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Human Capital Convergence: International Evidence

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Abstract

In the growth literature, evidence on income convergence is mixed. In the development literature, health and education indicators are also often used. This study examines whether health and education levels are converging across countries and calculates their convergence speed, using data from 100 countries during 1970–96. A 3SLS procedure is used in a joint analysis of human capital convergence. The results confirm that investments in education and health are closely linked. We find unconditional convergence for life expectancy and infant survival, and enrollment rates, on average and by gender; and conditional convergence for all human capital indicators, including class size.

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I. INTRODUCTION

In the growth literature, considerable attention has been given to whether income per capita is conditionally converging across countries over time.[2] The evidence is mixed, and no firm conclusions have been reached in the literature. In the development literature, other indicators of national welfare beyond income per capita, in particular, health and education levels, are often used as key social indicators to measure development progress. For example, the widely cited United Nations Development Program (UNDP) Human Development Index (HDI) gives equal weights to income, health, and education, in measuring countries' levels of development.

This study examines whether health and education levels are unconditionally and conditionally converging across countries. While taking a new look at human capital convergence with more variables, longer data sets and more countries than the handful of previous studies in the literature, this study also considers explicitly potential joint effects in the determination of changes in health and education capital. Our study is also the first to examine the rate of human capital convergence across countries.[3] Our measures of human capital include life expectancy, the infant survival rate, enrollment rates at primary, secondary, and tertiary levels, and the teacher-pupil ratio at primary and secondary levels. We use data from 100 countries (chosen for consistently defined data), over the years 1970–96 (the most recent data available). Included countries are listed in Table 1.

Descriptive statistics such as changes in the coefficient of variation are first examined. These statistics offer strong evidence of convergence in the *quantity* of human capital; but the only indicators for which the descriptive statistics fail to support convergence is class size—our best measure of the *quality* of education. The failure of simple convergence in class size is due to slow rates of improvement in the teacher-pupil ratio in Sub-Saharan Africa and Asia (where schooling coverage has recently extended to rural areas); and also by some increase in dispersion within regions. However, the coefficient of variation suggests convergence in class size, when adjusted for enrollment rates.

We then present evidence that education and health are joint investments with significant interaction effects at the aggregate level. In regression analyses, lagged dependent variables are used as instruments in a joint analysis of health and education convergence using a three stage least squares procedure, where one of the equations is related to growth in the education indicator and the other to the growth rate in the health indicator. With

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[2] In the economic growth literature unconditional convergence refers to the tendency of poor countries to grow faster than rich countries while conditional convergence refers to convergence conditional on determinants of the steady-state income level.

[3] The rate of convergence determines how quickly education and health indicators approach their steady state, a situation where each variable is growing at a constant rate.

unconditional convergence, the change in a human capital indicator is regressed only on its initial value. With conditional human capital convergence, the change in an education (health) capital indicator is regressed both on its own initial value and on that of the initial value of the health (education) indicator. Our first hypothesis is that education (health) human capital will grow faster in countries with low initial values of education (health), also after controlling for the initial value of health (education) human capital. Our second hypothesis is that countries with higher initial health (education) will have higher conditional growth rates of education (health). This joint convergence analysis provides a test at the macro level of the link between investments in education and health; and we find strong evidence for each of these hypotheses, although the impact of health on education is quantitatively much larger than that of education on health. In contrast to the simple descriptive statistics, the results also support convergence in primary and secondary teacher-pupil ratios. All tests for convergence, including the eigenvalue tests, consistently hold. Finally, we compute the speed of convergence of the various human capital indicators; we find much faster convergence for education than for health indicators.

We conclude that the clear evidence that health and education are joint investments may offer scope for a more integrated policy approach. In particular, one of the most effective investments in education quality may be to improve child health. The results thus offer some support at the macro level for poverty programs that take an integrated approach to addressing education, health, and nutrition, such as the program in Mexico (PROGRESA, Programa de Educación, Salud, y Alimentación) (SEDESOL, 2001).

The remainder of the paper is organized as follows. In section II, we offer a brief literature review. In Section III, we describe our data and present descriptive statistics on convergence. In Section IV we present our joint convergence analysis, test for links between education and health, and examine the rate of human capital convergence. Section V concludes.

