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ABSTRACT

Our panel data set on educational attainment has been updated for 146 countries from 1950 to 2010. The data are disaggregated by sex and by 5-year age intervals. We have improved the accuracy of estimation by using information from consistent census data, disaggregated by age group, along with new estimates of mortality rates and completion rates by age and education level. We use these new data to investigate how output relates to the stock of human capital, measured by overall years of schooling as well as by the composition of educational attainment of workers at various levels of education. We find schooling has a significantly positive effect on output. After controlling for the simultaneous determination of human capital and output, by using the 10-year lag of parents' education as an instrument variable (IV) for the current level of education, the estimated rate-of-return to an additional year of schooling ranges from 5% to 12%, close to typical Mincerian return estimates found in the labor literature.

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1. Introduction

Many observers have emphasized the crucial importance of human capital, particularly as attained through education, to economic progress (Lucas, 1988 and Mankiw, Romer and Weil, 1992). An abundance of well-educated people goes along with a high level of labor productivity. It also implies larger numbers of more skilled workers and greater ability to absorb advanced technology from developed countries. The level and distribution of educational attainment also have impact on social outcomes, such as child mortality, fertility, education of children, and income distribution (see for example Barro and Lee, 1994; de Gregorio and Lee, 2002; Breierova and Duflo, 2004; Cutler et al., 2006).

There have been a number of attempts to measure educational attainment across countries to quantify the relationship between it and economic and social outcome variables. Earlier empirical studies used school enrollment ratios or literacy rates (Romer, 1990, Barro, 1991, and Mankiw, Romer and Weil, 1992). But although widely available, these data do not adequately measure the aggregate stock of human capital available contemporaneously as an input to production.

Our earlier studies (1993, 1996, and 2001) filled this data gap by constructing measures of educational attainment for a broad group of countries. The figures were constructed at 5-year intervals from 1960 to 2000. The data showed the distribution of educational attainment of the adult population over age 15 and over age 25 by sex at seven levels of schooling. We also constructed measures of average years of schooling at all levels—primary, secondary, and tertiary—for each country and for regions in the world.

In this paper, we update and expand the data set on educational attainment. We extend our previous estimates from 1950 to 2010, and provide more, improved data disaggregated by sex and age. The data are broken down into 5-year age intervals, and the coverage has now expanded to 146 countries by adding 41, including 11 former Soviet republics. The accuracy of estimation has also improved by incorporating recently available census/survey observations.

The new data set improves on the earlier by using more information and better methodology. We construct new estimates by using information from survey/census data, disaggregated by age group. Previously, we adopted a perpetual inventory method, using the census/survey observations on the educational attainment of the adult population group over age 15 or over age 25 as benchmark stocks and new school entrants as flows that added to the stocks with an appropriate time lag. The flow estimates were estimated using information on school-enrollment ratios and population structure over time. But this method is subject to bias due to inaccuracy in estimated enrollment ratios and in benchmark censuses. In the current estimation, we reduce measurement error by using observations in 5-year age intervals for the previous or subsequent 5-year periods. We also construct new estimates of (a) survival/mortality rates by age and by education; and (b) completion ratios by educational attainment and by age group. These measures help improve the accuracy of the backward- and forward-estimation procedure.

The data set improvements address most of the concerns raised by critics, including Cohen and Soto (2006) and De La Fuente and Doménech (2006). They noted that the previous data set of Barro and Lee (1993, 2001) shows implausible time-series profiles of educational attainment for some countries. The new procedures have resolved these problems.

Our estimates of educational attainment provide a reasonable proxy for the stock of human capital for a broad group of countries. We use these new data to estimate the relationship between education and output based on a simple production-function approach. We investigate how output is related to human capital stock, measured by overall years of schooling as well as by the composition of attainment of workers at various levels of education. We find schooling has a significant effect on output. The estimated rate-of-return to an addition year of schooling is higher at secondary and tertiary levels than at primary level.

In the next section, we summarize the data and the methodology for constructing the estimates of educational attainment and discuss the modifications that have been made in the present update. In section 3, we highlight the main features of the new data set and compare the estimates with our previous ones (Barro and Lee, 2001) and alternative measures by Cohen and Soto (2007). Section 4 presents empirical findings on the relationship between education and income based on

the new data set. Section 5 presents our conclusions.

2. Data and Estimation Methodology

A. The Census data

The benchmark figures on school attainment (599 census/survey observations) are collected from census/survey information, as compiled by UNESCO, Eurostat, and other sources.[1] The census/survey figures report the distribution of educational attainment in the population over age 15 by sex and by 5-year age group, for most cases, in six categories: no formal education (*lu*), incomplete primary (*lpi*), complete primary (*lpc*), lower secondary (*lsi*), upper secondary (*lsc*), and tertiary (*lh*).[2]

Table 1 presents the distribution of countries by the number of available census/survey observations since 1950.[3] For total population aged 15 and over, 200 countries have at least 1 observation, and 103 countries have 3 or more observations. Table 2 shows the distribution of countries by census/survey year since 1950 (where the underlying figures are applied to the nearest 5-year value). For total population over age 15, for example, 64 observations are available for 1960, 85 for 1970, 90 for 1980, 91 for 1990, and 68 for 2000. These data points are used as benchmark figures on educational attainment.

B. Estimation of missing observations at the four broad levels

We calculate from 1950 to 2010 at the five year intervals the educational attainment of the

[1] There are additional data from OECD sources for 30 OECD countries since 1990. We have decided not to use these additional observations. As discussed in Barro and Lee (2001), most OECD data come from labor-force surveys based on samples of households or individuals, in contrast to the national censuses in the UNESCO database. There are significant differences between the OECD and our data for some countries. The discrepancies originate, in many cases, from the different classification schemes used by the OECD and UNESCO.

[2] When a census provides only numbers for a combination of several categories, such as no formal education, incomplete primary, and complete primary, we use decomposition methods to separate into categories. See Appendix Notes 2 and 3. See also Notes available online at: http://www.barrolee.com for more details.

[3] These census/survey observations include the countries/territories for which we could not construct the complete estimates of educational attainment because of other missing information. Appendix Table shows the census/survey information for the 146 countries for which we have constructed complete estimates.

population by 5-year age groups. First, we calculate the distribution of educational attainment at four broad categories—no formal education (*lu*), primary (*lp*), secondary (*ls*) and tertiary education (*lh*). Primary includes both incomplete primary (*lpi*) and complete primary (*lpc*), and secondary (*ls*) includes lower secondary (*lsi*) and upper secondary (*lsc*). Tertiary education (*lh*) also includes both junior-level (*lhi*) and higher-level tertiary (*lhc*).

We fill in most of missing observations by forward and backward extrapolation of the census/survey observations on attainment. The estimation procedure extrapolates the census/survey observations on attainment by age group to fill in missing observations with an appropriate time lag.

Let's denote $h_{j,t}^{a}$ as the proportion of persons in age group *a*, for whom *j* is the highest level of schooling attained- *j*=0 for no school, 1 for primary, 2 for secondary, and 3 for higher at time *t*. There are 13 5-year age groups ranging from *a* =1 (15–19 years old) to *a* =13 (75 years and over).

The forward extrapolation method assumes that the distribution of educational attainment of age group *a* at time *t* is the same as that of the age group that was five years younger at time *t*-5:

$$h_{j,t}^{a} = h_{j,t-5}^{a-1} \tag{1}$$

where age group *a* denotes, *a* =3: 25–29 age group, …*a* =10: 60–64 age group. This setting applies to persons who have completed their schooling by time *t*-5. As explained below, we adjust this formula by considering different mortality rates by education level for the old population aged 65 and over. For younger groups under age 25, we adopt a different method, considering that part of population is still in school during the transition period from *t* to *t*+5.

The backward extrapolation is expressed as:

$$h_{j,t}^{a} = h_{j,t+5}^{a+1} \tag{1a}$$

where age group *a* denotes, *a* =2: 20–24 age group, …*a* =9: 55–59 age group.

Thus, a person's educational attainment remains unchanged between age 25 and 59. An assumption here is that, in the same 5-year age group, the survival rate is the same regardless of a person's educational attainment. When we look at information from available censuses stratified by educational attainment and population structure by age group in the previous or subsequent 5-year periods, we find this assumption holds well for the population aged 64 and under, but not for older age groups. In a typical country, the mortality rate is higher for older people who are less-educated. The assumption of uniform mortality can then cause a downward bias in the estimation of the total educational stock.

If we consider the differences in survival rate by education levels, the forward extrapolation method is expressed by

$$h_{j,t}^{a} = h_{j,t+5}^{a+1} \bullet \delta_{j}^{a} \qquad (2)$$

where δ_{j}^{a} is the age-specific survival rate over the five years for the population in age group *a*, for whom *j* is the highest level of schooling.

For the population aged 60 and above (*a* =11, 12, and 13), we allow for the different mortality rates for the old population aged 60 and above by education levels.

By utilizing information from available censuses by age group in the previous and/or next 5-year periods, we have estimated the survival rates for the old population in the age group, 60–64, 65–69, and 70–74 (*a* =10,11, and 12) by education levels. The estimation results show that the more educated people have lower mortality rates. Appendix Note 1.A describes more details on the estimation of survival rates.

An important issue is how to combine forward and backward-flow estimates when both are available for a missing cell. We have carried out a simulation exercise in which we regressed the 'observed' actual census values of the various levels of educational attainment on the estimates generated from forward- and backward-flow estimates (based on both five- or ten-year lead and lagged values from actual censuses). We use the regression results to construct a weighted-

average of forward and backward-flow estimates (see Appendix Note 1.B for more details on how to combine forward-flow and backward-flow estimates).

Note that the forward and backward-flow estimates cannot be applicable for the two youngest cohorts between ages 15 and 24 because part of the population is in school during dates *t* and *t*+5. For these age groups (*a* =1: 15–19 age group and *a* =2: 20–24), we construct the estimates by using the estimates of the same age group in *t*–5 (or *t*+5) and the change in (age-specific) enrollment for the corresponding age groups over time (see Appendix Note 1.A. for more details).

C. Estimation of sub-categories of educational attainment

We have estimated school attainment at four broad levels of schooling: no school, some primary, some secondary, and some higher. We break down the three levels of schooling into incomplete and complete education by using estimates of completion ratios.

First, we describe our procedure for estimating missing observations for the subcategories for the primary schooling category. We filled in the missing cells using information from the available census/survey data. The completion rate at the primary level is expressed as a ratio of people who completed primary schooling but did not enter secondary schooling to people who entered primary school. For the remaining missing cells, we filled them in by forward and backward extrapolation of the census/survey observations on completion ratios with an appropriate time lag. This procedure applies to the age group *a*=3 (25–29) and above.[4] If both forward and backward estimates are available, we combine them by using the results of regression of the 'observed' actual census values of the various levels of completion ratio on the estimates generated from forward- and backward-flow estimates (based on both 5-year or ten-year lead and lagged values from actual censuses). On the other hand, we assume that the completion ratios for aged 15–19 and 20–24 are determined by age specific profile of completion ratios in each country (see Appendix Note 3).

[4] For the countries in which only the completion ratio for total population is available, we break down it into age groups based on the typical age profile of completion ratios constructed using the available data of the countries in the same region.

We applied similar methods to estimate missing observations for the subcategories for secondary and tertiary schooling. Secondary-school enrollees aged 15–19 are treated as incompletely educated at the secondary level, and higher-school enrollees aged 20–24 are treated as incompletely educated at the higher level. Appendix Note 3.B explains more details on how to combine forward-flow and backward-flow estimates of completion ratios.

D. Average Years of Schooling

The number of years of schooling for the population aged 15 and above, s_t, is constructed as

$$s_t = \sum_{a=1}^{A} l_t^a s_t^a \tag{3}$$

where l_t^g : the population share of group g in population 15 and above and s_t^a : the number of years of schooling of age group *a*— (*a* =1: 15–19 age group, *a* =2: 20–24 age group, … , *a* =13: 75 and above).

The number of years of schooling of age group *a* in time *t* is

$$s_t^a = \sum_j h_{j,t}^a Dur_{j,t}^a \tag{4}$$

where h_j^a the fraction of group *a* having attained the educational level j = *pri*, *sec*, *ter*, and *Dur* indicates the corresponding duration in years.

The duration data is constructed by taking account of changes in the duration system over time in a country. We suppose that changes in the duration of schooling at the primary level applied to new entrants in primary school (that is, ages 5–9) at the time of change.

