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GROWTH AND HUMAN CAPITAL: GOOD DATA, GOOD RESULTS

by

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PREFACE

Education and training — the major elements of human capital formation — have long been recognised as indispensable to the development process. Work at the Development Centre over many years, most recently by Katharina Michaelowa in Technical Paper No. 157 (2000) and Christian Morrisson in two forthcoming studies on health, education and poverty, has sought to clarify the policies necessary to maximise the impact of investment in human capital formation. Indeed, Michaelowa's publication points to the need for quality primary education, while highlighting the extra disadvantage for pupils from impoverished backgrounds. It suggests that the allocation of resources to education is at least as important as the level of those resources. Morrisson's studies demonstrate the two-way relationship between health and education, quantifying the effect of both on poverty.

Human capital is the most important production factor of modern times. As machines and capital increasingly substitute for what used to be the raw force of labour, nations as much as individuals need to invest heavily on their human capital. While few economists would disagree with such a conclusion, uncertainty remains about how to evaluate the various aspects of human capital formation. While education and training are certainly key aspects, but so are health, standards of living, access to basic services and social stability. The Development Centre is committed to continuing to develop analysis of these elements. Earlier work has allowed us to identify orders of priority in policy choice, but measurement techniques still need to be refined. I am happy to introduce this paper by Daniel Cohen and Marcelo Soto as a first contribution to a major activity in the 2001/2002 Programme of Work.

The primary purpose of this paper is to extend the work that has been performed by the OECD for a subgroup of 38 member and non-member countries. Our effort at the Development Centre has been to expand this dataset to other developing countries. The key to the methodology is to minimise the extrapolations and keep the data as close as possible to those directly available from national censuses. In some cases, this leads to estimates of educational attainment which are 50 per cent higher than those of the most widely used sources.

A number of critical results are obtained that show, in particular, that the difference between the number of years of schooling in the rich and in the poor countries have hardly narrowed over the years, at least when measured in absolute terms. The second part of the paper aims at demonstrating (econometrically) that it is, indeed, the absolute value of the differences rather than their relative difference that is the correct factor driving the potential convergence of poor countries towards the rich. From this perspective, much remains to be done to reduce wealth inequality across the world, at least in the essential dimension of human capital that pertains to education.

The authors acknowledge that they have not accounted for immigration and emigration which may significantly affect the educational level of the work force; the same can be said about the impact of epidemics, such as HIV/AIDS, which will tend to weaken the assumptions of mortality, considered here as homogenous within age groups. These imperfections will be addressed in their subsequent research, validating the claim in the title that good data produces good results.

Indeed the implication of the paper's findings reinforces those of Michaelowa and Morrisson: though education is part of the battle against poverty, poverty is, itself, a handicap in that struggle.

What the paper shows about education applies to most other dimensions of poverty: we often do not have the data, or the analysis, necessary to make statements like "globalisation is bad for the poor" or indeed its converse. Broadening the knowledge base is certainly a prerequisite for a fruitful discussion of the topic. This is why the activity in the 2001/2002 Programme of Work to which this research is addressed is called *Empowering People to Face the Challenge of Globalisation.*

Jorge Braga de Macedo
President
OECD Development Centre
September 2001

RÉSUMÉ

Ce Document technique présente un nouvel ensemble de données sur le capital humain, constitué des données rassemblées par l'OCDE sur un groupe de 38 pays Membres et non membres et élargi par le Centre de Développement à d'autres pays en développement. Notre méthodologie s'est attachée à limiter les extrapolations au maximum et à conserver des chiffres aussi proches que possible de ceux obtenus directement au moyen des recensements nationaux (dans l'esprit des travaux menés pour les pays de l'OCDE par De la Fuente et de Doménech). Nous avons ensuite utilisé ces nouvelles données pour tester un modèle néoclassique dans lequel le capital humain suit la formulation Log-linéaire préconisée dans les approches "à la Mincer". Tant les résultats par niveaux que la différence de premier ordre montrent que le modèle fonctionne extrêmement bien. Aucun effet externe n'a été observé, tant pour l'accumulation du capital physique que du capital humain. La productivité totale des facteurs (production défalquée de la contribution du capital physique et humain) apparaît cependant inférieure de près de 45 pour cent en moyenne dans les pays pauvres par rapport aux pays riches.

ABSTRACT

This paper presents a new data set on human capital. It is based upon data released at the OECD for a subgroup of 38 member and non-member countries, and an effort performed at the Development Centre to expand this data set to other developing countries. The key to our methodology is to minimise the extrapolations and keep the data as close as possible to those directly available from national censuses (in the spirit of the work of De la Fuente and Doménech for OECD countries). We then use this new data set to test a neo-classical model in which human capital follows the Log-Linear formulation which is favoured by Mincerian approaches. We find both in levels and in first difference that the model performs extremely well. No externalities seem to manifest themselves, either on physical or on human capital accumulation. Total factor productivity (output net of the contribution of human and physical capital), however, do appear to be smaller, by about 45 per cent in average, in the poor countries than in the rich.

I. INTRODUCTION

The role of human capital in economic growth is an everlasting topic which has changed course at least three times over the past two decades. The idea that human capital externalities could generate sustained growth over the long run has first been one of the critical features of the “new growth” literature following the work of Lucas (1988) and Romer (1990). Then a neo-classical revival started to evolve, best summarised by Mankiw, Romer and Weil (1992) (henceforth MRW) which themselves built upon the (more moderate) conclusions of Barro and Sala-i-Martin (1995). Yet, another “revisionist” approach started, that followed the work by Benhabib and Spiegel (1994), or Pritchett (forthcoming), and more recently Bils and Klenow (2000), according to which the role of human capital in economic growth has been vastly overstated, even from the (relatively) narrow neo-classical perspective.

We shall argue in this paper that part of the reason why the debate erred between these two extremes is due to the measurement of human capital, be it theoretically or empirically. Theoretically, it has not been very clear how human capital should be proxied. Years of schooling has long been thought of as the relevant proxy. Yet a simple glance at the data show that the regions where the rate of growth of human capital has been the fastest are also those where it started from very low levels (Africa being a prime example); it is hard to believe that a country that increased its average years of studies from 1 to 2 really doubled its stock of human capital and should correspondingly double, perhaps, its output as well. In the case of MRW, human capital is indirectly proxied through a law of motion which parallels that which pertains to physical capital. In their model, a fraction of GDP (itself proportional to secondary school enrolment) is diverted towards raising human capital. As demonstrated in Cohen (1996) however, this formulation when submitted to the test of its consistency with the data is clearly rejected. It is only recently that the macro-literature has turned to the micro-literature for help, specifically on the Mincerian approach which posits a log-linear (rather than a log-log) correspondence between income and years of schooling. With this approach, the poor countries’ performance are bleak: in absolute terms, they failed to narrow the gap with the rich countries, while they did succeed in relative terms. This yields a more satisfactory test of the neo-classical hypothesis (see Heckman and Klenow, 1997, for one of the earlier such tests).

The second problem which has been faced by the macroeconomic approach has to do with the quality of the data themselves. This has been a critical problem that has been recently emphasised by Domenech and De la Fuente. Focusing on a subgroup of 21 OECD countries, they have convincingly demonstrated that human capital data are quite unreliable. Measurement errors are also emphasised in Krueger and Lindahl (2000) which show that there is little information in data used by Benhabib and Spiegel (who also had the disadvantage of choosing the Log-Log specification for testing the effect of human capital on growth).

Our contribution in this paper rests on a new effort to raise the quality of the data and is based upon new data which has been released at the OECD for a subgroup of 38 member and non-member countries, and an effort performed at the Development Centre to expand this data set to other developing countries. The key to our methodology (explained in detail in Section II) is to minimise the extrapolations and keep the data as close as possible to those directly available from national censuses.

We then use our new data set to test a neo-classical model, in which human capital follows the Log-Linear formulation which is favoured by Mincerian approaches. We do find both in levels and in first difference that the model performs extremely well. The exponent of physical capital in the production function is 1/3 as predicted by the neo-classical model; the return to human capital is 8 per cent, as obtained, in average, in the analysis of the private returns to human capital. In other words, no externalities seem to manifest themselves, either on physical or on human capital accumulation. Total factor productivity (output net of the contribution of human and physical capital), however, do appear to be smaller, by about 45 per cent on average, in the poor countries than in the rich. Why this is so should be, we argue, the primary focus of the research.

II. A NEW DATA SET

This section describes the methodology that we have followed to build the estimates of educational level.

II.1 Methodology

Our approach seeks to use as much observable data as possible in order to minimise the use of arbitrary hypothesis. Three main sources are used here: *i)* the OECD database on education; *ii)* national censuses or surveys published by UNESCO's Statistical Yearbook; and *iii)* censuses obtained directly from national statistical agencies' web pages.