II. A Brief Literature Review

There is a substantial literature examining the extent to which per capita incomes are converging across countries over time. The pioneering work of Barro (1991) and Mankiw, Romer, and Weil (1992), demonstrated that the cross-country data can be read as consistent with either income nonconvergence or convergence; and the extensive research over the intervening years has not produced a consensus (see e.g. Pritchett (1997), and Jones (1997)).

At the same time, there have been a large number of studies in the literature confirming the importance of education, and more recently of health, in economic development. Babini (1991) examined coefficients of variation for education indicators for a sample of countries over the period 1960 to 1983. Since the coefficient of variation in the sample declined for enrollment rates at the three different levels of education, she concluded that these indicators were converging. She found the highest convergence at the primary level.

Ingram (1994) analyzed social indicators and productivity convergence in three developing country samples grouped according to income levels, using three measures of convergence:

(1) the elasticity of the social indicator, obtained by regressing the indicator on per capita GDP in each sample in a given year; (2) the coefficient of variation; and (3) the disparity in mean values of the indicators over time across country groups. Ingram concluded that life expectancy and primary school enrollment are converging over time.

In a cross-country growth framework, O'Neill (1995) presents evidence that convergence in education (using an enrollment ratio measure) has resulted in less income dispersion among the sample of developed countries; but for the world sample, incomes have diverged despite significant convergence in the quantity of education. He concludes that the discrepancy results from increases in the returns to education that favor developed countries.

In an important study, Cohen (1996) examined convergence of measured inputs across countries; his dependent variables were average growth rates from 1965-85 of the stock of physical capital per worker, and human capital per worker (average years of school completed of the working population). His 3SLS results indicated conditional convergence in education and physical capital.

There is a long tradition in economics in general, and development economics in particular, of viewing health and education as joint investments. As Mushkin (1962) put it, "health and education are joint investments made in the same individual. The individual is more effective in society as a producer and as a consumer because of these investments. And often the return on investment in health is attributed to education." In particular she argued that "a lengthening of life expectancy through improved health reduces the rate of depreciation of investment in education and increases the return to it."

Barro (1997) includes male and female education and life expectancy in growth regressions. His results suggest a strong positive conditional effect of years of schooling at the secondary and higher level for males aged 25 and over on the rate of growth. Perhaps surprisingly, Barro finds that female education at various levels has no direct effect on growth, though he acknowledges that female education enhances per capita income growth indirectly by lowering fertility.

In contrast, microeconomic studies find that education of girls has a higher social return than educating boys, at least in part because educating girls is associated with a reduction in child mortality, decreased fertility, and increased education achievement of their own children (Schultz, 1992).

A number of prominent poverty programs in developing countries explicitly integrate incentives for the development of health and education human capital among low-income families. A well-known example is that of the Mexican program (PROGRESA), which has as one of its central features the promotion of a package integrating education, health, and nutrition. From its launching in August 1997, the program has covered some 2.47 million households (SEDESOL 2001). Preliminary evaluations of this program (e.g., Hoddinott and Skoufias, 2001, and Schultz, 2001) indicate that its integrated approach has been quite successful.

The linkages between education and health are potentially quite extensive. On the one hand, greater health capital may improve the return to investments in education, in part because health is an important factor in school attendance and in the formal learning process of a child. A longer life also raises the return to investments in education; and better health at any point during working life may in effect lower the rate of depreciation of education capital. On the other hand, greater education capital may improve the return to investments in health, because many health programs rely on basic skills often learned at school including personal hygiene and sanitation, not to mention basic literacy and numeracy; and education is also needed for the formation and training of health personnel. Finally, an improvement in productive efficiency from investments in education raises the return on a lifesaving investment in health.

III. Human Capital Convergence: Data and Descriptive Statistics

The data in this study are drawn from two sources: the World Development Indicators (WDIs), World Bank; and UNESCO statistical yearbooks. The sample uses data from 100 countries (chosen for consistently defined and collected data), over 1970–96 (the most recent available for all countries).[4]

The gross enrollment rate is the number of pupils enrolled in a given level of education of any age divided by the population of the age-group which officially corresponds to the given level of education, multiplied by 100. School enrollment rates at the primary, secondary, and tertiary levels, as well as data on male and female primary and secondary enrollment rates, and teacher-pupil ratios, are drawn from the WDIs and UNESCO database.

