BBVA | RESEARCH

Working Paper, Nº 14/30
Madrid, 07 Nov 2014

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Revised, November 2014

Abstract

This paper describes the construction of series on the educational attainment of the adult population for a sample of 22 OECD countries covering the period 1960-2010. These series are then compared with (the OECD subsample of) the latest available version of other cross-country data sets on average years of schooling that are commonly used in the literature. Finally, statistical measures of the information content of the different series are constructed using the procedure developed by Krueger and Lindhal (K&L, 2001) and de la Fuente and Doménech (D&D, 2006). The exercise implies that there are important differences in quality across data sets and suggests that successive revisions have succeeded in increasing their signal to noise ratios.

Keywords: human capital, growth, measurement error.

JEL: O40, I20, O30, C19.

1: This paper is part of a research project cofinanced by BBVA Research and Fundación Rafael del Pino. We gratefully acknowledge additional support from the Spanish Ministry of Science and Technology through CICYT grants ECO2011-28348 and ECO2011-29050.
2: FEDEA and Instituto de Análisis Económico (CSIC)
3: BBVA Research and Universidad de Valencia

1. Introduction

The construction of homogeneous schooling series for broad samples of countries has been the main goal of a significant and growing number of papers over the last three decades. These series are an important input for empirical analyses of the determinants of economic growth and of other issues. They are generally constructed using data from international compilations of educational attainment and/or enrollment data from UNESCO and other organizations and employing different procedures to build up stock estimates from enrollment data and/or to fill in missing stock observations. The relevant literature includes papers by Kyriacou (1991), Lau, Jamison and Louat (1991), Lau, Bhalla and Louat (1991), Nehru, Swanson and Dubey (1995), Barro and Lee (B&L, 1993, 1996, 2001 and 2013), Cohen and Soto (C&S, 2007), de la Fuente and Doménech (D&D, 2002, 2006 and 2012), Lutz et al (2007) and Samir et al (2010).

The present paper updates and extends our earlier work in the area. Section 2 describes the construction of series on the educational attainment of the adult population for a sample of 22 OECD countries covering the period 1960-2010. These series are a revised and extended version of the data set constructed in de la Fuente and Doménech (2002 and 2006) that incorporates a fair amount of new direct information and extends the sample period by over fifteen years. Country details are contained in a separate Appendix that is available as de la Fuente and Doménech (2014). Section 3 compares our series with three other data sets that appear to be particularly useful for empirical researchers because of their quality and coverage. We focus in particular on the most recent available versions of the schooling series constructed by Barro and Lee (B&L), Cohen and Soto (C&S) and Lutz, Samir et al (L&S+), working in all cases with the same OECD subsample covered by our series.[1] Statistical measures of the information content of the different series are constructed in section 4 using the procedure developed by Krueger and Lindhal (K&L, 2001) and refined in de la Fuente and Doménech (D&D, 2006). The exercise implies that there are important differences in quality across data sets, with our own data and C&S's series clearly outperforming the other two data sets we consider, and suggests that the successive revisions of the different series have generally succeeded in increasing signal to noise ratios. There are also two appendices. The first one briefly reviews the construction of the B&L, C&S and L&S+ data sets and the second one extends part of our work to a large sample of non-OECD countries.

[1] For Barro and Lee, we use version 1.2 (released in 2011) of the data set described in B&L (2013), which is available at http://www.barrolee.com; for D&D we use version 3.1, as described in D&D (2014), which can be downloaded from https://ideas.repec.org/p/fda/fdaddt/2014-14.html; for L&S+, we work with an unpublished "current working version" supplied in 2012 by K. C. Samir, to whom we are grateful, and for C&S we use an updated version of their (2007) data set which was downloaded from http://soto.iae-csic.org/Data.htm in 2012. Since the C&S data come only at 10-year intervals, we use linear interpolation to complete the quinquennial series with which we work. We thank K. C. Samir and M. Soto for providing the latest available versions of their data.

2. Extended schooling series for a sample of OECD countries

The data set described in this section incorporates two major changes relative to our 2006 estimates of schooling levels.[2] First, we have extended the series from 1990 or 1995 to 2010. And second, we have incorporated a fair amount of new information taken mostly from the websites of national statistical institutes. As a result of this, our new series rely almost exclusively on national sources. To the extent possible, we have avoided the use of compilations produced by UNESCO and other international organizations whose attempts to homogenize the data may be counterproductive on occasion.

Our overall strategy for the construction of long series on educational attainment has been the same as in our previous papers: we have collected all the information we could find on the educational attainment of the adult population (aged 25 and over) in the countries of interest and used our best judgment to try to construct a plausible time series for each one of them. For most countries, reasonably complete educational data for recent years can be found on their National Statistical Institute's website. In many cases, this source provides a fairly detailed breakdown by age group that can be exploited to construct backward projections for earlier years. After exploiting these data, we have generally worked backwards in time, drawing on whatever other sources were available and trying to avoid unreasonable jumps in the series by choosing the most plausible figure when several were available for the same year, and by reinterpreting some of the data (as referring to broader or narrower schooling categories than the reported one) when it seemed sensible to do so. Missing observations were then filled in a variety of ways. Where possible, we interpolated between available observations. Otherwise, we have relied on miscellaneous information from a variety of sources in order to construct plausible estimates of attainment levels. We have avoided the use of flow estimates based on enrollment data because they seem to produce implausible time profiles, but we have made occasional use of enrollment data to complement other sources.

Clearly, the construction of our series involves a fair amount of guesswork (although considerably less than in the previous version). Our methodology looks decidedly less scientific than the apparently more systematic estimation procedures used by other authors starting from supposedly homogeneous data produced by UNESCO and other international organizations (see for instance Barro and Lee, 1996 and 2010, and Cohen and Soto, 2007). However, even a cursory examination of the data shows that there is no such homogeneity (see de la Fuente and Doménech, 2006). Hence, we have found it preferable to rely on judgment to try to piece together the available information in a coherent manner than to take for granted the accuracy of the primary data. As we will show below, the results do look more plausible than most existing series, at least in terms of their time profile, and perform rather well in terms of a statistical indicator of data quality.

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[2] Relative to version 3.0 of this series as described in de la Fuente and Doménech (2012), the main changes in the current paper have been the introduction of Mexico in the sample and a revision of the data for Spain and Portugal. For both countries we have incorporated data from the 2011 census. For Portugal, we have also incorporated direct data from the censuses of 1960 and 1970, have switched from an entry to a completion criterion and have modified slightly the definition of *L0*, which now includes only illiterates in the strict sense (and not those who have had no formal schooling but can read and write).

2.1. Attainment categories and average durations

We aim to provide estimates of the fraction of the population aged 25 and over (for short, population 25+ from now on) that has attained each of the levels of education shown in Table 1: illiterates (*L0*), primary schooling (*L1*), lower and upper secondary schooling (*L2.1* and *L2.2*) and two levels of higher education (*L3.1* and *L3.2*). Whenever possible, we break down upper secondary schooling attainment into an academic and a vocational component (*L2.2ac* and *L2.2voc*). We have tried (with uncertain success) to include upper-level vocational courses (ISCED 5 studies according to the international standard classification of educational attainment levels) in the first level of higher attainment, *L3.1*. We report *L0* only for the four countries where illiteracy rates are significant during most of the sample period (Portugal, Greece, Spain and Italy). For the rest of the sample, the lowest reported category is *L1*, and it includes all those who have not reached secondary school.

Table 1: Attainment levels and codes

code	*level*
L0	Illiterates
L1	Primary schooling
L2.1	Lower secondary schooling
L2.2	Upper secondary schooling
L2	Total secondary schooling = *L2.1* + *L2.2*
L3.1	Higher education, first cycle or short post-secondary courses
L3.2	Higher education, second cycle or full-length courses
L3	Total higher education = *L3.1* + *L3.2*

Depending on the country, attainment rates may reflect either the fraction of the population that has started each educational level or those who have completed it successfully (which in some cases requires a passing grade on an exit examination). Table 2 lists the attainment concepts used in each country for the different schooling levels. With the exception of *L1*, which generally includes those with incomplete primary education or no formal studies, the data available for calculating attainment rates tend to be based on a completion criterion, but there are numerous exceptions for which such data are not available and we have had to rely on an entry criterion. Hence, our estimates of attainment rates are not fully comparable across countries. On the other hand, they are generally consistent over time within each given country. While we have detected a few instances of countries that have switched from one criterion to the other, these changes do not seem to generate significant breaks in the series, suggesting perhaps that completion rates were close to 100% in the affected levels and countries.

Using our attainment series, we construct an estimate of the average years of total schooling for each country and period. Table 3 shows the cumulative durations of the different school cycles in each country that have been used for this calculation. These durations come mostly from the same national sources as our attainment data and correspond to the cutoff points we have used to identify the different schooling levels --even when these cutoffs are imposed by data availability and do not coincide exactly with the theoretical boundaries between different educational cycles. For example, in Canada primary school lasts for 5 or 6 years depending on the province but since the only data we have to approximate primary attainment refers to those who have completed 4 or less courses, we will assign a duration of 4 years to *L1* for purposes of calculating average attainment. Something similar happens in the case of the USA.

Table 2: Attainment measures: started (*s*) vs. completed (*c*)

	L1	*L2.1*	*L2.2*	*L2.2ac*	*L2.2voc*	*L3.1*	*L3.2*
Australia	s	s		s	c	c	c
Austria	s	s (a)		c	c	c	c
Belgium	s	s	c			c	c
Canada	s	s	s			s	c
Denmark	s	c		c	c	c	c
Finland	s	c	c			c	c
France	s	s		s	s	s	s
Germany	s	c		c	c	c	c
Greece	s	c	c			c (b)	c
Ireland (c)	s	c	c			c	c
Italy	s	c	c				c
Japan (d)	s	c	c			c	c
Netherlands (e)	s	c	c			c	c
New Zealand	s	c	c			c	c
Norway	s	s (a)	c			c	c
Portugal (f)	s	c	c			c	c
Spain	s	c	c	c	c	c	c
Sweden	s	s	s			s	s
Switzerland (g)	s	c	c			c	c
UK	s	c	c			c	c
USA	s	s	s			s	s
Mexico[h]	s	s	s	s	s	s	s

Notes:
(a) original data mostly refer to *L1+L2.1* rather than to *L2.1* per se.
(b) includes those over 25 currently enrolled in a university, TEI or intermediate school.
(c) Data refer mostly to completed degrees for 1991 onward; in earlier years, they refer to the highest level started but not necessarily completed. See the detailed country notes in the Appendix.
(d) Includes those over 25 who are currently enrolled in each level (insignificant except for university).
(e) Refers to LFS data for 2001 onward. For earlier years, we are not sure.
(f) For 1970 onward, for 1960 we are not quite sure except for L1.
(g) For LFS data for 2000 onward. For earlier years we are not sure but it seems likely the criterion has not changed, as there are no apparent breaks in the series.
(h) Partial data on attainment with a completion criterion are available. See the country note for Mexico.