We use the same sources and methodology to construct a panel data set on educational attainment of females by age group. The data on the distribution of educational attainment among the population, combined with the information for each country on the duration of school at each level, generate the number of years of schooling achieved by the average person at various levels and at all levels of schooling combined.

3. The Complete Data Set on Educational Attainment, 1950–2010

Tables 3 and 4 summarize the progress in educational attainment of the population aged 15 years and above by region and by income classification from 1950 to 2010 for the 146 countries that have complete information.[5]

The table considers two broad groups—24 advanced countries and 122 developing countries. The developing group is further broken down into six regions: Middle East/North Africa (18 countries), Sub-Saharan Africa (33), Latin America/Caribbean (25), East Asia/Pacific (19), South Asia (7), and Europe and Central Asia (20). Regional averages are computed by weighting each country's observation by its share in total population of the region.

Some of the important developments that represent the progress of developing countries in achieving higher educational attainment are summarized as:

- In 2010, the world population aged 15 and above is estimated to have an average of 7.8 years of schooling, increasing steadily from 3.2 years in 1950 and 5.3 years in 1980. The overall population over age 15 in high-income economies is estimated to have 11 years of schooling, compared to 7.1 years in developing countries. Both Sub-Saharan African and South Asian countries have the lowest at 5.2 years on average.

- Since 1950, the average years of schooling among the total population aged 15 years and above in developing countries increased significantly from 2.1 years to 7.1 years. In South Asia and Middle East/North Africa regions, average years of schooling have more than

[5] The additional countries/territories that have complete estimates in the new data set include Albania, Belize, Burundi, Brunei Darussalam, Cambodia, Congo, Cote d'Ivoire, Egypt, Gambia, Gabon, Lao People's Democratic Republic, Luxembourg, Libya, Morocco, Macao Special Administrative Region, Maldives, Malta, Mauritania, Mongolia, Namibia, People's Republic of China, Qatar, Reunion, Rwanda, Saudi Arabia, Tonga, United Arab Emirates, Viet Nam, Yemen. The data set include Croatia, Czech Republic, Serbia, Slovakia, and Slovenia as independent countries, replacing the former Yugoslavia and Czechoslovakia. The former USSR is replaced by the Russian Republic, Armenia, Azerbaijan, Estonia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Republic of Moldova, Tajikistan, and Ukraine.

doubled since the 1980s. In South Asia, for instance, average years of schooling among the total population aged 15 and over rose from 2.1 years in 1980 to 5.2 years in 2010.

- While higher secondary and tertiary completion and enrollment ratios account for most of the improvements in years of schooling in advanced countries, most of the improvements in developing countries are accounted for by higher primary and secondary completion and enrollment ratios (see Figure 1a).

- Average years of education among the population aged 15–24 years in developing countries rose from 3.15 years in 1950 to 6.48 years in 1990 and to more than 8.77 years in recent years (see Figure 1b). The improvements in completion and enrollment ratios at all levels among the younger cohorts in every generation continually contribute to rising average years of schooling as they mature over time. The biggest improvement in average years of schooling among the younger cohorts was recorded between 1970 and 1990 in both developing and advanced countries.

- Figure 2 shows that developing countries have successfully reduced illiteracy rates, especially among the younger cohorts. Specifically, the proportion of the uneducated in the total population over age 15 in developing countries has declined significantly over the past six decades since 1950, from 64.9% in 1950 to 20.1% in 2010. Among 15–24 year olds, this proportion has declined from 47.1% in 1950 to 7.1% in 2010.

- Table 4 summarizes the educational attainment among males and females by region since 1950. It shows that significant progress has been made by developing countries in terms of reducing gender inequality in education among the overall population over age 15. The ratio of female to male average years of schooling increased from around 57.7% in 1950 to 80.3% in 1990 and 85.9% by 2010.

Despite these major developments, many challenges in making education more inclusive remain. Notwithstanding significant improvements, the current level and distribution of educational attainment in developing countries is comparable only to that of advanced countries in the late

1960s (see Figure 1a).

- The gap between developing and advanced countries in average years of schooling among the overall population over age 15 remains high (3.94 years in 2010) as it has narrowed by only less than 1 year in the past 40 years.

  One factor that contributed to the slow reduction in this gap is the continued increase in the proportion of the population in advanced countries reaching higher levels of education.

  Also, the narrowing of the gap in average years of schooling among younger cohorts between developing and developed countries is less than enough to compensate for the huge gap among the older cohorts (see Figure 1b). For example, while the gap between the average years of schooling among 15–24 year olds in developing economies and advanced countries has narrowed since 1970 by around 1.58 years in 2010 (3.63 years in 1970 to 2.05 years in 2010), this gap has even widened by around 1 year (from 4.69 years in 1970 to 5.69 years) among those aged 65 years and above (see Figure 1a).

- The challenge of making education more gender inclusive also remains in many developing regions, such as South Asia, Middle East, and sub-Saharan Africa. The ratio of years of schooling among females to males remains below 70% in South Asia.

- The prospects of narrowing the educational attainment gap between developing and developed countries greatly rely on the capability of developing countries to (1) significantly increase enrollment ratios among new entrants (below 15 years old); and (2) catch up with the high rate of survival from primary to secondary level and from secondary to tertiary level (15–24 years old) in developing countries.

4. Comparison with Alternative Estimates

This section compares our estimates of educational attainment with other estimates. First, we

want to check our new estimates with our previous estimates in Barro and Lee (2001). Table 5 shows the means and standard deviation of levels and 10-year differences of the overlapping observations between the new Barro-Lee data set and Barro and Lee (2001) estimates over 1960–2000. The two estimates are highly correlated in both levels and 10-year differences, with correlation coefficients over 0.96.

Figure 3 shows that, on average, the new Barro-Lee estimates for average years of schooling for advanced countries are higher than the previous Barro-Lee estimates. For developing countries, estimates of average years of schooling until 1990 are slightly lower than the previous estimates. Figure 3 also shows that the new estimates display a smoother increasing trend in average years of schooling, both for developing and advanced countries, than the previous estimates.

Country level estimates are also much smoother over time. Figure 4 compares the new Barro-Lee estimates with Barro-Lee (2001) estimates for selected countries. The new estimates provide smother time profiles of educational attainment in Norway, the United States, Peru, and Venezuela.

We also compare the new estimates with the estimates by Cohen and Soto (2007). Cohen-Soto constructed a data set for average years of schooling for 95 countries at 10-year intervals for 1960–2010. They adopt data and methodology similar to ours. They use forward-flow and backward-flow methods to fill-in missing observations by extrapolating the census/survey observations on educational attainment by 5-year age group. But there are also significant differences. First, Cohen and Soto use OECD sources for OECD countries and UNESCO sources for non-OECD countries.[6] As discussed in Barro and Lee (2001), there exist significant differences between the OECD data and UNESCO censuses. Most OECD data come from labor-force surveys based on samples of households or individuals, in contrast to the national censuses in the UNESCO database. There are also significant differences in the classification of education systems between the OECD and the UNESCO sources. As a result, Cohen and Soto's procedure tends to over-estimate educational attainment for OECD countries (see Figure 5).

[6] For only a few OECD countries including Finland, Portugal and Turkey, Cohen and Soto combine both OECD and UNESCO sources.

Second, relying on only OECD sources, which are available since the 1990s, underutilizes available information. For example, Cohen and Soto's estimation for the United States relies on only two OECD surveys in 1991 and 1998. The data are then used to estimate missing observations in the earlier years by the backward-flow method, whereas for the age groups for which the backward estimates are not applicable, the estimates are constructed mainly by lagged enrollment rates. In contrast, our estimation for the United States relies on seven UNESCO censuses from 1950 to 2002, so that the census information on educational attainment by age group is used to fill in missing observations by both forward-flow and backward-flow estimates.

Third, for non-OECD countries, we use substantially more UNESCO censuses than Cohen and Soto. Cohen and Soto's estimation uses only 70 UNESCO censuses for 75 developing countries in their sample, compared to 392 for 122 developing countries in our sample. In fact, Cohen-Soto's estimates for 27 countries (including most sub-Saharan African countries) rely entirely on enrollment data. We believe our estimates based on more censuses must contribute to more accurate estimation of missing observations by forward-flow and backward-flow method by age-group.

Finally, Cohen-Soto do not consider the difference in mortality rates by educational levels nor the change in durations over time.

Table 5 shows means and standard deviations of average schooling years in levels and 10-year differences for the sample of the overlapping observations between the new Barro-Lee data set and Cohen-Soto (2007). The new Barro-Lee estimates for average years of schooling in 1960 are, on average, lower than those in Cohen and Soto (2007). However, the new Barro-Lee estimates for 2010 are higher on average. It also shows that the new Barro-Lee data set displays less dispersion than Cohen-Soto (2007). Lower dispersion is observed across estimates for developing countries and advanced countries across time, except for advanced countries in 1960.

Figure 5 show that the estimates for advanced countries in the new Barro-Lee data set are on average lower than in Cohen-Soto (2007) for the overall period, 1960-2010. Table 5 shows that

estimate for advanced countries are less correlated than those for developing countries. For developing countries, the new Barro-Lee estimates are on average very close to Cohen-Soto (2007) estimates in earlier years but higher for 2010.

We estimate reliability ratios for the new Barro-Lee estimates vis-à-vis Cohen-Soto (2007) in levels and first 10-year differences. As used by Krueger and Lindahl (2001) in checking quality of schooling data, the reliability ratio gauges the fraction of the variability of a (unobserved) true variable in the total variability of the variable measured with error. Suppose S_1 and S_2 represent two observed noisy measures of the (unobserved) true variable S. That is, $S_1 = S + e_1$ and $S_2 = S + e_2$, where e_1 and e_1 are the measurement error of S_1 and S_2. If e_1 and e_2 are uncorrelated, the reliability ratio of S_1 is defined as $R_1 = \text{cov}(S_1 , S_2) /\text{var}(S_1)$ and has probability limit equal to $\text{var}(S)/\text{var}(S_1)$. Similarly, the reliability ratio of S_2, $R_2 = \text{cov}(S_1 , S_2) /\text{var}(S_2)$ has probability limit equal to $\text{var}(S)/\text{var}(S_2)$.

Cohen-Soto (2007) showed that their estimates perform better as compared with Barro and Lee (2001). It turns out, however, the reliability ratio for the new Barro-Lee estimates is greater than that of Cohen Soto (2007), both in levels and 10-year differences in years of schooling for persons 15 years and older. Specifically, while the new Barro-Lee data set has reliability ratios of 0.99 for levels and 1.00 for differences, the reliability ratios of Cohen-Soto (2007) are 0.90 for levels and 0.88 for differences. This means that a greater proportion of the variability in observed levels and changes in the new Barro-Lee data set represents true levels and changes than in the Cohen-Soto (2007) data set. In other words, the new Barro-Lee data set conveys more signal than the Cohen-Soto (2007) data, both in levels and changes.[7]

Our estimates of educational attainment provide a reasonable proxy for the stock of schooling capital for a broad group of countries. However, the school attainment does not take account of the skills and experience gained after formal education. The measure does not directly measure the skills obtained at schools and, specifically, does not take account for differences in the quality

[7] We have also computed reliability ratios of De La Fuente and Domenech (2006) for the sample of OECD countries. The reliability ratios of the estimates by De La Fuente and Domenech are similar to those of our current data set. The results can be obtained from the authors upon request.

of schooling across countries. Figure 6 compares our concept of educational attainment with Hanushek and Woessmann's (2009) measure of human capital quality, which was constructed by standardizing and combining available international math and science test results, covering 1964–2003 for 50 countries.[8] Educational attainment and human capital quality measures are highly correlated but human capital quality is quite diverse for countries with similar levels of educational attainment.

5. Revisiting the Relationship between Education and Income

Using the updated Barro-Lee data set, we revisit the important relationship between education and income.

We set up a specification in which the cross-country differences in output per worker (working age population between 15-64 years old) are related to differences in human capital stock, measured by years of schooling, in addition to factor inputs and total factor productivity.

Assume the Cobb-Douglas production function such as,

$$Y = AK^{\alpha}H^{1-\alpha}. \quad (5)$$

where Y is output, K is the stock of physical capital, H represents human capital stock, and A denotes a measure of total factor productivity. By assuming $H = hL$, where h represents the amount of human capital per worker and L represents the number of workers, the production function can be rewritten,

$$Y = AK^{\alpha}(hL)^{1-\alpha} \quad (5a)$$

Expressing the variables in per worker term and then taking the log yields:

$$\ln(Y/L) = \ln A + \alpha \ln(K/L) + (1-\alpha)\ln(H/L) \quad (5b)$$

or

$$\ln y = \ln A + \alpha \ln k + (1-\alpha)\theta \ln h \quad (5c)$$

[8] See Hanushek and Woessmann (2009) for more details about their methodology for estimating human capital quality.

where *y* is output per worker and *k* is capital stock per worker.