Life expectancy at birth represents the number of years a newborn infant would live if prevailing age patterns of mortality at the time of its birth were to stay the same throughout its life. The infant survival rate is the difference between 1,000 live births and the infant mortality rate (the number of infants who die before reaching one year of age). Data on life expectancy and the infant mortality rate are drawn from the WDIs. Other missing values were linearly interpolated.

In the remainder of this section we report changes in averages and in standard deviations and coefficients of variation for education and health, for 1970 and 1996. The 1970–1996 data summarized in Table 2 are used in most of the formal empirical work in this paper.[5]

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[4] The one exception is the secondary teacher-pupil ratio, for which data is available for 92 countries.

[5] We separately examined data from the period 1970-1991, matching the Summers-Heston data set years, to test the robustness of all of our results using a common period and using these data as controls. The results, available from the authors, were not substantially affected.

Trends in the coefficient of variation, which measures convergence relative to the mean, has clear advantages for the study of convergence. If each country experiences an identical absolute increase in an indicator, the standard deviation would remain unchanged; but this would overlook the decrease in the percent difference across countries. Moreover, the coefficient of variation is unitless; consequently, its size is not dependent on the chosen units of measurement. However, the standard deviation might be preferred as a measure if *absolute* differences are considered most relevant; and preferences in this regard may be subjective. For example, if the average life expectancy rose from 45 to 55 years among poor countries, and from 65 to 75 years among rich countries, the standard deviation would record no change in dispersion over the period, while the coefficient of variation would record convergence. Observers might disagree about whether convergence has taken place in this case.[6] Thus, for completeness we present both measures in this section; but as it turns out, in most cases both measures indicate convergence across countries.

For the data on gross enrollment rates by levels and gender, teacher-pupil ratios, life expectancy, and the infant survival rate, the coefficients of variation and standard deviations are calculated for the entire sample and separately for five different regions for 1970 and 1996.[7] Table 2 reports the simple averages, significance levels for changes in the averages, standard deviations and coefficients of variation for human capital indicators for 1970 and 1996 for the entire sample and for five regions.

Average enrollment rates have increased over time in the entire sample and in all developing regions as indicated in Table 2 and Figure 1. For primary education, the improvement in average enrollments from 1970 to 1996 is statistically significant for Sub-Saharan Africa and Asia, and for the entire sample (driven by the significant increases in Sub-Sahara Africa and Asia). The coefficient of variation for the primary enrollment rate dropped from 0.34 in 1970

