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Policy Research Working Paper 5616

Education

Past, Present and Future Global Challenges

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Abstract

Progress in educational development in the world since 1900 has been slow and uneven between countries. Providing basic education for all children in developing countries has been and remains an unmet challenge of governments and international organizations alike. This is in sharp contrast to recent findings in the economics literature on the catalytic role of human capital for economic growth and social development in general. Using a newly constructed matched data set on education and national accounts in the 1950 to 2010 period, this paper estimates the loss of income and equity associated with not having a faster rate of human capital accumulation, using alternative methodologies and specific country examples. Such loss is projected backward (1900–1950) and forward (2010–2050) using plausible assumptions regarding what countries could have done in the past or may do in the future to accelerate human capital formation. The findings suggest that the welfare loss in terms of per capita income conservatively ranges from about 7 to 10 percent. Improved educational attainment is also shown to have an effect in reducing income inequality.

This paper is a product of the the Education Team, Human Development Network. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at hpatrinos@worldbank.org.

Education: Past, Present and Future Global Challenges[1]

Harry Anthony Patrinos and George Psacharopoulos[2]

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Contents

1. Introduction

Formal education is a relatively recent institution in the history of mankind dating a mere two centuries. The recognition that education relates to the country's development is even more recent, dating back just a few decades. Non-formal education of course existed since time immemorial in the form of philosopher/student or master/apprentice relationship, and some European universities date back to the 13th century. But organized schooling where children of a certain age were obliged to attend school started as late as the nineteenth century in England.

The link between education and economic development was instigated by the so-called human capital school originating at the University of Chicago in the early 1960s (Schultz 1961a; Becker 1964). According to early versions of human capital theory, expenditure on education is an investment with many similarities to investment in machines. National resources are used while the student is in school, in the form of direct outlays to education and foregone labor earnings. But later in life more educated workers contribute to national output more than less educated workers. The discounted difference between the cost and benefit flows related to education can lead to estimates of the profitability of investment in human capital.

This basic idea was expanded in the 1980s and 1990s to include predictions of the so-called new growth theory postulating that education, beyond enhancing an individual's productivity, also has an efficiency boosting "external" effect on others, thus further enhancing national output (Lucas 1988; Romer 1986, 1990). A flood of empirical research has followed attempting to estimate the effect of education on economic growth (see, for example, Barro 1991; Mankiw, Romer and Weil 1992; McMahon 1999; Benhabib and Spiegel 1994, 2005).

Throughout the short history of formal education it has been a perennial challenge as to how to provide the quantity and type of education that would maximize social welfare. In this paper we define the welfare loss related to education in terms of efficiency and equity. Given the lack of a global utility function, welfare loss in this paper really means loss of income. The efficiency component is estimated as a counterfactual of higher per capita income or its growth had educational development proceeded faster than indicated in the historical data. The equity component is estimated by the change in the Gini inequality index had countries followed more expansive education policies.

Our estimates of the loss associated with education spanning 1900 to 2050 are based on a comparison of two scenarios: (1) An inertia scenario where countries follow existing education policies and (2) a challenge scenario where countries would have followed more efficiency- and equity-oriented education policies.

Backward and forward extrapolation of the welfare loss is based on coefficients regarding the contribution of education to economic growth and equity in the "actual" or "data-known" period 1950 to 2000 from new estimates and the empirical literature on the subjects and, of course, assumptions regarding the application of such coefficients beyond the range of actual data. Given the highly aggregate nature of this exercise, high and low estimates are given.

The coefficients linking education to economic growth are derived from two subsets of the economics of education literature: (1) Micro estimates of the social rates of return to

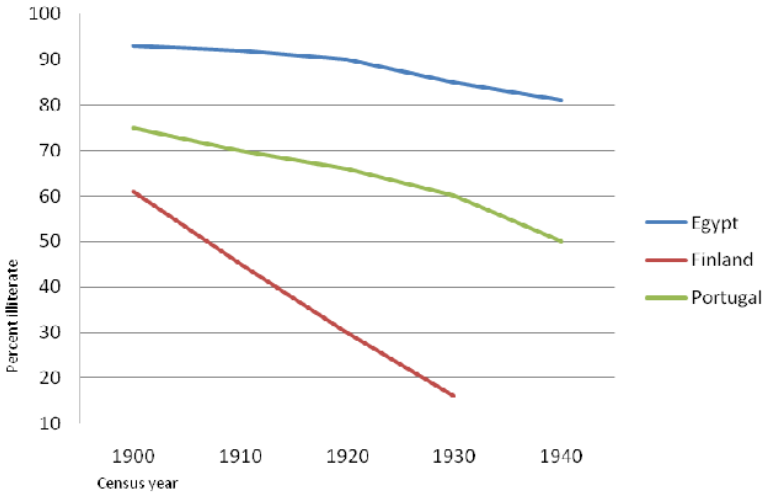
investment at different levels of education and (2) macro estimates of the contribution of education to economic growth. The data come from historical national accounts statistics and a variety of education databases.

The following section provides a bird's eye view of world educational development in the period 1900 to the present. Section 3 defines the education challenge. Section 4 provides a brief review of empirical findings regarding the contribution of education to economic growth and equity. Section 5 presents the methodology used in this paper for assessing the macro effect of one additional year of schooling on per capita income and applies it at the world, regional and individual country scale. Section 6 assesses the effect of illiteracy on per capita income. Section 7 estimates the effect of education on equity. Section 8 discusses several caveats associate with this study. The final section gives our best estimate of the size and over time evolution of the welfare loss related to education.

2. Historical perspective

Education statistics prior to 1950 are spotty. The first systematic collection of school enrolment statistics started well after the foundation of UNESCO in 1946. From the ability of people to sign their name in marriage registries in England and a few other countries, as well from population censuses, we know that the extent and progress of literacy has been very slow early in the twentieth century (Figure 1).

Figure 1. Progress in reduction of illiteracy in selected countries



Source: Based on Unesco (1953)

The slow buildup of human capital since 1900 in developing countries and the deceleration of human capital formation in Western countries since 1960 are shown in Table 1 and Figure 2. Such a pattern suggests an *S*-shaped over time trend in educational development, a theme that we will return to later in this paper.

Table 1. Mean years of schooling and illiteracy rates (%), 1870-2000

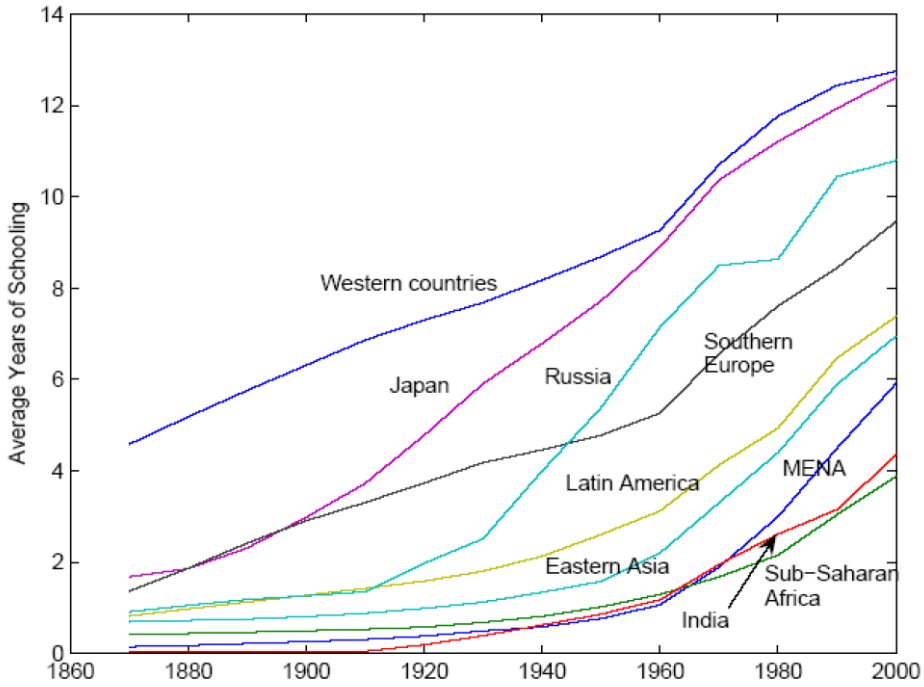
	Africa	Japan Korea Taiwan	Latin America	Eastern Europe	Europe & offshoots	China	South Asia	Other Asia	World mean
1870 School years	0.13	0.63	0.59	0.83	3.02	1.00	0.03	0.25	1.0
Illiteracy	96.5	82.9	86.0	79.1	37.2	82.3	99.3	94.6	78.9
1910 School years	0.27	2.41	1.28	1.61	5.00	1.26	0.27	0.50	1.8
Illiteracy	93.8	46.2	71.8	67.8	16.1	78.6	94.6	89.6	67.0
1950 School years	0.79	6.31	2.81	5.05	7.22	1.65	0.88	1.43	3.2
Illiteracy	85.2	13.2	44.7	12.1	4.5	73.8	83.9	73.4	51.2
1970 School years	1.71	8.78	4.13	7.65	9.06	3.33	2.25	3.35	4.7
Illiteracy	70.5	4.1	32.7	7.0	1.7	50.9	66.9	46.4	39.1
1980 School years	2.37	9.58	4.89	8.02	9.83	4.55	2.91	4.35	5.3
Illiteracy	60.4	2.0	26.6	6.6	1.6	37.1	60.1	34.5	33.3
1990 School years	3.18	10.29	6.22	9.47	10.50	5.66	3.31	5.57	6.1
Illiteracy	50.2	1.2	18.4	6.9	1.7	26.0	54.3	21.1	27.7
2000 School years	4.02	10.98	6.94	9.86	10.99	6.64	4.02	6.52	6.7
Illiteracy	39.5	1.3	14.5	5.5	1.8	19.7	48.3	15.3	23.6