Human capital per worker is assumed to have a relation to the number of years of schooling as follows:[9]

$$h = e^{\phi(s)} \tag{6}$$

In this equation, $\phi(s)$ measures the efficiency of a unit of labor, with *S* years of education being relative to one without any schooling. We further assume that $\phi(s)$ is linear,

$$h = e^{\theta s} \tag{6a}$$

Substituting (6a) into (5c) yields,

$$\ln y = \ln A + \alpha \ln k + (1-\alpha)\theta s \tag{7}$$

To measure the relationship between output and human capital, we estimate:

$$\log(y_t) = \beta_t + \beta_1 \log(k_t) + \beta_2(s_t) + \varepsilon_t \tag{8}$$

The coefficient β_1 is the share of capital in total output (α) and β_2 is the marginal rate-of-return to an additional year of schooling. The regression includes a period dummy variable, which represents total factor productivity that is assumed to vary over time. We also include a dummy variable for oil exporters.

We use data on average years of schooling from the updated Barro-Lee data set, and Penn World Table (PWT version 6.3) (Heston, Summers, and Aten, 2009) data on output per worker. Physical capital stock data is generated by perpetual inventory method following Bernanke and Gurkaynak's (2001) approach.[10] The data set is an unbalanced panel consisting of 962

[9] See Klenow and Rodriguez-Clare (1997) and Hall and Jones (1999).

[10] An initial value of the capital stock series for each country *I* is generated by: $K_{i,0} = I_{i,1} / (g_{i,1} + \delta)$ where K_0 is the capital stock, I_1 is the capital flow at year 1 or the year after the initial year, g_1 is the 5-year average annual growth rate around year 1, and is δ the depreciation which is assumed to be the same across countries (0.06). After we exclude the first 5 years of capital stock estimates, we construct the capital stock series using the perpetual inventory method: $K_{i,t} = K_{i,t-1}(1-\delta) + I_{i,t}$. The data on investment-to-GDP ratio, real GDP, and real GDP growth are from the

observations at 5-year intervals over the period 1970 to 2005 for 127 countries. We exclude 19 countries with less than 6 observations.[11]

We use random- and fixed-country-effects panel estimation procedures, as well as an instrument-variable (IV) estimation procedure.

The estimate on human capital (as well as physical capital-worker ratio) in equation (8) is subject to potential bias that may come from several sources. First, there can be omitted variable bias. It is plausible that some important institutional and economic factors that are not included as explanatory variables in the specification of the production function model can influence both output and human capital simultaneously. If an omitted variable varies by country, but is constant over time, an inclusion of country-fixed-effects term eliminates this source of endogeneity bias. The other potential source of bias comes from simultaneity. The significantly positive effect of education on output may reflect reverse causality. For example, people may invest more in education when they have higher (current or anticipated) income. This simultaneity bias can be, in principle, handled with instruments. The problem, however, is to find good instrumental variables. At the micro level, it is common to estimate Mincer-type regressions to gauge rates of return from education. Often people worry about the endogeneity of schooling with respect to income or earnings and use measures of ability or parents' income as instruments for schooling.

Adopting the methodology developed in the micro-labor literature, we use parental education as the instrument for the education variable in the IV estimation. The contemporaneous educational attainment for the population aged 15 and over includes a portion of educational attainment of the younger generation (e.g. between 15 and 25 years old), which may be correlated with current income. But, considering that the educational attainment of the parents' generation was accumulated by their past investment in education, it can be uncorrelated with the error term (ε_t) in equation (8). Specifically, we take the 10-year lag average years of schooling among the

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Penn World Table.

[11] To make the data more balanced, we use the 5-year lag of ln*k* in lieu of missing 10-year lag of ln*k* to instrument for capital-worker ratio in the IV estimation described later. Note that adding the excluded country samples or deleting observations without 10-year lagged instruments do not incur any significant change to the estimation results.

population of 40 years and over ($S_{(t\text{-}10)}$ 40-75) to represent parents' education and use it to instrument for the average years of schooling variable (S_t). We also use the 10-year lag of log capital-worker ratio to instrument for the log capital-worker ratio since we assume that the lagged capital-worker ratio is uncorrelated with the unobserved error term in equation (8).

Table 6 presents the estimation results of specification (8) to investigate the impact of education on output. We apply two different estimation techniques: random-effects and fixed-effects. Columns (1) and (2) of Table 6 present the random-effects and fixed-effects estimates. The estimated coefficients on the educational attainment variable are always positive and statistically significant, though marginal. In both random- and fixed-effects settings, the estimates for the rate-of-return to education are around 0.02. The estimates suggest that, holding other things constant, output for the world economy as a whole would increase by around 2% for every additional year of schooling.

Columns (3) – (4) in Table 6 present our estimates for random-effects and fixed-effects IV models. The estimated coefficients on the educational attainment variable are statistically significant. The IV fixed-effects estimate for the rate-of-return to education (12.1%) is higher than the IV random-effects estimate (5.5%). These figures are close to the typical Mincerian return estimates found in labor literature.[12] Comparing our results with columns (3) and (4) and without instruments (columns 1 and 2), our IV estimates for the rate-of-return to education are higher than our benchmark OLS estimates for both random- and fixed-effects models.

We extend our analysis to examine whether the return to human capital varies across regional groups. We estimate the following specifications:

$$\log(y_{r,t}) = \beta_t + \beta_1 \log(k_t) + \beta_{2r}(s_t * D_r) + \varepsilon_{r,t} \qquad (8a)$$

where D_r is dummy for region r.

[12] Cross-country evidence indicates that the average Mincerian return to schooling is centered around 10% (Psacharapoulos and Patrinos, 2004).

Columns (5), (6), (7), and (8) in Table 6 present our regional estimates for the random-effects and country fixed-effects models with and without instruments, respectively. Consistent with our earlier results (in Table 6 columns 1 – 4), the IV estimates for the rate-of-return to education, by region, are higher than the estimates without instruments, for both random-effects and fixed-effects models. Rates of return to education estimates vary across regions. Rate-of-return estimates in the three regions—the group of advanced countries, East Asia and the Pacific, and South Asia—are higher than in the other regions. The group of advanced countries has the highest IV fixed-effects rate-of-return estimate (13.3%). This figure suggests that on average, the wage differential between a primary school graduate and a secondary school graduate in this region is around 110%. By contrast, the estimated rate-of-return to education is quite low in Sub-Saharan Africa (6.6%) and Latin America (6.5%). Figure 7 shows the rate-of-return estimates by region.

We also examine whether the link between education and income changes by level of education.

$$\log(y_t) = \beta_t + \beta_1 \log(k_t) + \left(\theta_{pri} s_{t,pri} + \theta_{\sec} s_{t,\sec} + \theta_{ter} s_{t,ter}\right) + \varepsilon_t \qquad (8b)$$

Columns (9), (10), (11), and (12) in Table 6 present our estimates for random-effects and fixed-effects models with and without instruments, respectively.[13] Results confirm that the return to human capital varies across different levels of education. Based on the IV fixed-effects estimates, the return to every additional year of schooling is 10.0% at the secondary level and 17.9% at the tertiary level. This finding suggests that on average, the wage differential between a secondary-school graduate and a primary-school graduate is around 77%, and the wage differential between a college graduate and a primary-school graduate is around 240%.

Our results indicate that the return is negative, though not statistically significant, at the primary, and increasingly positive in secondary and tertiary levels, which is contrary to the usual pattern shown in the literature that Mincerian returns are decreasing by level of education

[13] Here we use the 10-year lag of parental education ($S_{l,(t\text{-}10)}$ 40-75 where l = *pri*, *sec*, *ter*) to instrument for years of schooling by level of schooling ($S_{l,t}$ 40-75) and, as in the other specifications, the 10-year lagged log capital-worker ratio is used to instrument for log capital-worker ratio by region.

(Psacharapoulos and Patrinos, 2004). But, there are also cross-country studies that present trends in rate-of-return that is increasing with levels of schooling (see for example, Schultz, 2004 and Duraisamy, 2002). Nevertheless, our finding that the estimated return to an additional year of primary schooling is negative is puzzling. The hypothesis that the return to human capital is the same for all regardless of educational attainment (H_0: $\theta = \theta_{pri} = \theta_{\text{sec}} = \theta_{ter}$ vs. H_A: $\theta_{pri} \neq \theta_{\text{sec}} \neq \theta_{ter}$) is always rejected, whereas the hypothesis that the return to human capital is the same for secondary and tertiary education is always accepted.

6. Concluding Remarks

Our new data set on educational attainment applies to 146 countries at five-year intervals from 1950 to 2010. The estimates are disaggregated by sex and by 5-year age intervals. These estimates improve on our previous, widely used data set by utilizing more information and better estimation methodology. We use the new schooling data to investigate the relationship between education and income. We confirm that the schooling of workers has a significantly positive effect on the level of income at the country level.

This improved data set on educational attainment should be helpful for a variety of empirical work. Our earlier estimates of educational attainment have been used in many studies. Up to February 2010, our papers on educational attainment data published in 1993, 1996, and 2001 have been cited in journals over 740 times, according to the *Social Science Citations Index*. The total number of citations by all journal articles, books, and working papers amounts to over 5,100, according to *Google Scholar*. Our estimates of educational attainment provide a reasonable proxy for the stock of human capital for a broad group of countries. The data set has been useful for studying the linkages across countries between education and important economic and social variables, such as economic growth, export competitiveness, fertility, income inequality, democracy, institutions, and political freedom. We expect that this new data set will help to improve the reliability of these types of analyses.

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Appendix Notes: Estimation Procedures

We use census/survey information compiled by UNESCO, Eurostat, and others as benchmark figures to estimate average years of schooling at 5-year intervals from 1950 to 2010. As discussed in the main text, these census figures report the distribution of educational attainment in the population over age 15 by sex and by 5-year age groups, at 5-year intervals. In most cases, the distribution of educational attainment is classified according to the following four broad categories: no formal education (*lu*), primary (*lp*), secondary (*ls*), and tertiary (*lh*). It is further classified in many cases into subcategories: incomplete primary (*lpi*), incomplete secondary (*lsi*), and incomplete tertiary (*lhi*).

1. *Estimation of missing attainment data by forward and backward extrapolation.*

We fill in most of the missing census observations by forward and backward extrapolation of the census/survey observations on attainment by age group, with an appropriate time lag. Notes Table 1 below summarizes the backward and forward estimation procedure by age group.

Table 1. General Rules for Estimating Missing Observations through Backward and Forward extrapolation

Age group (*a*)	Backward extrapolation	Forward extrapolation
15–19, 20–24	$h^a_{j,t} = h^a_{j,t+5} + \Delta enroll^a_{j,t}$	$h^a_{j,t} = h^a_{j,t-5} + \Delta enroll^a_{j,t}$
25–29, 30–35,…, 60–64	$h^a_{j,t} = h^{a+1}_{j,t+5}$	$h^a_{j,t} = h^{a-1}_{j,t-5}$
65–69, 70–74, 75–79	$h^a_{j,t} = h^{a+1}_{j,t+5} \cdot \delta_j$	$h^a_{j,t} = h^{a-1}_{j,t-5} \cdot \delta_j$

Note: $h^a_{j,t}$ is the proportion of people in age group *a*, for whom *j* is the highest level of schooling attained at time *t*, $\Delta enroll^a_{j,t}$ is the enrollment adjustment factor for age group *a* in level *j* at time *t*, and δ_j is the survival ratio for the education group *j* over the five year at time *t*.

A. We perform either backward or forward extrapolation when at least one benchmark figure is available from either an earlier or later period. If more than one benchmark figure is available, we use the figure from the closest period as the benchmark figure.

Aged 25–64. We assume that an individual's educational attainment remains unchanged from age 25 to 64 and that mortality is uniform across all individuals, regardless of educational attainment.

Hence, for age groups between 25 and 64, we fill the missing attainment data using the attainment of the younger age group from the previous period (forward) as benchmark or the attainment of the older age group from the succeeding period (backward).