Based on reports from its member and other non-member countries, the OECD has published detailed information on educational attainment, starting at the end of the 1980s. This information refers to the population aged 15 to 64 broken up in different age groups and is the cornerstone of our data set for high-income countries. The main advantage of the OECD's data is that the information is presented in a standardised form across countries. Our effort aims at extending the study performed by the OECD to missing periods and countries.

In order to fill the gaps in the data, we have first split the population into five years group intervals (15-19, 20-24,...) for each of the years 1960, 1970, 1980, 1990 and 2000 out of the UN Population statistics; we also include 2010 estimates from a forecast of the US Census Bureau. We then estimate school attainment in each age group using OECD, national or UNESCO census (see Table A1 in appendix for the detailed review of our sources). When such a census is not available for the period considered, but available at a further date, we extrapolate backward all relevant information from the latest census, by making the assumption that the school attainment of the population aged T in one census is the same as the school attainment of the population aged T-10, in the census performed 10 years earlier (see below for a discussion of this assumption). For the data which are still missing out of such backward computations, we extrapolate, whenever possible, the data available from an earlier census. To take an example, consider the case of a country for which no direct information exists on the sub-group of 60-64 years old in 1980. If possible, we first try to extract the information from the 1990 census by considering the sub-group aged 70-74 in 1990. If not available, we then try to extract the information from the 1970 census by considering the sub-group aged 50-54. When no relevant census exists (even earlier or later on), we then rely on school enrolment data to fill the missing information. To take the same example, consider the population aged 60-64 in 1980. Assuming that the entrance age in primary education is six years, this group was in age to start primary education between the years 1922 and 1926. By calculating the ratio of new entrants in first grade of primary school to the six-years-old population — i.e. the net intake rate — during, for instance, 1924, one can obtain an estimate of the part of the population aged 60-64 in 1980 that attended primary school. The same procedure provides an estimate of the fraction of each age group that went through each level of education for which there is no census information available. Several sources are used to determine the net intake rate. The main source is Mitchell (1993), who has published long series on primary, secondary and high school enrolment for most countries of the world, starting in the second half of the 19th century. This information is combined with UNESCO's Statistical Yearbook, which starting in 1950 also publishes systematically data on enrolment at different levels of education. In general both sources coincide, but this is not always the case. When important differences arise, UNESCO data are used. Population tables by age are taken from Mitchell, United Nations Demographic Yearbook, U. S. Census Bureau and national agencies. The appendix provides a description of the procedure that we used to compute net intake rates.

Other authors (see Nehru, Swanson and Dubey, NSD, 1995) have already used Mitchell's series to build educational indexes but have been criticised on the basis that they do not make use of censuses' information. As a consequence some of their country indexes bear little relationship with data measured directly from censuses. Moreover, de la Fuente and Doménech (2000) have noted the incidence of some implausible results in NSD's database. Namely, in 1960 Ireland's population is given an average of 14 years of schooling. Considering that most studies (including NSD's) assign less than 14 years to most educated countries in 1990, this figure must be an error. One important difference between NSD's approach and the present approach is that here Mitchell's data are only used to fill missing cells in existing data rather than to fill the entire database. The only continent where data primarily rely on Mitchell data is Africa, which is one reason why we shall drop it from our econometric analysis below.

A number of assumptions lie behind the use of censuses to infer educational attainment before and after the census is done. First, it is assumed that the mortality rate is distributed homogeneously inside each age group, independently of the level of education of the persons who are part of it. Although it can be argued that more educated people have lower mortality rates than the less-educated ones, the error introduced by the assumption of "death homogeneity" must be of second order. A second and more troublesome concern refers to migration. Even though census figures take into account the educational level of the full population, this methodology assumes that immigrants have the same educational level as the corresponding age group in the host country. If this is not the case, and assuming that the host country's population is in average more educated than the immigrants that they receive, the educational level for the years prior to immigration will be understated if immigration takes place before the census is carried out. An additional bias is introduced when net intake rates are used to compute the educational level instead of census data. Given that the historically observed intake rates are used to compute current educational levels for some age groups, immigration of relatively low educated persons will induce an overstatement of the educational level for those age groups. Similar arguments may be applied to countries having witnessed important flows of emigrants. Still in these cases the distortions are arguably lower than for countries receiving immigrants. The reason of this is that emigrants have plausibly an educational level close to their compatriots. But in any case the lack of information on the educational level of migration prevents taking its effects into account.

II.2 Data Set Description

The data set consists of 95 countries, distributed in major world regions as reported in Table A2 (Table A6 gives country by country results). The regions correspond to Middle East and North Africa (MENA, 8 countries), Sub-Saharan Africa (SSA, 26), Latin America and Caribbean (LAC, 23), East Asia and Pacific (EAP, 8), South Asia (SA, 3), Europe and Central Asia (ECA, 4) and High-Income countries (HI, 23). The data have been computed for the beginning of each decade from 1960 to 2000, plus a projection for 2010. This projection is based on population projections by age taken from the U. S. Census Bureau web site and the estimates of educational attainment for the year 2000. The average numbers of schooling come as follows. The detailed results are shown in the appendix.

Table 1. **Years of Schooling**

	1960	1970	1980	1990	2000	2010
High income	8.7	9.8	10.9	11.6	12.1	12.5
All poor countries	2.1	2.9	3.7	4.8	5.7	6.5

In 2000, the labour force in high-income countries had an average of 12 years of schooling, while the poor countries have reached 5.7 years of schooling. Note the contrast between the average growth rate of schooling in poor countries and its absolute increase. In relative terms, we see a mild pattern of convergence going on, as the ratios have shifted from one to four to a ratio of one to two. In absolute terms, however, the picture is totally different: the difference between rich and poor essentially stays constant over the years. No catch up in embodied in the accumulation of human capital.

A geographical breakdown is presented in the appendix. The MENA region displays the highest increase in the number of years of study since 1960, five years, followed by EAP countries, with just over four years. The MENA region has also the fastest growth rate in years of schooling, with an annual 4.8 per cent rise, followed by SA with 3.2 per cent. The most sluggish region has been SSA with an increase slightly over 2.5 years during the last 40 years. When the growth rate is considered instead, SSA countries perform fairly well, occupying the third place among the most dynamic regions in the world. If the absolute increase is considered, SSA exhibits the lowest change. In contrast to Sub-Saharan countries, EAP countries display the second fastest rise in the number of schooling years, while they are ranked only in the fourth place when the percentage change is considered. This result stresses the bias introduced in empirical studies when the growth rate in schooling years is used instead of the absolute increase and confirms recent findings by Temple (2001).

By 2010, high-income countries will have twelve and a half years of schooling, followed well behind by ECA countries, with only 8.4 years. As a matter of fact, the most educated regions of the developing world will have fewer years of study than that exhibited by the average of high-income countries half a century earlier. Moreover, SSA will be just as educated as LAC was in 1970. When investment in education is measured as the percentage change in the years of schooling, all the world regions have been converging towards high-income countries' stage. Sub-Saharan African countries perform relatively well compared to the rest of the world, however, when investment is measured as the level increase in years of schooling, Sub-Saharan African countries have been lagging behind the rest of the world. Summing up, since the 1960s, and most probably before, Sub-Saharan African countries have exhibited one of the least educated labour forces in the world and there are no signs that this position will start to be reversed in the coming years.

II.3 Comparison with Other Sources

This section compares the data on schooling obtained in the present methodology to the data reported by Barro and Lee (BL, 2000) and de la Fuente and Doménech (2001). Correlations between the three sources are presented in Table A3 in levels and in Table A4 in first differences. The comparison with BL's data is of particular interest since most of panel data studies on education and growth use their data set as a primary source. Based on UNESCO's database on educational attainment — which is itself based on national censuses and sample surveys — BL have built an upgraded data set for the population aged 15 years or over who attained some level of education (we carried out the comparison for both groups). In years when censuses or surveys are not available, BL estimate the educational attainment using enrolment rates. Although our methodology appears to be very similar to BL, a number of substantial differences emerge. Although the broad correlation in levels is fairly high (about 90 per cent), it drops dramatically in first difference (to less than 10 per cent). There are those which are due to difference of sources, and those due to differences of methodology.

The first examples pertain to the cases when we use more census information than BL does. This is for instance the case of Jordan. We assign to this country 9.1 average years of schooling for the population aged 15 and over in 1990, while BL assign 5.9 years. This is one of the highest differences between both data sets referring to average years of schooling (similar disparities are found for the population aged 25 and over). To our knowledge the last data on educational attainment in Jordan published in UNESCO's Statistical Yearbook (which are used by BL) is from 1961. This means that BL's data are based on that census and later figures have been completed following a perpetual inventory approach using enrolment and mortality rates. On the other hand, Jordan has reported its own estimates of educational attainment to the OECD for the year 1999. We estimate Jordan's educational attainment based on that report, filling back the data for 1990 as described above. This approach leads to very different numbers. For instance, secondary attainment for the population aged 15 and above is 45.5 per cent in our data set while BL's figure is 30.2 per cent. Luckily, Jordan's statistical office web site publishes educational attainment figures based on a 1994 census. This shows that the percentage of the population aged 15 and over with preparatory (i.e. first level of secondary education) or full secondary education is 44.3 per cent. This is very close to this article's estimate. Moreover, the illiteracy rate reported in the web site is 15 per cent. Comparing this figure with the 32.2 per cent of "no-schooling" population in BL's data and the 13.1 per cent in our data set makes it clear that the OECD source provides estimates that are much closer to reality.

