to schooling, as well as from the rejection of the instruments' validity by Sargan tests. But the fact that, after omitting log(k), years of schooling becomes highly significant is a sign that collinearity is affecting the precision of the estimation.

One way to get rid of the collinearity problem is to reformulate the model. By subtracting αlog(y) from both sides of equation (6*a*) and after dividing by (1-α) we obtain:

$$\log(y_{it}) = \frac{\alpha}{1-\alpha}\log\left(\frac{k}{y}\right)_{it} + rS_{it} + \frac{\eta_i}{1-\alpha} + \frac{\tau_t}{1-\alpha} + \frac{\varepsilon_{it}}{1-\alpha} \tag{7a}$$

and its corresponding version in first differences:

$$\Delta\log(y_{it}) = \frac{\alpha}{1-\alpha}\Delta\log\left(\frac{k}{y}\right)_{it} + r\Delta S_{it} + \frac{\Delta\tau_t}{1-\alpha} + \frac{\Delta\varepsilon_{it}}{1-\alpha} \tag{7b}$$

The lower scatter of Figure 1 represents the relationship between years of schooling and the log of the capital-output ratio. Although the R^2 (=0.53) is still high its reduction reflects that years of schooling are less correlated with log(k/y) than with log(k).

Topel (1999) has already estimated equations (7*a*) and (7*b*) but by constraining the coefficient α to specific values (he chooses 0.35 and 0.5) or by assuming that the ratio k/y is constant for each country along time. Under this last assumption he treats k/y as a country specific effect and estimates (7*a*) and (7*b*) by fixed-effect and OLS methods.

Table 3 presents unconstrained estimates for the system (7*a*-*b*). The OLS estimation in levels in column (1) results in a coefficient r equal to 21.7 per cent and highly significant. This value reflects the return to schooling that allows for physical capital to adjust to changes in S so that the ratio k/y stays constant and therefore it should be seen as a long-term return to schooling. The "short-term" effect of an additional year of schooling — the increase in income per worker that would be obtained without an endogenous response of k — is 0.217×(1–0.181)=17.8 per cent. This figure is still very large. Measurement error problems in both k and y variables may be the cause of the implicit low or even negative (column 2) estimates obtained for α. In fact, any measurement error affecting y will lead to a spurious negative correlation between log(y) and log(k/y). Besides, if k is also measured with error, OLS methods will yield estimates for α biased towards zero. As mentioned before, first-difference regressions aggravate measurement error problems, hence the strange results obtained in column (2). The fixed-effect estimator yields qualitative similar results: a non-significant coefficient for the capital to output ratio, and a highly significant coefficient for years of schooling.