Aged 15–19 and 20–24. Since direct backward or forward extrapolation is not applicable for these two youngest age groups, we use attainment and enrollment data to estimate missing attainment data. We assume that the change in enrollment leads to a proportional change in attainment over time with time lag. Hence, for these age groups, we use estimates for the same age group from the previous (or in the next) period as benchmark and adjust this benchmark figure by the change in enrollment over time or the enrollment adjustment factor. The following summarizes how the age-specific enrollment adjustment factors are derived in case of backward extrapolation.

Table 2. Enrollment Adjustment Factor

Level	Backward extrapolation
No education	$-(enroll^{a}_{pri,t} - enroll^{a}_{pri,t-5})$
Primary	$(enroll^{a}_{pri,t} - enroll^{a}_{pri,t-5}) - (enroll^{a}_{\text{sec},t} - enroll^{a}_{\text{sec},t-5})$
Secondary	$(enroll^{a}_{\text{sec},t} - enroll^{a}_{\text{sec},t-5}) - (enroll^{a}_{ter,t} - enroll^{a}_{ter,t-5})$
Tertiary	$(enroll^{a}_{ter,t} - enroll^{a}_{ter,t-5})$

Note: $enroll^{a}_{j,t}$ is the enrollment rate for age group *a* in level *j* at time *t*.

Aged 65 and over. For older age groups, however, we distinguish between a less-educated population (uneducated and people who have reached the primary level) and a more-educated population (reached at least secondary schooling). We assume mortality is higher for the less-educated and lower for the more- educated. We estimate the survival ratio for less-educated (δ^{L}_{R}) and for more-educated (δ^{U}_{R}) individuals, for advanced countries (R = OECD) and for developing countries (R = non-OECD) using a weighted least squares procedure with the available census information and the following equations.

$$lu_{R} = \delta^{L}_{R} lu^{70+}_{R,t-5} \qquad (1a)$$

$$lu_R = (\delta_R^L)^2 lu_{R,t-10}^{70+} \quad (1b)$$

$$lp_R = \delta_R^L lp_{R,t-5}^{70+} \quad (1c)$$

$$lp_R = (\delta_R^L)^2 lp_{R,t-10}^{70+} \quad (1d)$$

$$ls_R = \delta_R^U ls_{R,t-5}^{70+} \quad (1e)$$

$$ls_R = (\delta_R^U)^2 ls_{R,t-10}^{70+} \quad (1f)$$

$$lh_R = \delta_R^U lh_{R,t-5}^{70+} \quad (1g)$$

$$lh_R = (\delta_R^U)^2 lh_{R,t-10}^{70+} \quad (1h)$$

We have obtained estimates $\hat{\delta}_{OECD}^L$ = 0.966 (s.e. = 0.01, t-stat =87.94) and $\hat{\delta}_{OECD}^U$ = 1.065 (s.e. = 0.02, t-stat = 65.67) for advanced countries, and $\hat{\delta}_{OECD}^L$ = 0.969 (s.e. = 0.01, t-stat =132.78) and $\hat{\delta}_{NONOECD}^U$ = 1.068 (s.e. = 0.03, t-stat = 38.14) for developing countries. We then apply the estimated survival ratio to adjust the backward or forward estimate for mortality rate differences between less-educated and more-educated individuals (see Notes Table 1).

B. If two or more benchmark figures are available from both earlier and later periods, a weighted average of backward and forward estimates is used as the benchmark. We derive the weights for combing the backward and forward estimates for OECD countries and for non-OECD countries, for each education category, by estimating the following system of simultaneous equations through a weighted least squares estimation procedure. The estimation uses the sample of available actual censuses.

$$h_R^a = \beta_{R11} h_{R,t-5}^a + \beta_{R21} h_{R,t+5}^a \text{ , where } \beta_{R11} + \beta_{R21} = 1 \quad (2a)$$

$$h_R^a = \beta_{R12} h_{R,t-5}^a + \beta_{R22} h_{R,t+10}^a \text{ , where } \beta_{R12} + \beta_{R22} = 1 \text{ and} \quad (2b)$$

$$\beta_{R12} = (\beta_{R11}) / (1 - \beta_{R11} + \beta_{R11}^{\ 2})$$

$$h_R^a = \beta_{R13} h_{R,t-10}^a + \beta_{R23} h_{R,t+5}^a \text{ , where } \beta_{R13} + \beta_{R23} = 1 \text{ and} \quad (2c)$$

$$\beta_{R12} = (\beta_{R11}{}^2) / (1 - \beta_{R11} + \beta_{R11}{}^2)$$

$$h_R^a = \beta_{R14} h_{R,t-10}^a + \beta_{R24} h_{R,t+10}^a \text{ , where } \beta_{R14} + \beta_{R24} = 1 \text{ and} \qquad \text{(2d)}$$

$$\beta_{R14} = (\beta_{R11}{}^2) / (1 - 2\beta_{R11} + 2\beta_{R11}{}^2)$$

We have obtained $\hat{\beta}_{OECD11}$ = 0.4607 (se = 0.01, t-stat = 82.49) for advanced countries. For developing countries, $\hat{\beta}_{NONOECD11}$ = 0.5492 (se = 0.01, t-stat = 102.67).

We note that, aside from missing observations for the years when no census was undertaken, there are other data issues we need to address to estimate average years of schooling. In what follows (Note 2 and Note 3), we discuss these issues and the procedure for estimating missing observations by category and subcategory. Specifically, we have to estimate missing *lu* data and decompose overlapping attainment data by age group across and within categories before estimating average years of schooling by age group.

2. *Estimation of missing lu data*. Some census data do not report *lu* or the proportion of those who have no formal education, and do report *lp*, *ls*, and *lh* among the educated members of the population only. To avoid overestimation of average years of schooling, for census years with missing *lu*, we use the illiteracy rate, primary enrollment ratio, or *lu* from other census years to estimate *lu*. We then adjust *lp*, *ls*, and *lh* to reflect both the educated and uneducated members in the total population. In some instances, data on *lu* is not missing but overlapped with other category(ies) or subcategory(ies). The procedure for estimating *lu* in this case is discussed in the following note (Note 3).

3. *Decomposition of overlapping observations*

A. *Observations that are overlapping across attainment categories*. In many OECD and non-OECD countries, available census data do not report data according to these four broad categories. Some census data report the proportion of those who have reached primary level

together with those who have no formal education (*lulp*). A number of countries also report the combined proportion of those who have reached secondary schooling or less (*lulpls*). Also, some census data report *lpls* or the combination of those who have reached primary or secondary levels.

To decompose these overlapping census observations we use enrollment data. Specifically, for census years where *lu* is combined with other category(ies) or subcategory(ies) (i.e., *lulp, lulpi, lulplsi, lulpls*), we use adjusted primary and/or secondary enrollment ratio by age group from earlier or later years and the age distribution profile to decompose the overlapping observations. The adjusted enrollment ratio is the gross enrollment ratio minus the proportion of repeaters. The age distribution profile is the relative population distribution by age group within an educational attainment at a specific time period. If the gross enrolment ratio is not available, the net enrolment ratio is used as a proxy for the adjusted enrollment ratio.

B. *Observations that are overlapping within an attainment category.* For more accurate estimates of average years of schooling, we also estimate distribution in each of the three broad educated categories (i.e., *lp, ls, lh*) if distribution data by subcategory (i.e., *lpi*, *lsi*, *lhi*) is missing. Specifically, we estimate and use available data on completion ratios to decompose overlapping observations within each category to sub-categories (i.e. $h^a_{jc,t} = h^a_{j,t} \cdot c^a_{j,t}$ and $h^a_{ji,t} = h^a_{j,t} - h^a_{jc,t}$). For countries with complete and available completion ratio data (i.e., for all age groups at either the primary, secondary, or tertiary level) for at least one year, we use a backward or forward estimation procedure to estimate the completion ratio for earlier and later years, respectively. The following describes the procedure for estimating missing data on the completion ratio in more detail.

i. *Estimating the primary and secondary completion ratio.* Table 3 below presents the rules for extrapolating from earlier or later years through a backward or forward extrapolation procedure for missing primary and secondary completion ratio data.

If available, we use country-specific completion ratio data to perform either or both backward or forward extrapolation of missing completion ratio data. Otherwise, we use income/regional

(advanced and developing countries) average estimates for the same age group and the same period.

Table 3. Rules for Extrapolating Primary and Secondary Completion Ratio

Age group (a)	Backward extrapolation	Forward extrapolation
15–19	$c_{j,t}^{15-19} = c_{j,t+5}^{25-29} \cdot (c_{j,t+5}^{15-19} / c_{j,t+5}^{20-24})$	$c_{j,t}^{15-19} = c_{j,t-5}^{20-24} \cdot (c_{j,t-5}^{15-19} / c_{j,t-5}^{25-29})$
20–24		$c_{j,t}^{20-24} = c_{j,t-5}^{20-24} \cdot (c_{j,t-5}^{20-24} / c_{j,t-5}^{25-29})$
25–29, 30–34,…, 65–69	$c_{j,t}^{a} = c_{j,t+5}^{a+1}$	$c_{j,t}^{a} = c_{j,t-5}^{a-1}$
70–74		$c_{j,t}^{70-74} = c_{j,t-5}^{70-74}$
75–79	$c_{j,t}^{75-79} = c_{j,t+5}^{75+79} \cdot (c_{j,t}^{75-79} / c_{j,t+5}^{70+74})$	$c_{j,t}^{75-79} = sh_{t-5}^{70-74} \cdot c_{j,t-5}^{70-74} + sh_{t-5}^{70-74} \cdot c_{j,t-5}^{75-79}$

Note: $c_{j,t}^{a}$ is the completion ratio or the proportion of people in age group a, for whom j is the highest level of schooling attained at time t who have completed j. $sh_t^a = pop_t^a / pop_t^{15+}$ or the share of the population in age group a to the total population at time t.

If complete country-specific or regional average completion ratio data are available from both earlier and later periods, we combine backward and forward estimates using advanced and developing countries primary/secondary completion weights.

Estimation of primary/secondary completion weights for advanced and developing countries. We also derive the weights by estimating the following system of simultaneous equations using available completion ratio data through a weighted least squares estimation procedure.

$$c_R^a = \beta_{R15} c_{R,t-5}^a + \beta_{R25} c_{R,t+5}^a \text{ , where } \beta_{R15} + \beta_{R25} = 1 \quad (3a)$$

$$c_R^a = \beta_{R16} c_{R,t-5}^a + \beta_{R26} c_{R,t+10}^a \text{ , where } \beta_{R16} + \beta_{R26} = 1 \text{ and} \quad (3b)$$

$$\beta_{R16} = (\beta_{R15}) / (1 - \beta_{R15} + \beta_{R15}^{\,2})$$

$$c_R^a = \beta_{R17} c_{R,t-10}^a + \beta_{R27} c_{R,t+5}^a \text{ , } \beta_{R17} + \beta_{R27} = 1 \text{ and} \quad (3c)$$

$$\beta_{R16} = (\beta_{R15}^{\,2}) / (1 - \beta_{R15} + \beta_{R15}^{\,2})$$

$$c_R^a = \beta_{R18} c_{R,t-10}^a + \beta_{R28} c_{R,t+10}^a \text{ , } \beta_{R18} + \beta_{R28} = 1 \text{ and} \quad (3d)$$

$$\beta_{R16} = (\beta_{R15}^{\,2}) / (1 - 2\beta_{R15} + 2\beta_{R15}^{\,2}) .$$

For advanced countries, we have obtained the estimates: $\hat{\beta}_{priOECD15} = 0.4754$ (se = 0.02, t-stat = 26.50) and $\hat{\beta}_{\sec OECD15} = 0.25$ (se = 0.05, t-stat = 4.78). For developing countries,

$\hat{\beta}_{priNONOECD15}$ = 0.3077 (se = 0.04, t-stat = 8.45) and $\hat{\beta}_{\sec NONOECD15}$ = 0.5929 (se = 0.03, t-stat = 20.69).

Aged 15–19 and 20–24. As with attainment data, we cannot directly estimate the completion ratio for those aged 15–19 and 20–24. We assume that the distribution of completion between two age groups will be stable across time. Hence, as shown in the table below, to estimate the completion ratio for 15–19 year olds through forward estimation, we use the completion ratio for the older age group from a later period as the benchmark figure and adjust this by multiplying with the ratio between the completion ratio among 15–19 year olds and the completion ratio among 20–25 year olds during the benchmark period. For 20-24 year olds, we use the completion ratio for the same age group from the earlier period and adjust it by the ratio between the completion ratio of 20–24 and 25–29 year olds.