Source: Based on Morrisson and Murtin (2007: Table 2)

The pattern in Table 1 shows that between 1970 and 2000, average years of schooling rose by similar amounts across all regions at about 2-3 years of schooling. The biggest increases are in China and the smallest in South Asia. Other than China and Other Asia, there is only modest convergence in average years of schooling between developed and developing worlds. The pace of world growth in human capital accelerated in the second half of the 20th century. Since 1950, world years of schooling have increased relatively steadily at a rate of 0.6 to 0.7 years per decade. Before 1950, only Europe, North America and the OECD countries of Asia maintained that pace of schooling increase. That means that the current developing countries are adding human capital at a pace comparable to that of the current developed countries. The recent acceleration of world human capital development is due to developing countries investing at the pace of developed economies. The developed economies have not slowed their pace, adding about 0.7 years of schooling per decade for the last 130 years.

More comprehensive education data exist for the period 1950-2010 in 5-year intervals referring to 146 countries (Table 2). Pooling together such data for the whole period, world educational development (measured by the mean years of schooling of the population aged 15-plus) evolved as shown in Figure 3.

Figure 2. Historical progress in building human capital stock



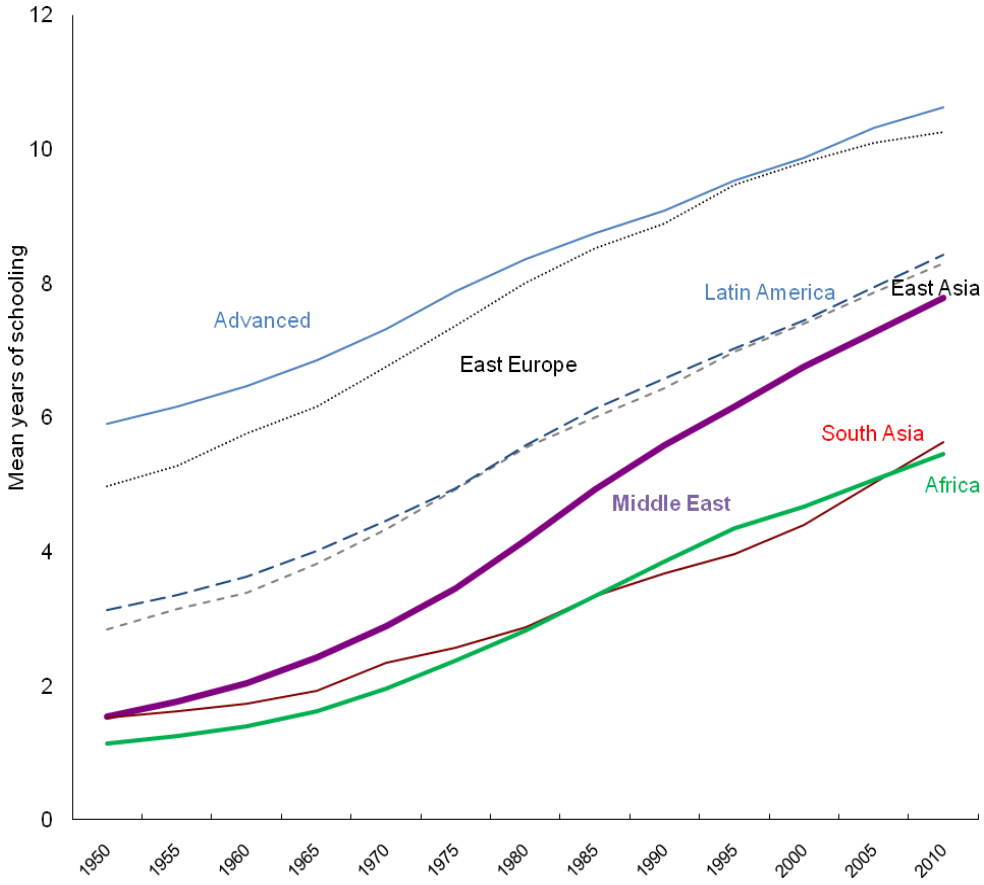
Source: Morrisson and Murtin (2008: Figure 14)
Note: Country grouping as in original

Table 2. Mean years of schooling of the population by region, 1950-2010

Year	Advanced economies	East Asia & Pacific	Europe & Central Asia	Latin America & Carr.	Middle East & N. Africa	South Asia	Sub Saharan Africa	World mean
1950	5.9	2.8	5.0	3.1	1.5	1.5	1.1	3.1
1955	6.2	3.1	5.3	3.3	1.8	1.6	1.3	3.3
1960	6.5	3.4	5.8	3.6	2.0	1.7	1.4	3.6
1965	6.9	3.8	6.2	4.0	2.4	1.9	1.6	3.9
1970	7.3	4.3	6.8	4.5	2.9	2.3	2.0	4.4
1975	7.9	4.9	7.4	4.9	3.5	2.6	2.4	4.9
1980	8.4	5.6	8.0	5.6	4.2	2.9	2.8	5.4
1985	8.7	6.0	8.5	6.1	4.9	3.3	3.3	6.0
1990	9.1	6.4	8.9	6.6	5.6	3.7	3.9	6.4
1995	9.5	7.0	9.5	7.0	6.2	4.0	4.3	6.9
2000	9.9	7.4	9.8	7.4	6.8	4.4	4.7	7.3
2005	10.3	7.9	10.1	7.9	7.3	5.0	5.1	7.7
2010	10.6	8.3	10.2	8.4	7.8	5.6	5.5	8.1
World	8.2	5.5	7.8	5.6	4.4	3.1	3.0	5.5

Source: Based on Barro and Lee (2010)

Figure 3. Educational progress by region, 1950-2010



There are three clusters of educational development: (1) High in the advanced economies of Europe, North America and Central Asia; (2) moderate in Latin America and the Middle East; and (3) low in South Asia and Sub-Saharan Africa.

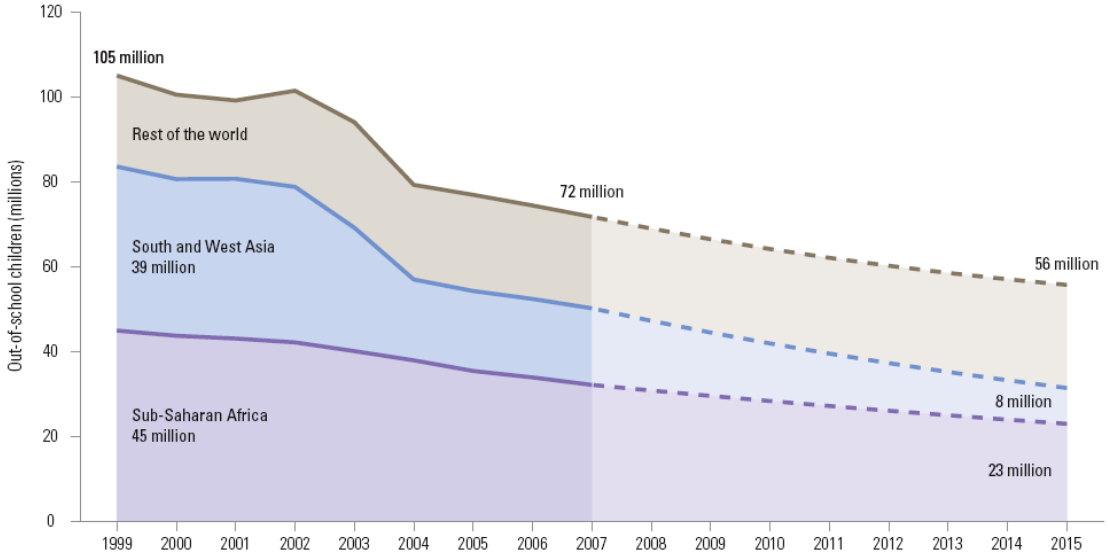
Building human capital stock is a long term affair. For a typical country it takes 35-80 years to make a transition from 10 percent net primary enrollment to 90 percent (Wils 2003; Wils and O'Connor 2003a). Education transition follows an *S*-shaped curve due to the diminishing speed of increases in attainment over time, and the fact that there is only so much education one can attain in terms of years of schooling (Meyer et al. 1992). After all, compulsory schooling is set, and most graduate programs are for a specified length.