The second source of discrepancy is due to a different methodology for extrapolating the missing data. BL do not use age specific estimates, as we do. This leads them to extrapolate missing data for the whole population either backwards or forwards, while we explicitly fill the missing data for specific age groups. Take for instance the case when a census is available at a time T+10 to infer data on time T. While we only need to guess the school attainment of the older group at time T, BL need to make an aggregate backward forecast for the population as a whole. This is prone to create more unreliable data.

Our data are also sometimes at odds with BL on the composition of school attainments (but not for the aggregate data). This is for instance the case of Hungary. This country exhibits the most important contrast in the attainment levels between BL's data and this article's data set. According to BL, in 1970 81.8 per cent of the population aged 25 and over had some primary education and only 5.1 per cent had secondary education. On the other hand, our measure says that 31.4 per cent had attended primary education and 60.3 per cent, secondary education. This differences persist in the following decades. But analysing the data more carefully it is found that until 1992 primary and secondary education lasted for 8 and 4 years respectively. Then, starting in 1993 the last four years of primary education have been reclassified as the first stage of secondary education. The estimates for Hungary are so different from BL's data because we build educational attainment from a later survey. Most of the differences in attainment levels with BL's data hinge on such divergences in classification. However these kinds of discrepancies should not lead to important differences in the measure of average years of study if the proper number of years is assigned to each level of education. Consequently, it is crucial to keep coherence between the classification of levels and the years of study assigned to each level. As a matter of fact, when the average number of years are compared, the differences between BL's data and our data are minor in the case of Hungary. On the other hand, the changes in the classification of levels reveal the vulnerability of the studies using the secondary enrolment rate as a proxy for investment in human capital.

A final source of discrepancies with BL's database is that a number of results are just implausible or simply errors. Some examples of the last case are Austria in 1960, where the percentages of the population over 25 assigned to each level of education (including no schooling) totals only 84 per cent; or Spain in 1990, where the same operation for the population over 15 equals 103 per cent. Although these errors may be easily corrected, there are some features in this database that raise more concern. De la Fuente and Doménech (2000) (DD henceforth) have already drawn attention on the strange pattern followed among others, by the percentage of the population having attained higher education in Canada. According to BL's data, higher education increases sharply in 1975 and 1980, and then goes back to its previous level in 1985. As DD point out, this is the result of classification changes rather than the actual pattern of educational achievement. Besides these classification issues, other results in BL's database are clearly at odds with what one would expect. For example, in 1960 Bolivians aged 15 and over were just as educated as French were; and in 1980 the average Ecuadorian had more years of study than the average Italian. Summing up, these strange results put in evidence the significance of a more accurate database on education achievements.

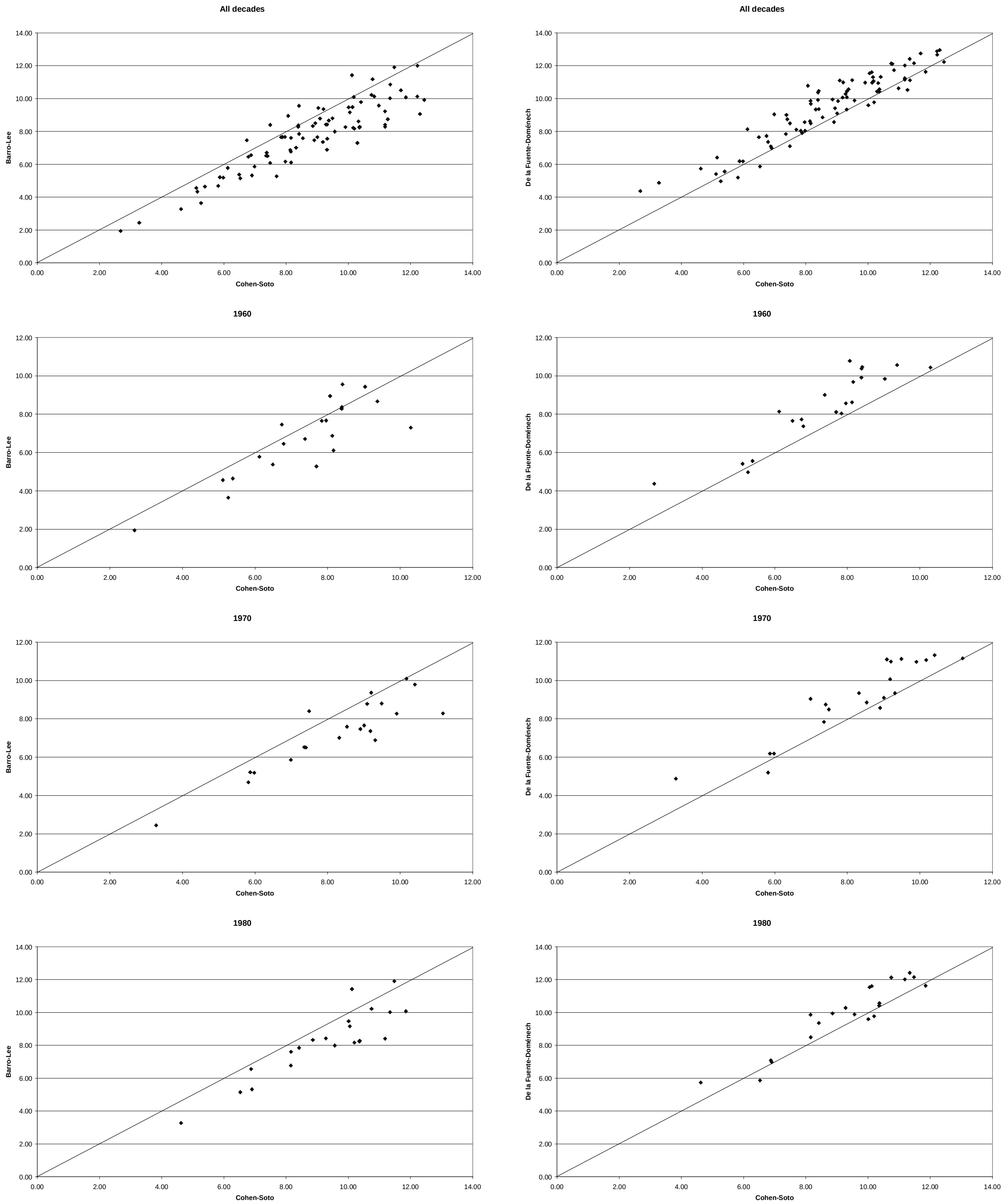
DD (2000, 2001) have moved forwards in this direction and proposed a new data set for 21 high-income OECD countries. They make a considerable effort to correct for the classification issues described earlier, based on all the information that they were able to collect. Although their approach is less systematic than BL's, they get a data set that looks more plausible and closer to national sources' information (which is not always identical to UNESCO's). The third column of Table A3 shows the correlation between DD data and this study, for each level of education. Not surprisingly, the "no-schooling" category exhibits the highest correlation, as most OECD countries in the sample have no "no-schooling" population. The correlation goes down in the primary and secondary levels, but remains high. Note that these numbers are not directly comparable to the correlation with BL's data since they refer to different samples of countries. The correlation between the average years of schooling is also very high, as shown in Table A4. The differences are again due mainly to classification problems and the techniques used to distinguish between primary and the first stage of secondary education. In fact, for a number of countries (Austria, Denmark, Finland, France, Germany, Norway, Sweden, Switzerland and United Kingdom), the OECD database do not distinguish between primary and the first level of secondary education, hence the need of ad hoc methods to estimate them. Table A4 shows also the correlation with BL's data for the same OECD countries used by DD. As expected, it is lower than the correlation with DD.

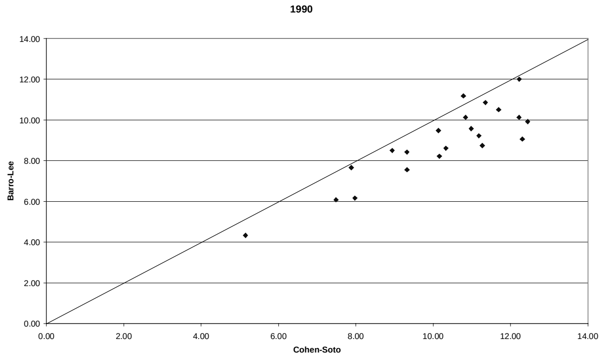
Figure 1 plots our data set and BL's and DD's data, using OECD countries as a common sample. The graphs show the close link between the different indexes of schooling. When all the decades are pooled together, there is clearly an upward relationship between the indexes. The positive association holds for all the decades and is stronger with DD's data than with BL's. Not surprisingly, the linkage with BL's data is somehow blurred in 1960. The graphs bring out another feature: for each one of the decades, BL's data have a tendency to exhibit fewer years of schooling and DD's more than our data set. DD indicate that their data are not directly comparable to BL's, since their estimates refer to people having attended some educational level, whereas BL's refer to people having completed a certain level. Hence, DD's years of schooling data are generally biased upwards.