When using backward estimation, we use the completion ratio among 25–29 year olds from the earlier period as benchmark to estimate the completion ratio for both 15–19 and 20–24 age groups. We adjust the benchmark value by multiply it with the ratio of the completion ratio between the corresponding age group (15–19 or 20–24 year olds) and 25–29 year olds during the benchmark period.

Aged 70 and over. For 70–74 year olds, we use the completion ratio for the same age group from the previous period as benchmark. For 75 years and above, we use the population weighted average of the completion ratios for 70–74 year olds and 75 and above during the reference period.

Since direct backward estimation is not applicable for individuals aged 75 years and above, when using backward estimation we use the completion ratio of the same age group and adjust it by the ratio of completion ratio among 75–79 year olds during the benchmark period to that of 70–74 year olds.

ii. Estimating tertiary completion ratio. Since tertiary data is not reported by subcategory for most countries, we use available tertiary completion ratio data reported by the UN Demographic

Yearbook (various years) and Kaneko (1986) to derive country-specific and income/region (advanced and developing countries) tertiary completion ratio estimates by age group. Again, we use a backward and forward estimation procedure to estimate completion ratio for years with missing information.

For time periods with no available tertiary completion ratio estimate, we again estimate missing values through a backward or forward estimation procedure, as discussed above. We also use a combination of backward and forward estimates and apply the appropriate tertiary completion ratio weight (estimation described below)

Aged 15–19 and 20–24. We assume that tertiary completion is relatively stable for the two younger age groups. Hence, when using either a backward or forward estimation procedure to estimate missing tertiary completion ratio for the 15–19 and 20–24 age groups, we use an unadjusted tertiary completion ratio for the same age group in the benchmark year (see table below).

Aged 25–29. When using forward estimation for ages 25–29, we multiply the completion ratio for the same age group with the ratio of completion ratio between 25–29 and 30–34 in the benchmark period.

Aged 75 and above. When estimating tertiary completion ratio for individuals 75 years and above through backward estimation, we also use the tertiary ratio for the same age group in the next period as the benchmark figure and adjust it by the ratio of the tertiary completion ratio between 75–79 to 70–74 in the same benchmark figure. When estimating through forward estimation, we use both the population weighted average of the tertiary completion ratio of 70–74 and 75 and above during the benchmark period.

Tertiary completion weights for advanced and developing countries. If both backward and forward estimates are available, we again combine backward and forward estimates using tertiary completion weights for advanced and developing countries. We also estimate these weights as in primary and secondary completion weights discussed in Note 2.B.i.

We have obtained estimates, $\hat{\beta}_{terOECD15}$ = 0.5111 (se = 0.03, t-stat = 18.88) for advanced countries and $\hat{\beta}_{terNONOECD15}$ = 0.4680 (se = 0.06, t-stat = 8.32) for developing countries.

Table 4. Rules for Extrapolating Tertiary Ratio

Age group (*a*)	Backward extrapolation	Forward extrapolation
15–19, 20–24	$c_{j,t}^{a} = c_{j,t+5}^{a}$	$c_{j,t}^{a} = c_{j,t-5}^{a}$
25–29	$c_{j,t}^{a} = c_{j,t+5}^{a+1}$	$c_{j,t}^{25-29} = c_{j,t-5}^{25-29} \cdot (c_{j,t-5}^{25-29} / c_{j,t-5}^{30-34})$
30–34, 35-39,…, 65–69		$c_{j,t}^{a} = c_{j,t-5}^{a-1}$
70–74		
75–79	$c_{j,t}^{75-79} = c_{j,t+5}^{75+74} \cdot (c_{j,t}^{75-79} / c_{j,t+5}^{75+74})$	$c_{j,t}^{75-79} = sh_{t-5}^{70-74} \cdot c_{j,t-5}^{70-74} + sh_{t-5}^{70-74} \cdot c_{j,t-5}^{75-79}$

Note: $c_{j,t}^{a}$ is the completion ratio or the proportion of persons in age group *a*, for whom *j* is the highest level of schooling attained at time *t* who have completed *j*. $sh_{t}^{a} = pop_{t}^{a} / pop_{t}^{15+}$ or the share of the population in age group *a* to the total population at time *t*.

Table 1. Breakdown of Number of Countries by Number of Census-Survey Observations

Number of observations (1950–2005)	Number of countries: All		Advanced		Developing	
	MF	F	MF	F	MF	F
1	54	53	1	1	53	52
2	43	47	1	1	42	46
3	32	29	3	3	29	26
4	22	26	4	4	18	22
5	29	26	8	8	21	18
6	11	8	2	2	9	6
7	3	4	1	2	2	2
8	5	4	4	3	1	1
9	0	0	0	0	0	0
10	1	1	0	0	1	1
Total	200	198	24	24	176	174

Note: The data refer to census-survey observations for educational attainment for the total (MF) and female (F) populations in each age category.

Table 2. Breakdown of Number of Countries by Number of Census-survey Year

Census-survey year (to the nearest 5-year value)	Number of countries: All		Advanced		Developing	
	MF	F	MF	F	MF	F
1950	25	25	8	8	17	17
1955	14	13	1	1	13	12
1960	64	64	15	15	49	49
1965	30	29	4	4	26	25
1970	85	81	17	17	68	64
1975	43	42	7	7	36	35
1980	90	87	18	18	72	69
1985	26	24	5	5	21	19
1990	91	88	14	13	77	75
1995	26	24	4	4	22	20
2000	68	68	11	11	57	57
2005	37	37	15	15	22	22
Total	599	582	119	118	480	464

Note: The data refer to census-survey observations for educational attainment for the total (MF) and female (F) populations in each age category.

Table 3. Trends of Educational Attainment of the Total Population Aged 15 and Over by Region

Region (no. of countries) and Year	Population Aged 15 and over (Million)	Highest level attained							Average years of schooling
		No Schooling	Primary		Secondary		Tertiary		
			Total	Completed	Total	Completed	Total	Completed	
		(% of population aged 15 and over							
World (146)									
1950	1588	47.2	38.1	18.8	12.5	6.0	2.2	1.1	3.17
1960	1831	42.5	38.4	19.1	16.3	8.1	2.7	1.4	3.65
1970	2221	35.6	38.1	20.2	22.4	11.4	3.9	2.0	4.45
1980	2761	30.6	33.0	17.8	30.5	12.4	6.0	3.1	5.29
1990	3413	25.5	30.5	17.5	35.6	16.1	8.3	4.4	6.09
2000	4064	20.1	27.5	17.5	41.8	21.5	10.6	5.9	6.98
2010	4759	14.8	25.2	17.6	48.0	26.1	11.9	6.7	7.76
Advanced (24)									
1950	428	9.2	60.1	38.1	25.0	12.7	5.7	2.8	6.22
1960	476	7.8	54.1	34.5	31.1	16.8	6.9	3.5	6.81
1970	541	6.2	45.3	31.7	38.6	21.8	9.9	5.1	7.74
1980	614	5.5	34.2	24.6	44.4	26.7	16.0	8.3	8.82
1990	683	5.5	27.0	19.7	44.9	25.9	22.6	11.6	9.56
2000	746	3.4	19.1	14.8	49.5	31.7	28.0	15.4	10.65
2010	805	2.3	14.2	11.5	57.9	37.7	25.6	14.5	11.03
Developing (122)									
1950	1160	61.2	30.0	11.7	7.9	3.5	0.9	0.5	2.05
1960	1355	54.7	32.9	13.7	11.1	5.1	1.3	0.7	2.55
1970	1681	45.1	35.8	16.4	17.2	8.1	1.9	1.0	3.39
1980	2146	37.7	32.7	15.9	26.5	8.3	3.1	1.6	4.28
1990	2730	30.5	31.4	16.9	33.3	13.6	4.8	2.6	5.22
2000	3318	23.9	29.4	18.2	40.1	19.2	6.6	3.8	6.15
2010	3954	17.4	27.4	18.8	46.0	23.7	9.2	5.1	7.09
By Region									
Middle East and North Africa (18)									
1950	48	88.1	8.5	3.5	2.6	1.1	0.9	0.5	0.76
1960	58	84.3	10.2	4.4	4.2	1.8	1.2	0.7	1.07
1970	75	75.6	14.1	6.1	8.4	3.8	2.0	1.0	1.78
1980	102	61.6	19.0	8.3	15.9	8.2	3.5	1.8	3.04
1990	142	45.2	24.1	11.3	25.6	14.5	5.1	2.8	4.58
2000	196	32.9	26.4	12.8	32.8	19.6	7.9	4.4	5.90
2010	256	24.5	24.4	14.8	39.6	23.3	11.6	6.0	7.12
Sub-Saharan Africa (33)									
1950	61	77.1	17.7	5.0	4.6	1.2	0.6	0.1	1.28
1960	76	72.3	22.1	6.5	5.0	1.3	0.7	0.2	1.52
1970	97	64.6	26.5	6.9	8.1	2.2	0.8	0.2	2.02
1980	129	55.2	32.1	11.0	12.0	3.8	0.8	0.3	2.76
1990	175	43.6	36.4	17.1	18.4	6.2	1.5	0.5	3.93
2000	233	38.4	35.9	19.3	23.5	7.3	2.2	0.7	4.62
2010	295	32.6	37.9	23.5	26.9	8.6	2.5	0.9	5.23

Region (no. of countries) and Year	Population Aged 15 and over (Million)	No Schooling	Highest level attained: Primary Total	Primary Completed	Secondary Total	Secondary Completed	Tertiary Total	Tertiary Completed	Average years of schooling
			(% of population aged 15 and over						
Latin America and the Carribean (25)									
1950	98	45.9	46.6	15.5	6.5	3.0	1.0	0.6	2.57
1960	124	39.1	49.7	17.6	9.6	4.2	1.5	1.0	3.07
1970	161	30.2	52.4	20.3	14.9	6.1	2.5	1.5	3.82
1980	215	22.5	52.6	15.4	19.5	8.3	5.3	3.0	4.60
1990	278	16.5	48.6	15.7	26.9	12.2	8.0	4.5	5.79
2000	351	12.2	41.9	23.3	35.9	18.0	9.9	5.7	7.13
2010	425	7.7	34.5	22.3	45.1	25.3	12.6	7.1	8.26
East Asia and the Pacific (19)									
1950	496	67.1	24.7	8.6	7.8	4.2	0.4	0.2	1.77
1960	556	56.6	30.9	12.1	11.6	6.6	0.9	0.5	2.50
1970	695	40.4	39.4	17.2	19.0	11.6	1.3	0.7	3.66
1980	900	26.4	40.5	19.8	31.3	10.0	1.8	0.9	4.84
1990	1168	23.0	36.4	19.5	37.2	19.6	3.4	1.7	5.60
2000	1377	14.3	33.2	19.3	46.5	30.4	6.0	3.5	6.82
2010	1593	7.9	30.1	19.0	51.7	38.1	10.3	5.8	7.94
South Asia (7)									
1950	282	76.1	20.5	5.7	2.9	1.0	0.6	0.3	1.02
1960	341	73.4	22.4	7.0	3.6	1.2	0.6	0.3	1.16
1970	423	68.7	24.1	10.6	6.2	1.8	1.1	0.6	1.59
1980	543	69.2	14.1	8.5	14.5	1.7	2.1	1.1	2.10
1990	694	53.1	18.6	13.6	24.6	2.7	3.7	2.0	3.41
2000	879	44.7	19.5	15.8	31.3	4.0	4.6	2.7	4.22
2010	1100	33.2	21.5	18.8	39.8	6.0	5.5	3.0	5.24
Europe and Central Asia (20)									
1950	174	16.1	61.1	32.9	20.0	7.5	2.7	1.5	4.83
1960	199	11.7	56.6	32.5	28.0	10.2	3.7	2.1	5.56
1970	229	7.8	46.0	29.6	40.5	14.4	5.7	3.1	6.69
1980	257	5.4	33.4	23.5	52.3	18.6	8.9	4.9	7.88
1990	272	3.4	25.5	18.5	59.0	21.8	12.0	7.1	8.85
2000	283	2.5	22.8	16.3	60.0	22.7	14.6	8.5	9.13
2010	284	1.3	16.4	11.8	65.5	25.3	16.9	9.9	9.65