Since these durations are applied to all countries without any correction, our estimates of average schooling will be biased upward in those cases where attainment shares are not based on completed studies.[3] For the same reason, our figures may not always be strictly comparable with Barro and Lee's (1996 or 2010) average schooling series, which in principle apply a uniform completion criterion across countries. On the other hand, we are not sure of the quality of the supposedly homogenized attainment data used by these authors. Since the underlying information is presumably the same in

[3] For an illustration, see the country note on Mexico in de la Fuente and Doménech (2014a).

both cases, it seems likely that Barro and Lee's data –and that constructed by other authors—will also contain some noise arising from cross-country differences in how attainment is measured.

Table 3: Cumulative years of schooling by educational level

	L1	*L2.1*	*L2.2*	*L3.1*	*L3.2*
Australia	6	10	12	14	16
Austria	4	8	12	15	17
Belgium	6	9	12	15	16
Canada	4	8	12	14	16
Denmark	6	9	12	14	17
Finland	6	9	12	15	17
France	5	9	12	14	17
Germany	4	10	12	14	16
Greece	6	9	12	14	16
Ireland	6	9	12	14	16
Italy	5	8	13	-	18
Japan	6	9	12	14	16
Netherlands	6	10	12	15	17
New Zealand	7	10	12	14	16
Norway	7	10	13	15	18
Portugal	6	9	12	15	17
Spain	6	10	12	14	17
Sweden	7	10	13	15	17
Switzerland	8	9	12	14	17
UK	5	10	12	15	17
USA	4	8	12	14	16
Mode	*6*	*9*	*12*	*14*	*16*
Mexico	6	9	12	15	17

- *Note*: in the case of Spain, we take into account changes in the durations of school cycles over time. See the relevant section of the Country Appendix (D&D, 2014).

2.2. Backward and forward projections

As noted above, in a number of countries we rely on backward projections of census data disaggregated by age group in order to estimate attainment shares in the early part of the sample period. The procedure we use is essentially the one developed by Cohen and Soto (2007), as refined by Barro and Lee (2010) in order to (partially) allow for differences in survival rates across population subgroups with different levels of educational attainment.

The basic idea is extremely simple. Let h^a_{jt} denote the share of the population of age group *a* that has attained educational level *j* at time *t*. If we assume that individual school attainment does not change over time once agents reach the age of 25 (which is probably a rather good approximation), that there are no migration flows (or that migrants have the same educational level as the rest of the population) and that survival probabilities are independent of educational attainment, then the mean educational level of a given 25+ cohort remains constant over time. Under these assumptions, in particular, the attainment shares of a given cohort (say cohort *a* at time *t*) can be simply moved back over time to *t-5* (at which time it constituted age group *a-1*) so that we can estimate h^{a-1}_{jt-5} by

(1) $\hat{h}^{a-1}_{jt-5} = h^{a}_{jt}$

The most problematic of these assumptions is likely to be that survival rates are independent of educational attainment. According to Barro and Lee (2010), this assumption holds rather well in the data for the population below 65, but not so for those over this age. Following these authors, we will modify equation (1) for the 65+ population at time *t-5* to allow survival rates to depend partially on education. For this age group, we will use

(2) $\hat{h}^{a-1}_{jt-5} = \dfrac{h^{a}_{jt}}{1-\hat{\rho}_j}$

where $1-\hat{\rho}_j$ is an estimate of the relative survival rate over five years of the population 65+ with schooling *j*. In practice, *j* ranges over only two categories: *H* for highly educated people (with some secondary attainment or better) and *L* for people with a low educational level (no schooling or primary education) and is constant over time and across countries. We use Barro and Lee's (2010) estimates of relative survival rates for OECD countries,

$$1-\rho_L = 0.966 \quad \text{and} \quad 1-\rho_H = 1.065$$

When equation (2) is used to construct a backward projection, the estimates of h^{a-1}_{jt-5} are rescaled if necessary so that they add up exactly to 100% (across educational categories, *j*, at each point in time). Finally, attainment shares for the population 25+ are constructed by weighting the estimated attainment shares of the different cohorts by the observed weights of those cohorts in the 25+ population at time *t*-5 (w^{a}_{t-5}):

(3) $\hat{h}^{25+}_{jt-5} = \sum_a w^{a}_{t-5} \hat{h}^{a}_{jt-5}$

Table 4: Backward projection estimates of attainment shares

	years estimated using BP	*using data from*	*age breakdown available*
Australia	1961, 1966 & 1971	1976 census	5-yr groups until 65+, extended
Austria	1961	1971 census	5-year groups until 95+
Belgium	1961	1981 census	25-44, 45-64 and 65+
Denmark	1973	1983 register	5-yr groups until 60-62, extended
Finland	1960 & 1965	1970 register	5-year groups until 85+
France	1960	1968 census	10-year groups until 75+
Greece	1961 & 1971	1981 census	5-year groups until 85+
Ireland	1961	1966 census	5-year groups until 70+
Sweden	1960	1970 census	25-34, 35-44 and 45-59, extended
Spain	1960	1970 census	5-year groups until 70+

Table 4 lists those countries where backward projections have been used to estimate attainment shares in the sixties and seventies. The first column gives the years for which attainment shares have been estimated using this procedure, the second one the year corresponding to the detailed attainment data that have been used to construct the projection, and the third one gives the age breakdown provided in this source. The finer this breakdown is and the smaller the open-ended interval with which it ends, the more reliable the projection will be.[4] On the whole, the most problematic case among those listed in Table 4 is that of Belgium, where the earliest available data comes from 1981 and provides only a rather coarse breakdown by age. Similar but somewhat less severe problems arise in Sweden. Australia and Denmark, where the residual older category starts at 65 years of age or below. To try to mitigate the problems this poses, we have tried to approximate the attainment levels of subsets of the open-ended highest-age group, thereby extending the disaggregated attainment data to older cohorts, by extrapolating on the basis of the data available for younger ones.[5]

Table 5: Forward projection estimates of attainment shares

	Last available census observation	*Projected forward to*	*Using the growth rate of attainment shares according to*
Canada	2001	2005 & 2010	LFS 25+
France	2008	2010	LFS 25+
New Zealand	2006	2010	LFS 25-64

Since the results of the 2011 round of censuses are not yet available in some countries, in a few cases we have had to project forward to 2010 the last available census observation using data from some other source, typically the Labor Force Survey (LFS). When census and LFS data are reasonably similar in the most recent year for which both are available, we have used the LFS data directly to complete the series. When the two sources display significant differences, however, we have preferred to project forward the last available census observation using the growth rates of attainment shares over the period of interest according to the alternative source that is available for recent years (and rescaling such shares as needed so they add up to 100% in each given year). Table 5 lists the cases when this method has been used. It shows the last available census observation, the reference attainment series whose growth rates are used to project the census results forward, and the years for which such projections are made.

2.3. Estimating primary attainment in some countries

A number of countries do not generally separate primary education from lower secondary schooling and report a single attainment level that comprises all basic or mandatory courses. To preserve the homogeneity of our attainment categories, we have estimated the breakdown of compulsory schooling into L1 and L2.1. For some countries we have managed to find enough information to make what should be a reasonable guess, generally by combining information on L1 from a single census

[4] The procedure implicitly assumes a common survival probability and a common distribution of attainment within each age group. As the age segments get larger and larger, these assumptions become more and more problematic and may induce increasingly larger biases in our estimates.

[5] See for instance the country notes for Australia. While the margin of error of this procedure is considerable, it is likely to reduce the overall error by not forcing us to apply a uniform survival probability to a very heterogeneous group that contains people of very different ages -- which, in turn, are likely to present considerable differences in average attainment.

with data on the age distribution of the population. For others, we have used data from close neighbors. In particular, we have used information for Germany and Norway to estimate the breakdown in Austria and Denmark, respectively.[6] The procedure used in each case is summarized in Table 6 and described in detail in the country appendix (D&D, 2014).

Table 6: Separating *L1* from *L2.1* in some countries

	Estimation procedure
Austria	Data available for 1995 + use Germany's *L1/(L1+L2.1)* ratio as a reference
Canada	Estimated using data disaggregated by age group for 2001
Denmark	Data available for 1991 onward + use Norway as a reference
Finland	Data available for 1960 and 2008 from Unesco, DYB and EAG
Germany (West)	Data available for 1970, 1985 and 1996
Japan	Data available for 1960 + link to weight of surviving older cohorts in 25+ population
Norway	Data available for 1995 (disaggregated by age group) and 2009
Switzerland	Estimated by Swiss Statistical Office until 1999 + assume constant ratio thereafter

- *Note:* For further details, see the detailed country notes in D&D (2014).

2.4. Treatment of the "unknown attainment category"

In many countries the available data on the educational breakdown of the population contains an "unknown" or "unstated" category. In most cases, this group is rather small and we have simply ignored it, i.e. computed attainment shares as a fraction of the population whose attainment is known, which is equivalent to imputing the unknown group to the rest of the available categories in proportion to their respective size. In the cases of Australia and New Zealand, however, the weight of the unknown category is quite high (reaching up to 25% and 15% of the total adult population). Since this makes our results quite sensitive to how we allocate this group, we have dealt with the problem more carefully than in other cases. In particular, we have assumed that the probability that a person will fail to report his attainment level decreases with education. The details are discussed in the country notes for Australia and New Zealand.

2.5. Data availability

Data availability varies widely across countries. Table 7 shows the fraction of the reported data points that are taken from "direct observations" and the dates of the earliest and latest such observations available for secondary and higher attainment levels. The number of possible observations is typically 22 for each level of schooling (two sublevels times eleven quinquennial observations) but it may be smaller since some sublevels do not exist in certain countries.[7] For those countries where primary and lower secondary education are typically reported together (identified with an asterisk), the two categories included in secondary attainment for purposes of Table 7 are *L1+L2.1* and *L2.2*.

[6] See the country notes in Section 4 below for further details.

[7] In the case of Italy, there seem to be no short higher education courses, so the number of possible observations at the university level drops to eleven.

In addition to data from national censuses, labor force surveys and educational registers, we count as direct observations backward projections constructed using census data on educational attainment broken down by age group and the age structure of the population and various "reasonable guesses" that incorporate some information from census or survey data. As can be seen in the table, for most of the countries in the sample we have enough primary information to reconstruct reasonable attainment series covering the whole sample period. The more problematic cases are highlighted using bold characters. For Denmark and West Germany (in the case of secondary education) the earliest available direct observation refers to 1970 or later. In these two cases, we have projected attainment rates backward to 1960 using the (rather tenuous) relevant information we could find, but we are unsure of the reliability of our estimates. Belgium is also a problematic case because even though we can construct a backward projection for 1961 using data from the 1981 census, the period over which we are extrapolating is long and the available age breakdown of the population is rather coarse.