3. Defining the challenge

Governments and international organizations alike have been trying hard to improve educational development over the past 50 years or so. Yet, such efforts have proved to be a real challenge in developing countries regarding basic education. The United Nations, UNESCO, UNICEF, the International Labor Office and the World Bank have all

been promoting education as a basic human right and growth engine.[3] Target years for achieving Education for All have been set and reset because the targets have been missed. According to the latest statistics more than one in four primary school age children are out of school in sub-Saharan Africa, and in South and West Asia more than one third of the adult population are illiterate (Unesco 2010). And, as shown in Figure 4, the outlook does not seem very promising. Many primary school age children in poor countries, and most of Sub-Saharan Africa, are not in school because they start at a late age. Some of those who start at a late age may well finish primary school, so while at any point in time one out of four children of primary school age are not in school the fraction who *never* go to school is much lower.

Figure 4. Out-of-school trend and projection to 2015



Source: Unesco (2010: Figure 2.8)

4. Review of the analytical literature

Efficiency. Empirical applications on the effect of education in promoting efficiency have followed two grand analytical routes: micro and macro. The micro literature focused in estimating the so-called "social rate of return to investment in education." This measure compares the benefits of having more education to the costs of obtaining that education. The benefits are typically measured by the earnings difference between more and less educated workers, that under competitive conditions approximates the productivity differential between the two kinds of workers. The costs consist of direct private and

[3] For example, the United Nations 1948 Declaration of Human Rights, the 1961 Addis Ababa UNESCO Conference of African States on the Development of Education in Africa, the 1990 Jomtien World Conference on Education for All, the 2000 Dakar World Education Forum and the United Nations Millennium Development Goals.

public expenditure on schooling, plus the forgone earnings of those who are in school rather than working.

Estimates of social returns to education, as commonly found in the literature, ignore non-income benefits of education (for example, improved health) and the possibility of positive externalities from education, such as productivity spillovers, lower crime, reduced use of social services, increased civic participation, and so on.

The private rate of return to an investment in a given level of education in such a case can be estimated by finding the rate of discount (*r*) that equalizes the stream of discounted benefits to the stream of costs at a given point in time. In the case of university education lasting five years, for example, the formula is:

$$(1) \qquad \sum_{t=1}^{42} \frac{(W_u - W_s)_t}{(1+r)^t} = \sum_{t=1}^{5} (W_s + C_u)_t (1+r)^t$$

where (W_u - W_s) is the earnings differential between a university graduate (subscript *u*) and a secondary school graduate (subscript *s*, the control group). C_u represents the direct costs of university education (tuition, fees, books), and W_s denotes the student's foregone earnings or indirect costs.

Typical results of rate of return applications are reported in Table 3 showing that the returns are higher when investment takes place at the lower level of education, especially in low income countries. This well documented pattern is due to diminishing returns as investment in human capital ascends by level of education, similar to the diminishing returns on investment in physical capital. In addition, the returns to education are higher in developing countries because of the scarcity of human capital in those countries relative to industrial countries.

Table 3. Social returns to investment in education by level and per capita income group (%)

	Educational level		
Per capita income group	Primary	Secondary	Higher
Low income	21.3	15.7	11.2
Middle income	18.8	12.9	11.3
High income	13.4	10.3	9.5
World average	18.9	13.1	10.8

Source: Based on Psacharopoulos and Patrinos (2004: table 2)

An alternative methodology is the so-called “Mincerian earnings function” used mainly to estimate the private returns to education (Mincer 1974):

$$(2) \qquad Ln\,(Y_i) = f(S_i, \underline{Z}_i)$$

where *Y* refers to the earnings of person *i*, *S* to the number of years of schooling and *Z* to a battery of other individual characteristics. The property of this semi-logarithmic expression is that the regression coefficient of the years of schooling can be interpreted as the rate of return to investment in education.

Table 4. Macro-estimated returns to one additional year of schooling

Effect	Source
No significant effect of years of schooling on economic growth	Benhabib and Spiegel (1994)
Each additional year of schooling attainment in a country is associated with about 30% higher GDP per capita	Heckman and Klenow (1997)
A one-year increase in the average years of schooling of the labor force raises output per worker between 5% and 15%	Topel (1999)
A one year increase of years of schooling associated with 0.30% per year faster growth	Bils and Klenow (2000)
Macro-estimated rate of return to schooling between 18% and 30%	Krueger and Lindahl (2001)
A one-year increase in average education raises per capita income between 3% to 6%	Bassanini and Scarpetta (2001)
A one year increase in the mean years of schooling is associated with a rise in per capita income by 3%-6%, or a higher growth rate of one percentage point	Sianesi and van Reenen (2003)
No evidence of wide social returns to education based on cross-county regressions	Pritchett (2006)
Macro-estimated rate of return to schooling 27%	de la Fuente and Domenech (2006)
Macro-estimated rate of return to schooling between 9.0 and 12.3%	Cohen and Soto (2007)
Macro returns to years of schooling 36.9%, or each year of schooling is statistically significantly associated with a long-run growth rate that is 0.58 percentage points higher	Hanushek and Woessmann (2008)
Controlling for physical capital stock, the rate of return to the average year of schooling is 12.1%	Barro and Lee (2010)

Such a function has also been applied in a macro context where Y refers per capita income or output per worker in country i and S to the mean years of schooling of the population or the work force. The enrolment ratio at different levels of education has also been used in lieu of years of schooling as an independent variable. Table 4 gives typical results of application of such function fitted to pooled cross-country-time data.

Another methodological line of estimating the contribution of education to economic growth has been instigated by the work of Solow (1956, 1957) who added technical change (T) as an independent variable in an aggregate production function, along with the traditional factors of production physical capital (K_p) and labor input (L) in order to explain output (Y). Omitting time subscripts for expository simplicity, the Solow function takes the form

(3) $$Y = f(K_p, L, T)$$

Schultz (1961a,b) challenged Solow's formulation and added education as a determining factor of income. A stream of empirical research followed along two alternative measures of the education input: "Schultz-type" and "Denison-type" growth accounting.

In Schultz-type accounting, human capital (K_h) is added as an independent variable in the production function, along with physical capital (K_p) and the number of people employed:

(4) $$Y = f(L, K_p, K_h)$$

Differentiating with respect to time as to get the growth rate of output (g_y), and making elementary substitutions, one gets the estimating expression:

(5) $$g_y = s_l . g_l + \frac{I_p}{Y} r_p + \frac{I_h}{Y} r_h$$

where s_l is the share of labor in national income, g_l the rate of growth of the labor force, I is the investment in physical (p) or human (h) capital, and r the rate of return on the respective investment. Therefore, r_p and r_h correspond to the return on physical and human capital. Note that r_h corresponds to the coefficient of schooling in our estimates, namely equation (2), though $\underline{r_h}$ in Schultz's model corresponds to the social rate of return while the coefficient on S gives the private rate of return.

In Denison's formulation, instead of adding human capital in monetary terms, the labor force (L) is split up by level of education, say L_0, L_1, L_2, and L_3, to denote those whose highest qualification is no schooling, primary, secondary and higher education:

(6) $$Y = f(K_p, L_0, L_1, L_2, L_3)$$

Differentiating with respect to time, growth accounting takes the form:

(7) $$g_y = s_{l0} . g_{l0} + s_{l1} . g_{l1} + s_{l2} . g_{l2} + s_{l3} . g_{l3} + \frac{I_p}{Y} r_p$$

where s_i stands for the wage share of labor with the i^{th} qualification in national income, and g_i for the rate of growth of workers with that qualification.