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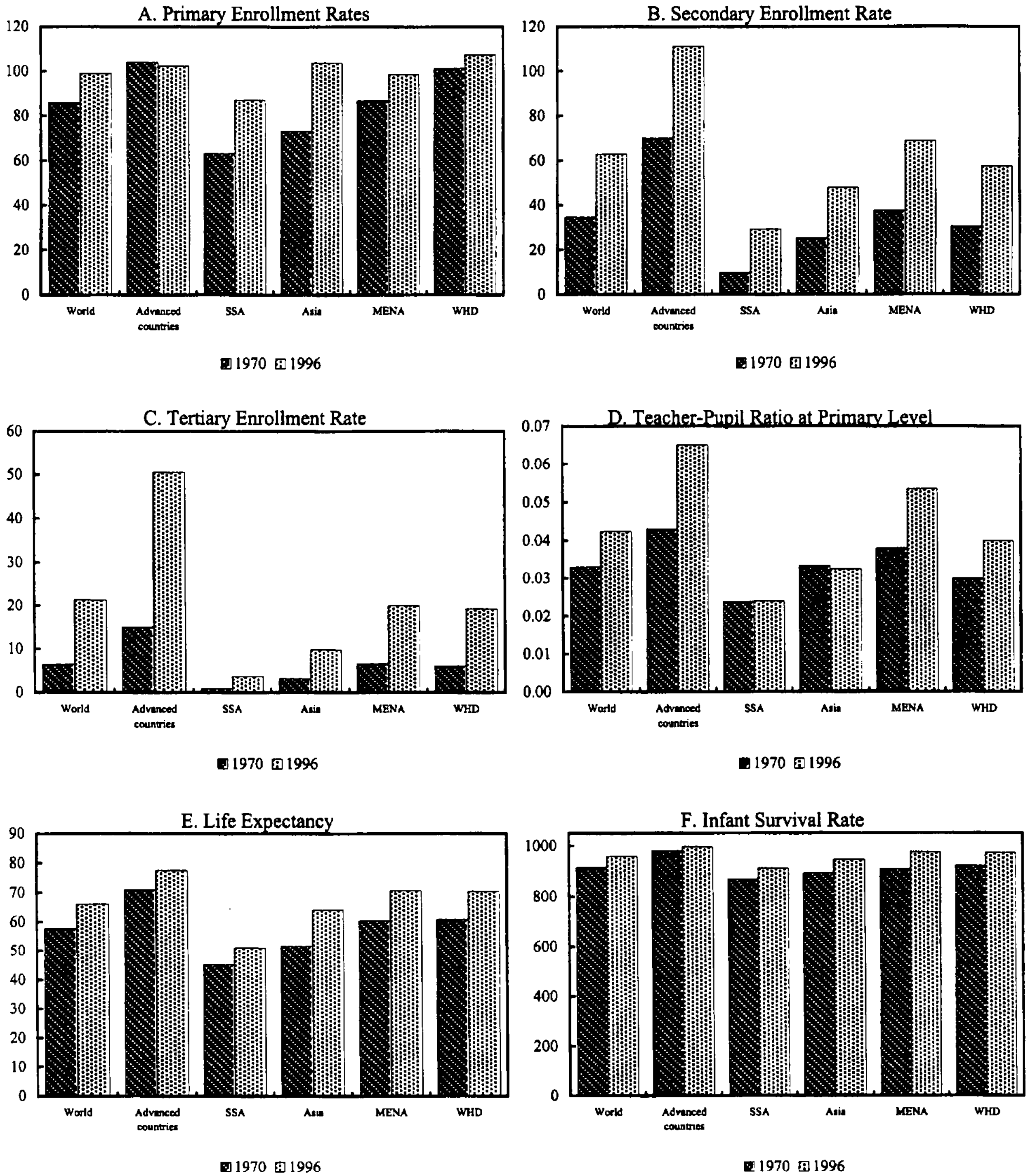
[6] Thus if the *relative* (or percentage) advantages of developed over developing countries were most relevant, the coefficient of variation would be more appropriate; but if absolute differences were deemed more relevant, the standard deviation would be the preferred measure. It may also be argued that there are some additional advantages to using the standard deviation when measuring progress in a variable defined as a 'bad,' such as the infant mortality rate, rather than as a good, such as the infant survival rate. Using the same data, the coefficient of variation will increase when examining decreases in the infant death rate but decrease when examining increases in the infant survival rate. However, this problem can be avoided by a suitable redefinition of variables, such as from the commonly used infant mortality rate to the equivalent but less commonly reported infant survival rate, as we do in this paper.

[7] While it is of interest to examine the trends for conditional convergence within the five regions, nevertheless, the main conclusion should be derived from the overall sample; the regional trends clearly do not determine the world trend.

Figure 1. Social Indicators by Regions, 1970 and 1996 1/
(Averages across countries)



Sources: World Development Indicators, World Bank; and UNESCO databases.

1/ Latest year available; most data are for 1996.

Notes: SSA denotes Sub-Sahara Africa; MENA constitutes Middle East, North Africa, and developing Europe; WHD indicates Western Hemisphere countries.

to 0.21 in 1996 (Figure 2). This convergence trend is also found within all regions. The average secondary enrollment rate has increased across the entire sample and the differences in averages from 1970 to 1996 are statistically significant in all regions. The coefficient of variation for the secondary enrollment rate in the entire sample and regions also shows convergence over time. For the entire sample, the coefficient fell from 0.78 in 1970 to 0.57 in 1996, and it also fell within each region. The average tertiary enrollment rate has increased in the entire sample and in all regions and the differences in averages from 1970 to 1996 are statistically significant. For the entire sample, the coefficient of variation for the tertiary enrollment rate fell from 1.17 in 1970 to 0.96 in 1996; and this measure also showed convergence in all regions. In sum, the lowest coefficient of variation is found for primary enrollment rate, reflecting the fact that full coverage is being approached with compulsory primary education, followed by the secondary and tertiary enrollment rates, respectively; but convergence is apparent at each level.