Table 7: Summary measures of data availability

	secondary attainment			*university attainment*		
	direct/tot. observ.	*first observ.*	*last observ.*	*direct/tot. obs.*	*first observ.*	*last observ.*
Australia	15/22	1961	**2006**	16/22	1961	**2006**
*Austria**	14/22	1961	2010	14/22	1961	2010
Belgium	12/22	1961	2010	14/22	1961	2010
*Canada**	20/22	1961	2010	20/22	1961	2010
Denmark*	14/22	**1973**	2010	14/22	**1973**	2010
*Finland**	22/22	1960	2010	22/22	1960	2010
France	16/22	1960	2010	11/22	1960	2010
Greece	12/22	1961	2010	12/22	1961	2010
*W. Germany**	8/14	**1970**	1991	13/14	1961	1991
United Germany	9/10	1991	2010	10/10	1991	2010
Ireland	10/22	1961	2006	9/22	1961	2006
Italy	14/22	1961	2010	7/11	1961	2010
*Japan**	12/22	1960	2010	12/22	1960	2010
Netherlands	14/22	1960	2010	14/22	1960	2010
N. Zealand	14/22	**1966**	2008	14/22	**1966**	2008
*Norway**	18/22	1960	2010	18/22	1960	2010
Portugal	11/22	1960	2011	11/22	1960	2011
Spain	12/22	1960	2011	12/22	1960	2011
Sweden	16/22	1960	2010	16/22	1960	2010
*Switzerland**	13/22	1960	2010	13/22	1960	2010
UK	12/22	1961	2010	10/22	1961	2010
USA	22/22	1960	2010	22/22	1960	2010
Mexico	12/22	1960	2010	12/22	1960	2010

- (*) Countries where primary and lower secondary attainment are generally not reported separately.

2.6. Data tables

Table 8 contains our estimates of average years of schooling. Detailed results on attainment levels are available at https://ideas.repec.org/p/fda/fdaddt/2014-14.html. We report an illiteracy series only for four countries (Spain, Italy, Greece and Portugal). For the remaining countries, illiteracy rates are extremely low and are therefore ignored.

Table 8: Average years of schooling

	1960	*1965*	*1970*	*1975*	*1980*	*1985*	*1990*	*1995*	*2000*	*2005*	*2010*
Australia	10.23	10.33	10.46	10.61	10.89	11.08	11.33	11.61	11.88	12.15	12.47
Austria	9.22	9.40	9.57	9.83	10.11	10.43	10.71	10.94	11.17	11.65	11.93
Belgium	7.28	7.57	7.86	8.11	8.35	8.74	9.17	9.77	10.41	10.85	11.29
Canada	9.88	10.23	10.62	11.11	11.63	11.97	12.29	12.55	12.80	13.04	13.29
Denmark	10.34	10.50	10.65	10.83	11.01	11.15	11.22	11.44	11.70	11.95	12.13
Finland	7.89	8.18	8.53	8.97	9.42	9.89	10.36	10.82	11.25	11.67	12.07
France	6.43	6.67	7.03	7.56	8.09	8.71	9.40	9.97	10.57	11.29	11.89
Germany (West)	9.60	10.04	10.48	10.92	11.35	11.82	12.01				
*Germany**							11.95	12.03	12.05	12.11	12.21
Greece	5.43	5.75	6.06	6.48	6.93	7.38	7.84	8.46	9.12	9.64	10.12
Ireland	7.46	7.60	7.72	8.10	8.54	8.99	9.45	9.97	10.50	11.05	11.59
Italy	4.95	5.21	5.46	5.94	6.48	7.00	7.51	8.15	8.83	9.51	9.99
Japan	8.59	9.02	9.46	9.99	10.52	10.92	11.31	11.61	11.90	12.16	12.43
Netherlands	8.09	8.45	8.81	9.29	9.81	10.32	10.84	11.26	11.63	12.15	12.36
New Zealand	7.75	8.08	8.41	8.73	9.06	9.39	9.86	10.10	10.67	11.15	11.31
Norway	10.96	11.22	11.48	11.69	11.90	12.05	12.22	12.43	12.68	12.90	13.11
Portugal	3.58	3.94	4.29	4.69	5.09	5.64	6.22	6.73	7.22	7.85	8.50
Spain	4.70	4.84	4.99	5.32	5.66	6.17	6.73	7.41	8.13	8.88	9.64
Sweden	9.04	9.30	9.57	10.05	10.53	11.02	11.65	12.14	12.67	13.08	13.40
Switzerland	10.28	10.53	10.78	10.96	11.13	11.35	11.57	11.81	11.94	12.12	12.35
UK	6.69	7.13	7.58	8.03	8.48	9.08	9.70	10.40	10.86	11.18	11.60
USA	10.56	10.97	11.33	11.76	12.14	12.44	12.66	13.01	13.19	13.30	13.46
Mexico	4.07	4.39	4.71	5.23	5.74	6.33	6.91	7.40	7.88	8.37	8.86

(*) Germany refers to the united country. In this case, the "1990" observations refer to 1991.

3. A comparison of several schooling series

In this section we compare the attainment series described in the previous section (D&D, 2014) with the latest available versions of the C&S, B&L and L&S+ data sets, restricted to our sample of 21 OECD countries (excluding Mexico).[8] We find that there are significant differences across these four sources in terms of both their cross-section and their time series profiles. Another cause for concern is that some series display extremely large changes in attainment levels over periods as short as five years (particularly at the secondary and tertiary levels).

Table 9 shows that the overall correlation (computed over common observations) between different estimates of average years of schooling is reasonably high when the data are measured in levels and considerable lower when we work with growth rates. The high overall correlation across the series in levels, moreover, hides significant discrepancies across them. As an example, Figure 1 compares B&L's (2013) estimates of years of schooling in 2000 with our own (D&D, 2014), after normalizing each series by the corresponding sample average. As can be seen in the figure, the discrepancies between the two sources are very large for a number of countries. B&L provide much more optimistic estimates of relative attainment than we do in the cases of New Zealand (with a difference of 22.4

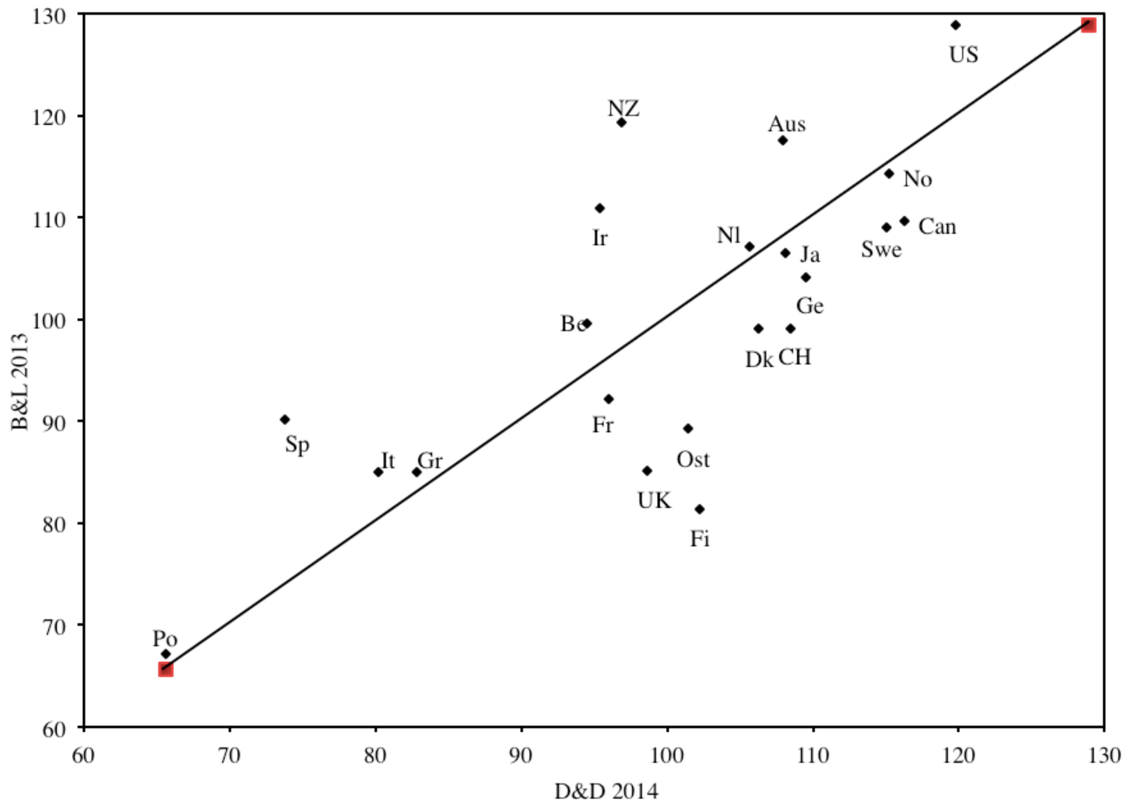
[8] Appendix 1 reviews the construction of these data sets and Appendix 2 extends some of the work in this section and the next one to a broad sample of non-OECD countries.

points between the two estimates in favor of B&L), Spain (+16.3) and Ireland (+15.4), and are much more pessimistic for Finland (-20.8), the UK (-13.6) and Austria (-12.2), to mention only the more extreme cases. These discrepancies substantially change the relative position of some countries within the attainment distribution. New Zealand, for instance, drops from the 2nd position to the 14th as we go from B&L to D&D, while Ireland goes from 5th to 16th and Finland rises from 20th to 11th.