Typical results from the early literature on the macro contribution of education to economic growth based on "Schultz-type" and "Denison-type" growth accounting are presented in Table 5. The results show consistency with the micro literature in the sense that the effect of education on growth is substantial.

Table 5. The contribution of education to economic growth in the early literature

Country	Contribution of education to the economic growth rate (%)
Belgium	14.0
Canada	25.0
Korea	16.0
UK	12.0
USA	15.0

Source: Psacharopoulos (1984)
Note: Estimates are based on within-country growth accounting using Schultz (1961b) and Denison (1967) methodologies

The 1980s experienced the appearance of endogenous growth theory (Lucas 1988; Romer 1990). In their formulation, beyond a measure of human capital that is actually used by different firms in the economy (K_h), *S* years output also depends on the average level of human capital ($\overline{K}_h$). In addition, human capital is endogenous, rather than exogenous, in the system; that is, human capital is produced by using resources:

(8) $Y = \overline{K}_h \, f(K_h, L)$

(9) $K_h = f(Y, \overline{K}_h)$

The dramatic theoretical implications of endogenous growth theories is that output is no longer constrained by the constant-returns-to-scale property of the Solow production function, and that "knowledge" (proxied by $\overline{K}_h$) becomes a kind of public good that spills over the economy as an externality, allowing output to grow beyond the measurable inputs. Another, equally important implication of this model is that, by virtue of the average stock of human capital being a public good, there might be social underinvestment in human capital formation. This implication is very relevant to the education challenge topic of this paper.

Empirical applications of the new growth theory are relatively recent, diverse, and not easily summarized. Although some studies have reported a high impact of education on growth, others have argued that there is little or nothing to be learned from the empirical growth literature (for example, Topel 1999; Pritchett 2006; Banerjee and Dufflo 2005; Durlauf, Johnson and Temple 2005).

The inconsistency between micro and newer macro evidence on the returns to education has occupied the literature for a long time (for example, Krueger and Lindahl 2001; Sianesi and van Reenen 2003). The main reason for such inconsistency is that countries differ in many other respects that cannot easily be measured and controlled for in cross-country regressions, whereas within-country micro data automatically control for such factors.

5. Estimating the challenge

"Growth with equity" is a contemporary development goal espoused by governments and international organizations (for example, World Bank 2005). In theoretical terms one can assume that social welfare (*SW*) consists of two components: efficiency (*EF*) and equity (*EQ*), as in the following social welfare function:

(10) $SW = f\,(EF, EQ)$

This function could be specified as:

(11) $SW = (Y/P)^{\alpha}\ (1 - GINI)^{\beta}$

where (*Y*/*P*) is per capita income, *GINI* is the common inequality index and α and β the value of the weights one puts at the efficiency and equity components. Assigning such weights implies a value judgment that is best left to voters and politicians. The education challenge in this framework is how particular education policies (for example, greater coverage of primary education) are conducive or not to changing the values of per capita income and income distribution in a way that promotes social welfare.[4]

Data and sources

The following data were used in our simulations:

- Historical national accounts data from Maddison (2010)
- Investment in education data from the World Bank on line indicators (EdStats)
- Education data from Barro and Lee (2010) and World Bank indicators
- Micro returns to education from Psacharopoulos and Patrinos (2004)
- Gini coefficients from the Word Bank indicators

Although all measures of education are used in this paper, our central education variable is the average years of schooling of the population aged 15-plus. This choice is dictated both by the availability of a solid comparable database spanning 60 years (1950-2010), and the fact this measure is a summary of educational development encompassing all levels (Barro and Lee 2010). This measure of education also links to an extensive body of recent theoretical and empirical economic growth literature from which we can borrow parameters or compare our estimates. It also happens that the educational level of the population, rather than the work force, is more appropriate in a macro analysis of this kind in order to catch the wider or external effects of education on per capita income, for example, by lowering fertility or improving health conditions of the population at large.

It should be mentioned at the outset that years of schooling sometimes or often masks the quality of schooling; for example, four years of education in Finland does not equal four years of schooling in Colombia. Hanushek and Woessmann (2008) have shown that education quality affects economic growth. Increases in wages from a one standard deviation increase in cognitive test scores range from a low 5 percent in Ghana (Jolliffe 1998) to a high of 48 percent in South Africa (Moll 1998). In South Arica, Gustafsson, van der Berg, Shepherd and Burger (2011) using a grade- and race-specific educational

[4] For an application of this framework to an actual country case, see Psacharopoulos (1977).

quality measure in a Mincerian earnings function, find that an improvement of 1.07 standard deviations in the quality measure for adults aged 20 to 29 results in an income improvement of 30 percent. Hanushek and Kimko (2000) found that a one-standard deviation change in labor force quality is associated with a nearly 1 percentage point higher economic growth rate. Coulombe et al. (2004) report that a 1 percent higher literacy score raises labor productivity by 2.5 percent. However, there are no historical data back to 1900 on education quality to use in our analysis.

In addition to the spottiness of the historical data, there are many new countries in the known data period that did not exist before 1950 (for example, breakups of colonial territories), and many others that did not exist before 1990 (for example, the offshoots of the former Soviet Union), thus limiting the number of education-income observations. For all the above reason we opted to work with regional averages in the simulations and projections. Of course we report illustrative individual country stories when sufficient data are available.

Efficiency and equity links

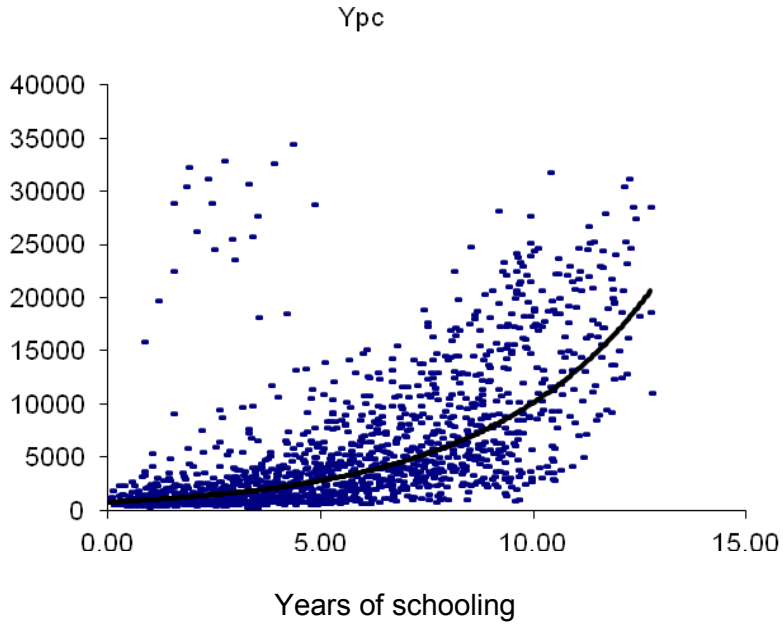
Figure 5 plots 1,596 pairs of observations of per capita income and years of schooling in 146 countries between 1950 and 2010. Treating the oil-rich countries in the upper left quadrant as outliers, the shape of the income-education relationship seems to illustrate a threshold level of 6 years of schooling as a necessary condition for the returns to schooling to manifest. In the new growth literature Azariadis and Drazen (1990) were the first to suggest what educators (Anderson and Bowman 1963) and economic historians (Easterlin 1981) had been saying for a long time: that there might be a threshold in terms of human capital accumulation before a country can reap growth benefits. In their words:

> *"once … the stock of knowledge surpass[es] certain critical values, aggregate production possibilities may expand especially rapidly"* (Azariadis and Drazen 1990).

Benhabib and Spiegel (2005) identified an even lower threshold of human capital. Unless nations had a critical value of about 2 years of schooling in 1960 they achieved lower growth rates over the next 35 years relative to the comparators. Sala-I-Martin, Doppelhofer and Ronald Miller (2004) found that a 10-percentage-point increase of the primary school enrollment rate is associated with a 0.27-percentage-point increase of the growth rate.

Figure 5. The relationship between years of schooling and per capita income, 1950-2010 (based on pooled country-year data)

Per capita income (in constant $US 1990)



Methodology

The welfare loss associated with more or less education is obtained in three steps:

Step 1. A link is established between education and income by fitting a semi-logarithmic "Mincerian" macro-function:

(12) $Ln\,(Y_{it}) = a + b\,S_{it}$

to data on per capita income (Y) and years of schooling (S) in country i in year t. The b coefficient in this function can be loosely interpreted as a macro return to investment in one extra year of schooling (Mincer 1974).