Figure 1

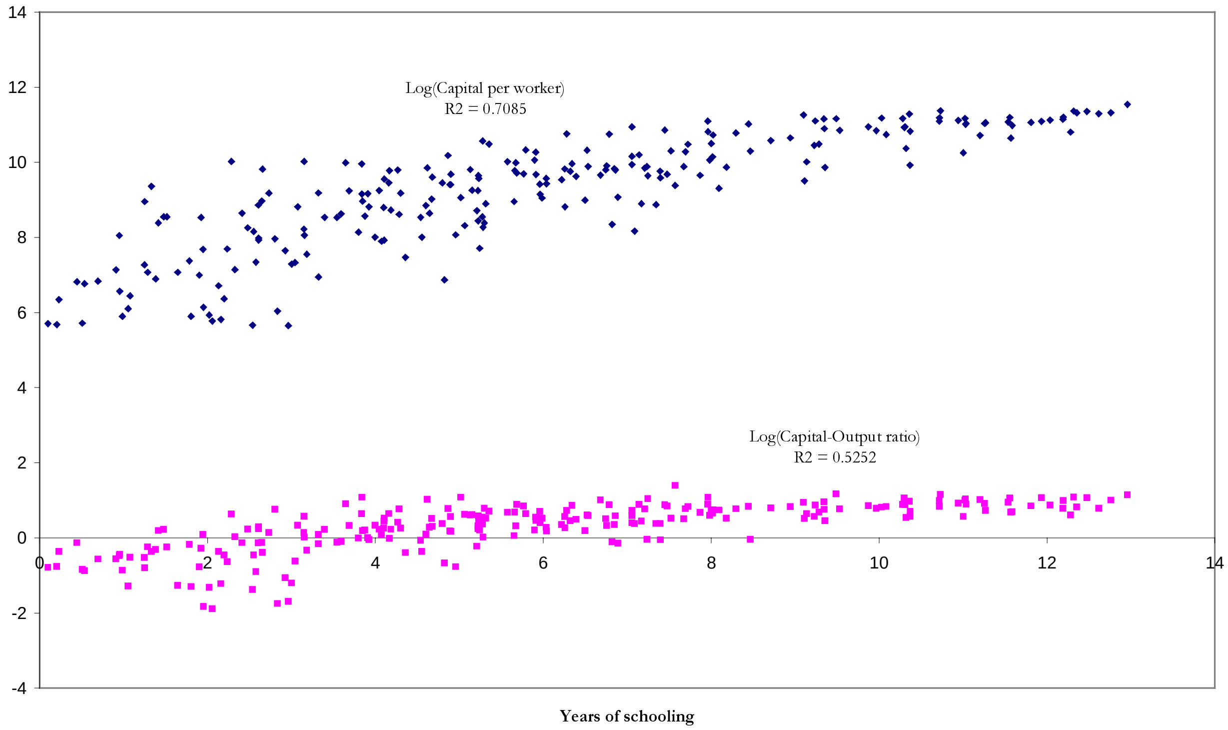

Table 3. **The Effect of Schooling after Dealing with Collinearity**

Equation Estimated: $\log(y_{it}) = \frac{\alpha}{1-\alpha}\log\left(\frac{k}{y}\right)_{it} + rS_{it} + \frac{\eta_i}{1-\alpha} + \frac{\tau_t}{1-\alpha} + \frac{\varepsilon_{it}}{1-\alpha}$

	OLS (Levels) (1)	OLS (Differences) (2)	Within (Levels) (3)	GMM (Differences) (4)	GMM (System) (5)	GMM (System-2) (6)
Observations	313	230	230	230	313	313
$\text{Log}(k/y)_{it}$	0.221	-0.213	0.012	0.330	0.824	0.572
	(0.112)	(0.105)	(0.017)	(0.338)	(0.313)	(0.212)
S_{it}	0.217	0.093	0.158	-0.013	0.122	0.158
	(0.024)	(0.044)	(0.046)	(0.162)	(0.050)	(0.034)
Implicit Δ	0.181	-0.271	0.012	0.248	0.452	0.364
Sargan	–	–	–	0.020	0.190	0.190
2nd order serial correlation	–	–	–	0.182	0.729	0.797

Notes: Time dummies included (not reported). Robust standard errors in parenthesis. Sargan and serial correlation tests show probability values. One-step results for columns (4) and (5). Two-step results for column (6). Ten-year observations for the period 1960-90. y_{it} is GDP per worker, from Summers and Heston, PWT 5.6; S_{it} is years of schooling from Cohen and Soto (2001); k_{it} is stock of physical capital per worker from Easterly-Levine (2001).

System GMM estimates display fairly reasonable results. The one-step estimates yield a capital share equal to 0.824/1.824=45.2 per cent and a semi-elasticity of income with respect to S equal to 0.122×(1–0.452)=6.7 per cent. The corresponding numbers in a two-step estimation are 36.4 per cent and 10 per cent, respectively[6]. These numbers are larger than those reported by Topel (1999; Table 2, column 5) who, conditioning on a capital share equal to 35 per cent, finds a marginal effect of schooling equal to 5.5 per cent. On the other hand, the results of this paper show that the marginal effect of schooling at a macro level is surprisingly close to the standard private return observed in labour studies. For instance, from more than 60 country-level studies, Psacharopoulos (1994) reports a world average Mincerian return equal to 10.1 per cent. Consequently, if micro returns are taken at face value, these results point to an absence of externalities to schooling[7].

Alternatively, if an increase in the level of human capital induces an expansion of physical capital, as predicted by neoclassical and endogenous growth models, the total macro return to schooling would be higher than the typical private one. Indeed, under the assumption of a constant capital-output ratio the total return to schooling would be placed between 12.2 per cent and 15.8 per cent. Some care should be taken with the interpretation of these figures. The large long-term return to schooling does not represent externalities in the sense of Lucas (1988). In Lucas's model, the social marginal product of human capital is higher than the private marginal return in the short run — i.e. without taking into consideration the endogenous response of physical capital. Therefore the proper way to analyse if these externalities exist in the real world is to compare the macro and micro marginal return of years of schooling. The results obtained in Table 3 point to the absence of this kind of externalities. However, what Table 3 does show is that, contrary to the findings of most of the recent empirical literature, the neoclassical approach to human capital is strongly supported by the evidence, and years of schooling present a return surprisingly close to the standard value found in micro studies.