Table 4. Educational Attainment by Sex, 1950–2010

Region (no. of countries) and Year	Average years of schooling (population 15 age and over) Females (A)	Males (B)	Gender Ratio (A/B, %)
World (146)			
1950	2.68	3.67	73.1
1960	3.12	4.20	74.2
1970	3.86	5.04	76.7
1980	4.70	5.88	80.0
1990	5.58	6.60	84.5
2000	6.47	7.47	86.7
2010	7.28	8.21	88.6
Advanced (24)			
1950	5.89	6.58	89.5
1960	6.44	7.21	89.4
1970	7.38	8.14	90.7
1980	8.42	9.25	91.0
1990	9.29	9.85	94.4
2000	10.39	10.92	95.1
2010	10.90	11.16	97.7
Developing (122)			
1950	1.50	2.60	57.7
1960	1.95	3.14	62.0
1970	2.73	4.04	67.6
1980	3.63	4.91	74.0
1990	4.65	5.78	80.3
2000	5.59	6.69	83.6
2010	6.54	7.62	85.9
By Region			
Middle East and North Africa (18)			
1950	0.44	1.07	41.3
1960	0.63	1.51	41.5
1970	1.10	2.47	44.5
1980	2.08	3.97	52.5
1990	3.53	5.58	63.1
2000	5.03	6.75	74.5
2010	6.41	7.83	81.8
Sub-Saharan Africa (33)			
1950	1.03	1.55	66.7
1960	1.12	1.93	58.1
1970	1.52	2.55	59.5
1980	2.08	3.47	59.9
1990	3.17	4.71	67.3
2000	3.97	5.30	74.9
2010	4.63	5.83	79.4
Latin America and the Carribean (25)			
1950	2.38	2.77	85.8
1960	2.85	3.29	86.7
1970	3.56	4.09	87.0
1980	4.39	4.82	91.1
1990	5.69	5.90	96.5
2000	7.06	7.21	97.9
2010	8.21	8.32	98.7

Region (no. of countries) and Year	Average years of schooling (population 15 age and over) Females (A)	Males (B)	Gender Ratio (A/B, %)
East Asia and the Pacific (19)			
1950	1.12	2.40	46.8
1960	1.72	3.24	53.0
1970	2.86	4.42	64.7
1980	4.11	5.54	74.1
1990	5.26	5.92	88.9
2000	6.21	7.41	83.8
2010	7.47	8.39	88.9
South Asia (7)			
1950	0.41	1.57	26.0
1960	0.52	1.75	29.8
1970	0.87	2.27	38.1
1980	1.41	2.75	51.4
1990	2.26	4.48	50.5
2000	3.40	4.99	68.3
2010	4.25	6.20	68.6
Europe and Central Asia (20)			
1950	4.31	5.53	77.9
1960	5.16	6.06	85.1
1970	6.23	7.25	85.9
1980	7.42	8.41	88.2
1990	8.55	9.20	92.9
2000	9.30	8.93	104.1
2010	9.89	9.36	105.7

Table 5. Comparison of Average Years of Schooling (Over Age 15 and 25) Between Series

A. Barro-Lee 2010 and Barro-Lee 2001	Obs	Correlation	**Barro-Lee 2010**		**Barro-Lee 2001**	
			1960	2000	1960	2000
World						
Levels	984	0.96	4.00	6.98	4.30	6.58
			2.57	*2.73*	*2.54*	*2.79*
10-year difference	746	0.97		5.93		5.97
				2.72		*2.77*
Advanced countries						
Levels	201	0.92	7.03	10.65	6.96	9.77
			2.21	*1.55*	*2.27*	*1.85*
10-year difference	155	0.92		9.55		9.21
				1.78		*1.99*
Developing countries						
Levels	783	0.95	2.46	6.10	2.96	5.82
			2.02	*2.52*	*1.99*	*2.43*
10-year difference	591	0.96		5.06		5.19
				2.46		*2.40*

B. Barro-Lee 2010 and Cohen-Soto (2007)	Obs	Correlation	**Barro-Lee 2010**		**Cohen-Soto (2007)**	
			1960	2010	1960	2010
World						
Levels	540	0.94	3.54	7.78	4.03	7.40
			2.56	*2.71*	*2.85*	*3.05*
10-year difference	450	0.95		6.86		6.71
				2.78		*3.06*
Advanced countries						
Levels	132	0.83	6.81	11.03	8.14	11.66
			2.23	*1.37*	*2.10*	*1.77*
10-year difference	110	0.82		10.66		11.15
				1.59		*1.86*
Developing countries						
Levels	408	0.95	2.10	7.00	2.23	6.37
			1.76	*2.50*	*1.91*	*2.53*
10-year difference	340	0.95		5.94		5.63
				2.48		*2.46*

Obs = overlapping observations

Notes: Figures presented in this table represent overlapping observations only. The new Barro-Lee data set consists of a total of 1,898 observations on average years of schooling at 5-year intervals for 146 countries (1950–2010); Barro-Lee data set (2001): 930 observations for 107 countries (1960-2000); Cohen-Soto (2007): 570 observations at 10-year intervals for 95 countries (1960–2010). Of these 95 countries, 5 countries are not in Barro-Lee (2010). Numbers in italics are standard deviations.

Source: Authors' calculations based on Barro-Lee (2001), Cohen-Soto (2007) data sets and own data.

Table 6. OLS and IV Regression Results for Log Output per Worker

A. Rate-of-return to Schooling: Total Population, 15 years and above

ln(Real GDP per worker)	OLS		IV	
	Random	Fixed	Random	Fixed
	(1)	(2)	(3)	(4)
ln(capital stock per worker)	0.652	0.650	0.580	0.544
	[27.3]***	[20.1]***	[18.3]***	[12.3]***
Ave. years of schooling	0.017	0.019	0.055	0.121
	[1.77]*	[1.74]*	[3.26]***	[3.16]***
Observations	962	962	962	962
Number of countries	127	127	127	127
R-squared	0.87	0.61	0.86	0.55

B. Rate-of-return to Schooling by Region

	(5)	(6)	(7)	(8)
ln(capital stock per worker)	0.625	0.596	0.560	0.492
	[23.0]***	[15.1]***	[16.4]***	[8.55]***
Ave. years of schooling				
North Africa and Middle East	0.008	-0.001	0.057	0.078
	[0.57]	[0.04]	[2.91]***	[2.43]**
Sub-Saharan Africa	0.006	0.004	0.038	0.066
	[0.51]	[0.27]	[1.76]*	[1.78]*
Latin America	0.000	-0.001	0.034	0.065
	[0.02]	[0.05]	[1.81]*	[1.82]*
East Asia	0.032	0.052	0.052	0.103
	[2.52]**	[3.91]***	[2.43]**	[2.53]**
South Asia	-0.015	0.001	0.035	0.113
	[0.57]	[0.05]	[1.09]	[1.97]**
Europe and Central Asia	-0.012	0.008	0.015	0.085
	[0.94]	[0.38]	[0.75]	[1.56]
Advanced countries	0.031	0.047	0.066	0.133
	[3.27]***	[3.90]***	[3.75]***	[3.39]***
Observations	962	962	962	962
Number of countries	127	127	127	127
R-squared	0.87	0.62	0.87	0.58

C. Rate-of-return to Schooling by Educational Attainment

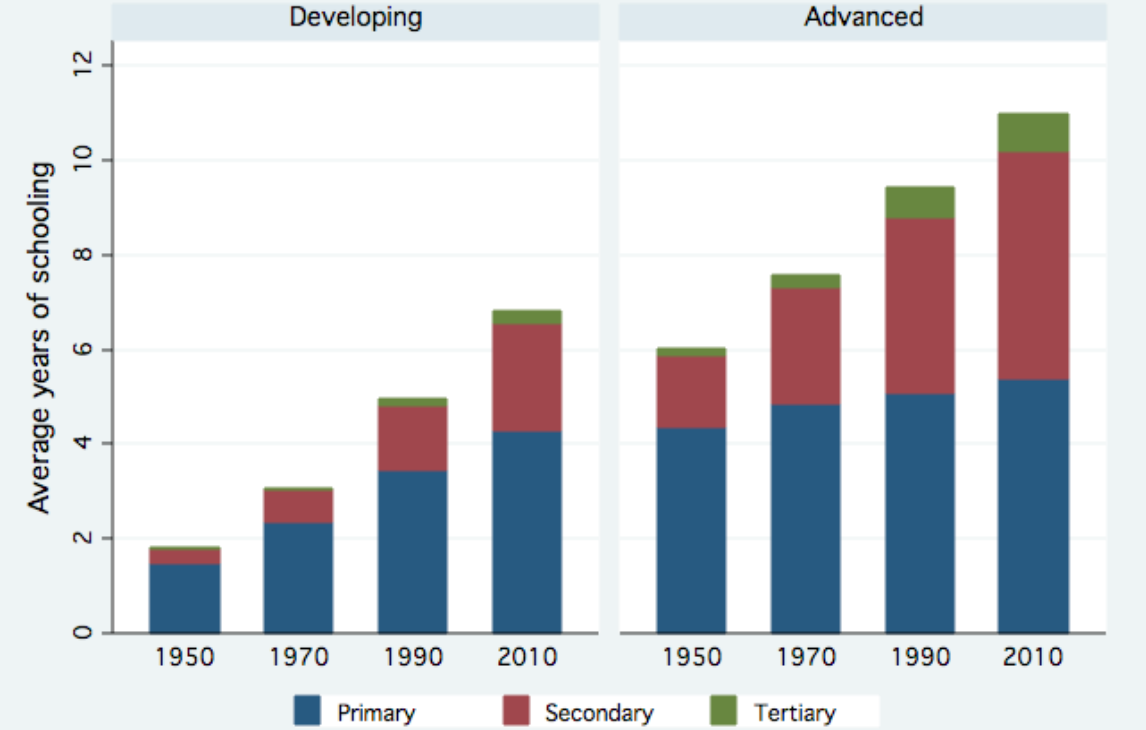
	(9)	(10)	(11)	(12)
ln(capital stock per worker)	0.634	0.613	0.569	0.534
	[26.4]***	[18.1]***	[17.8]***	[13.0]***
Ave. years of schooling				
Primary	-0.042	-0.055	-0.023	-0.045
	[3.13]***	[3.19]***	[0.98]	[0.83]
Secondary	0.063	0.063	0.103	0.100
	[3.94]***	[3.66]***	[2.62]***	[2.26]**
Tertiary	0.211	0.173	0.268	0.179
	[3.54]***	[2.52]**	[2.01]**	[0.83]
Observations	962	962	962	962
Number of countries	127	127	127	127

R-squared	0.88	0.62	0.87	0.62

Notes: Robust t/z statistics in brackets. *significant at 10%; ** significant at 5%; *** significant at 1%.
Intercept term, oil exporters dummy and time dummies are included but not reported.
Instrument for the average years of schooling (*s*) is the 10-year lag of *s* among 40-74 years old (L2.*s*40-74); For the average years of schooling (*s*) by region, say region *j*, the instrument is the 10-year lag of *s* among 40-74 years old in region *j*; Instrument for the average years of schooling (*s*) among those who have reached level *k* is the 10-year lag of *s* among 40-74 years old who have reached level *k*; Instrument for log capital-worker ratio is the 10-year lagged variable.