Step 2. Predicted values of income ($\hat{Y}$) are obtained by applying the a and b coefficients of the above function to assumed values of years of schooling ($\hat{S}$):

(13) $\hat{Y} = e^{(a+b\hat{S})}$

where e is the base of the natural logarithms.

Step 3. The welfare loss is defined as the percent increase of the base per capita income had the country a higher level of educational attainment:

(14) Welfare loss = $((\hat{Y} - Y)/Y) / 100$

Data periods

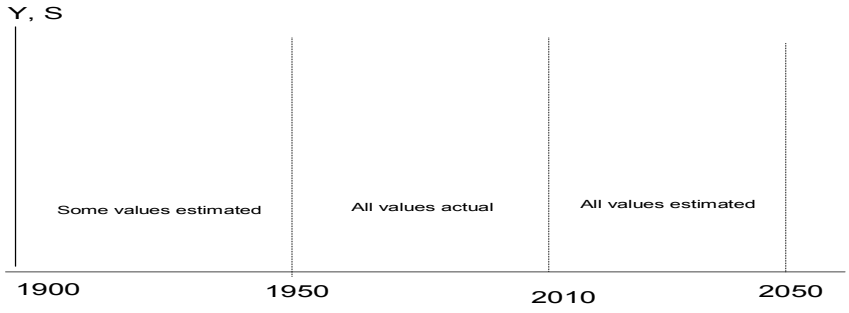
There are three distinct data periods in the 150 years time span considered in this paper, as shown in Figure 6:

1. The 1950 to 2010 period refers to actual data on income and education available in our database.

2. The 1900 to 1950 period contains a mix of actual data and estimated data, as for example, many countries in the data set did not exist in the that period.

3. The 2010 to 2050 period contains only assumed or estimated data based on the known trends in the 1950 to 2010 period or assumptions.

Figure 6. Actual and estimated data periods



An illustrative case

Before applying our methodology on a world scale, it should be useful to illustrate it by comparing only two countries' record regarding education and economic growth: South Korea and Pakistan. Table 6 contrasts the educational and economic history of the two countries in the "known" 1950-2010 period. Both countries started with more or less the same per capita income in 1950, but Korea had a considerable advantage in years of schooling relative to Pakistan. By 2010 Korea's level of educational development reached nearly 12 years of schooling, equivalent to the average adult having completed secondary schooling, whereas Pakistan's educational development has not yet reached 6 years of schooling – a minimum for literacy. Since 1950 the income difference grew dramatically in favor of Korea. In constant prices Korea's per capita income grew 23-fold versus Pakistan's 3-fold growth, corresponding to a 5.2 percent versus 1.8 percent rate of economic growth. Many analysts have attributed much of the differential economic performance of Korea and Pakistan to the difference in the countries' educational development (Easterlin 1981; World Bank 1993).

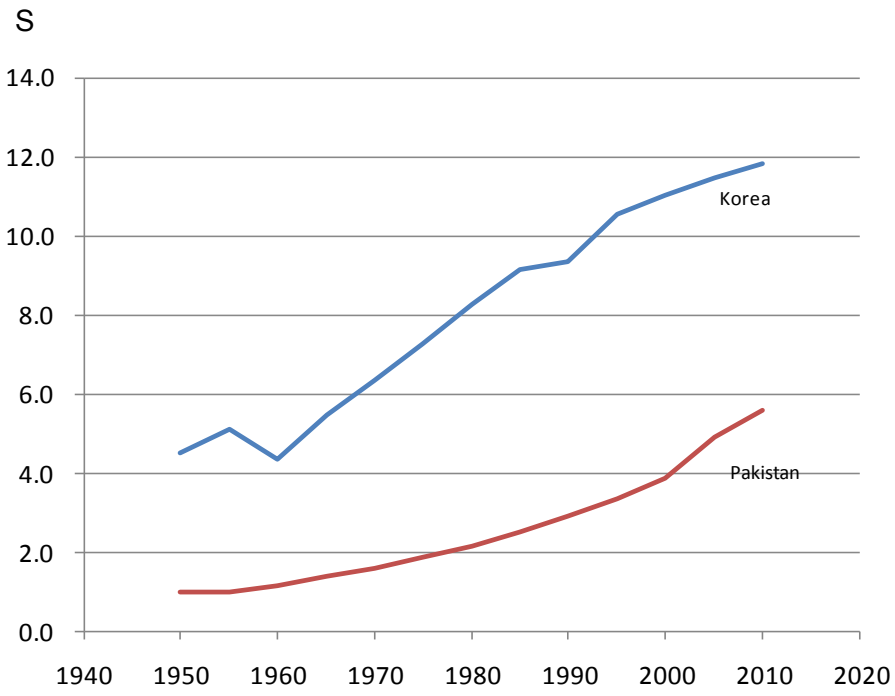
Table 6. Comparing Korea and Pakistan

Country/ Year	Years of schooling (15+ years old)		Per capita income (1990 constant $)		Economic growth rate (%)
	1950	2010	1950	2010	
Pakistan	1.0	5.6	643	2,239	1.8
S. Korea	4.5	11.8	854	19,614	5.2

Source: Years of schooling from Barro-Lee (2010); per capita income from Maddison (2010)

It may take a decade for a country to increase the mean level of education attainment of the population by one year, as shown in Figure 7. It also depicts the *S*-shaped path countries follow in their educational development history. That is, slow progress is made in the beginning, then accelerating and eventually slowing down.

Figure 7. Mean years of schooling of the adult population, Korea and Pakistan



In order to establish what Pakistan's per capita income would have been in the period 1900 to 2050 had it followed a different education policy, we must first establish a relationship between education and income. In this illustrative example such a relationship is obtained by fitting a Mincerian function using per capita income (*Y*) and years of schooling (*S*) circa 2009 in 128 countries:

(15) $\text{Ln } Y = 5.805 + 0.351\, S$, $R^2 = 0.62$, N = 128
(t=14.4)

Variants of the above Mincer-macro function using per capita income as the dependent variable in cross-country data have been fitted by Krueger and Lindahl (2001), Heckman and Klenow (1997) and Hanushek and Woessmann (2008). Our estimate of a 35 percent "return" to one additional year of schooling is nearly identical to theirs. After fitting such a function, Heckman and Klenow (1997) concluded that:

> *"each additional year of schooling attainment in a country is associated with about 30% higher GDP per capita, whether one looks at 1990, 1985 or 1960….. The macro-Mincer coefficients….are consistent with large positive external productivity gains to economy-wide schooling attainment."*

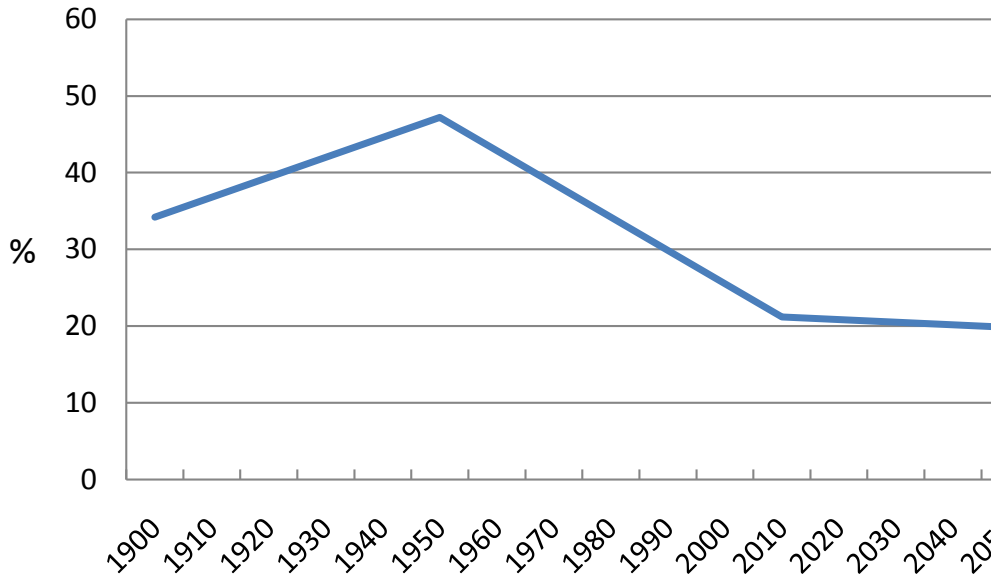
Barro and Lee (2010), among many others, have fitted the same function using output per worker (rather than per capita income) as the dependent variable and adding a measure of physical capital stock as an independent variable. Since their estimate of the *b* coefficient is about one-half of ours, we adopted a 50 percent reduction of our estimated welfare loss as a lower bound. Table 7 and Figure 8 present estimates the welfare loss in terms of potentially higher per capita income had Pakistan a higher level of educational attainment as indicated in Col. 2, Table 7.