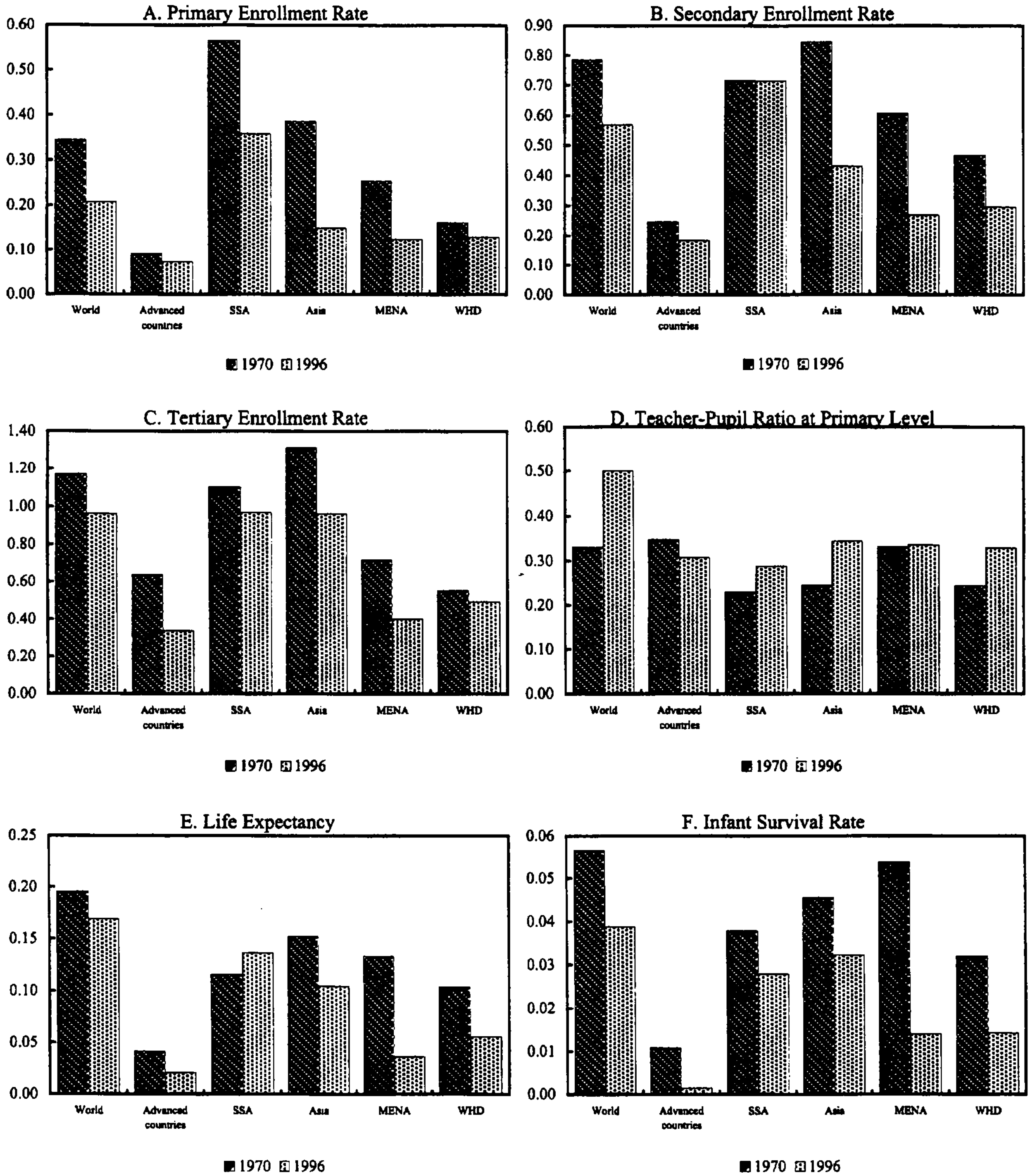
Table 2 also shows that the coefficient of variation for both male and female primary enrollments are declining over time, though it is lower in the case of males. The coefficient of variation was 0.29 for male primary enrollment rate in 1970, dropping to 0.19 in 1996, while the coefficient of variation for the female primary enrollment rate dropped from 0.41 in 1970 to 0.24 in 1996. The average male primary enrollment rate grew from about 91 percent in 1970 to 102 percent in 1996, this difference being statistically significant at the 1 percent level. The average female primary enrollment rate grew from about 80 percent in 1970 to 95 percent in 1996, where the difference is also significant at the 1 percent level. However, the difference between male and female education at the primary level of education remained statistically significant at the 5 percent level.