Comparison with Barro-Lee Data

This section studies the robustness of the results of this paper to changes in the data on schooling. The results presented above are obtained with Cohen and Soto (2001) data on years of schooling, but most of recent cross-country and panel growth regressions use the Barro and Lee (1993) data set of schooling. One major difference between Barro and Lee data and the data used in this paper is that the former refers to years of schooling of all the population above a specific age (typically 25 and over) whereas the latter refers to the labour force between ages 15 and 64. However, Cohen-Soto's data is also available for the population aged 25 and over, so it is these series which are used for comparison[8]. That data set also includes estimates of years of schooling for population aged 15 and over. The comparison is carried out with the latest version (2000) of Barro and Lee's data. The sample includes 73 countries only because there are a number of countries, mainly from sub-Saharan Africa, which are not available in Barro and Lee (2000) data. Table 4 displays the main results (from now on, only one-step system GMM estimates are reported). The returns to schooling are higher when Barro and Lee data are used. The differences are particularly large for the series referring to population aged 15 and over. However, none of the coefficients obtained are significant at a 5 per cent level. What is more, the implicit physical capital share obtained with the Barro-Lee data is around 49 per cent, which casts doubt on the validity of the regressions. The conventionally used measure of schooling — that is, years of schooling for population 25 and over — yields more standard results. Both sources result in short-term returns around 7 per cent in the short term and between 12 per cent and 13 per cent if physical capital is allowed to increase in the long term so that the capital to output ratio does not change. The coefficients on Barro-Lee's series have a larger standard error, which means that schooling is only significant at a 10 per cent level. This may be caused by a larger measurement error in Barro-Lee's series, as Cohen and Soto (2001) argue. In all, although the point estimates do not vary significantly with the series used for years of schooling, regressions with Barro and Lee (2000) series of schooling display higher standard errors, which is hindering the significance of schooling in those regressions.

Table 4. **Comparison with Barro-Lee (2000) Data**

Equation Estimated: $\log(y_{it}) = \frac{\alpha}{1-\alpha}\log\left(\frac{k}{y}\right)_{it} + rS_{it} + \frac{\eta_i}{1-\alpha} + \frac{\tau_t}{1-\alpha} + \frac{\varepsilon_{it}}{1-\alpha}$

	Schooling from Barro-Lee (2000)		Schooling from Cohen-Soto (2001)	
	Population			
	15 and over	25 and over	15 and over	25 and over
$\text{Log}(k/y)_{it}$	0.957	0.858	0.851	0.698
	(0.377)	(0.374)	(0.374)	(0.336)
S_{it}	0.161	0.127	0.092	0.123
	(0.083)	(0.073)	(0.068)	(0.051)
Implicit Δ	0.489	0.462	0.460	0.411
Sargan	0.480	0.302	0.320	0.250
2nd order serial correlation	0.574	0.551	0.424	0.460

Notes: 73 countries; 278 observations. Time dummies included (not reported). Robust standard errors in parenthesis. System GMM estimation, one-step results. Sargan and serial correlation tests show probability values. Ten-year observations for the period 1960-90. y_{it} is GDP per worker, from Summers and Heston, PWT 5.6; S_{it} is years of schooling for population 15 or 25 and over; k_{it} is stock of physical capital per worker from Easterly-Levine (2001).

Testing the Constant Return Hypothesis

The production function of Mankiw *et al.* (1992) expressed in equation (1) implies that rough labour L enters as separate factor of production, but the results presented above are based on the assumption that the production function has constant returns on physical and human capital (i.e. $\alpha + \beta = 1$). This hypothesis can be tested straightforwardly from (1). Recalling that H= exp(r S)×L and taking logs, the production function can be written as:

$$\log(Y_{it}) = \alpha\log(K_{it}) + \beta(rS_{it} + \log(L_{it})) + (1-\alpha-\beta)\log(L_{it}) + \eta_i + \tau_t + \varepsilon_{it} \qquad (8)$$

If the sum of the true α and β is one, the estimated coefficient on $\log(L_{it})$ should be close to zero. Estimation of equation (8) requires prior knowledge of the magnitude of r. Columns (1) and (2) of Table 5 present estimates by setting lower and upper values of r at 10 per cent and 16 per cent, respectively. The estimated $(1 - \alpha - \beta)$ is not statistically different from zero, as predicted by the hypothesis of constant returns on K and H.