Table 7. Pakistan: Welfare loss as percent of per capita income

Year (1)	Enhanced years of schooling (2)	Per capita income (constant 1990 $) Actual (3)	Per capita income (constant 1990 $) Simulated (4)	Welfare loss (%) Lower bound (5)	Welfare loss (%) Upper bound (6)
1900	0.2	264	354	17.1	34.2
1950	3.0	643	947	23.6	47.2
2010	6.0	2,239	2,714	10.6	21.2
2050	8.0	4,570	5,475	9.9	19.8

Source: Based on equation (15), Table 6 and assumed enhanced years of schooling
Notes: Col. 2, hypothetical years of schooling used in the simulation
Col. 3, Actual or projected per capita income given the 1950-2010 growth rate
Col. 4, Estimate value based on equation (15) and Col. 2
Col. 5 = (Col. 6) / 2
Col. 6 = ((Col. 4 – Col. 3) / Col 3)100

Figure 8. Welfare loss associated with not having one additional year of schooling, Pakistan (upper bound)



Alternative Pakistan simulation

The Mincerian function was fitted to just the time-series observations for Pakistan, 1950-2010. The number of observations is only 13 because the education data are available in 5-year periods (see Table 8):

(16) $\text{Ln } Y = 6.319 + 0.290\ S, \qquad R^2 = 0.89,\ N = 13$
$(t = 9.41)$

Table 8. Alternative Pakistan simulation using time series

Schooling/loss	1900	1950	2010	2050
Inertia *S*	0.1	0.9	5.6	7.0
Enhanced *S*	1.3	1.9	6.6	7.8
Upper bound loss (%)	42.0	34.0	34.0	26.0
Loss lower bound (%)	21.0	17.0	17.0	13.0

The results are largely consistent with the 13 percent micro-estimated social rate of return to investment in primary education in Pakistan in 1975 (Psacharopoulos 1985: table A-1).

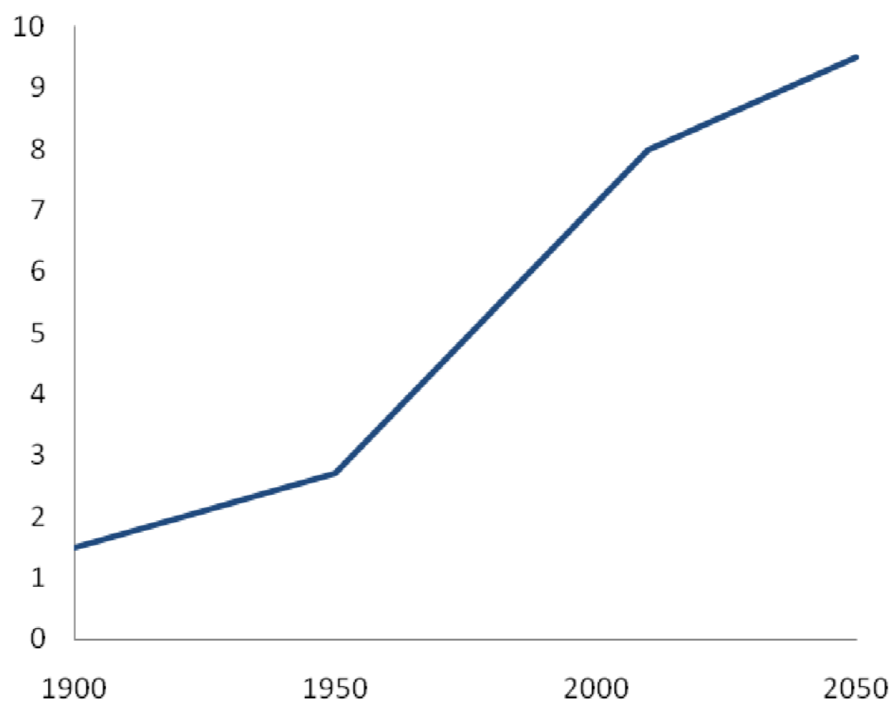
World estimates

The macro-Mincerian function was fitted to pooled country-year data for the period 1950-2010 for which we have on average 11 actual observations on the mean years of schooling of the population 15-plus years and per capita income:

(17) $$\text{Ln } Y = 6.645 + 0.258\, S, \quad R^2 = 0.54,\ N = 1596$$
$$(t{=}42.98)$$

Predicted values of per capita income were estimated under assumed years of schooling and returns to education for the 1900-1950 and 2010-2050 periods that no data exist. The assumed inertia values of half-year of mean world years of schooling for 1900 and ten years for 2050 were obtained by extrapolating backward and forward the actual 1950-2010 trend shown in Figure 9 to fit a mild *S*-curve, as suggested by the historical data reviewed earlier. The enhanced schooling values were assumed to be just one extra year of schooling relative to the inertia values (Table 9).

Figure 9. Actual and assumed years of schooling of world population



Given the fact the low levels of *S* correspond mostly to primary education and the later years to post compulsory education, it was assumed that the known period returns to education of 28.5 percent, would be 30 percent in the1900-1950 period and 20 percent in the 2010-2050 period. Most of the education increase of education in the early period must have been that of farmers, and our early returns assumption is consistent with Jamison and Lau's (1982) findings on the effect of farmers' education on agricultural productivity.

Table 9. Welfare loss associated with not having one additional year of schooling, World

Year	Inertia S	Enhanced S	Welfare loss (%) Lower bound	Upper bound
1900	0.5	1.5	17.5	35.0
1950	2.7	3.7	14.7	29.4
2010	8.0	9.0	14.7	29.4
2050	10.0	11.0	11.1	22.1

Note: Enhanced S = Inertia S + 1

Regional estimates

The years of schooling coefficient of fitting the basic Mincerian function (equation 12) within regional groups of countries is reported in Table 10. This is the upper bound of what countries might have lost in the period of known actual data by not having one more year of schooling. East Asia and the Pacific that includes many dynamic economies in the period 1950-2010 exhibit the highest loss, whereas Latin America and Sub-Saharan Africa the least. Such pattern might be due to two reasons. First, it is a well know fact that the Mincerian function underestimates the returns to primary education; that is, the level of education most relevant to these countries (Psacharopoulos 1994). Second, the inferior education quality in Latin America and Sub-Saharan Africa relative to other countries could be depressing returns in those regions. Also, it could be due to the fact that education is worth so much more in East Asia, especially the fast growing "tigers", that any deviation from the optimum shows larger relative losses. The fact that income loss differs between regions could be due to differences regarding economic institutions or access to capital.

Table 10. The welfare loss of not having one more year of schooling, by region, 1950-2010

Country group	Welfare loss (% per capita income)
Advanced economies	20.2
East Asia and Pacific	34.3
Europe and Central Asia	22.8
Latin America and Carr.	16.1
Middle East and N. Africa	14.5
South Asia	21.0
Sub-Saharan Africa	17.0
World	**25.8**

Source: Equation (12) fitted within regional groups of countries
Note: When multiplied by 100 the education coefficient measures the percent increase of per capita income associated with one extra year of schooling; all coefficients are statistically significant at the 1% probability level or better

Yearly estimates

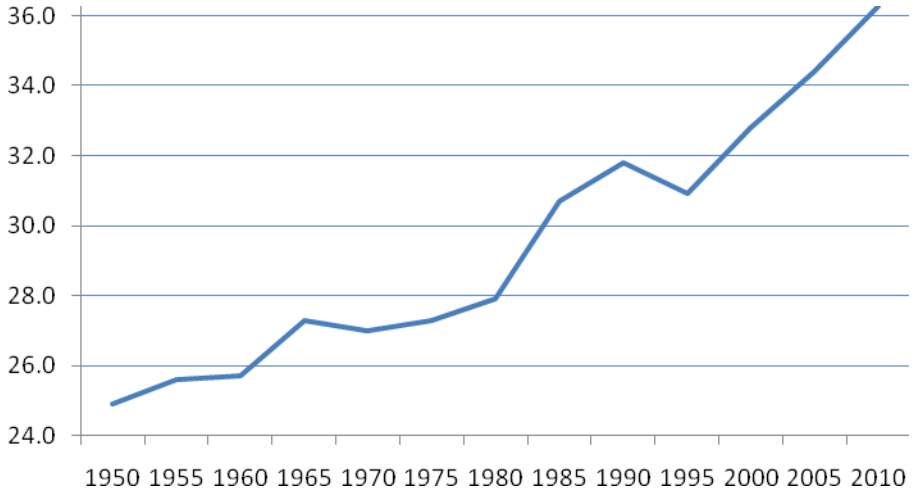
Mincerian macro regressions were fitted within each year. As shown in Table 11 and Figure 10 the macro returns to schooling seem to increase over time, a trend that might be counter-intuitive given expected diminishing returns to investment in education as the stock of human capital rises. But the new growth theory provides some clues for this pattern. According to Azariadis and Drazen (1991) cited earlier, there is a threshold level of schooling after which returns increase significantly. As more and more people achieve higher levels of schooling, and since schooling attainment is not infinite (see *S*-shape above), relative earnings tend to decline, and the individual rate of return will decrease, as predicted by classical economic theory. The point here is that increased schooling does not increase inequality, and may in fact contribute to its decline. The steady increase in schooling demonstrated in Table 1 should result in falling inequality in the world over time, but not necessarily a falling gap between developed and developing countries because of the lack of convergence in schooling across rich and poor countries, as demonstrated in the recent growth literature.