Figure 1. Educational Attainment of the Total Population over Age 15

a. Average years of schooling, by educational level



Note: Advanced countries = Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, USA, United Kingdom.

b. Average years of schooling, by age group

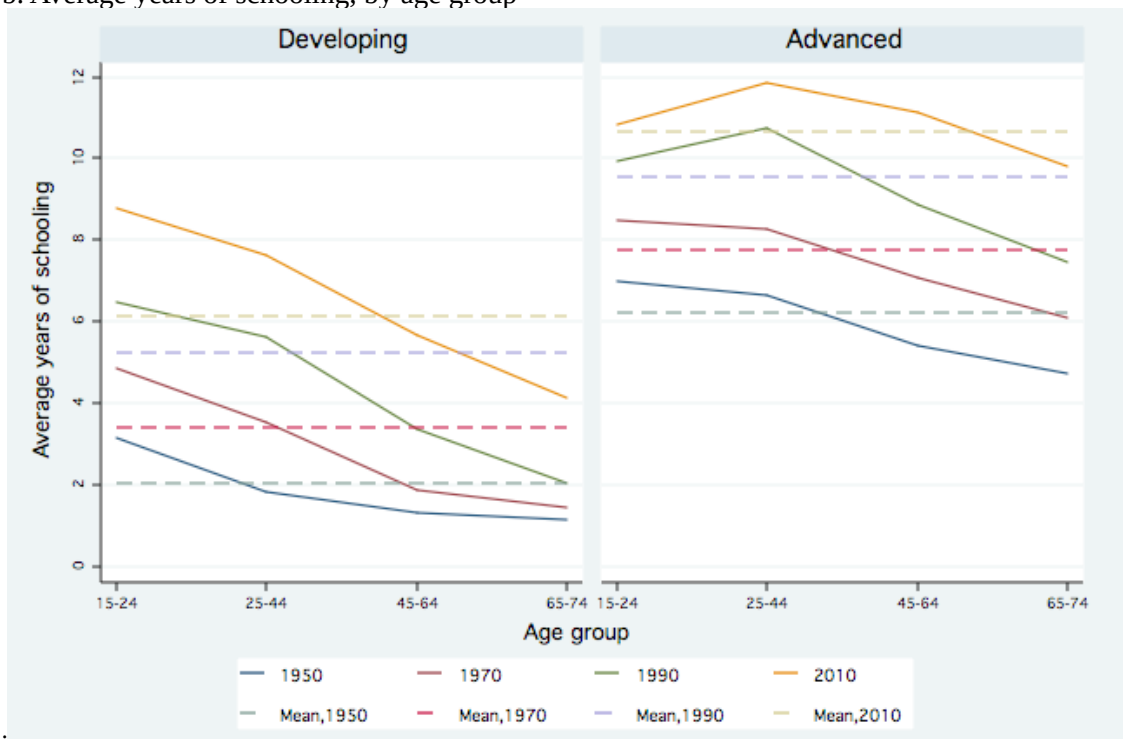


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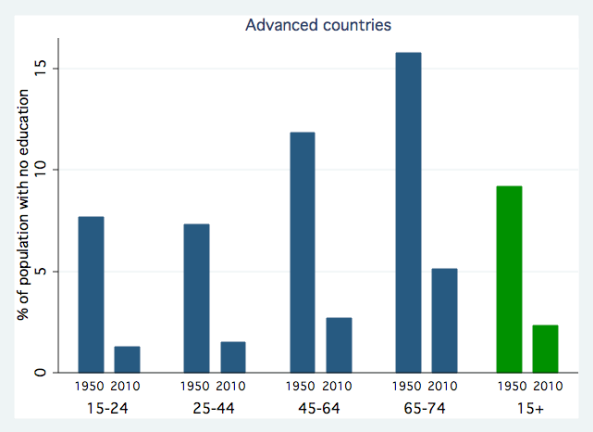
Figure 2. Proportion of Population (15 Years Old and Above) with No schooling, by Age Group



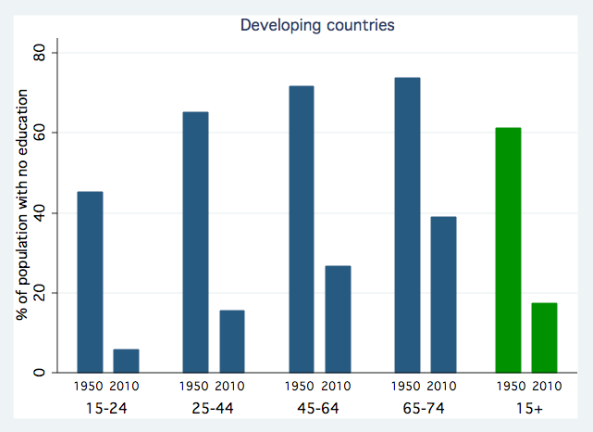


Figure 3. Comparison of Barro-Lee (2010) and Barro-Lee (2001) Estimates

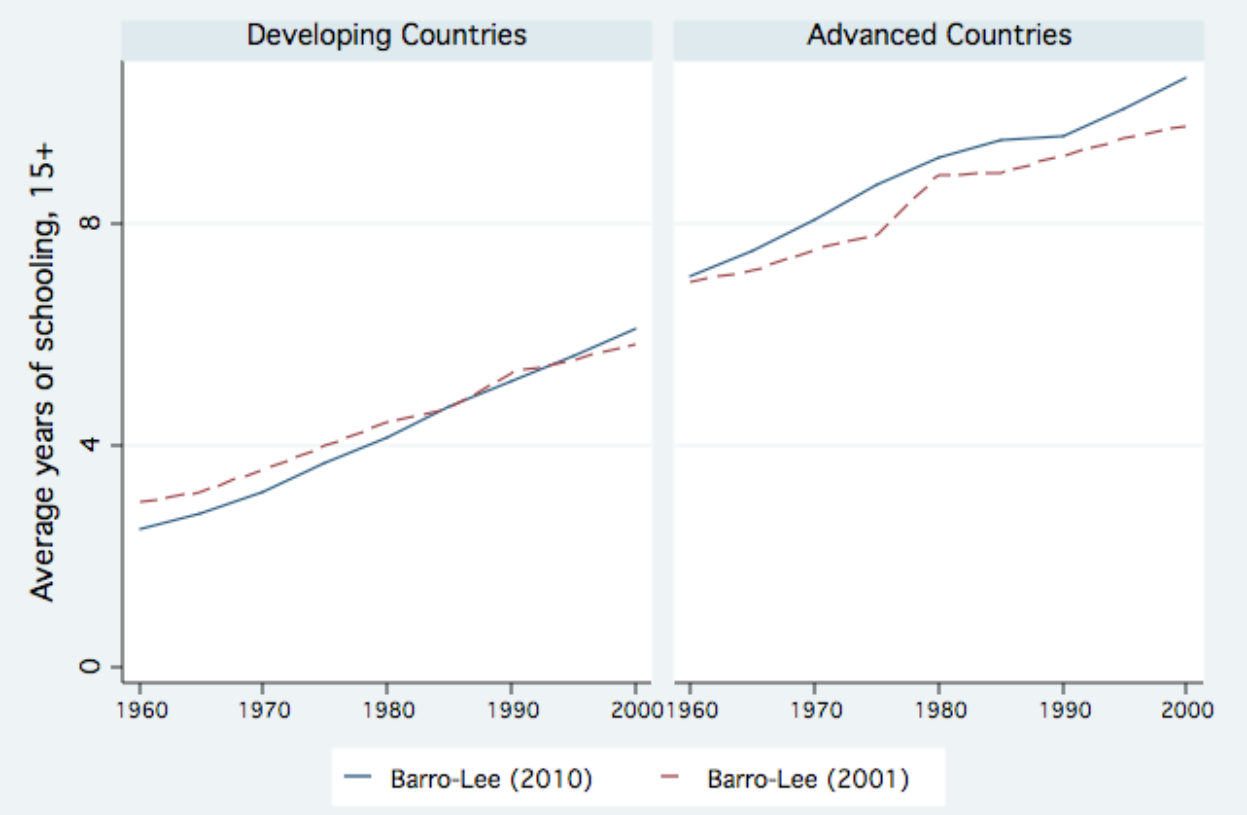


Figure 4. Average Years of Schooling, Barro-Lee (2010) and Barro-Lee (2001) Estimates, Selected Countries