Table 9: Correlation among alternative estimates of average years of schooling over common observations in the OECD21 sample, quinquennial data in levels/growth rates

	C&S	*L&S*	*D&D*
Barro and Lee (B&L 13)	0.819/0.336	0.732/0.569	0.801/0.311
Cohen and Soto (2007)		0.839/0.702	0.929/0.563
Lutz, Samir et al ()			0.905/0.808

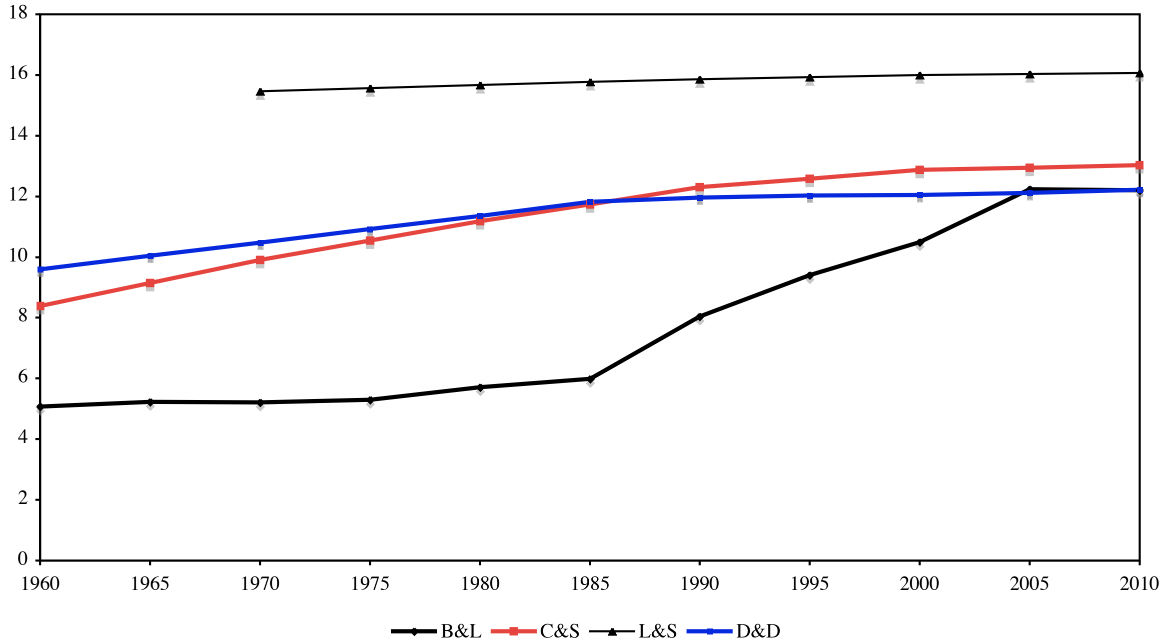
Figure 1: Average years of schooling in 2000: B&L (2013) vs D&D (2014)
Normalized years of schooling in 2000, B&L vs. D&D



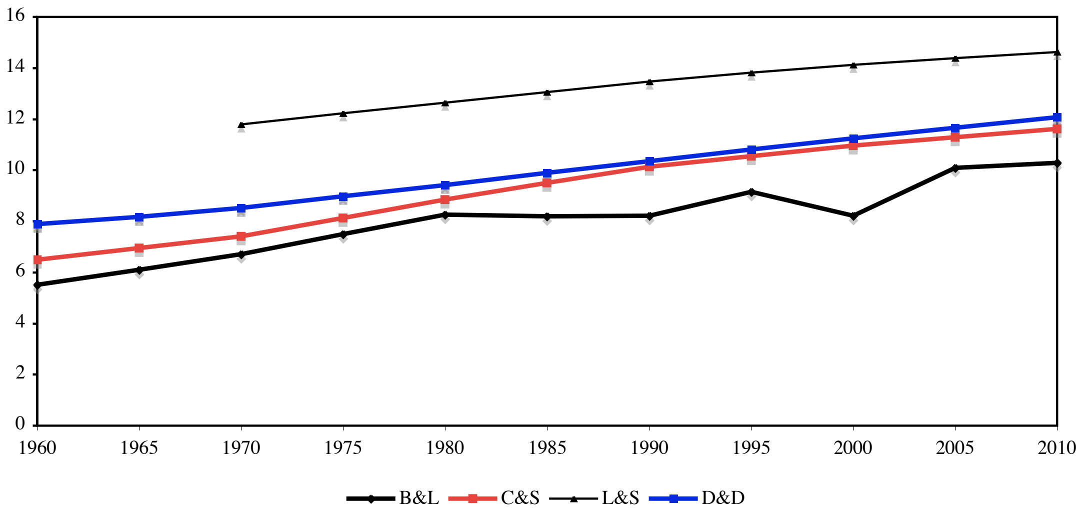
- *Legend*: *Pr* = Portugal; *Sp* = Spain; *It* = Italy; *Gr* = Greece; *Be* = Belgium; *Ir* = Ireland; *Fr* = France; *NZ* = New Zealand; *UK* = United Kingdom; *Ost* = Austria; *Fi* = Finland; *Dk* = Denmark; *Nl* = Netherlands; *Aus* = Australia; *CH* = Switzerland; *Ja* = Japan; *Ge* = Germany; *Swe* = Sweden; *No* = Norway; *Can* = Canada; *US* = United States.

Figure 2: Average years of schooling according to different sources

a. Germany



b. Finland



Looking in greater detail at the different attainment series for a given country, the differences can also be quite significant. As an illustration, Figure 2 compares the four series of average years of schooling in the cases of Germany and Finland. For Germany, the C&S and D&D series roughly agree on their average levels and on the existence of a soft upward trend, while L&S+ paint a much flatter time profile at a significantly higher attainment level. Finally, B&L's series displays a completely different profile for the same country: after starting from a much lower level, these authors' estimate of German attainment rises rapidly during the second half of the sample period and converges to D&D's series in its final decade.[9] For Finland, the pattern is similar. C&S and D&D roughly agree, L&S+ is significantly more optimistic and B&L's series displays an implausible time profile, with surprising fluctuations in average years of schooling during the second half of the sample period.

To compare the cross-section profiles of the different series of years of schooling in a somewhat more systematic manner, we begin by normalizing each of them by its contemporaneous sample mean and by calculating the average of these normalized figures during the period in which all four series overlap (1970-2010), which is shown in Table 10. Working with this summary indicator of average relative schooling over the entire sample period, Figure 3 shows the differences across sources, taking as a reference Barro and Lee's (2013) estimates. Figure 4 is constructed in the same way but working now with the observed variation in normalized schooling between 1970 and 2010.

Table 10: Normalized years of schooling average value over the period 1970-2010

	B&L13	*C&S*	*L&S*	*D&D14*
USA	135.1	119.6	112.6	124.0
New Zealand	130.0	107.9	111.0	96.6
Australia	126.3	119.3	100.5	112.2
Norway	114.8	110.4	127.7	121.1
Canada	113.5	115.1	122.3	119.5
Ireland	112.0	88.2	90.5	93.3
Netherlands	108.6	101.5	100.6	105.0
Sweden	108.4	105.5	99.8	113.3
Switzerland	106.5	122.4	118.2	114.0
Japan	106.1	110.4	127.3	109.5
Denmark	104.4	107.5	124.8	111.9
Belgium	98.3	91.7	89.6	91.9
Finland	92.9	97.4	116.7	101.2
UK	88.4	111.9	84.9	94.3
Germany	88.0	118.6	139.0	115.0
Austria	87.5	99.8	118.9	105.3
Greece	85.5	78.0	69.6	78.0
France	80.8	89.1	77.9	91.4
Italy	78.9	78.9	66.8	74.3
Spain	71.8	74.3	52.1	67.8
Portugal	62.2	52.3	49.2	60.5
Average	*100*	*100*	*100*	*100*

- *Note:* Average of quinquennial observations. For C&S we interpolate between decennial observations to complete the quinquennial series prior to calculating the average.

As in the case of Figure 1, some of the disagreements across sources are very important. For instance, Barro and Lee place Germany in the lower half of the distribution of attainment, with an average relative schooling index of 88 over the period 1970-2010, while all other sources place it in the upper tail of the distribution, with an index of around 120 or higher. The opposite happens in the cases of New Zealand and Ireland, where B&L's figures are much more optimistic than the rest.

[9] Our data for this country refer to West Germany until 1985 and to the united country thereafter. The same seems to be true for B&L (see their Appendix notes on Germany). On the other hand, C&S always refer to the entire country (see footnote 6 in p. 56) and the same must be true for L&S+ by construction since they work with the 2000 census. Our estimates suggest that attainment differences between East and West Germany at the time of unification were very small, so differences across data sets on the treatment of Germany should not make a big difference.

Table 9 suggests that the D&D, C&S and L&S+ series are somewhat closer to each other than to the B&L data set, which stands apart, displaying generally lower correlations with the other three sources than these have among themselves. Figures 3 and 4 tend to confirm this conclusion: there is broad agreement across the other three sources regarding at least the sign of the difference with the B&L series and quite often its magnitude, both in levels and in long differences (between 1970 and 2010). There are many exceptions to this pattern, however. For instance, L&S+ are considerably more optimistic about Japan, Denmark and Finland than the other three sources, which are relatively close to each other for these countries.

Figure 3: Normalized years of schooling, differences with B&L (2013) based on average normalized schooling over the period 1970-2010

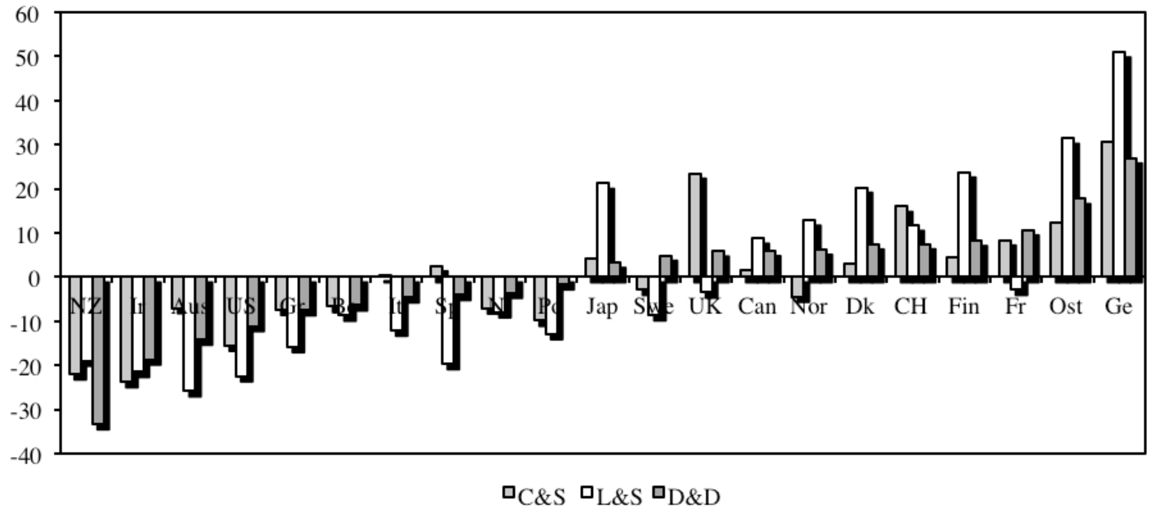
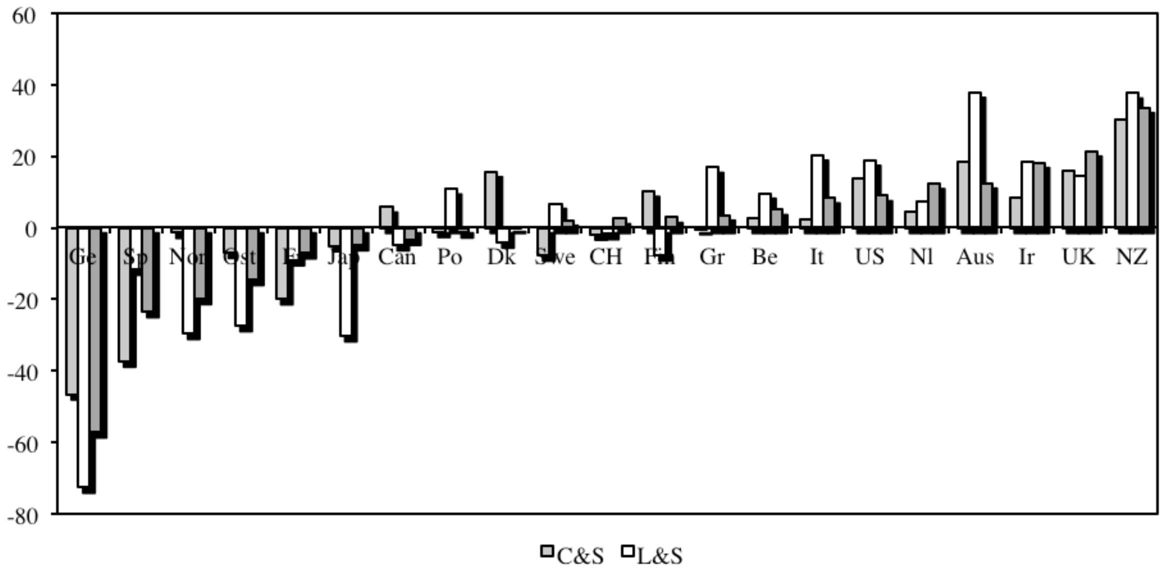


Figure 4: Variation in normalized years of schooling between 1970 and 2010, differences with B&L (2013)



To construct a rough measure of the degree of agreement across series in levels, we will say that two sources agree for a given country if the maximum difference between them in terms of average normalized years of schooling is less than 5% of their average value. We find that there is no country for which all four sources agree. The highest degree of agreement (10 countries out of 21) is attained by comparing our data with the C&S series, and the lowest (2 countries) corresponds to the combination of B&L with L&S+. Table 11 shows the degree of pairwise agreement of the different series, measured by the percentage of cases in which the stated agreement criterion is satisfied.