However, at the country level, higher levels of schooling for a larger proportion of the population lead to spillover effects, as more people are able to learn and share knowledge. Thus it is not odd to see declining individual returns to schooling while social returns continue to rise. Individual returns to schooling at early stages of development, when only a fraction of the population is educated, could reflect "rents" as educated individuals are able to extract surplus earnings. As education rises, rents are eliminated and returns seem to decrease, while for society the more educated population contributes to more social learning and thus higher social returns.

Table 11. Over time trend of the returns to education

Year	Returns (%)
1950	24.9
1955	25.6
1960	25.7
1965	27.3
1970	27.0
1975	27.3
1980	27.9
1985	30.7
1990	31.8
1995	30.9
2000	32.8
2005	34.4
2010	36.3
Overall	**25.8**

Figure 10. Over time trend of the returns to education



Welfare loss using growth accounting

Estimates of the welfare loss in terms of a potentially higher growth rate in the growth rate in 21 countries using the Schultz methodology described above (equation 5) are presented in Table 12. The countries were selected on the criterion that social returns to education were available for all levels of education using the most reliable "full-method" estimation (equation 1, above). The education policy variable is the share of the GDP allocated to education. The simulation is based on a hypothetical increase in such share by one percentage point. As previous micro evidence has indicated, there exists extensive variation of the returns across countries. In our macro analysis, such returns are averaged out in order to arrive at a global estimate of the welfare loss. Moreover, we use a higher bound estimate in making the predictions.

The results show that educational development, measured as the effort a country puts on education, accounts to just over one-half percentage point to a country's economic growth rate. Or, a country's growth rate could have been 3.3 percent higher had the country invested one extra percentage point of the GDP to education.

Table 12. Growth accounting simulation of the welfare loss

Country	r Overall social r, full method average (%)	(Ie/Y) inertia ed. exp. as % of GDP (%)	r*(Ie/Y) Inertia educ. contrib. growth points	Enhanced education contri-bution growth points if (Ie/Y) + 1	Enhanced -inertia difference in growth points	Actual inertia Growth rate	Enhanced to inertia growth rate (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Argentina	7.7	4.6	0.35	0.43	0.08	4.1	1.9
Brazil	20.7	4.0	0.83	1.04	0.21	2.9	7.1
Chile	11.1	3.9	0.43	0.54	0.11	5.3	2.1
China	12.9	2.5	0.32	0.45	0.13	8.0	1.6
Colombia	15.1	3.1	0.47	0.62	0.15	3.2	4.7
Ecuador	12.4	1.3	0.16	0.29	0.12	2.0	6.2
Ethiopia	13.7	3.9	0.54	0.67	0.14	5.3	2.6
Ghana	15.8	4.7	0.74	0.90	0.16	4.8	3.3
Israel	10.0	6.6	0.66	0.76	0.10	4.3	2.3
Japan	8.4	3.7	0.31	0.39	0.08	1.2	7.0
Malawi	13.8	4.1	0.57	0.70	0.14	3.9	3.5
Mexico	12.5	4.9	0.61	0.74	0.13	2.9	4.3
Nepal	11.0	3.0	0.33	0.44	0.11	4.0	2.7
Paraguay	14.6	5.3	0.77	0.92	0.15	2.7	5.4
Philippines	10.9	3.5	0.38	0.49	0.11	3.8	2.9
Singapore	13.6	3.1	0.42	0.56	0.14	6.1	2.2
Spain	9.8	4.3	0.42	0.52	0.10	2.9	3.4
Uganda	35.5	2.5	0.89	1.24	0.36	6.3	5.6
UK	7.5	4.6	0.35	0.42	0.08	2.4	3.1
Venezuela	13.3	3.0	0.40	0.53	0.13	3.1	4.3
Vietnam	8.1	2.9	0.23	0.31	0.08	7.3	1.1
World mean	**13.9**	**4.0**	**0.55**	**0.69**	**0.14**	**4.0**	**3.3**

Source: Based on the estimated education term of equation (5)

Notes: Col.2 from Psacharopoulos and Patrinos (2004), average of social rates of return, full method

Col. 3 from World Bank indicators

Col. 4 = (Col. 2) * (Col. 3)/100

Col. 5 re-estimation based on a 1 percentage point increase in education expenditure

Col. 6 = (Col. 5 - Col. 4)

Col. 7 from Maddison (2010)

Col. 8 = (Col. 6 / Col. 7) * 100

6. The welfare loss of illiteracy

The simulations presented above were based on one extra year of schooling relative to the counties' historical and inertia-projected educational attainment. We now ask the question: What is the welfare cost of illiteracy? This is estimated as the effect of some countries at some point in their history having less than 5 years of schooling on average.[5]

In order to do this simulation we assigned to countries in this category 5 years of schooling and fitted again the main Mincerian function (equation 17, above):

(18) $\text{Ln } Y = 5.530 + 0.381\ \hat{S}, \qquad R^2 = 0.46,\ N = 1596$
$(t=37.2)$

The 38.1 percent return to years of schooling in the above function is of course exaggerated because of the artificial assignment of extra human capital to countries in the past were below the literacy level. Subtracting from this coefficient the 25.8 percent return of the base equation (17), above, we obtain a net return of 15.3 percent due to literacy. Or, the welfare loss associated with illiteracy is equivalent to a 15.3 percent drop in per capita income. Note that this result is especially robust in the sense that, by comparing the base to the "literacy-for-all" function we net out or hold constant differences between counties in the physical capital stock and many other unobservables that affect per capita income. Gustafsson, van der Berg, Shepherd and Burger (2011) report that in South Africa an increase of literacy from 21 to 50 percent on the PIRLS scale, GDP per capita would be around 23% higher.

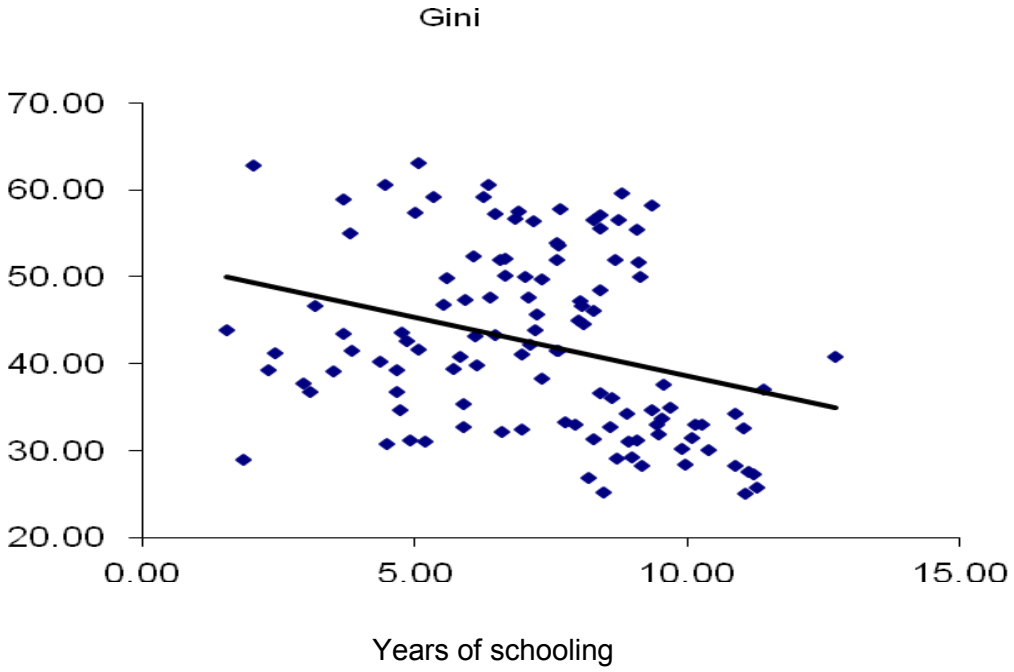
7. Equity links

In our database we could match Gini coefficients and mean years of schooling for 114 country cases in the 1985 to 2005 period. Figure 11 shows that income inequality declines with increasing levels of schooling. One extra year of schooling is associated with a reduction of the Gini by 1.4 points (on the Word Bank scale measuring the Gini from 0-100, rather than 0-1):

(19) $\text{Gini} = 52.088 - 1.351\ S, \qquad R^2 = 0.10,\ N = 114$
$(t=3.5)$

[5] About one half of the observations belong to this category.