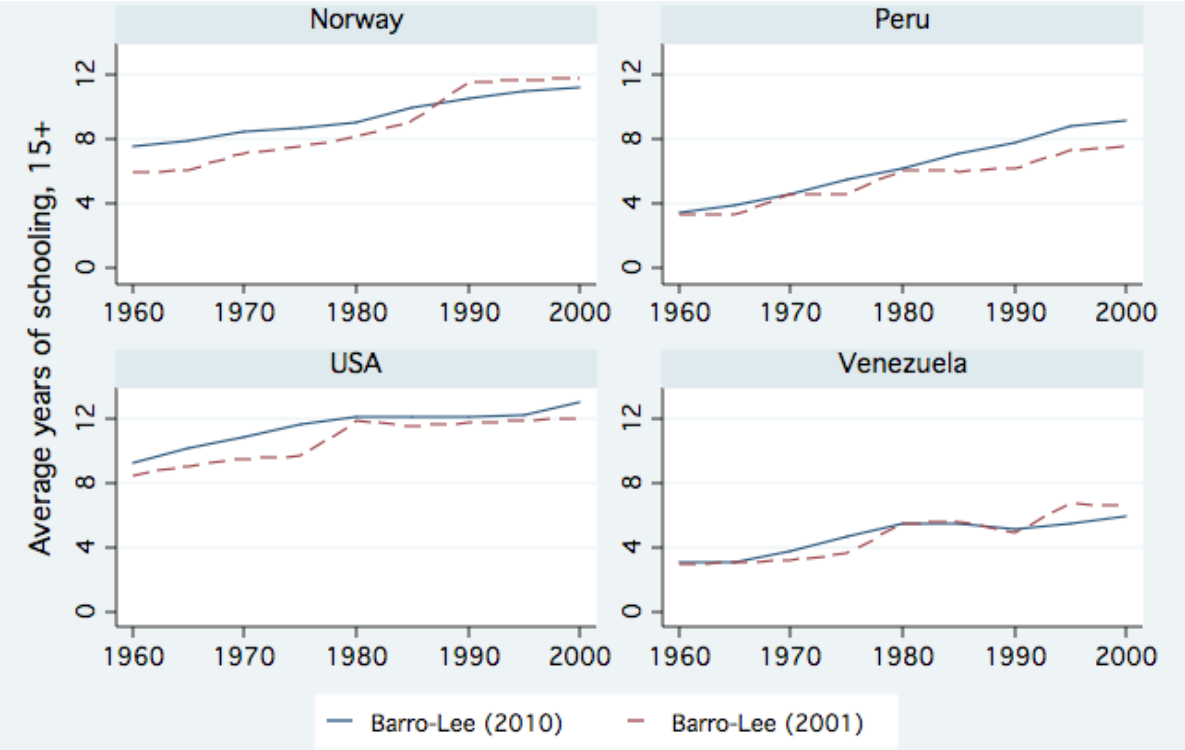


Figure 5. Comparison of Barro-Lee (2010) and Cohen-Soto (2007) Estimates

Trend, 1960–2010

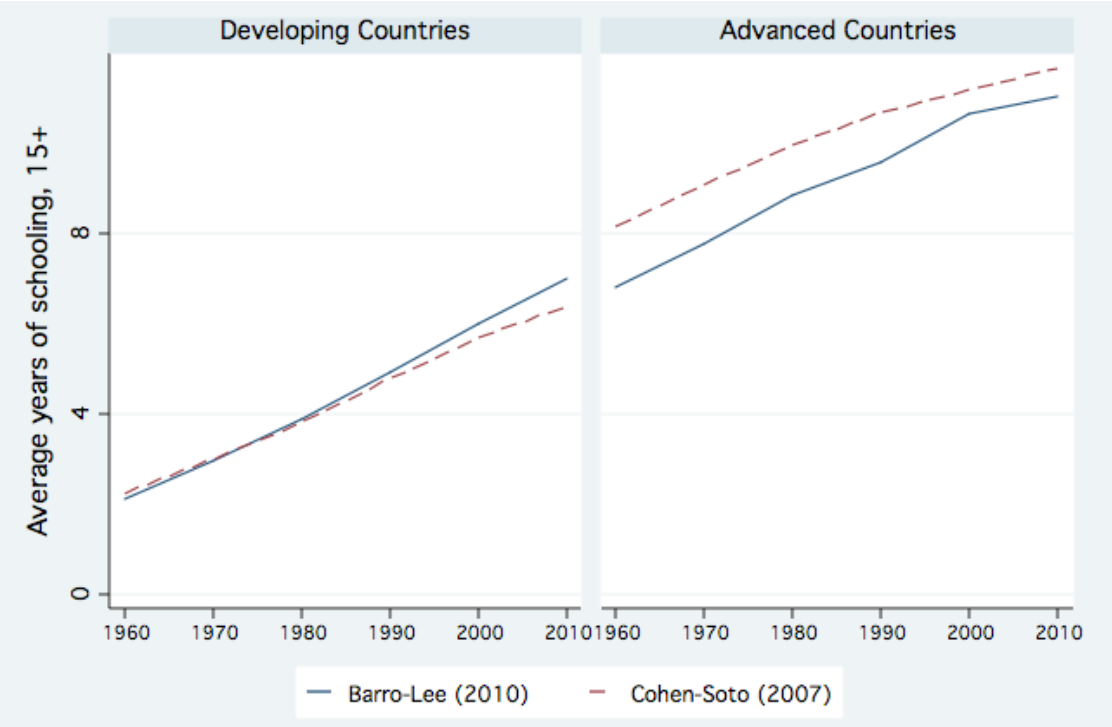
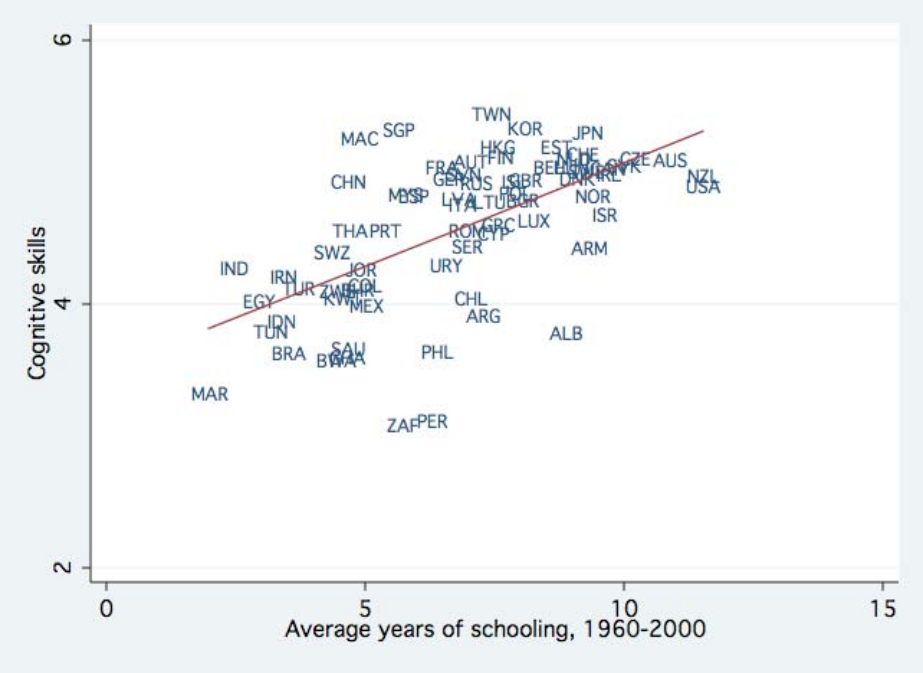
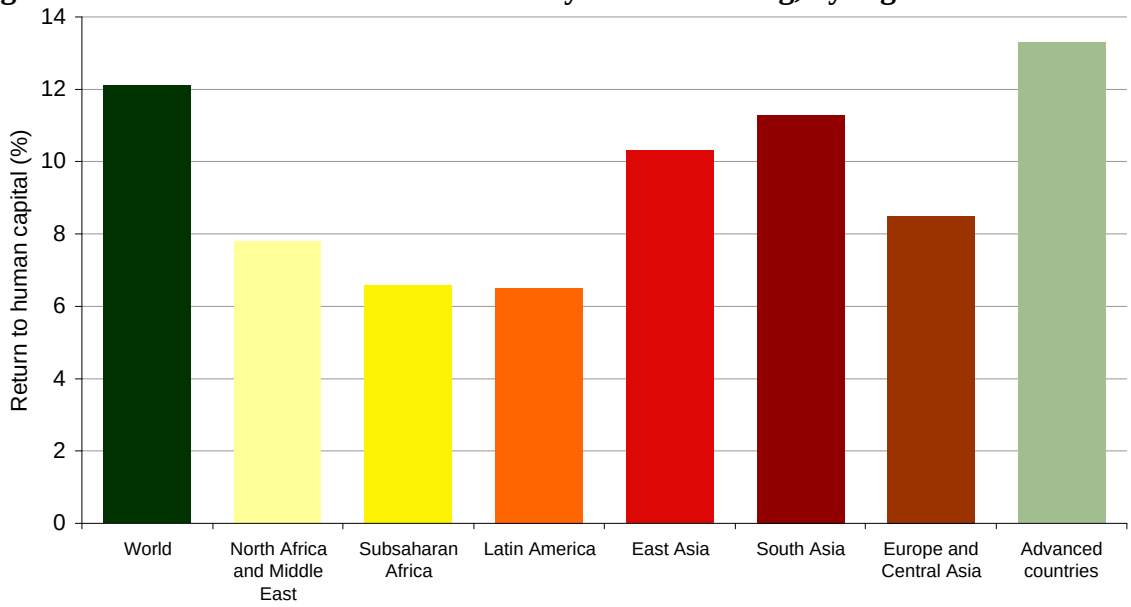


Figure 6. Comparison of Barro-Lee (2010) Years of Schooling Estimates and Hanushek-Woessmann (2009) Labor Force Quality Estimates



Note: Figures on years of schooling are simple average years of schooling for 1960–2000.

Figure 7. Rates of Return to an additional year of schooling, by region



Source: Country fixed-effects instrumental variable (IV) regression estimates presented in Table 6 column (8).

Appendix Table. Availability of Educational Attainment Census/Survey Data by Country

Region/Country	No. of censuses	Original census year											
		1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Middle East and North Africa													
Algeria	4		1954		1966*	1971						2000	
Bahrain	4				1965#	1971				1991		2001	
Cyprus	5	1946#		1960						1992		2001	2005
Egypt	2						1976		1986				
Iran, Islamic Republic of	3		1956		1966						1996		
Iraq	2		1957		1965								
Israel	4			1961		1972		1982					2006
Jordan	2			1961				1979					
Kuwait	6					1970	1975	1980	1985		1995		2006
Libyan Arab Jamahiriya	3				1964#		1973		1984				
Malta	3	1948			1967								2005
Morocco	1					1971							
Qatar	2								1986				2004
Saudi Arabia	1												2004
Syrian Arab Republic	3			1960		1970						2002	
Tunisia	5				1966		1975	1980	1984		1994		
United Arab Emirates	1						1975						
Yemen	1						1975#						
Sub-Saharan Africa													
Benin	3							1979#		1992*		2000	
Botswana	4				1964#	1971		1981#		1991			
Burundi	1									1990			
Cameroon	1						1976						
Central Africa	2						1975			1988			
Congo	1								1984				
Cote d'Ivoire	1									1988			
Democratic Republic of the Congo	1		1955										
Gabon	1										1993		
Gambia	2						1973				1993		
Ghana	2			1960#		1970							
Kenya	3			1962		1969		1979					
Lesotho	2				1966		1976						
Liberia	2			1962#			1974#						
Malawi	4				1966		1977		1987			1998	
Mali	1						1976						
Mauritania	1									1988			
Mauritius	6	1952		1962		1972			1983	1990		2000	
Mozambique	2							1980			1997		
Namibia	2			1960						1991			
Niger	1						1977						
Reunion	2		195#4		1967#								
Rwanda	1							1978					

Region/Country	No. of censuses	Original census year											
		1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Senegal	1						1976						
Sierra Leone	1				1963#								
South Africa	6			1960		1970		1980*	1985		1996	2001	
Sudan	2		1956						1983				
Swaziland	3				1966		1976		1986				
Togo	2					1970		1981					
Uganda	4			1959#		1969				1991		2002	
United Republic of Tanzania	1											2000	
Zambia	4					1969		1980#		1990	1993#		
Zimbabwe	2									1992		2002	
Latin America and the Caribbean													
Argentina	6	1947#		1960#		1970		1980#		1991		2001	
Barbados	3					1970		1980				2000	
Belize	4			1960		1970		1980		1991			
Bolivia	3						1976			1992		2001	
Brazil	5	1950				1970	1976	1980					2004
Chile	6	1952		1960#		1970		1982		1992		2002	
Colombia	4	1951					1973#				1993		2006
Costa Rica	5	1950			1963	1968	1973						2007
Cuba	2		1953					1981					
Dominican Republic	2			1960#		1970							
Ecuador	6	1950		1962			1974	1982		1990		2001	
El Salvador	5	1950		1961#		1971*				1992			2006
Guatemala	5	1950			1964#		1973	1981					2006
Guyana	2					1970		1980					
Haiti	4	1950				1971		1982	1986*				
Honduras	3			1961			1974		1983				
Jamaica	5			1960		1970		1982		1991		2001	
Mexico	6			1960#		1970*#		1980		1990		2000	2006
Nicaragua	2	1950				1971*							
Panama	6	1950		1960		1970*		1980		1990		2000	
Paraguay	7	1950		1962#		1972#		1982		1992		2002	2006
Peru	4			1961		1972		1981			1993		
Trinidad and Tobago	3					1970		1980		1990			
Uruguay	5				1963		1975		1985		1996		2006
Venezuela	5	1950		1961		1971		1981		1990			
East Asia and the Pacific													
Brunei Darussalam	3			1960		1971		1981					
Cambodia	1											1998	
China	3							1982		1990*		2000	
China, Hong Kong SAR	7				1966	1971	1976	1981	1986	1991		2001	
China, Macau SAR	3					1970				1991#			2006
Fiji	4				1965		1976		1986		1996		
Indonesia	5			1961		1971		1980		1990		2000#	

Region/Country	No. of censuses	Original census year											
		1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Lao, People's Democratic Republic	1										1995		
Malaysia	4			1957#				1980*		1991		2000	
Mongolia	2									1989		2000	
Myanmar	4		1953#				1973		1983	1991			
Papua New Guinea	2					1971		1980					
Philippines	8	1948	1956	1960#		1970	1975#	1980#		1990#		2000	
Republic of Korea	10		1955#	1960	1965	1970	1975	1980	1985	1990	1995	2000	
Singapore	5					1970		1980		1990		2000#	2006
Taiwan	5				1965#		1975	1980*				2001	2005
Thailand	4			1960		1970		1980				2000	
Tonga	2								1986#		1996		
Viet Nam	2							1979		1989			
South Asia													
Afghanistan	1							1979					
Bangladesh	4			1961#			1974	1981				2001	
India	4			1961		1971#		1981		1991			
Maldives	2								1985			2000	
Nepal	5			1961		1971		1981*		1991		2001	
Pakistan	5			1961#				1981		1990		1998	2006
Sri Lanka	3				1963	1969		1981					
Europe and Central Asia													
Albania	1											2001	
Armenia	1											2001	
Bulgaria	4		1956		1965					1992		2001	
Croatia	2									1991		2001	
Czech Republic	5			1961		1970		1980		1991			2006
Estonia	2									1989		2000	
Hungary	6			1960	1963	1970		1980		1990		2001	
Kazakhstan	2									1989		1999	
Kyrgyzstan	1											1999	
Latvia	2									1989		2000	
Lithuania	3									1989		2001	2007
Republic of Moldova	1									1989			
Poland	5			1960		1970		1978		1988		2002	
Romania	5		1953#		1966		1977*			1992		2002	
Russian Federation	4			1959		1970				1989	1994		
Serbia	5		1953*			1971		1981		1991		2002	
Slovakia	5			1961		1970		1980		1991		2001	
Slovenia	4		1953*			1971		1981				2002	
Tajikistan	1									1989			
Ukraine	2					1970						2001	
Advanced Countries													
Australia	3				1966	1971		1981					
Austria	5			1961#		1971		1981		1991			2005
Belgium	3			1961#		1970							2006
Canada	8	1951		1961		1970	1975	1981	1986	1991		2001	

Region/Country	No. of censuses	Original census year											
		1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Denmark	4								1983	1991	1994	2001	
Finland	8	1950		1960		1970#		1980	1985	1990		2000	2006
France	5		1954#	1962				1982		1990			2004
Germany	6					1970#	1978	1980	1985			2001	2006
Greece	6	1951		1961				1981		1991		2001	2005
Iceland	1			1960									
Ireland	5				1966	1971		1981		1991		2002	
Italy	5	1951		1961		1971		1981					2005
Japan	4			1960		1970		1980		1990			
Luxembourg	2									1991		2001	
Netherlands	3			1960		1971							2005
New Zealand	5				1966#		1976	1981		1991		2001	
Norway	8	1950#		1960		1970	1975	1980		1990		2001	2006
Portugal	5			1960		1970		1981		1991			2006
Spain	4					1970		1981		1991			2006
Sweden	5					1970#	1974	1979			1995		2005
Switzerland	5			1960		1970		1980				2000	2005
Turkey	7	1950#			1965#		1975	1980	1985		1993		2006
United Kingdom	4	1950#		1961		1971	1976#						
United States	8	1950		1960		1970		1980		1990*	1994	2002	2005

Notes: * indicates that the census has information for total population only; + indicates that census has information for female population only; # indicates that the census has information for a broad age group only.
SAR = Special Administrative Region