The average male secondary enrollment rate grew from about 37 percent in 1970 to 63 percent in 1996, while female secondary enrollment rate grew from about 32 percent in 1970 to 62 percent in 1996; both differences are statistically significant at the 1 percent level. Importantly, the difference between male and female education at the secondary level of education is now statistically insignificant, suggesting improved gender equality at the secondary level. The coefficient of variation was 0.71 for the male enrollment rate in 1970 dropping to 0.54 in 1996, while the coefficient of variation for the female secondary enrollment rate dropped from 0.88 in 1970 to 0.62 in 1996.

The ratios of female to male primary and secondary enrollment rates also increased substantially; in both cases the female enrollment rate is now 93 percent of that of the male enrollment rate. The improvement is statistically significant in all regions (except for primary education for the Western Hemisphere region, where the ratio increased from 0.96 to 0.98, and for the advanced countries, where the ratio remained 1:1). The coefficient of variation decreased for both female to male primary and secondary enrollment ratios in all regions. Thus, there are clear trends to greater gender equality in education, and regional and international convergence toward a 1:1 ratio.

The descriptive statistics do not, however, unambiguously indicate convergence in class size. Globally, there has been a small improvement in the average teacher-pupil ratio at the

Figure 2. Social Indicators by Regions, 1970 and 1996 1/
(Coefficients of variation)



Sources: World Development Indicators, World Bank; and UNESCO databases.

1/ Latest year available; most data are for 1996.

Notes: SSA denotes Sub-Sahara Africa; MENA constitutes Middle East, North Africa, and developing Europe; WHD indicates Western Hemisphere countries.

primary level; it increased from about 0.033 in 1970 to about 0.042 in 1996; this increase is significant at the 1 percent level. There were statistically significant increases in three regions: the advanced countries, the Western Hemisphere region, and the MENA (Middle-East, North Africa, and developing Europe) region. In contrast, there were no significant changes in the teacher-pupil ratio for sub-Saharan Africa and Asia. Partly as a result the coefficient of variation for the teacher-pupil ratio at the primary level increased for the entire sample, from 0.39 in 1970 to 0.50 in 1996. The coefficient of variation also increased in all regions except for the advanced countries and MENA. At the secondary level, the average teacher-pupil ratio has in general remained constant globally; it has risen for the advanced countries and the MENA region, but has actually fallen in sub-Saharan Africa. Globally, the coefficient of variation has risen, from 0.36 to 0.39, a smaller increase than for primary education; but the coefficient of variation has fallen within all regions except for the advanced countries and Asia. The failure of simple convergence in the teacher-pupil is largely driven by lack of improvement in class size in Sub-Saharan Africa and Asia, but also by some increase in dispersion within regions.

Class size is arguably our best available quantitative indicator of education capital quality (although life expectancy may proxy for the quality of general human capital throughout the life span); and so failure to find convergence in this indicator would be of great significance. However, test statistics for the joint human capital investment analysis in the next section presents a brighter picture for convergence in human capital quality. In addition, it may be argued that the best measure of the quality of educational investments is the product of the enrollment ratio and the teacher-pupil ratio (adjusted teacher-pupil ratio). This is because we can have a low enrollment ratio with a high teacher-pupil ratio; that is, a high teacher-pupil ratio may reflect an extreme level of human capital inequality, rather than a high level of educational quality. As seen in Table 2, the adjusted teacher-pupil ratios at the primary and secondary levels show a significant improvement over the period. The coefficients of variation also suggest convergence in these adjusted ratios. We examine these indicators further in the following section.