Figure 11. The relationship between years of schooling and income inequality, 1950- 2010 (based on country-year pooled data)



8. Caveats

The results reported above are subject to several qualifications necessitated by the overly aggregate nature of the exercise spanning 146 countries and one and a half centuries. Cross-country regressions tacitly assume that all countries are on the same production frontier. Yet this is hardly the case (Klenow and Rodriguez-Clare 1997). The classic counter-factual is that of comparing Sri Lanka and other South Asian countries. Sri Lanka has a highly educated labor force relative to its neighbors, yet its economic growth record has been dismal. The reason for such bad economic performance has not been the lack of education; rather the political environment that has dampened incentives and opportunities for human capital to release its productivity (Bruton 1996; Lal and Myint 1996). Also, variables used in typical macro growth regressions do not capture cross-country variation in growth of labor force participation or hours of work (Stokey 1994).

Estimates of the returns to education are typically based only on wage earners and do not include the self-employed. This is due to the fact that most household surveys do not collect income data for the self-employed, or at least not at the individual level. There are two problems with this. First, there is sample selection bias. Second, many studies have shown that the returns to education among the self-employed are lower than those of wage earners. Indeed, this is particularly true of Sub-Saharan Africa, where there is little evidence of returns to education to farmers and other self-employed workers. Thus, these estimates of the benefits of education are likely to overestimate the true benefits (Jolliffe1998).

Countries also differ in many other aspects than those measured by the physical and human capital stock, for example, a different culture and discipline towards study and work; quality of schooling; quality of institutions; quality of policymaking; openness of economy; democracy; civil rights; economic freedoms. There are many other "causal" variables that are likely to have a positive effect on growth and also likely to be positively correlated with the error term, such as investment rates, trade policies, colonial history, monetary policies, restrictions on markets. Such omitted variables can lead to large margins of error in accounting for differences in the economic growth path between countries.

Even if other inputs in production are held fixed, countries that limit the scope for using human capital should generate low estimates of the social returns to schooling. There will only be a return to human capital when there is disequilibrium due to shocks caused by technology, prices, or other factors that require a reallocation of resources (Schultz 1975). Countries that limit shocks by setting input or output prices centrally, or countries that use traditional technologies that do not change, will have limited returns to human capital. The former reason is why returns to schooling doubled following the transition to market (Fleisher et al. 2005), while the second is why returns to schooling are larger off-farm than on farm in countries with traditional agricultural methods (Fafschamps and Quisumbing 1999; Godoy et al. 2005). Countries with bad institutions that create returns to corrupt actions will have human capital diverted to nonproductive expropriation of the returns of entrepreneurs rather than productive innovation (Murphy et al. 1991, 1993). That suggests that the economic environment is critical to the return to an additional year of schooling.

One possibility running in the opposite direction that might be that our estimates are underestimates of the real impact of education is the existence of externalities. However, there is no clear evidence in the literature on the existence or magnitude of such externalities (Banerjee and Duflo 2005; Lange and Topel 2006; Pritchett 2006).

The most plausible argument for large positive social returns is from agglomeration economies where all firms in a locality become more productive because of an atypically high density of educated. This argument makes the most sense in an industrialized economy rather than in the developing economies that have been our focus.

Because of liquidity constraints in developing poor children spend less time in school when their families get an unforecastable negative income shock from weather, unemployment due to national business cycles or localized job loss, or currency crises. However, it is unclear if transitory shocks that reduce current schooling result in a permanently lower level of schooling completed.

Another issue is the resource cost of "fixing" the challenge. In the case of education, a very large amount of resources would have to be used to provide an additional 1-2 years of schooling or, alternatively, ensure that everyone has enough years of schooling to be literate, and this cost needs to be subtracted from the welfare gains associated with such an increase in the years of schooling of the population. Put another way, the welfare loss of having low levels of schooling is offset, at least to some extent, by the actual uses made of the resources that would have to be devoted to avoid those low levels of schooling.

If, as is likely, the marginal cost of schooling is increasing in years of schooling, then the cost of adding an additional year of schooling will be greater than the average cost of attaining the current level of schooling. Rising marginal cost of schooling mean that estimates of current marginal returns to schooling will overstate the returns to further increases in schooling attainment.

9. Conclusion

In order to provide a best and conservative indication of the welfare loss associated with one extra year of schooling we adjusted the lower bound estimates presented in Table 9, above, by 41 percent. This adjustment is based on the difference between private and social returns to primary education, as in Psacharopoulos and Patrinos (2004, Table 2). Making a similar adjustment to the gross loss associated with literacy we obtain a 9 percent net loss on overage during the 1950-2010 period on which this estimate is based. As indicated in the last column of Table 1, World illiteracy has been falling by about three percentage points per decade. Based on linear interpolation and extrapolation of the historical data, the 9 percent central loss estimate has been adjusted upwards and downwards to obtain values for 1900 and 2050, respectively. Table 13 shows our best estimates of the welfare loss associated with a lower level of educational attainment over one and a half century.

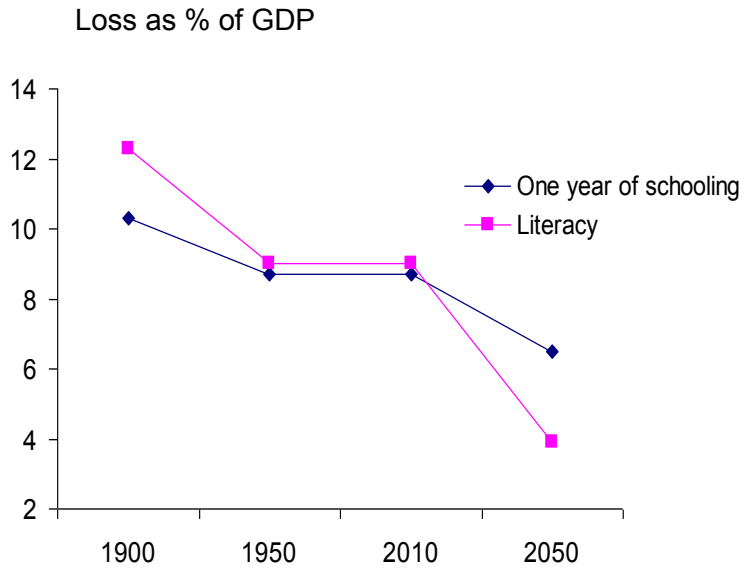
Our lower bound estimate of the global loss in terms of a lower or potentially higher per capita income, had countries a higher level of educational attainment by one schooling year, is depicted in Figure 12. Such losses range from 7 to 10 percent over the 150 year period. The loss from illiteracy ranges from about 4 to 12 percent.

Table 13. Welfare loss in terms of lower per capita income because of low educational attainment

	Percent GDP loss from:	
Year	One school year deficiency	Illiteracy
1900	10.3	12.3
1950	8.7	9.0
2010	8.7	9.0
2050	6.5	3.8

Based on our growth accounting results, the welfare or income loss amounts to about 1 percentage point of the average country's growth rate had the countries invested one percentage point more of their GDP on education. In addition to the above efficiency effects, one additional year of schooling is associated with a reduction of inequality by 1.4 points on the Gini scale.

Figure 12. Global welfare loss from the World's education challenge



Investments in the health, knowledge and skills of the people—human capital—are as important as investments in the more visible, physical capital of the country. Every country that sustained high growth for long periods put substantial effort into schooling its citizens and deepening its human capital. Conversely, considerable evidence suggests that other developing countries are not doing enough (Commission on Growth and Human Development 2008). This is the remaining challenge.

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