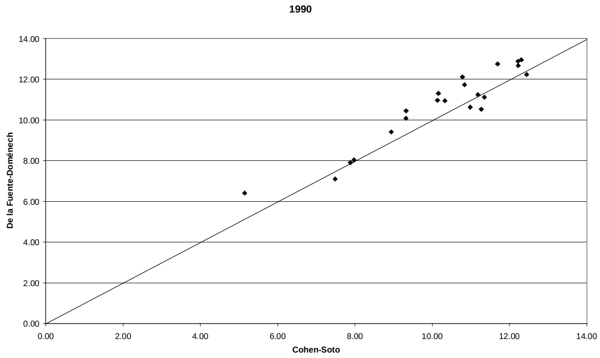
Figure 1. **Comparison of OECD Countries**

Plots with Barro-Lee data

Plots with de la Fuente-Doménech data







Krueger and Lindahl (2000) compute the reliability ratio to check the quality of the data provided by BL and others. If there are two different measures, say X1 and X2, of total years of schooling X, the reliability ratio of X1 is defined as Rx1 = cov(X1, X2)/var(X1). If the measurement errors of X1 and X2 are not correlated, Rx1 has probability limit var(X)/[var(X)+var(e1)] where e1 is the measurement error of X1. Therefore, the reliability ratio measures the fraction of the variability of a measure that is due to the variability of the true variable. Krueger and Lindahl find that, whereas the reliability ratio is high when the data are in levels, it drops considerably when they are taken in first-differences.

Table A5 reports the reliability ratios of different measures of change in years of schooling. When all the countries are pooled together, our index has a ratio of 0.58, which is pretty high considering that these are first-difference series. Moreover, the figure is higher than BL's. Second, BL's ratios are not significantly different from zero for OECD countries. This means that for these countries the variability of the change in years of schooling is submerged by measurement error. Third, DD's data and ours display the highest reliability ratios, especially when compared between them. However, this last result comes as no surprise since both series are based on the same sources. Overall, the ratios give some support to the quality of our data. The next step will be to test them in standard growth regressions.

III. INCOME AND HUMAN CAPITAL

Let us now put our data to the test of their correlation with income per capita.

III.1 Theoretical Benchmark

Let us start with a simple neo-classical production function following here the previous approach by Mankiw, Romer and Weil. Take that production can be written as:

$$Q_t = A_t^{1-\alpha} K_t^{\alpha} H_t^{1-\alpha}$$

where K_t is aggregate physical capital and H_t is aggregate human capital (human capital per head multiplied by labour force). Suppose that physical capital is accumulated according to the usual law of motion:

$$\dot{K}_t = -dK_t + sQ_t$$

where d is the depreciation rate of capital and s the saving rate. Assume also that μ is the rate of growth of technological progress and that n is the rate of growth of aggregate human capital. In the steady state of such modified Solow model, one can write:

$$(d + n + \mu)K_t = sQ_t$$

One can then rewrite:

$$LogQ_t = (1-\alpha)LogA_t + \alpha Log\frac{s}{d+n+\mu}Q_t + (1-\alpha)LogH_t$$

or equivalently:

$$LogQ_t = LogA_t + \frac{\alpha}{1-\alpha}\left[Logs - Log(d+n+\mu)\right] + LogH_t \qquad (1)$$

In the standard neo-classical case where α =1/3, one should then find $\alpha/(1-\alpha)=0.5$. In this case the dynamics of capital accumulation should be fairly rapid, so that the steady-state assumption is not too extreme.

The critical question is how should one proxy human capital. MRW have indirectly addressed this question by focusing on a presumed law of motion of human capital, in which it is accumulated in a manner that is perfectly collinear to the accumulation of physical capital. Specifically they write:

$$\dot{H} = -dH_t + s_H Q_t$$

in which *d*, the depreciation rate of human capital, is taken to be identical to the depreciation of physical capital, s_H is a ratio which is essentially worth the secondary school enrolment of children and Q_t is total output. They then indirectly measure human capital as the steady state of such law of motion. This formulation implies that the dynamics of income per capita do not depend upon the composition of human and physical capital, an assumption which is rejected by the data. See Cohen (1996) in which it is shown that human capital accumulation relies more on human capital than upon output.

An alternative method is simply to proxy human capital by the number of years of schooling (as in Benhabib and Spiegel), which seems innocuous but — as the previous section demonstrated — has wide implications so far as the rate of growth is concerned. In this paper, we shall simply follow the Mincerian approach to human capital which shows that a Log-linear model should be favoured in the case where agents choose optimally the number of years of study s an investment which yields a constant return over their lifetime. This Mincerian approach has gained pre-eminence in macro studies, after the work by Bils and Klenow (whose working paper was circulated in 1998) and Heckman and Klenow (1997). It has also been adopted by Hall and Jones (1998), and Krueger and Lindhal (2000) and Bloom and Canning (2000). Pritchett (forthcoming but circulated in 1996) was one of the first proponents of such formulation. In its simplest macroeconomic form we shall then write:

$$LogH_t = a + bYS_t + \varepsilon_t \quad (2)$$

where $LogH_t$ is the logarithm of the human capital of a country at a given time *t*, and YS_t is the number of year of studies. (We ignore the role of experience.)

In order to have an idea of the magnitudes involved we can refer to Table 2, which is drawn from Bils and Klenow and where we have simply averaged the results over four groups of countries: High Income, Latin America, Asia, Africa.

Table 2. **Returns to Schooling**

High Income	0.069
Latin America	0.109
Asia	0.095
Africa	0.131
US	0.093

Source: Bils and Klenow(2000) and authors' calculation.

These averages show some disparities, although across groups differences are rather small, especially when compared to within group differences (see Bils and Klenow, 2000, Table B1, page 1180). Perhaps surprisingly the wider dispersion arises from within high income countries in which some countries such as Austria or Sweden achieve an extremely low return to education: 3.9 per cent in Austria, 2.6 per cent in Sweden (although in this latter country, the analysis was based on 1981 data). Asian and

Latin American countries average a return to schooling which is fairly in line to the U.S. number.

III.2 Empirical Estimates: MRW Meets Mincer

We shall first estimate equation (1) in levels, and take LogH to be simply proxied by a multiple of the number of years of schooling as in (2). Total factor productivity is proxied by lagged urbanisation rate (Urban), continental dummies (one for each continent) and time dummies. To our knowledge this specification, which simply matches MRW and Mincer, has not been tested directly. Bils and Klenow calibrate but do not test directly this regression. Krueger and Lindhal only estimate a growth version. Heckman and Klenow do not use investment. Our sample includes all countries, rich and poor, but excludes Africa due to the lower quality of the data.

Table 3. **Income Per Capita (in Log)**

	3.1 (OLS)	3.2 (GMM)
Urban	1.1×10^{-2} (5.3)	1.0×10^{-2} (2.55)
Log ($INV/(d+n+\mu)$)	0.46 (5.7)	0.41 (2.0)
Years Schooling	0.085 (4.0)	0.10 (2.06)
R^2	0.83	0.83
J statistic		1.54×10^{-3}

(Time and geographical dummies omitted (see text); t statistics in parentheses. Instruments reported in the text).

This regression 3.1 is almost miraculous. For one thing (as already reported in a different format by Mankiw, Romer and Weil) the coefficient of $Log[s/(d+n+\mu)]$ exactly fit its theoretical value, namely 0.5. Furthermore the return to education, 8.5 per cent, is fairly much in line with the average return obtained from micro data. The residual value of the continental dummies is important. We get a negative gap of 27 per cent for Eastern Europe, 29 per cent for MENA, 66 per cent for South Asia, 52 per cent for Latin America. When averaging the poor continents, we then find that they experience a 45 per cent gap. Similar results would be obtained by directly including a dummy for poor countries in equation 3.1 or by running separately a regression for high income and one for low income group. The gap can be interpreted as a technological barrier, not explained by human capital scarcity, which may pertain to the sheer effect of geography, or the legacy of colonial past.

There are clearly a number of problems with running such regression. The most important has to do with the endogeneity of the schooling variable. To the extent that higher income countries do generate higher education rather than simply the other way around, the OLS coefficient is likely to be biased upward. If anything, this would indicate that the true coefficient is actually smaller than the one which is reported, hence deflating further idea that there are externalities to human capital accumulation. This is obviously the case unless measurement errors bias the coefficient downwards.