Moreover, from the estimated coefficients on $\log(K_{it})$ and $\log(H_{it})$ the hypothesis that $\alpha + \beta = 1$ is strongly supported. Nevertheless the estimated β lacks of precision and turns out to be not significant. Collinearity between the regressors is weakening the precision of the estimates yet again. We can deal with collinearity in the same way as before. After subtracting $\alpha\log(Y)$, dividing by $1 - \alpha$, and regrouping terms, equation (8) becomes:

$$\log(Y_{it}) = \frac{\alpha}{1-\alpha}\log(\frac{K_{it}}{Y_{it}}) + \frac{\beta}{1-\alpha} rS_{it} + \log(L_{it}) + \frac{\eta_i}{1-\alpha} + \frac{\tau_t}{1-\alpha} + \frac{\varepsilon_{it}}{1-\alpha} \qquad (9)$$

Under the hypothesis of constant returns on K and H, equation (9) shows that the coefficient on rS_{it} is equal to one. According to the results in column (3) of Table 5, the value of r yielding coefficients consistent with the constant return hypothesis is 13.3 per cent. This implies a social return to one additional year of schooling of 7.5 per cent, which is very much in line with Topel (1999) and with the findings of the standard labour studies for private returns. From the results presented in Table 5, the hypothesis of constant returns on K and H seems to be confirmed.

The only advantage of assuming that α and $\beta = 1$ is to identify what we have called the long-term return r to one additional year of schooling, i.e. the total response in output to increases in human capital, allowing for an hypothetical response of physical capital, assuming constant returns is immaterial from a policy perspective. The policy relevant question is whether social returns to schooling are larger than the private ones. The main indication of Tables 3 and 5 is that this is not the case.

Table 5. **Testing the Constant Return Hypothesis**
Dependent Variable is $\log(y_{it})$
(System GMM Estimation)

Equation			Equation	
$\log(Y_{it}) = \alpha\log(K_{it}) + \beta(rS_{it} + \log(L_{it})) + (1-\alpha-\beta)\log(L_{it}) + \eta_i + \tau_t + \varepsilon_{it}$			$\log(Y_{it}) = \frac{\alpha}{1-\alpha}\log(\frac{K_{it}}{Y_{it}}) + \frac{\beta}{1-\alpha} rS_{it} + \log(L_{it}) + \frac{\eta_i}{1-\alpha} + \frac{\tau_t}{1-\alpha} + \frac{\varepsilon_{it}}{1-\alpha}$	
	(1) r=0.1	(2) r=0.16		(3) r free
Observations	313	313		313
$\log(K_{it})$	0.503 (0.095)	0.503 (0.095)	$\log(K/Y)_{it}$	0.782 (0.347)
$rS_{it}+\log(L_{it})$	0.535 (0.370)	0.334 (0.231)	S_{it}	0.133 (0.049)
$\log(L_{it})$	-0.095 (0.304)	0.106 (0.180)	$\log(L_{it})$	0.778 (0.243)
Sargan	0.195			0.267
2nd order serial correlation	0.803			0.869

Notes: Time dummies included (not reported). Robust standard errors in parenthesis. Sargan and serial correlation tests show probability values. One-step results. Ten-year observations for the period 1960-90. Y_{it} is total GDP, from Summers and Heston, PWT 5.6; S_{it} is years of schooling from Cohen and Soto (2001); K_{it} is stock of total physical capital from Easterly-Levine (2001); L_{it} is workers from Easterly-Levine (2001).

IV. MORE ON HUMAN CAPITAL

This section explores the effects of considering alternative formulations for the human capital function.

Heterogeneity in Returns to Education

Mincerian returns based on country-level studies reported by Psacharopoulos (1994) vary from an average 6.8 per cent in OECD countries to 13.4 per cent in sub-Saharan Africa. This evidence suggests that the macro return to years of schooling may also vary from country to country. If that is the case, we can express the return for each country as:

$$r_i = \bar{r} + \tilde{r}_i , \qquad (10)$$

where $\bar{r}$ is the world average return and $\tilde{r}_i$ is the country deviation from the world average. A similar decomposition would be given by differences in schooling quality across countries, where those with better quality have higher returns[9].

To illustrate the effects of a varying return, consider again equation (7*a*) but with a return to schooling given by (10). A new source of bias in OLS estimates is due to the fact that a term equal to $\tilde{r}_i S_{it}$ is present in the residual of that equation. Consequently, the sign of the bias introduced by this term depends on whether $\tilde{r}_i$ and S_{it} are positively or negatively correlated. According to the micro evidence presented by Psacharopoulos the return to years of schooling is lower in countries with higher levels of education, so this would suggest that the correlation $\sigma_{\tilde{r},S}$ between $\tilde{r}_i$ and S_{it} is negative. This would imply that methods of estimation that do not account for differences in returns across countries result in an estimated world average return biased downwards.