Table 11: Degree of agreement between different pairs of normalized schooling series in levels

	C&S	*L&S*	*D&D*
Barro and Lee (B&L 13)	38%	10%	19%
Cohen and Soto (C&S)		24%	48%
Lutz, Samir et al (L&S)			24%

Figure 5: Fitted distribution of the growth rate of years of schooling, different data sets OECD21 sample

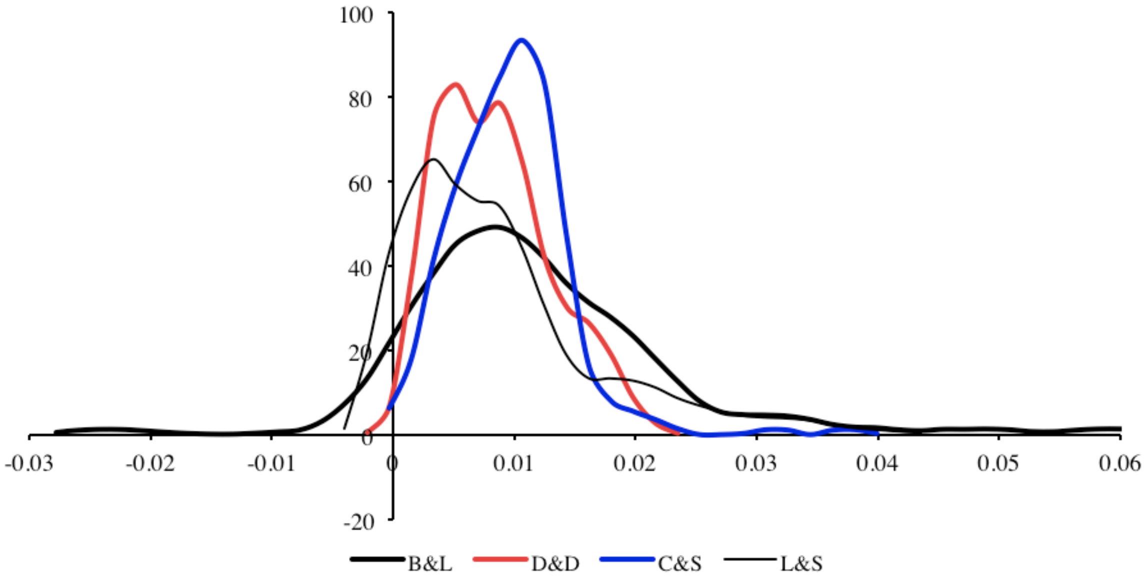
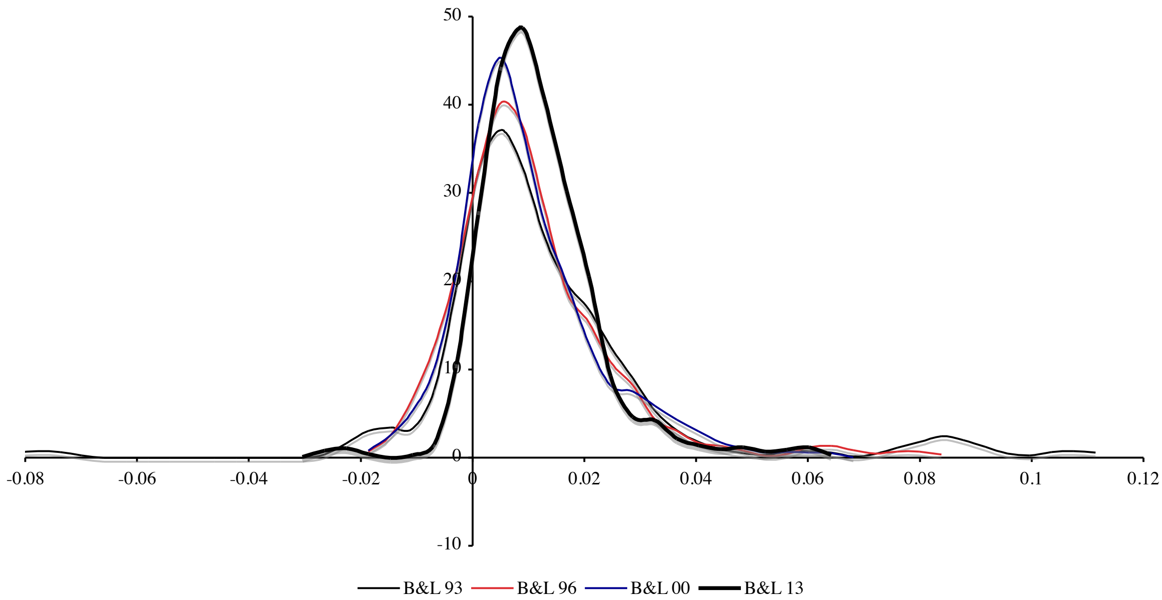


Table 12: Range of different estimates of the growth rates of years of schooling

	D&D14	*C&S*	*L&S*	*B&L*
max	2.05%	3.73%	4.06%	5.92%
min	0.04%	0.08%	-0.06%	-2.52%
% of negative observations	0.00%	0.00%	1.19%	6.19%
% of observations above 2%	0.48%	1.90%	10.71%	15.24%

When we turn to the time profiles of the different data sets, C&S, D&D and L&S+ display a considerably smoother pattern than B&L. This is clearly illustrated in Figure 5, where we have plotted the fitted distribution of the annualized quinquennial growth rate of average years of schooling (using in each case all the available observations for the same OECD sample). The differences in the range of this variable across data sets are enormous: while our annual growth rates range between 0.04% and 2.05%, Barro and Lee's go from -2.52% to 5.92%; moreover, 6.2% of the observations in this last data set are negative, and 15.2% of them exceed 2%. As shown in Table 12, C&S and L&S+ occupy intermediate positions in terms of their range. The L&S+ series are very smooth by construction, but this is consistent with a fairly thick upper tail that comes largely from high growth rates of attainment in the Mediterranean countries during the early part of the period. On the other hand, there are several countries where L&S+ paint a very flat attainment profile that stands in contrast with other sources. The countries were this pattern is most clearly apparent are Japan and Norway.

Figure 6: Fitted distribution of the growth rate of years of schooling, different versions of the Barro and Lee data set



As shown in Figure 6, an implausibly broad range of values (for the data in growth rates) is a common feature of all versions of the Barro and Lee data set. We believe that this anomaly, which seems to arise from these authors' reliance on UNESCO data, cannot be corrected by any improvements in the fill-in procedure alone.

The volatility of the B&L series is a warning signal that it contains sharp breaks and implausible changes in attainment levels over very short periods. While this problem has become less severe with successive revisions of the data set, it remains even in its 2013 version. As an illustration, Figures 7 and 8 show the evolution of Barro and Lee's (2013) upper secondary and university attainment rates for the population 25+ in a number of countries that display rather implausible time profiles. In some cases, attainment shares fall over time and in others they rise very sharply, displaying increases of over 10 or even 15 points over a 5-year interval that are virtually impossible.

Figure 7: Evolution of university attainment levels in selected countries according to B&L (2013), % of the 25+ population

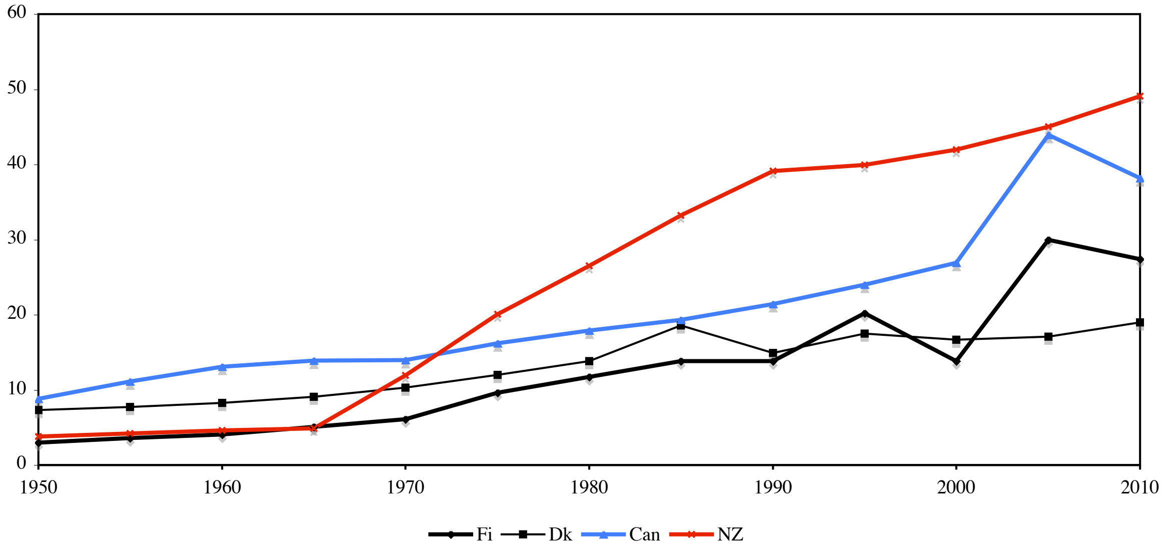
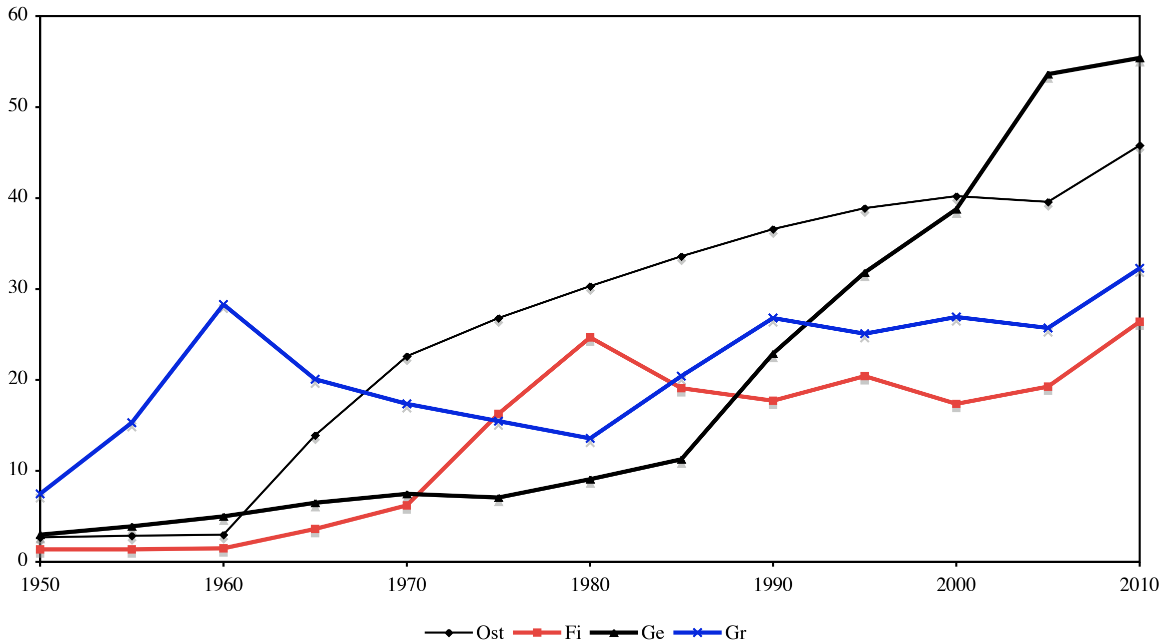