In order to correct these problems, we have to look for instruments. Instrumenting years of schooling amounts to looking for a variable that is well correlated to current school achievements and not to total factor productivity. One such potential candidate is early schooling. In order to see why, we have simply analysed the increase in the number of years of schooling as a function of continental dummies, years of schooling at the beginning of period, its square and initial income. We find the following results.

Growth of Schooling

INCOME	0.047 (0.5)
INITIAL SCHOOLING	0.175 (3.2)
SCHOOLING SQUARED	-0.017 (-4.7)
	R^2=0.28

(Time and geographical dummies omitted; *t* statistics in parentheses.)

Interestingly, one sees that initial income appears to play no role whatsoever in the build up of schooling, while schooling and schooling squared are highly significant (in fact school alone does a similar job). We then decided to instrument schooling by 1900 school enrolment, in order to get the earliest possible school variable. From our data base, this was obtained by taking the school attainment of individuals aged 60-64 in 1960. We also include the ranking of the country in 1900 school attainment as instrument to account for a potential additional bias of the country towards education. We also include the lagged value of the relative price of investment as an instrument for the country bias against investment. The results are presented in equation 3.2 estimated with GMM. We see that the results are slightly higher with respect to human capital, and slightly lower in the case of physical capital although in neither case significantly so. The J statistic show that over-identifying restriction tests do not reject exogeneity (p value of 0.60). With respect to human capital, the results support the view that measurement errors introduce a bias slightly larger than the one introduced by the endogeneity of years of schooling. However GMM and OLS estimates are fairly close.

IV. GROWTH AND EDUCATION

As a test of robustness of the results obtained above, we have simply regressed the growth rate of income per head on the increase in the number of years of schooling. We also included directly a POOR dummy for all developing countries. (In fact similar results would be obtained by taking each sub-sample of rich and poor countries separately). We also neglect investment dynamics in order to focus on the impact of education on growth and we only report OLS estimates (intrumenting with beginning-of-period level of schooling and squared schooling provides similar point estimates). The results are shown in Table 4. We find essentially the same coefficient as those that were found in Table 3, namely a return of about 8 per cent to the years of schooling (column 4.1). One finds however that the regression does not explain more than 20 per cent of the variance. This is consistent both with Easterly *et al.* (1993) and with Bils and Klenow (2000): growth (as opposed to levels) is too erratic to be reasonably well explained by the increase (even on a decade-long basis) of human capital.

Table 4. **Growth of Income and School Attainments**

	4.1	4.2	4.3	4.4	4.5
Urban (-1)	-1.9×10^{-4} (-2.3)	-2.4×10^{-4} (-2.3)	-1.5×10^{-4} (-1.6)	-1.2×10^{-4} (-1.6)	-1.9×10^{-4} (-2.3)
POOR	-1.04×10^{-2} (-2.80)	-0.80×10^{-2} (-1.6)	-0.9×10^{-2} (-2.31)	-1.4×10^{-2} (-2.42)	-0.008 (-1.45)
Δ Years Schooling	8.45×10^{-2} (2.51)	8.64×10^{-2} (2.56)		8.95×10^{-2} (2.6)	0.078 (2.2)
Initial Income				-3.1×10^{-3} (-0.72)	
Δ Barro-Lee			2.8×10^{-2} (1.45)		
Initial Years of Schooling		7.8×10^{-4} (0.76)			
Initial School Enrolment					0.007 (0.63)
R^2	0.20	0.21	0.21	0.21	0.21

(Time dummies not reported; *t* statistics in parentheses. OLS estimates.)

Let us now add some further features to this growth regression. When one adds as an explanatory variable the initial level of education, as in equation 4.2, it does not add any additional power to the equation. This settles, at least for these data, the long standing opposition between the effects of levels and the effects of the increase of human capital on growth. We find quite simply that levels are correlated to levels and growth, to growth. The importance of the quality of the data is evidenced in equation 4.3: when one takes Barro-Lee's data in first difference, we find a very low coefficient (2.8 per cent) and not significant. When initial income is added to the regression (in equation 4.4), it does not have any additional power. The POOR dummy captures a divide between rich and poor which is therefore discontinuous between the North and the South. Whether this is a geographical outcome (as in Frankel and Romer and Sachs and Warner), the legacy of poor institutions (as in Jones and Hall) or a problem of diffusion (as suggested in Coe, Helpman and A. Hoffmaister, 1995) should be a primary matter of concern for the research to come. Another feature is obtained when including secondary school enrolment, which has been used by MRW as a proxy for the variable s_H (and criticised for this reason in Klenow and Rodriguez-Clare, 1997). One sees (in 4.5) that it does not add any power either (although in isolation, it is indeed significant). Bils and Klenow were surprised that growth was explained better by initial school enrolment than initial number of years of schooling. Combined with the result presented in equation 4.2, our results suggests that secondary school enrolment serves as a proxy for the increase of the number of years of studies (see the partial correlation in Table A3) which is why it is favoured econometrically to the level of school attainments.

V. CONCLUSION

This paper has presented a new set of data on human capital, whose informational content is as close as possible to the data presented in national, OECD or UNESCO censuses. When these data are used to test a neo-classical model that embeds the Mincerian approach to human capital into Mankiw, Romer and Weil version of the Neo-classical model, we find that they perform extremely well. Physical and human capital do appear to carry social returns which are essentially identical to the private ones.

These evidences do not foreclose the endogenous growth insights. As already pointed out by other papers [Klenow and Rodriguez-Clare (1997) or Bernanke and Gürkaynak (2001)], all that we learn from such exercises is that the Cobb-Douglas production function is a reasonable approximation of the productive process. It leaves intact the critical question of why and how the factors of production are accumulated. Poverty traps such as envisaged by Aziaradis and Drazen are clearly a distinct possibility. Furthermore, the critical question of why total factor productivity of poor countries remain abnormally low remains a pressing problem, where many of the insights of endogenous growth theory should offer a precious guide to the analysis.

APPENDIX

This appendix describes how enrolment figures are used to estimate net intake ratios. One major flaw in the use of the enrolment rate is that they do not take into account the students that have entered the school and have later dropped out. Indeed, even though these students have not accomplished a certain level of education, they might have learned basic tools that are not considered when dropouts are ignored. This is not an important problem in most OECD countries where dropout rates are very low. But developing countries, and especially low-income countries, display dropout rates reaching up to 15 per cent, hence the importance of considering it. Another factor to take into account is the presence of repeaters, which leads to an overstatement of the number of students having attended formal education. Although existing studies generally adjust their estimates by the repeaters' effect, they fail to take into account the dropout effect.

The present procedure estimates net intakes from enrolment figures. Calling *Nt* the net intakes in year t, *d* the drop out rate, *r* the repetition rate and *P* the duration in years of primary school, $(1\text{-d-r})^P$. *Nt* will then succeed to finish primary schooling in *P* years.

Making the reasonable assumption that each student may repeat a maximum of three times during the primary scholarship, each grade is composed of students that have never repeated and students that have repeated once, twice or three times. Calling *g* the growth rate of net intakes, the expression linking primary enrolment E_t to net intakes N_t in year *t* is:

$$E_t = N_t \sum_{j=0}^{P-1} (1-d-r)^j \left[\frac{r^3 C'(j+1,3)}{(1+g)^{j+3}} + \frac{r^2 C'(j+1,2)}{(1+g)^{j+2}} + \frac{rC'(j+1,1)}{(1+g)^{j+1}} + \frac{C'(j+1,0)}{(1+g)^{j}} \right] \quad \text{(A.1)}$$

where *C'(K, i)* is a combinatorial with repetition of *i* out of *K* years. From this expression it is possible to obtain net intake data, based on enrolment series published by Mitchell or UNESCO. The right-hand side of equation (A.1) is a function of three parameters: the repetition rate (r), the dropout rate (d) and the net intake growth rate (g). In stationary state, the primary enrolment grows at the same rate as net intakes. Thus *g* may be computed from the enrolment growth rate. One particular case is when $d = r = g = 0$. In this case, $E_t = N_t \times P$ and therefore, the number of new entrants is simply equal to the pupils enrolled in primary divided by the duration of primary. UNESCO provides indicators for primary schooling on repetition rates and survival rates for most countries in the world starting in 1970. The survival rate — which is defined as the percentage of students enrolled in the first grade who are expected to reach the final grade — is used to compute the dropout rate. Defining *s* as the survival rate and noting that,

$$s = (1-r-d)^P (1 + rP + r^2 C'(P,2) + r^3 C'(P,3))$$

it can be deduced that the dropout rate is equal to,

$$d = (1 - r) - \left[\frac{s}{(1 + rP + r^2C'(P,2) + r^3C'(P,3))} \right]^{\frac{1}{P}}$$

Cases with an important proportion of new entrants over the official entrance age do not involve important errors because the overstatement of net intakes that these pupils introduce in a specific cohort are compensated by the pupils of that cohort that do not enter at the official age but later. If the pattern of new entrants over the official entrance age suffers little variation from year to year, net intake figures may be taken as a reliable estimate of the students entering to school at the official entrance age. The same argument may be given for the countries presenting a large number of intakes under the official entrance age.