On the other hand, it may be that high private returns are not matched by high aggregate productivity, especially in developing countries, as suggested by Pritchett (2001). Moreover, Hanushek and Kimko (2000) highlight that schooling quality differs considerably among countries and in general it is lower in the poorer and less educated ones. Therefore, if more educated countries benefit from higher quality schooling, in these countries r_i would be higher than in countries where S is low. In that case $\sigma_{\tilde{r},S}$ would be positive and the estimated $\bar{r}$ would be biased upwards. Of course this reasoning neglects the endogeneity of S inherent in growth regressions, which also bias the estimated average r_i upwards. Note also that instrumental variable methods do not solve the endogeneity problem introduced by return heterogeneity since any instrument that is correlated with S_{it} will also be correlated with $\tilde{r}_i S_{it}$.

A preliminary check of whether the heterogeneity in returns to schooling is biasing the estimated average return consists in analysing the exogeneity of instruments used in GMM estimation. The Sargan tests in Table 3 reject the hypothesis of endogeneity of instruments — although at a significance level of 19 per cent only — which suggests that heterogeneity is not important. Yet, a more straightforward method to analyse the heterogeneity problem consists in splitting the sample in two, according to the level of schooling of each country in 1960, and then compare the returns obtained in each sub-sample. This is done in columns (1) and (2) of Table 6. Countries with a low level of schooling exhibit a long-run return of 23.4 per cent, which is considerably higher than the average of the preferred regressions of Table 3 (the last two columns of that table). The short-term effect of schooling on income is equal to 13.8 per cent. This is slightly higher than the micro returns reported by Psacharopoulos (1994) in developing countries, which are as high as 13.4 per cent in sub-Saharan Africa and 12.4 per cent in the Latin America and Caribbean region. On the other hand, column (2) shows that countries with a high level of schooling present a lower and non-significant average coefficient $\bar{r}$. Moreover, the Sargan test indicates that the instruments for this equation are not exogenous, implying that coefficients are estimated inconsistently. This is a sign that for this sub-sample of countries there is an omitted variable that determines income by its own but that is also correlated with human and physical capital. Finding this variable is far beyond the purpose of this paper.

Table 6. **Heterogeneity and Linearity of Schooling**
Dependent Variable: $\log(y_{it})$
(System GMM Estimation)

	(1) (Low S; 42 countries)	(2) (High S; 41countries)	(3)
Observations	151	162	313
$\text{Log}(k/y)_{it}$	0.697 (0.334)	0.508 (0.387)	0.872 (0.486)
S_{it}	0.234 (0.085)	0.087 (0.055)	
$\text{Log}(S_{it})$			0.505 (0.313)
Implicit Δ	0.411	0.337	0.466
Sargan	0.581	0.006	0.033
2nd order serial correlation	0.304	0.060	0.260

Notes: Time dummies included (not reported). Robust standard errors in parenthesis. Sargan and serial correlation tests show probability values. One-step results. Ten-year observations for the period 1960-90. y_{it} is GDP per worker, from Summers and Heston, PWT 5.6; S_{it} is years of schooling from Cohen and Soto (2001); k_{it} is stock of physical capital per worker from Easterly-Levine (2001).

The main conclusion of this section is that the return to one additional year of schooling is higher in countries with lower levels of schooling. However this result does not imply that there are externalities to education in less-educated countries, since the return found in labour studies for these countries are also higher than the world average. What is more, the macro return in less-educated countries found in this paper is only slightly higher than the corresponding return found by the micro literature.

Linearity of Years of Schooling

The Mincerian representation in macro regressions has become popular only in the last few years, thanks to the works of Bils and Klenow (2000), Hall and Jones (1999), Pritchett (2001) among others. Earlier cross-country studies (e.g. Benhabib and Spiegel, 1994; Islam, 1995) assumed that human capital and years of schooling are linked linearly, that is h = r S. Under this assumption income per worker could be expressed as:

$$\log(y_{it}) = \frac{\alpha}{1-\alpha}\log\left(\frac{k}{y}\right)_{it} + \log(S_{it}) + \log(r_i) + (\eta_i + \tau_t + \varepsilon_{it})/(1-\alpha) \qquad (11)$$

Equation (11) predicts a coefficient equal to 1 on $\log(S_{it})$, which is tested in column (3) of Table 6. The coefficient on log(S) is estimated at 0.51. Not surprisingly, this value is higher than those obtained for years of schooling in the Mincerian specification, but it falls short from the predicted value of 1. Moreover, the estimated coefficient is not statistically different from zero — as found by Benhabib and Spiegel and Islam — and the specification is rejected by the Sargan test. These results persuasively show that the Mincerian approach is indeed a better representation for the human capital function.