Figure 8: Evolution of upper secondary attainment levels in selected countries according to B&L (2013), % of the 25+ population



4. Measuring data quality: SUR estimates of reliability ratios

In this section we will construct an indicator of the quality of the different schooling series using D&D's (2006) extension of the procedure suggested by Krueger and Lindhal (K&L, 2001). As K&L note, the information content of a noisy proxy for a variable of interest can be measured by its *reliability ratio,* defined as the ratio of signal to signal plus measurement noise in the data. When several noisy measures of the same magnitude are available, estimates of their respective reliability ratios can be obtained by regressing these variables on each other. Under certain assumptions, the coefficients obtained in this manner can be used to approximate the bias induced by measurement error (which will be a decreasing function of the reliability ratio) and to obtain consistent estimates of the parameters of interest in growth regressions.

Let H be the true stock of human capital and let $P_1 = H + \varepsilon_1$ be a noisy proxy for this variable, where the measurement error term ε_1 is an iid disturbance with zero mean and uncorrelated with H. The reliability ratio of this series (r_1) is defined as

$$(4)\ r_1 \equiv \frac{var\ H}{var\ P_1} = \frac{var\ H}{var\ H + var\ \varepsilon_1}$$

Assume now that in addition to P_1 we have a second imperfect measure of human capital, $P_2 = H + \varepsilon_2$, where ε_2 is also iid noise. Then, the covariance between P_1 and P_2 can be used to obtain an estimate of the variance of H whenever the measurement error terms ε_1 and ε_2 are uncorrelated. Under this assumption, r_1 can be estimated by

$$(5)\ \hat{r}_1 = \frac{cov\ (P_1, P_2)}{var\ P_1}$$

which happens to be the formula for the OLS estimator of the slope coefficient of a regression of P_2 on P_1. Hence, to estimate the reliability of P_1 we run a regression of the form $P_2 = c + r_1 P_1$.[10] It must be noted, however, that if the measurement errors of the two series are positively correlated ($E\varepsilon_1\varepsilon_2 > 0$) as may be expected in many cases, $\hat{r}_1$ will overestimate the reliability ratio and hence understate the extent of the attenuation bias induced by measurement error.

D&D (2006) build on this approach by exploiting the availability of a number of alternative human capital series to construct a minimum-variance estimator of the reliability ratio. The desired estimator of the reliability ratio of data set k, known as the *SUR reliability ratio*, can be obtained by estimating as a restricted SUR with a common slope a set of equations in which series k is used to try to explain other series, j, i.e. a system of the form

$$(6)\ P_j = c_{jk} + r_k P_k + u_{jk} \quad \text{for } j = 1..., K \text{ and } j \neq k$$

The reliability ratio of Barro and Lee's (2013) data set, for instance, can be estimated by using this series of average years of schooling as the explanatory variable in a set of regressions where the dependent variables are the average years of schooling according to other sources.

The exercise we have just described is repeated for several transformations of average years of schooling. In particular, we estimate reliability ratios for years of schooling measured in levels (H_{it}) and in logs (h_{it}), in first differences (ΔH_{it}) and in annual growth rates (Δh_{it}), and for some of these variables measured in deviations from their respective country means ($H_{it} - H_i$ and $h_{it} - h_i$). Notice that the last two expressions in this list correspond to the "within" transformations often used to remove fixed effects. We also estimate all the reliability ratios twice, once with the raw data and a second time after removing period means from the different schooling series.

Table 13: SUR estimates of reliability ratios, OECD 21 sample

a. Raw data

	Hit	*hit*	*ΔHit*	*Δhit*	*Hit-Hi*	*hit-hi*	*average*
B&L 12	0.704	0.649	0.038	0.096	0.704	0.617	*0.468*
	[0.037]	[0.033]	[0.025]	[0.030]	[0.026]	[0.024]	
C&S	0.915	0.911	0.416	0.610	**0.984**	**1.014**	*0.808*
	[0.027]	[0.025]	[0.077]	[0.063]	[0.022]	[0.022]	
L&S	0.608	0.658	0.323	0.482	0.877	0.803	*0.620*
	[0.022]	[0.018]	[0.032]	[0.022]	[0.022]	[0.022]	
D&D 14	**1.013**	**1.079**	**0.490**	**0.942**	0.981	1.012	***0.919***
	[0.022]	[0.020]	[0.055]	[0.058]	[0.017]	[0.018]	
average	*0.810*	*0.824*	*0.323*	*0.525*	*0.886*	*0.856*	*0.704*
Obs.	169	169	148	148	169	169	

b. Data in deviations from period means

	Hit	*hit*	*ΔHit*	*Δhit*	*Hit-Hi*	*hit-hi*	*average*
B&L 12	0.628	0.604	0.025	0.084	0.084	0.226	*0.275*
	[0.044]	[0.040]	[0.023]	[0.029]	[0.026]	[0.030]	
C&S	0.886	0.878	**0.599**	0.704	**0.813**	**1.065**	***0.824***
	[0.031]	[0.027]	[0.094]	[0.063]	[0.107]	[0.054]	
L&S	0.534	0.606	0.288	0.431	0.276	0.444	*0.430*
	[0.020]	[0.017]	[0.031]	[0.022]	[0.024]	[0.021]	
D&D 14	**0.994**	**1.072**	0.462	**0.850**	0.527	0.822	*0.788*
	[0.025]	[0.022]	[0.041]	[0.051]	[0.032]	[0.031]	
average	0.760	0.790	0.344	0.517	0.425	0.639	*0.579*
Obs.	169	169	148	148	169	169	

Notes:
- Standard errors in brackets below each estimate.
- Data are reported at 5-year intervals except by Cohen and Soto who do it at 10-year intervals. We use linear interpolation (with the data in levels) to complete these series prior to all calculations.
- Panel *a* corresponds to the variables as originally measured. The estimates shown in panel *b* are obtained after removing the corresponding period means. This is done by introducing period dummies in equation (4).
- All equations are estimated using data for 1970-2010, which is the period over which the four series overlap.

The results are shown in the two panels of Table 13.[11] The last row of each table shows the average value of the reliability ratio for each type of data transformation (taken across data sets), and the last column displays the average reliability ratio of each data set (taken across data transformations). It

[10] Intuitively, regressing P_2 on P_1 gives us an idea of how well P_1 explains the true variable H because measurement error in the dependent variable (P_2 in this case) will be absorbed by the disturbance without generating a bias. Hence, it is almost as if we were regressing the true variable on P_1.

[11] In Appendix 2 we undertake the same exercise for non-OECD countries. We find that estimated reliability ratios are somewhat higher in the non-OECD than in the OECD sample. This may be partly the spurious result of a higher correlation of errors across data sets but may also have something to do with the greater variation of schooling in this sample.

should be noted that, while reliability ratios must lie between zero and one, some of the estimates reported in Table 13 fall outside these bounds, suggesting that a positive correlation in error terms across data sets may be inflating our estimates of reliability ratios, especially when the data are used in levels or logs.

Our mean estimate of the reliability ratio in the OECD sample is 0.704 for the raw data and 0.579 after removing period fixed effects. Since these figures are significantly higher than those obtained in our (2006) paper using an earlier generation of schooling data sets (0.386 and 0.335), one encouraging conclusion is that recent studies seem to have succeeded in improving the quality of the data. Even so, a considerable amount of measurement error seems to remain in the data. As is well known, this can generate a substantial downward bias in estimates of the coefficient of schooling in growth equations and production functions, particularly when the data are used in differences or in growth rates. The problem is particularly acute in the case of the B&L data set, which has by far the lowest average reliability ratio both with the raw data and after removing period means, followed by the L&S+ series. Cohen and Soto's and our own series appear to have the highest information content but even in this case the likely bias can be quite large in some specifications.

5. Conclusion

In a series of highly influential papers, Barro and Lee have constructed estimates of educational attainment in a broad sample of countries starting from Unesco compilations of census results and using an increasingly sophisticated perpetual inventory procedure to fill in gaps in these data. In a paper written a few years ago (D&D 2006), we pointed out that the versions of B&L's series that were available at the time tended to be rather volatile, presumably as a result of changes in classification criteria, and that this translated into relatively low reliability ratios that alerted of a potentially serious bias toward zero in the estimation of the coefficient of human capital in production functions and growth regressions, particularly when the data were used in differences. In the same paper we constructed an alternative schooling series for an OECD sample that tried to increase the signal-to-noise ratio in the data by introducing previously unused sources to reconstruct plausible time profiles for attainment in each country. A roughly contemporaneous and similarly motivated study by Cohen and Soto (2007) led to similar conclusions and produced a third attainment series that was generally closer to our own than to Barro and Lee's figures.