In a second step one can estimate the percentage of population having completed primary school by multiplying the survival rate by the net intake rate. Finally, a similar procedure is used to estimate attainment in secondary and higher education.

Not all the countries have full information. In several cases, especially in African countries, data on population are very limited and available only back to 1950. In these cases, it is assumed that net intake rates before 1950 were the same as that year. While this assumption may appear unrealistic, it is unlikely to introduce important errors because, as the data show, enrolment and net intake rates were very low in 1950 and close to zero in secondary and higher education. Thus the error will be limited to (the very low) participation in primary education.

In other cases, like the two world wars, there is no information for most European countries. In these cases, the information is taken from the closest year with available data. This procedure is unlikely to lead into relevant error, since figures change little from year to year.

Table A.1. **Census used for Each Country**

Country	Source							TOTAL CENSUS
	UNESCO				OECD DATABASE		WEBSITE	
Algeria								0
Angola								0
Argentina			1980	1991		1999		3
Australia					1991	1998		2
Austria					1991	1997		2
Bangladesh							1991	1
Belgium					1991	1998		2
Benin								0
Bolivia			1976	1992				2
Brazil			1980			1999		2
Bulgaria								0
Burkina Faso								0
Burundi								0
Cameroon			1976					1
Canada					1991	1998		2
Central African republic								0
Chile						1999		1
China								0
Colombia		1973						1
Costa Rica		1968						1
Côte d'Ivoire								0
Cuba								0
Cyprus	1960							1
Denmark					1991	1998		2
Dominican Republic		1970						1
Ecuador			1982	1990				2
Egypt			1976	1986				2
El Salvador		1971						1
Ethiopia								0
Fiji			1976	1986				2
Finland	1960	1970	1980	1990		1998		5
France					1991	1998		2
Gabon								0
Germany					1991	1998		2
Ghana		1970						1
Greece						1997		1
Guatemala								0
Guyana								0
Haiti				1986				1
Honduras	1961		1983					2
Hungary						1998		1
India	1961		1981	1992				3
Indonesia	1961		1980			1999		3
Iran		1966						1
Iraq	1957	1965						2
Ireland					1991	1998		2
Italy					1991	1998		2
Jamaica	1960		1982					2

Table A.1 (contd.)

	Source								
Country	UNESCO				OECD DATABASE		WEBSITE		TOTAL CENSUS
Japan						1998			1
Jordan	1961					1999			2
Kenya			1979						1
Korea						1998			1
Madagascar									0
Malawi									0
Malaysia						1999			1
Mali									0
Mauritius				1990					1
Mexico						1998			1
Morocco									0
Mozambique									0
Myanmar									0
Nepal									0
Netherlands					1991	1998			2
New Zealand					1991	1998			2
Nicaragua		1971							1
Niger									0
Nigeria									0
Norway					1991	1998			2
Panama			1980						1
Paraguay			1982			1999			2
Peru						1999			1
Philippines						1999			1
Portugal	1960	1970	1981		1991	1998			5
Romania									0
Senegal									0
Sierra Leone									0
Singapore		1970	1980				1990	2000	4
South Africa		1970		1985					2
Spain					1991	1998			2
Sudan			1983						1
Sweden					1991	1998			2
Switzerland					1991	1998			2
Syria		1970							1
Tanzania									0
Thailand			1980			1999			2
Trinidad & Tobago									0
Tunisia			1984			1999			2
Turkey					1991	1998			2
Uganda		1969							1
United Kingdom					1991	1998			2
United States					1991	1998			2
Uruguay			1975			1999			2
Venezuela	1961		1981	1990					3
Zambia			1980						1
Zimbabwe						1999			1

Table A.2. **Regional Summary: Education**

		SCHOOLING		
Region	**Year**	**Average Years of Schooling**	**Change** (Years) **1960 - 2000**	**Change** (annual %) **1960 - 2000**
Middle-East & North Africa	1960	0.9		
	1970	1.6		
	1980	2.7		
	1990	4.3		
	2000	5.9	5.0	4.8%
	2010	6.9		
Sub-Saharan Africa	1960	1.4		
	1970	1.7		
	1980	2.1		
	1990	3.0		
	2000	3.9	2.5	2.7%
	2010	4.3		
Latin America & Caribbean	1960	3.8		
	1970	4.5		
	1980	5.3		
	1990	6.7		
	2000	7.6	3.7	1.7%
	2010	8.2		
East Asia & Pacific	1960	2.3		
	1970	3.2		
	1980	4.3		
	1990	5.4		
	2000	6.4	4.1	2.6%
	2010	7.3		
South Asia	1960	1.2		
	1970	1.9		
	1980	2.6		
	1990	3.1		
	2000	4.3	3.1	3.2%
	2010	5.3		
High-Income Countries	1960	8.7		
	1970	9.8		
	1980	10.9		
	1990	11.6		
	2000	12.1	3.4	0.8%
	2010	12.5		
Eastearn Europe & Central Asia	1960	5.3		
	1970	5.8		
	1980	6.5		
	1990	7.1		
	2000	7.8	2.6	1.0%
	2010	8.4		

Table A.3. **Correlation of Years of Schooling**
Population 25 and over, OECD Countries

Barro - Lee		
0.908	De la F. - Doménech	
0.897	0.938	This paper

Table A.4. **Correlation of Change in Years of Schooling**
Population 25 and over, OECD countries

Barro - Lee			
0.104	De la F. - Doménech		
0.082	0.468	This paper	
0.023	0.321	0.314	Secondary Enrollment

Table A.5. **Reliability of Series in Differences**

All the Countries

Reliability of:	
Barro - Lee	Cohen - Soto
0.37	0.58

OECD Countries

	Reliability of:		
(compared to)	Barro - Lee	De la Fuente- Doménech	Cohen - Soto
Barro - Lee	--	0.28	0.26
De la Fuente- Doménech	0.04	--	0.56
Cohen - Soto	0.03	0.39	--

Table A.6. **Years of Schooling**
(Population aged 15-64 who is not studying)

Country	Year	Years of schooling
Algeria	1960	1.21
Algeria	1970	1.74
Algeria	1980	3.15
Algeria	1990	4.86
Algeria	2000	6.36
Algeria	2010	7.23
Angola	1960	0.10
Angola	1970	0.26
Angola	1980	0.93
Angola	1990	1.90
Angola	2000	2.38
Angola	2010	2.92
Argentina	1960	6.13
Argentina	1970	6.76
Argentina	1980	7.52
Argentina	1990	8.71
Argentina	2000	8.30
Argentina	2010	8.80
Australia	1960	9.82
Australia	1970	11.04
Australia	1980	12.20
Australia	1990	12.76
Australia	2000	13.09
Australia	2010	13.25
Austria	1960	8.28
Austria	1970	9.28
Austria	1980	10.31
Austria	1990	10.94
Austria	2000	11.43
Austria	2010	11.70
Bangladesh	1960	1.92
Bangladesh	1970	2.23
Bangladesh	1980	2.58
Bangladesh	1990	3.00
Bangladesh	2000	4.23
Bangladesh	2010	5.03
Belgium	1960	7.39
Belgium	1970	8.29
Belgium	1980	9.24
Belgium	1990	10.03
Belgium	2000	10.84
Belgium	2010	11.42
Benin	1960	0.41
Benin	1970	0.54
Benin	1980	0.91
Benin	1990	1.78
Benin	2000	2.30
Benin	2010	2.73
Bolivia	1960	3.60
Bolivia	1970	4.67
Bolivia	1980	5.96
Bolivia	1990	7.34
Bolivia	2000	8.09
Bolivia	2010	8.74
Brazil	1960	3.07
Brazil	1970	3.69
Brazil	1980	4.27
Brazil	1990	6.53
Brazil	2000	7.50
Brazil	2010	8.19
Bulgaria	1960	7.30
Bulgaria	1970	8.04
Bulgaria	1980	8.97
Bulgaria	1990	9.55