The Role of Experience

In addition to years of schooling, the original equations of Mincer (1970, 1974) include a quadratic expression on individual worker's experience. With average years of schooling by age on hand (see Cohen and Soto, 2001), a proxy for average experience of the labour force may be constructed for each country. Average experience E is built following the expression:

$$E = \sum_g w_g \left(\overline{A}_g - \max\left(A_{min}; S_g - A_s\right)\right) \qquad (12)$$

In expression (12), $\overline{A}_g$ is the mid-age of group g (for groups going from age 15-19 to 60-64); A_{min} is the minimum age at which workers are assumed to start working (set at 15); S_g is the average years of schooling of group g; A_s is the typical starting age in formal education; and w_g is the population weight of the group g.

Columns (1) and (2) of Table 7 display the results after including experience. Neither the linear nor the quadratic form provides significant coefficients. This is at odds with labour market evidence, which typically shows that experience has a positive effect on wages. At least two reasons may be the cause of this result. First, it may be possible that the positive correlation between experience and wages found in the micro literature is not the consequence of higher productivity. Higher wages may be the result of labour contract agreements where workers receive an increase in their pay as time goes by, without necessarily being more productive. If that is the case, the positive effect of experience found in micro studies would not reflect a true increase in productivity, hence the lack of correlation between experience and output in macro regressions.

Table 7. **The Effects of Experience**

Equation Estimated: $\log(y_{it}) = \frac{\alpha}{1-\alpha}\log\left(\frac{k}{y}\right)_{it} + \log(h_{it}) + \frac{\eta_i}{1-\alpha} + \frac{\tau_t}{1-\alpha} + \frac{\varepsilon_{it}}{1-\alpha}$

(System GMM Estimation)

	(1)	(2)	(3)	(4)	(5)	(6)
Observations	313	313	313	313	313	313
$Log(k/y)_{it}$	0.898 (0.350)	0.917 (0.342)	0.680 (0.473)	0.790 (0.322)	0.722 (0.251)	0.594 (0.303)
S_{it}	0.143 (0.053)	0.145 (0.053)				
Experience $_{it}$	-0.166 (0.169)	0.280 (1.363)				
Experience $_{it}$^2		-0.012 (0.035)				
$S_{it\ (15\text{-}24)}$			0.109 (0.078)			0.090 (0.214)
$S_{it\ (25\text{-}44)}$				0.090 (0.045)		0.190 (0.119)
$S_{it\ (45\text{-}64)}$					0.129 (0.034)	0.151 (0.155)
Implicit Δ	0.473	0.478	0.405	0.441	0.419	0.373
Sargan	0.414	0.343	0.055	0.148	0.037	0.007
2nd order serial correlation	0.993	0.640	0.382	0.768	0.710	0.794

Notes: Time dummies included (not reported). Robust standard errors in parenthesis. Sargan and serial correlation tests show probability values. One-step results. Ten-year observations for the period 1960-90. y_{it} is GDP per worker, from Summers and Heston, PWT 5.6; S_{it} is years of schooling from Cohen and Soto (2001); k_{it} is stock of physical capital per worker from Easterly-Levine (2001). For experience, see the text. In column (6), $S_{it\ (g)}$ are weighted by the share of the age group g in total labour force.

Another reason behind the lack of significance of experience in macro regressions is measurement error. This may be more serious than the measurement error present in years of schooling because E is obtained residually from age and years of schooling. Thus, if the latter is imperfectly measured its error is integrally passed on the experience variable. Moreover, E neglects any period during which the average worker is unemployed and thus it overestimates real experience in countries suffering from pervasive and protracted unemployment.

A different way of studying the effects of labour experience on aggregate productivity consists in analysing the return to schooling by different age groups. Assuming that the quality of education has not changed over time, and that the more experience a worker gets the more productive he is, then years of schooling of older workers should display a larger productivity coefficient than schooling of the younger ones. On the other hand, if the quality of education has increased secularly, then it is possible that younger workers be more productive than the older ones, in spite of their lack of experience. In that case no prediction could be made about the relative productivity of experienced and non-experienced workers. This method of analysing the effects of experience is somewhat unconventional because it assumes that the productivity of schooling changes with experience, as opposed to the standard Mincerian approach. Columns (3) to (5) show that schooling productivity is higher for the older group of workers and is not different from zero for the younger ones. When years of schooling of all three groups are included in a same regression (column 6), a similar pattern holds but the estimates are not significantly different from zero. Collinearity between the different measures of schooling (countries with relatively well-educated elderly workers have relatively well-educated younger ones) may be the cause of these imprecise estimates. Besides, Sargan tests indicate that the instruments used are not exogenous and so the estimates are likely to be biased upwards. In sum the evidence that productivity of schooling increases with age is weak.