This paper revisits the issue after the completion of a new round of studies that have updated and improved the available attainment series. After updating our series, we compare our results with those of other recent studies and estimate reliability ratios for each series using several data transformations that correspond to standard estimation techniques. On the positive side, estimated reliability ratios for the more recent data sets are higher than those for earlier series, suggesting that successive data revisions have succeeded in increasing signal to noise ratios. On the other hand, our results also suggest that the potential attenuation bias continues to be rather high, particularly in differenced specifications. Somewhat surprisingly, even the latest careful revision of B&L's data set has not removed some of its more implausible features. Our estimates of reliability ratios also suggest that this source has the lowest signal-to-noise ratio among the four data sets we compare. We believe these problems have their origin in Barro and Lee's reliance on data from Unesco compilations that are likely to contain a considerable amount of noise. If we are right, the problem cannot be corrected by any improvements in the procedure used to fill-in gaps in the Unesco data, which seems to have been the main focus of B&L's recent work on the issue.

Appendix 1: The construction of some schooling data sets

Barro and Lee (B&L, 1993) construct attainment series for a large number of countries covering the period 1960-85 by combining data on enrollment rates with census information, both taken primarily from UNESCO compilations. To estimate attainment levels in years for which census data are not available, they use a short-cut perpetual inventory procedure that can be used to estimate changes from nearby (either forward or backward) benchmark observations using data on enrollments and the age distribution of the population. This data set, which has been extensively used in the empirical growth literature, has been revised, updated and extended in a series of papers by the same authors (B&L, 1996, 2001 and 2013). It has also been criticized by other researchers, who have constructed alternative schooling series that attempt to improve the signal-to-noise ratio in the data.

Barro and Lee's work has focused on expanding data coverage, improving the procedure used to fill in gaps in the census data and providing an increasingly detailed breakdown of the information by sex and age group while continuing to rely on Unesco compilations as their main source of raw attainment and enrollment data. Other authors, however, have relied increasingly on other sources in an attempt to eliminate anomalies in the data arising in all likelihood from changes in classification criteria that are hard to detect in the supposedly homogenized Unesco data. After documenting the problems found in the most widely used schooling series, de la Fuente and Doménech (D&D 2002, 2006, 2012 and 2014) construct new attainment data for a sample of 21 or 22 OECD countries. Mistrustful of the homogeneity of UNESCO's compilations, these authors rely primarily on OECD and national sources and focus on constructing plausible time profiles for attainment in each country. Cohen and Soto (2002, 2007) refine B&L's fill-in procedure by making full use of the available census data on attainment by age group in order to allow survival rates to differ across age groups (see below). They also incorporate new survey data from the OECD's in house database and attempt to mitigate the problem caused by changes in classification criteria by disregarding census observations that may be affected by such changes and relying instead on backward projections based on more recent census information.[12] This approach is taken to the extreme by Lutz et al (2007), who construct schooling series going back to 1970 by projecting backward data taken exclusively from a single census, that of 2000. Samir et al (2010) revise these series and extend the Lutz et al (2007) data set forward using the same basic data for around 2000 and a similar methodology to project attainment forward. As noted, we will work with an unpublished current working version of these series to which we will refer as the L&S+ data set (for Lutz, Samir et al).

In this section we will take a closer look at the content of these four series and at the methodology used to construct them. All of these data sets provide information on the fraction of the adult population (understood as those of age 15 or 25 and over) that has attained each of several possible educational levels and on the average years of schooling of such population, in some cases disaggregated by sex and/or by age group.

[12] The authors are not very explicit on how classification changes are detected. They seem to rely on changes in the duration of the different school cycles as reported in Unesco's Yearbook (see p. 53).

The seven levels of schooling considered by B&L and C&S are: no schooling and complete and incomplete primary, secondary and higher education.[13] D&D consider two cycles (lower and upper) of secondary and higher education and L&S+ distinguish only between no schooling and primary, secondary and higher education. They include persons with incomplete lower secondary training in their primary category and those with incomplete short college careers are counted as having only secondary attainment.

In most cases, average years of schooling are calculated using attainment shares and the theoretical durations of the different school cycles in each country. B&L (1993 and 1996) use constant durations, taken from UNESCO's Statistical Yearbook and in principle applying to 1965.[14] In their more recent work, the same authors (B&L, 2000 and 2013) allow for changes in durations over time and take into account that such changes are incorporated only gradually into the stock of human capital as the affected cohorts enter the adult population. D&D and C&S apply recent theoretical durations to the entire period. D&D (2012 and 2014) take their standard durations from national sources,[15] while C&S (2007) seem to rely on Unesco data (see footnote 1 in p. 53). L&S+ also rely on Unesco data on durations for 2000 or a nearby year but they use a slightly different approach. Instead of using standard durations directly, they rely on these data to estimate (in an admittedly ad-hoc manner) the average years spent in school by persons included in each attainment category.[16]

As noted, Barro and Lee rely primarily on UNESCO and other UN compilations of census/survey data but also take some information from the web pages of Eurostat and several national statistical institutes. On the other hand, they disregard OECD data on educational attainment claiming that they may not be compatible with other sources because they are generally based on (labor force or other) surveys rather than on full censuses as most of the UNESCO data. As a result, they argue, OECD data tends to exclude people of retirement age and thus refers to a different population group than the census data (typically 25-64 in the OECD vs. 15+ or 25+ in most censuses). They also note that these data are based on a different classification scheme that, among other things, lumps together all persons with less than upper secondary attainment (B&L 2001, pp. 558-60). Cohen and Soto (2007) by contrast, rely primarily on OECD data for those countries for which they are available. For most OECD member countries, their estimates are based only on OECD data for the nineties, ignoring a large amount of information available in other sources. L&S+ (2007 and 2010) only use census or

[13] Barro and Lee include in the "incomplete secondary" category those who have started the first cycle of secondary education but not progressed beyond this level, and in the "complete secondary" those who have started but not necessarily completed upper secondary schooling (and have not started post-secondary education). These authors include "short" college-level diplomas in incomplete higher education, together with incomplete longer degrees. In the case of Cohen and Soto, it is not clear whether they follow the same convention or define their complete and incomplete secondary and higher education categories with a different criterion.

[14] When no data are available on the separate durations of the two cycles of secondary, Barro and Lee assign half the total duration of secondary to each cycle. Incomplete primary also gets assigned ½ of the duration of complete primary education. For incomplete and complete higher education they use 2 and 4 years in all countries. C&S (20007) assign half of a level's theoretical duration to the incomplete category.

[15] In the case of Spain, we take into account changes in durations as a result of educational reforms.

[16] This sort of correction seems particularly pertinent in the case of L&S because they use rather broad educational attainment categories. As the authors note, a person included in L1 in Mexico could have stayed in school anywhere between 1 day and 9 years minus one day. Since attributing 9 years of schooling to all these people would surely overestimate their attainment, it seems preferable to take an intermediate figure for the

survey data for the year 2000, broken down by age group and taken from censuses (mostly as compiled by UNESCO) or labor force or demographic and health surveys. This has the advantage of ensuring that a consistent attainment classification is applied (retroactively) to all cohorts throughout the sample period, but may bias the results in countries with significant migration flows. Finally, D&D (2012) rely primarily on national sources and make only occasional use of UNESCO data and other compilations.

In both B&L and C&S, there is some ad-hoc filtering of original census data. Cohen and Soto disregard earlier censuses when they suspect there have been changes over time in classification criteria and proceed by projecting backward more recent and presumably more homogeneous census data. As noted, Barro and Lee disregard OECD data and in their 2013 paper they adjust some census observations that seem to be "off trend" (in the cases of Canada 1975, France 1955 and 1990, Italy 1980 and Korea 1990, see B&L 2012).

Table A.1: Key features of several schooling data sets

	B&L (1993)	*B&L (1996)*	*B&L (2000)*	*C&S (2007)*	*B&L (2012)*	***L&S+* (2007/10)**	*D&D (2014)*
period	1960-85	1960-90	1960-2000	1960-2010	1950-2010	1970-2000/10	1960-2010
frequency	5 yrs.	5 yrs.	5 yrs.	10 yrs.	5 yrs.	5 yrs.	5 yrs.
population group	25+	15+, 25+	15+, 25+	15+, 25+	15+, 25+	15+, 25+	25+
disaggregation by	sex	sex	sex	-	sex&age	sex&age	-
# of countries							
with complete data	106	105	109	95	146	120	22
with incomplete data	23	21	33		45		
% of direct observations	40.2%	35.1%	27.7%	24.4%	25.0%	14.3%	58.7%
basic fill-in procedure	Perpetual inventory	Perpetual inventory	Perpetual inventory	Projections with detailed data by age group	Projections with detailed data by age group	Projections with detailed data by age group	Linear interpolation+ backward projections w/ detailed data by age group
enrollment variable used in fill-in procedure	gross enroll-ment ratio	net enroll-ment ratio	gross enroll-ment ratio adjusted for repeaters	estimated net intake ratios	gross enrollment ratio adjusted for repeaters	none	none
survival probs. vary with:							
educational level	no	no	no	no	partially	yes	partially
age	no	no	no	yes	yes	yes	yes
allow for changes in durations	no	no	yes	no	yes	no	only for Spain

Table A.1 shows the geographical and time coverage of the relevant studies and summarizes some of their key features. All studies begin by collecting "direct" census or survey data, which make up

average schooling of the population with primary attainment even if this cannot be based on precise data. See Samir et al, pp. 403-4.

between 14% and 59% of the potential observations. Missing observations are then estimated using either interpolation or some sort of fill-in procedure to construct forward or backward projections using nearby census observations and possibly enrollment data. In the first three versions of the Barro and Lee data set, this is done using a short-cut perpetual inventory procedure in which the attainment of the adult population at time *t* is estimated as a weighted average of the attainment of the same age group in a nearby census year and the attainment of new entrants into the desired age group during the intervening period, which is estimated using enrollment data, possibly adjusted for repeaters and dropouts, or net intake rates (the fraction of the relevant population that enters each educational cycle).[17]

Cohen and Soto (2007) improve on this procedure by using the available detail on attainment by age group to construct more accurate forward and backward projections. The main advantage of this procedure is that it implicitly allows survival probabilities (in the period elapsed since the census observation that is used as a starting point) to vary across cohorts, whereas the short-cut perpetual inventory procedure used in previous papers imposed a common survival rate for the entire adult population. In the latest version of their data set, Barro and Lee (2013) adopt this methodology and introduce a further refinement that allows survival probabilities to vary with the level of education for the oldest cohorts. D&D (2012 and 2014) employ this refined procedure in the backward projections they use to extend the series in those countries for which there are no data in the earlier years of the sample period, but rely on linear interpolation to fill in gaps between available census data.

L&S (2007 and 2010) use an extrapolation procedure similar to the one used by C&S (2007) and B&L (2013). L&S+ deviate from the standard practice in other studies in that they rely on a single census, which is projected backward and forward.[18] While having some obvious drawbacks, this procedure does have the advantage of avoiding problems arising from changes in classification criteria over time. Some of the details of the projection procedure also differ from previous studies. In principle, L&S+ allow mortality rates to differ across age and attainment groups and over time. Unlike B&L and C&S, they do not use enrollment data when estimating the attainment level of the youngest and oldest cohorts at each point in time. Instead, they basically extrapolate the cross-cohort attainment pattern found in their basic data to estimate the attainment of new entrants into the adult population and that of unobserved age groups that are part of the oldest, open-ended population segment (typically the group 65+).