Bulgaria	2000	10.59
Bulgaria	2010	11.48
Burkina Faso	1960	0.05
Burkina Faso	1970	0.10
Burkina Faso	1980	0.23
Burkina Faso	1990	0.44
Burkina Faso	2000	0.93
Burkina Faso	2010	1.50
Burundi	1960	0.70
Burundi	1970	0.70
Burundi	1980	0.99
Burundi	1990	1.08
Burundi	2000	2.04
Burundi	2010	2.41
Cameroon	1960	1.33
Cameroon	1970	1.88
Cameroon	1980	3.04
Cameroon	1990	4.07
Cameroon	2000	4.65
Cameroon	2010	4.92
Canada	1960	9.11
Canada	1970	10.37
Canada	1980	11.59
Canada	1990	12.36
Canada	2000	13.07
Canada	2010	13.30
Central African Republic	1960	0.50
Central African Republic	1970	0.71
Central African Republic	1980	1.38
Central African Republic	1990	2.13
Central African Republic	2000	2.87
Central African Republic	2010	3.23
Chile	1960	6.19
Chile	1970	7.05
Chile	1980	8.18
Chile	1990	9.14
Chile	2000	9.94
Chile	2010	10.77
China	1960	2.26
China	1970	3.10
China	1980	4.10
China	1990	5.06
China	2000	5.96
China	2010	6.79
Colombia	1960	3.70
Colombia	1970	4.30
Colombia	1980	4.89
Colombia	1990	6.03
Colombia	2000	7.13
Colombia	2010	7.81
Costa Rica	1960	3.26
Costa Rica	1970	3.91
Costa Rica	1980	4.68
Costa Rica	1990	5.91
Costa Rica	2000	6.72
Costa Rica	2010	7.65
Cote d'Ivoire	1960	0.27
Cote d'Ivoire	1970	0.54
Cote d'Ivoire	1980	1.48
Cote d'Ivoire	1990	2.48
Cote d'Ivoire	2000	3.18
Cote d'Ivoire	2010	3.74
Cuba	1960	3.52
Cuba	1970	4.30
Cuba	1980	5.48
Cuba	1990	7.47
Cuba	2000	8.93
Cuba	2010	9.88
Cyprus	1960	5.53
Cyprus	1970	6.34

Cyprus	1980	7.14
Cyprus	1990	8.00
Cyprus	2000	8.87
Cyprus	2010	9.73
Denmark	1960	9.08
Denmark	1970	10.08
Denmark	1980	11.03
Denmark	1990	11.54
Denmark	2000	12.20
Denmark	2010	12.32
Dominican Republic	1960	2.52
Dominican Republic	1970	3.54
Dominican Republic	1980	4.04
Dominican Republic	1990	4.90
Dominican Republic	2000	5.88
Dominican Republic	2010	6.43
Ecuador	1960	4.29
Ecuador	1970	5.15
Ecuador	1980	6.26
Ecuador	1990	7.21
Ecuador	2000	8.22
Ecuador	2010	8.82
Egypt	1960	1.01
Egypt	1970	1.64
Egypt	1980	2.92
Egypt	1990	4.96
Egypt	2000	6.76
Egypt	2010	8.04
El Salvador	1960	2.01
El Salvador	1970	2.55
El Salvador	1980	3.59
El Salvador	1990	4.54
El Salvador	2000	5.10
El Salvador	2010	5.53
Ethiopia	1960	0.12
Ethiopia	1970	0.22
Ethiopia	1980	0.53
Ethiopia	1990	1.25
Ethiopia	2000	1.93
Ethiopia	2010	2.60
Fiji	1960	3.87
Fiji	1970	4.95
Fiji	1980	6.32
Fiji	1990	7.39
Fiji	2000	8.00
Fiji	2010	8.48
Finland	1960	6.85
Finland	1970	7.96
Finland	1980	9.49
Finland	1990	10.73
Finland	2000	11.68
Finland	2010	12.28
France	1960	6.73
France	1970	8.02
France	1980	9.34
France	1990	10.36
France	2000	10.73
France	2010	11.35
Gabon	1960	1.90
Gabon	1970	2.32
Gabon	1980	3.64
Gabon	1990	4.62
Gabon	2000	5.13
Gabon	2010	6.18
Germany	1960	9.52
Germany	1970	11.14
Germany	1980	12.65
Germany	1990	13.21
Germany	2000	12.95
Germany	2010	12.74

Ghana	1960	1.89
Ghana	1970	3.18
Ghana	1980	4.36
Ghana	1990	4.82
Ghana	2000	5.26
Ghana	2010	5.64
Greece	1960	5.94
Greece	1970	6.74
Greece	1980	7.72
Greece	1990	8.71
Greece	2000	9.90
Greece	2010	10.73
Guatemala	1960	1.64
Guatemala	1970	1.92
Guatemala	1980	2.65
Guatemala	1990	3.92
Guatemala	2000	4.84
Guatemala	2010	5.32
Guyana	1960	5.10
Guyana	1970	5.68
Guyana	1980	6.68
Guyana	1990	7.54
Guyana	2000	8.51
Guyana	2010	9.21
Haiti	1960	1.12
Haiti	1970	1.45
Haiti	1980	2.06
Haiti	1990	3.13
Haiti	2000	3.60
Haiti	2010	4.41
Honduras	1960	1.90
Honduras	1970	3.39
Honduras	1980	4.10
Honduras	1990	4.64
Honduras	2000	5.32
Honduras	2010	5.71
Hungary	1960	7.57
Hungary	1970	8.33
Hungary	1980	9.32
Hungary	1990	10.10
Hungary	2000	10.87
Hungary	2010	11.27
India	1960	1.17
India	1970	1.95
India	1980	2.61
India	1990	3.15
India	2000	4.34
India	2010	5.32
Indonesia	1960	1.60
Indonesia	1970	2.89
Indonesia	1980	3.80
Indonesia	1990	5.98
Indonesia	2000	7.25
Indonesia	2010	7.99
Iran	1960	0.71
Iran	1970	1.33
Iran	1980	2.28
Iran	1990	3.84
Iran	2000	5.34
Iran	2010	6.66
Iraq	1960	0.37
Iraq	1970	1.25
Iraq	1980	2.66
Iraq	1990	4.87
Iraq	2000	6.11
Iraq	2010	6.60
Ireland	1960	7.25
Ireland	1970	8.01
Ireland	1980	8.94
Ireland	1990	9.53

Ireland	2000	10.17
Ireland	2010	10.59
Italy	1960	5.82
Italy	1970	6.78
Italy	1980	7.96
Italy	1990	9.10
Italy	2000	10.33
Italy	2010	11.02
Jamaica	1960	4.82
Jamaica	1970	5.77
Jamaica	1980	7.24
Jamaica	1990	8.09
Jamaica	2000	8.66
Jamaica	2010	9.05
Japan	1960	9.48
Japan	1970	10.37
Japan	1980	11.20
Japan	1990	11.93
Japan	2000	12.61
Japan	2010	13.11
Jordan	1960	2.58
Jordan	1970	5.22
Jordan	1980	7.40
Jordan	1990	9.36
Jordan	2000	10.28
Jordan	2010	10.18
Kenya	1960	1.86
Kenya	1970	2.80
Kenya	1980	3.99
Kenya	1990	5.24
Kenya	2000	6.06
Kenya	2010	6.52
Korea	1960	4.98
Korea	1970	6.82
Korea	1980	9.11
Korea	1990	11.00
Korea	2000	12.34
Korea	2010	13.34
Madagascar	1960	1.43
Madagascar	1970	1.52
Madagascar	1980	2.06
Madagascar	1990	2.96
Madagascar	2000	3.71
Madagascar	2010	4.07
Malawi	1960	2.13
Malawi	1970	2.20
Malawi	1980	2.32
Malawi	1990	3.32
Malawi	2000	4.28
Malawi	2010	5.31
Malaysia	1960	3.22
Malaysia	1970	4.60
Malaysia	1980	6.22
Malaysia	1990	7.98
Malaysia	2000	9.31
Malaysia	2010	10.22
Mali	1960	0.21
Mali	1970	0.30
Mali	1980	0.69
Mali	1990	0.95
Mali	2000	1.14
Mali	2010	1.60
Mauritius	1960	2.99
Mauritius	1970	4.18
Mauritius	1980	5.65
Mauritius	1990	6.89
Mauritius	2000	7.59
Mauritius	2010	8.19
Mexico	1960	3.98
Mexico	1970	4.90

Mexico	1980	5.90
Mexico	1990	7.06
Mexico	2000	7.95
Mexico	2010	8.43
Morocco	1960	0.61
Morocco	1970	0.95
Morocco	1980	1.51
Morocco	1990	2.41
Morocco	2000	3.58
Morocco	2010	4.50
Mozambique	1960	0.45
Mozambique	1970	0.78
Mozambique	1980	1.05
Mozambique	1990	2.02
Mozambique	2000	2.39
Mozambique	2010	2.45
Myanmar	1960	1.03
Myanmar	1970	1.64
Myanmar	1980	2.79
Myanmar	1990	3.62
Myanmar	2000	4.42
Myanmar	2010	5.01
Nepal	1960	0.25
Nepal	1970	0.43
Nepal	1980	0.80
Nepal	1990	1.66
Nepal	2000	3.27
Nepal	2010	4.57
Netherlands	1960	8.34
Netherlands	1970	9.35
Netherlands	1980	10.28
Netherlands	1990	10.72
Netherlands	2000	11.34
Netherlands	2010	11.50
New Zealand	1960	8.98
New Zealand	1970	9.87
New Zealand	1980	10.72
New Zealand	1990	11.02
New Zealand	2000	12.09
New Zealand	2010	12.48
Nicaragua	1960	2.30
Nicaragua	1970	2.61
Nicaragua	1980	3.85
Nicaragua	1990	5.31
Nicaragua	2000	6.31
Nicaragua	2010	7.08
Niger	1960	0.07
Niger	1970	0.13
Niger	1980	0.37
Niger	1990	0.76
Niger	2000	1.02
Niger	2010	1.25
Nigeria	1960	1.05
Nigeria	1970	1.28
Nigeria	1980	1.41
Nigeria	1990	2.61
Nigeria	2000	3.89
Nigeria	2010	4.37
Norway	1960	9.05
Norway	1970	10.30
Norway	1980	11.56
Norway	1990	12.32
Norway	2000	12.48
Norway	2010	12.71
Panama	1960	4.60
Panama	1970	5.22
Panama	1980	6.86
Panama	1990	7.87
Panama	2000	8.56
Panama	2010	9.12