V. CONCLUSIONS

This paper has revisited the findings of earlier empirical studies on schooling and growth, a literature that has failed to find a role for schooling as an input in a standard production function. It is shown that when problems of model specification and inconsistency in estimation are properly dealt with, years of schooling fit well in a neoclassical production function. Point estimates for the semi-elasticity of income per worker to years of schooling range from 7 per cent to 10 per cent. Furthermore, if physical capital is allowed to increase as a response to an expansion of human capital — as predicted by neoclassical and endogenous growth models — the long-term effect of one additional year of schooling rises from 12 per cent to 16 per cent. These are estimates of the world average macro return to schooling. However there seems to be substantial heterogeneity in the return according to the level of schooling of each country, evidence that matches the results of micro studies closely. Average returns in countries with low levels of schooling range from 14 per cent in the short run to 23 per cent in the long run.

The long run returns are higher than the conventional Mincerian return found in the micro literature, but this does not represent externalities to human capital in the sense of Lucas (1988). The higher returns are the result of a hypothetical endogenous response of physical capital to human capital changes, which would leave the capital-output ratio constant in the long run. The observation that the capital-output ratio increases as countries become richer hints that the long-term macro return to schooling is at least as high as the typical micro one.

This leads us to the question of what allows countries to improve schooling attainment. Most empirical studies try to reveal the income elasticity to schooling, but this provides precious little guidance on the policies that may lead to higher levels of schooling. One interesting line of research is the role of health and life expectancy in private decisions on schooling investment. In this respect, the theoretical works of Boucekkine *et al.* (2001) and of Kalemli-Ozcan *et al.* (2000), where increases in life expectancy raise investment in human capital, are an important step ahead. Complementary empirical studies in this field would help to back up this hypothesis.

A different question refers to the measure of human capital. The empirical literature uses the concept of human capital and years of schooling almost interchangeably. However, Mulligan and Sala-i-Martin (2000) have shown that more comprehensive measures of human capital for the United States have grown twice as fast as average years of schooling during the 1980s. If one is interested in determining the macro return to schooling this is not a serious concern, but growth or level accounting exercises, relying on years of schooling as a measure for human capital

(Easterly and Levine, 2001; Hall and Jones, 1999), may be overestimating the importance of total factor productivity in explaining variations of output. Broader measures of human capital worldwide will elucidate this question. In the meantime, Cohen and Soto (2001) have made available new series of years of schooling, series that are less contaminated by measurement error and that perform better in growth regressions, as is shown in this paper.

NOTES

1. The endogenous growth models of Lucas (1988) also see human capital as an input of the production function.

2. Physical capital stocks are from Easterly-Levine (2001).

3. Krueger and Lindahl report a reliability ratio of 0.58 for the change of Barro-Lee's data over the period 1965-85, when regressed against Kyriacou's (1991) data. Apart from computing the reliability ratios over a different time span and a different benchmark, the ratios are not comparable because Cohen and Soto use ten-year changes over the period 1960-90 while Krueger and Lindahl use the full twenty-year change in their computations of reliability ratios.

4. The original Mincerian equation also includes terms in labour experience and squared labour experience. This is explored in Section IV.

5. Note that since estimation in first-differences implies the loss of the first observation, the results are not directly comparable to those of column (1).

6. Some care should be taken with the standard errors reported in the two-step GMM estimates. Blundell and Bond (1998) and Blundell *et al.* (2000) show that the standard errors underestimate the true variability of the coefficients obtained in two-step GMM estimators. See Windmeijer (2000) for a correction of this problem.

7. There is a huge literature on whether these micro returns are properly measured but this topic goes far beyond the scope of this paper. So the 10.1 per cent result is taken for granted and is used only for comparison with the macro results obtained in this paper.

8. The complete Cohen and Soto (2001) database on years of schooling and educational attainment is available at: http://www.oecd.org/xls/M00021000/M00021750.xls.

9. Note however that if better quality does have an impact on the return of schooling, then countries with higher levels of schooling (which are also those with better quality) should present higher returns. This is contradicted by Psacharopoulos's data.

BIBLIOGRAPHY

ARELLANO, M. and S. BOND (1991), "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *Review of Economic Studies* 58, pp. 277-297.

BARRO, R. (1997), *Determinants of Economic Growth: A Cross-Country Empirical Study*, MIT Press, Boston.

BARRO, R. and J. LEE (2000), "International Data on Educational Attainment: Updates and Implications", *CID Working Paper* Nº 42, Harvard University.

BARRO, R. and J. LEE (1993), "International Comparisons of Educational Attainment", *Journal of Monetary Economics* 32(3), pp. 363-94.

BARRO, R. and X. SALA-I-MARTIN (1995), *Economic Growth*, McGraw-Hill, New York.

BENHABIB, J. and M. SPIEGEL (1994), "The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data", *Journal of Monetary Economics* 34, pp. 143-73.