In most cases, the basic fill-in procedure is applied using a coarse classification into four broad educational levels (no schooling, some primary, some secondary and some higher education) and the finer breakdown is completed ex-post using estimates of completion ratios, i.e. of the fraction of each population subgroup that has actually completed each school cycle.

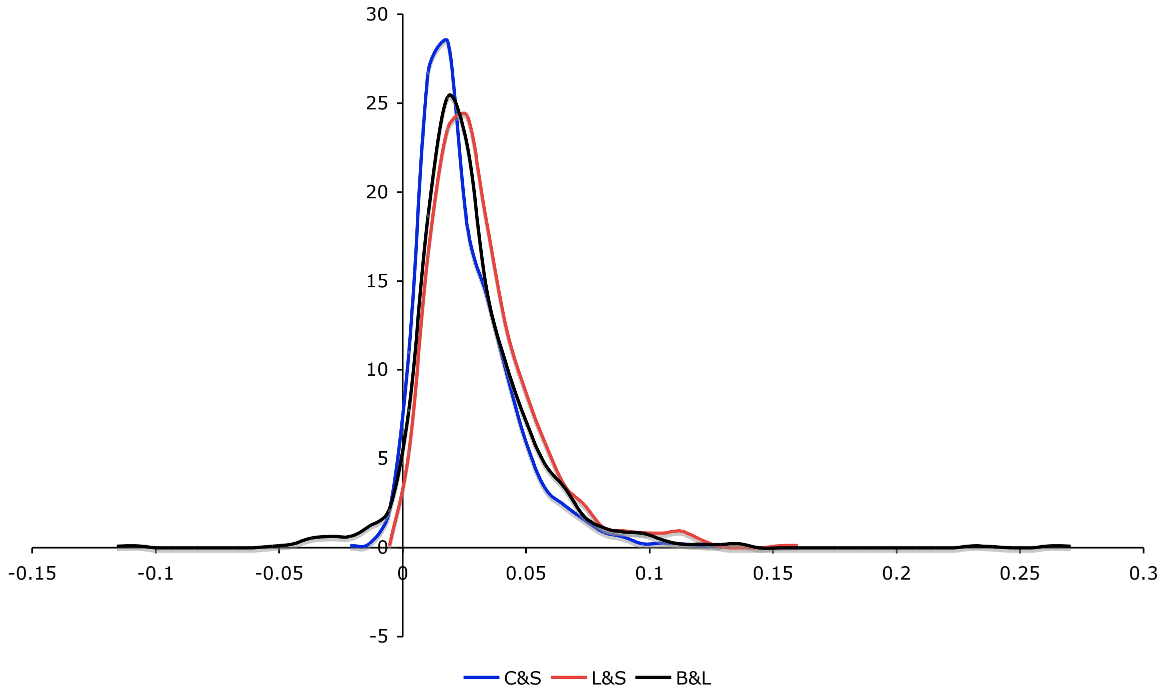
[17] For the details of this procedure and the refinements introduced by different authors, see Appendix 1.

[18] The forward projections are constructed under several scenarios that incorporate different assumptions on fertility and migration rates and on the evolution of educational attainment in younger cohorts. The data we use for 2010 seem to be based on the central scenario ("global education trend") and, at any rate, they will not be very sensitive to such assumptions since the relevant birth rates are known as of 2000 and the rest of the assumptions affect only the very youngest 15+ cohorts in 2010.

Appendix 2: Barro and Lee vs. Cohen and Soto and Lutz, Samir et al outside the OECD21

Unlike D&D, C&S, L&S+ and B&L provide data for a large number of non-OECD countries. Sixty-three countries outside the OECD21 sample used in the text are covered by all three sources. Using this common non-OECD sample, we have fitted distributions to the data in growth rates and estimated SUR reliability ratios for these three data sets. The results are largely consistent with those obtained with the OECD21 sample: the B&L series display the highest volatility, as evidenced by the thicker tails of its estimated distribution in Figure A.1, and tend to have lower reliability ratios than the other two sources, particularly when we work with the data in differences or growth rates (see Table A.2).

Figure A.1: Fitted distribution of the growth rate of years of schooling, different data sets common countries outside the OECD21



It is worth noting that the estimated reliability ratios are somewhat higher in the non-OECD sample. This is likely to be somewhat misleading, however, because the number of available primary sources that can be drawn upon to construct estimates of educational attainment is probably higher in developed than in underdeveloped countries. As a result, the variation across data sets is likely to be smaller in LDCs, and this will tend to spuriously raise the estimated reliability ratio in a way that will simply reflect a higher correlation of errors across data sets (i.e. an upward bias in the estimated reliability ratio). On the other hand, the result may also have something to do with the fact that the variation of the schooling data is greater in the non-OECD sample. Hence, while we are probably underestimating the amount of noise in this larger sample, it is also likely that the signal will be stronger in it.

Table A2: SUR estimates of reliability ratios, non-OECD21 sample

a. Raw data

	Hit	*hit*	*ΔHit*	*Δhit*	*Hit-Hi*	*hit-hi*	*average*
B&L	1.041	1.015	0.345	0.366	0.984	0.901	*0.775*
	[0.011]	[0.015]	[0.025]	[0.027]	[0.011]	[0.016]	
C&S	0.990	0.937	0.519	0.719	1.116	1.045	*0.888*
	[0.014]	[0.011]	[0.038]	[0.037]	[0.015]	[0.014]	
L&S	0.798	0.899	0.563	0.578	0.785	0.828	*0.742*
	[0.009]	[0.010]	[0.032]	[0.026]	[0.008]	[0.011]	
average	*0.943*	*0.951*	*0.476*	*0.554*	*0.962*	*0.925*	*0.802*

b. Data in deviations from period means

	Hit	*hit*	*ΔHit*	*Δhit*	*Hit-Hi*	*hit-hi*	*average*
B&L	1.041	1.010	0.329	0.316	0.648	0.581	*0.654*
	[0.013]	[0.017]	[0.025]	[0.026]	[0.024]	[0.027]	
C&S	0.941	0.894	0.533	0.678	0.657	0.764	*0.745*
	[0.015]	[0.011]	[0.039]	[0.035]	[0.032]	[0.025]	
L&S	0.793	0.915	0.544	0.603	0.673	0.722	*0.708*
	[0.011]	[0.012]	[0.031]	[0.027]	[0.024]	[0.023]	
average	*0.925*	*0.940*	*0.469*	*0.532*	*0.659*	*0.689*	*0.702*

Notes:

- Standard errors in brackets below each estimate.
- Data are reported at 5-year intervals except by Cohen and Soto who do it at 10-year intervals. We use linear interpolation (with the data in levels) to complete these series prior to all calculations.
- Panel *a* corresponds to the variables as originally measured. The estimates shown in panel *b* are obtained after removing the corresponding period means. This is done by introducing period dummies in equation (4).
- All equations are estimated using data for 1970-2010, which is the period over which the four series overlap.

References

Barro, R. and J-W. Lee (1993). "International Comparisons of Educational Attainment." *Journal of Monetary Economics* 32, pp. 363-94.

Barro, R. and J-W. Lee (1994). "Data set for a panel of 138 countries." Mimeo, Harvard University.

Barro, R. and J-W. Lee (1996). "International Measures of Schooling Years and Schooling Quality." *American Economic Review* 86(2), *Papers and Proceedings*, pp. 218-23.

Barro, R. and J-W. Lee (2000). "International data on educational attainment, updates and implications." NBER Working Paper no. 7911. (http://www.nber.org/papers/w7911).

Barro, R., and Lee, J.-W. (2001). "International data on educational attainment: Updates and implications." *Oxford Economic Papers, 3*, 541–563.

Barro, R. and J-W. Lee (2013). "A New Data Set of Educational Attainment in the World, 1950-2010." *Journal of Development Economics* 104, pp. 184-98.

Barro and Lee (2012). "Appendix Notes to A New Data Set of Educational Attainment in the World, 1950-2010." Mimeo. http://www.barrolee.com/

Cohen, D. and M. Soto (2007). "Growth and Human Capital: Good Data, Good Results." *Journal of Economic Growth* 12, pp. 51–76.

de la Fuente, A. and R. Doménech (2002). "Educational attainment in the OECD, 1960-90." CEPR Discussion Paper no. 3390.

de la Fuente, A. and R. Doménech (2006). "Human capital in growth regressions: how much difference does data quality make?" *Journal of the European Economic Association 4(1)*, pp. 1-36.

de la Fuente, A. and R. Doménech (2012). "Educational attainment in the OECD, 1960-2010, version 3.0." Barcelona GSE Working Paper no. 658. http://ideas.repec.org/p/aub/autbar/911.12.html

de la Fuente, A. and R. Doménech (2014). "Educational attainment in the OECD, 1960-2010, version 3.1." FEDEA, Documento de Trabajo 2014-14, Madrid. https://ideas.repec.org/p/fda/fdaddt/2014-14.html

Kaneko, M. (1986). "The educational composition of the world's population: a database." Washington DC, the World Bank, Education and Training Department, Report No. EDT 29.

Krueger, A. and M. Lindahl (2001). "Education for growth: why and for whom?" *Journal of Economic Literature* XXXIX, pp. 1101-36.

Kyriacou, G. (1991). "Level and Growth Effects of Human Capital, A Cross-Country Study of the Convergence Hypothesis." Mimeo, NYU.

Lau, L, D. Jamison, and F. Louat (1991). "Education and Productivity in Developing Countries: an Aggregate Production Function Approach." Report no. WPS 612, the World Bank.

Lau, L., S. Bhalla and F. Louat (1991). "Human and physical capital stock in developing countries: construction of data and trends." Draft mimeo, *World Development Report,* World Bank.

Lee, J-W. and R. Barro (2001). "Schooling quality in a cross-section of countries." *Economica* 68, pp. 465-88.

Lutz, W., A. Goujon, K.C. Samir and W. Sanderson (2007). "Reconstruction of populations by age, sex and level of educational attainment for 120 countries for 1970-2000." *Vienna Yearbook of Population Research 2007*, pp. 193-235. http://www.iiasa.ac.at/Research/POP/edu07/index.html

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, pp. 379-401.

Psacharopoulos, G. and A. Arriagada (1986). "The educational composition of the labour force: an international comparison," *International Labour Review*, 125(5), Sept.-Oct., pp. 561-74.

Samir KC, B. Barakat, A. Goujon, V. Skirbekk , W. Sanderson and W. Lutz (2010). “Projection of populations by level of educational attainment, age, and sex for 120 countries for 2005-2050.” *Demographic Research*: Volume 22, Article 15.

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

United Nations (various years). *Demographic Yearbook*, New York.

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