Paraguay	1960	4.03
Paraguay	1970	4.55
Paraguay	1980	5.21
Paraguay	1990	5.96
Paraguay	2000	6.59
Paraguay	2010	7.03
Peru	1960	4.27
Peru	1970	5.23
Peru	1980	6.39
Peru	1990	7.47
Peru	2000	8.32
Peru	2010	9.01
Philippines	1960	4.45
Philippines	1970	5.28
Philippines	1980	6.26
Philippines	1990	7.17
Philippines	2000	7.94
Philippines	2010	8.62
Portugal	1960	3.15
Portugal	1970	4.11
Portugal	1980	5.57
Portugal	1990	5.91
Portugal	2000	7.28
Portugal	2010	7.89
Romania	1960	7.22
Romania	1970	7.48
Romania	1980	8.31
Romania	1990	9.18
Romania	2000	10.00
Romania	2010	10.99
Senegal	1960	0.39
Senegal	1970	0.56
Senegal	1980	1.25
Senegal	1990	1.90
Senegal	2000	2.56
Senegal	2010	2.96
Sierra Leone	1960	0.76
Sierra Leone	1970	1.05
Sierra Leone	1980	1.95
Sierra Leone	1990	2.83
Sierra Leone	2000	3.61
Sierra Leone	2010	4.00
Singapore	1960	4.20
Singapore	1970	5.84
Singapore	1980	5.79
Singapore	1990	7.06
Singapore	2000	9.82
Singapore	2010	11.17
South Africa	1960	4.32
South Africa	1970	4.80
South Africa	1980	5.13
South Africa	1990	5.66
South Africa	2000	7.35
South Africa	2010	8.83
Spain	1960	5.79
Spain	1970	6.52
Spain	1980	7.45
Spain	1990	8.44
Spain	2000	9.50
Spain	2010	10.27
Sudan	1960	1.06
Sudan	1970	1.38
Sudan	1980	2.10
Sudan	1990	2.39
Sudan	2000	2.87
Sudan	2010	3.02
Sweden	1960	8.68
Sweden	1970	9.97
Sweden	1980	11.26
Sweden	1990	12.04

Sweden	2000	11.72
Sweden	2010	12.11
Switzerland	1960	10.96
Switzerland	1970	11.81
Switzerland	1980	12.48
Switzerland	1990	12.96
Switzerland	2000	12.73
Switzerland	2010	12.57
Syria	1960	2.09
Syria	1970	2.99
Syria	1980	4.17
Syria	1990	5.67
Syria	2000	7.09
Syria	2010	7.59
Tanzania	1960	2.03
Tanzania	1970	2.00
Tanzania	1980	2.08
Tanzania	1990	2.88
Tanzania	2000	3.47
Tanzania	2010	3.74
Thailand	1960	2.60
Thailand	1970	3.15
Thailand	1980	3.87
Thailand	1990	6.50
Thailand	2000	7.51
Thailand	2010	8.50
Trinidad & Tobago	1960	6.75
Trinidad & Tobago	1970	7.23
Trinidad & Tobago	1980	8.47
Trinidad & Tobago	1990	9.23
Trinidad & Tobago	2000	9.60
Trinidad & Tobago	2010	9.85
Tunisia	1960	0.83
Tunisia	1970	1.58
Tunisia	1980	2.73
Tunisia	1990	3.32
Tunisia	2000	4.44
Tunisia	2010	5.20
Turkey	1960	2.14
Turkey	1970	3.07
Turkey	1980	4.16
Turkey	1990	5.22
Turkey	2000	6.25
Turkey	2010	6.89
Uganda	1960	1.20
Uganda	1970	1.80
Uganda	1980	2.16
Uganda	1990	2.54
Uganda	2000	3.31
Uganda	2010	4.71
United Kingdom	1960	9.11
United Kingdom	1970	10.32
United Kingdom	1980	11.57
United Kingdom	1990	12.28
United Kingdom	2000	13.12
United Kingdom	2010	13.34
United States	1960	10.18
United States	1970	11.27
United States	1980	12.19
United States	1990	12.62
United States	2000	12.63
United States	2010	13.24
Uruguay	1960	5.32
Uruguay	1970	6.04
Uruguay	1980	6.85
Uruguay	1990	7.67
Uruguay	2000	8.36
Uruguay	2010	8.98
Venezuela	1960	2.93
Venezuela	1970	5.28

Venezuela	1980	6.28
Venezuela	1990	5.35
Venezuela	2000	6.26
Venezuela	2010	7.25
Zambia	1960	3.01
Zambia	1970	3.84
Zambia	1980	5.02
Zambia	1990	5.30
Zambia	2000	6.10
Zambia	2010	6.45
Zimbabwe	1960	3.56
Zimbabwe	1970	4.28
Zimbabwe	1980	5.27
Zimbabwe	1990	7.09
Zimbabwe	2000	8.29
Zimbabwe	2010	8.82

BIBLIOGRAPHY

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

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

BENHABIB, J. and M.M. SPIEGEL (1994), "The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-country Data", *Journal of Monetary Economics* 34(2), 143-173.

BERNANKE, B. and R. GÜRKAYNAK (2001), "Is Growth Exogenous? Taking Mankiw, Romer and Weil Seriously", *NBER Macroeconomics Annual*.

BILS, M. and P. KLENOW (2000), "Does Schooling Cause Growth?", *American Economic Review*, (90)5, 1160-83.

BLOOM, D. and D. CANNING (2000), "Health, Human Capital and Economic Growth, Commission on Macroeconomics and Health", mimeo.

COE, D., E. HELPMAN and A. HOFFMAISTER, 1997, "North-South R&D Spillovers", *Economic Journal*, 107(440).

COHEN, D. (1996), "Tests of the Convergence Hypothesis: Some Further Results", *Journal of Economic Growth*, 1(3), 351-61.

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

DE LA FUENTE, A. and R. DOMÉNECH (2001), "Educational Attainment in the OECD, 1960-1995", manuscript.

EASTERLY, W., M. KREMER, L. PRITCHETT and L. SUMMERS (1993), "Good Policies or Good Luck? Country Performances and Temporary Shocks", *Journal of Monetary Economics*, 32(3), 459-83.

HECKMAN, J. and P. KLENOW (1997), "Human Capital Policy", mimeo, University of Chicago.

KLENOW, P. and A. RODRIGUEZ-CLARE (1997), "The Neo-Classical Revival in Growth Economics: Has it Gone Too Far?", *NBER Macroeconomics Annual*.

KRUEGER, A. and M. LINDAHL (2000), "Education for Growth: Why and For Whom", NBER 7591.

MANKIW, G., D. ROMER and D. WEIL (1992), "A Contribution to the Empirics of Economic Growth", *Quarterly Journal of Economics*, 107(2), 402-437.

MINCER, J. (1974), "Schooling, Experience and Earnings", Columbia University Press.

MITCHELL, B.R. (1993), *International Historical Statistics: Africa, Asia and Oceania 1750-1988*, M Stockton Press, New York, NY.

MITCHELL, B.R. (1998*a*), *International Historical Statistics: Europe 1750-1993*, M Stockton Press, New York, NY.

MITCHELL, B.R. (1998*b*), International Historical Statistics: The Americas 1750-1993, M Stockton Press, New York, NY.

NEHRU, V., E. SWANSON and A. DUBEY (1995), "A New Database on Human Capital Stocks in Developing and Industrial Countries: Sources Methodology and Results", *Journal of Development Economics*, 46(2), 379-401.

OECD (2000), *Investing in Education: Analysis of the 1999 World Education Indicators*, Paris.

PRITCHETT, L., forthcoming, "Where Has All The Education Gone?, *World Bank Economic Review*.

SACHS, J. and A. WARNER (1995), "Economic Reform and the Process of Global Integration", Brookings Paper on Economic Activity, (0)1, 1-95.

TEMPLE, J. (1999), "A Positive Effect of Human Capital on Growth", Economic Letters, 65(1), 131-134.

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

UNESCO (various issues), *Statistical Yearbook*, Paris.