BILS, M. and P. KLENOW (2000), "Does Schooling Cause Growth?", *American Economic Review* 90(5), pp. 1160-1183.

BLUNDELL, R. and S. BOND (1998), "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models", *Journal of Econometrics* 87, pp. 115-143.

BLUNDELL, R., S. BOND and F. WINDMEIJER (2000), "Estimation in Dynamic panel Data Models: Improving on the Performance of the Standard GMM Estimator", *in* BALTAGI, B. (ed.), "Nonstationary Panels, Panel Cointegration, and Dynamic Panels", *Advances in Econometrics* 15, JAI Press, Elsevier Science, Amsterdam.

BOUCEKKINE, R., D. DE LA CROIX and O. LICANDRO (2002), "Vintage Human Capital, Demographic Trends and Endogenous Growth", *Journal of Economic Theory*, forthcoming.

CASELLI, F., G. ESQUIVEL and F. LEFORT (1996), "Reopening the Convergence Debate: A New Look at Cross-Country Growth Empirics", *Journal of Economic Growth* 1, pp. 363-389.

COHEN, D. and M. SOTO (2002), *Why Are Some Countries So Poor? Another Look at the Evidence and a Message of Hope*, Technical Paper No. 197, OECD Development Centre, Paris.

COHEN, D. and M. SOTO (2001), *Growth and Human Capital: Good Data, Good Results*, Technical Paper No. 179, OECD Development Centre, Paris.

DE LA FUENTE, A. and R. DOMÉNECH (2000), "Human Capital in Growth Regression: How Much Difference Does Quality Data Make", *CEPR Discussion Paper* 2466.

EASTERLY, W. and R. LEVINE (2001), "It's Not Factor Accumulation: Stylized Facts and Growth Models", *World Bank Economic Review* 15(2), pp. 177-219.

GOLLIN, D. (2002), "Getting Income Shares Right", *Journal of Political Economy* 110(2), pp. 458-474.

HALL, R. and C. JONES (1999), "Why Do Some Countries Produce So Much More Output Per Worker Than Others?", *Quarterly Journal of Economics* 114(1), pp. 83-116.

HANUSHEK, E. and D. KIMKO (2000), "Schooling, Labor Force Quality, and the Growth of Nations", *American Economic Review* 90(5), pp. 1184-1208.

ISLAM, N. (1995), "Growth Empirics: A Panel Data Approach", *Quarterly Journal of Economics* 110(4), pp. 1127-1170.

KALEMLI-OZCAN, S., H. RYDER and D. WEIL (2000), "Mortality Decline, Human Capital Investment, and Economic Growth", *Journal Development Economics* 62, pp. 1-23.

KRUEGER, A. and M. LINDAHL (2001), "Education for Growth: Why and for Whom?", *Journal of Economic Literature* 39, pp. 1101-1136.

KYRIACOU, G. (1991), "Level and Growth Effects of Human Capital: A Cross-Country Study of the Convergence Hypothesis", *NYU Economic Research Report* 91-26.

LUCAS, R. (1988), "On the Mechanics of Economic Development", *Journal of Monetary Economics* 22, pp. 3-42.

MANKIW, G., R. ROMER and D. WEIL (1992), "A Contribution to the Empirics of Economic Growth", *Quarterly Journal of Economics* 107(2), pp. 407-437.

MINCER, J. (1974), *Schooling, Experience and Earnings*, Columbia University Press, New York.

MINCER, J. (1970), "The Distribution of Labor Incomes: A Survey", *Journal of Economic Literature* 8(1), pp. 1-26.

MULLIGAN, C. and X. SALA-I-MARTIN (2000), "Measuring Aggregate Human Capital", *Journal of Economic Growth* 5(3), pp. 215-252.

PRITCHETT, L. (2001), "Where Has All the Education Gone?", *World Bank Economic Review*, 15(3), pp. 367-391.

PSACHAROPOULOS, G. (1994), "Returns to Investment in Education: A Global Update", *World Development* 22(9), pp. 1325-1343.

SUMMERS , R. and A. HESTON (1991), "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988", *Quarterly Journal of Economics* 106(2), pp. 327-368.

TEMPLE, J., 2001, "Generalizations that Aren't? Evidence on Education and Growth", *European Economic Review*, 45(4-6), pp. 905-918.

TOPEL, R. (1999), "Labor Markets and Economic Growth", *in* O. ASHENFELTER and D. CARD (eds.), *Handbook of Labor Economics*, Vol. 3c, pp. 2943-2984, Elsevier Science, Amsterdam.

WINDMEIJER, F. (2000), "A Finite Sample Correction of the Variance of Linear Two-Steps GMM Estimators", *Institute for Fiscal Studies Working Paper* 00/19.

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