Turning to health, world life expectancy increased by an impressive eight years in the quarter century of our sample. This increase is statistically significant at the 1 percent level globally as well as in all regions, but varies widely in magnitude. In particular, life expectancy increased by over 12 years in Asia but less than six years in sub-Saharan Africa in this 1970–96 period. Globally, the coefficient of variation for life expectancy decreased from 0.20 in 1970 to 0.17 in 1996. The coefficient of variation also decreased in all regions except for Sub-Sahara Africa, where it increased from 0.12 to 0.14.

The average infant survival rate has improved dramatically from about 914 in 1970 to 957 in 1996; this increase is significant at the 1 percent level both globally and within each region. The coefficient of variation and standard deviation of the infant survival rate show convergence globally and in every region.

IV. Examining Human Capital Convergence with 3SLS

As noted earlier, there are good reasons to expect that education and health human capital investments may strongly interact. Building on the literature reviewed in Section II, in the remainder of this section we consider joint convergence of health and education human capital.

A. Unconditional convergence of human capital

In examining unconditional convergence in a regression framework, only a lagged independent variable appears on the right hand side of the regression, without other controls. In this paper, we examine unconditional human capital convergence in the following estimation framework,

$$Dedu = \ln(edu_i)_{96} - \ln(edu_i)_{75} = a + b\ln(edu_i)_{75} \quad (1)$$

$$Dlife = \ln(life_i)_{96} - \ln(life_i)_{75} = a' + b'\ln(life_i)_{75} \quad (2)$$

where the left-hand sides represent difference of logs for education indicators (total enrollment rates by levels and gender (Dedu)), and difference of logs for life expectancy (Dlife), respectively, for the period of 1975–96; and *i* is a country index. The right hand sides are the corresponding initial 1975 values of the proxies for education in equation (1) and for life expectancy in equation (2). The equations are estimated jointly using 3SLS; the instruments are the 1970 values of the right-hand side variables.[8]

Tables 3 and 4 report results for unconditional human capital convergence with 3SLS, for life expectancy and enrollment rates; the results in Table 3 reflect overall enrollment averages, while those in Table 4 consider enrollment rates separately by gender. As indicated in regression set (1), equation (1.1), in Table 3, the coefficient on initial primary education is negative and statistically significant at the 1 percent level, while in equation 2, the coefficient on initial life expectancy is also negative and statistically significant at the 1 percent level.[9] The speed of convergence for primary enrollment rate, λ, is equal to 0.038, implying that this

[8] Results were generated from the 3SLS procedure in the LIMDEP package, which except for using instrumental variables otherwise follows the GLS estimator for the seemingly unrelated linear regressions (SURE) model.

[9] A negative coefficient on a lagged dependent variable implies that a country with initial lower level, will experience higher growth in that variable.

variable moves halfway to the steady state in about 18 years.[10] In contrast, the value of λ for life expectancy is 0.007 implying that this variable moves halfway to the steady state in about 99 years.

Regression set (2) in Table 3 shows the corresponding equations for growth of the secondary enrollment rate and life expectancy; in equations (2.1) and (2.2) the coefficients on the initial value of secondary enrollment rate and life expectancy are also negative and significant at the 1 percent level. The speed of convergence for the secondary enrollment rate is 0.017, lower than for primary enrollments, implying that this variable moves halfway to steady state in about 41 years. Finally, equations (3.1) and (3.2) similarly show that the coefficients on the initial value of tertiary enrollment rate and life expectancy are negative and again are statistically significant at the 1 percent level, suggesting that all of these indicators are unconditionally converging. The faster speed of convergence for primary enrollments over secondary and tertiary enrollments, and for secondary over tertiary enrollments, is statistically significant at the 1 percent level in each case.

Table 4 reports unconditional human capital convergence for enrollment rates by gender at the primary and secondary levels and life expectancy. All the coefficients on initial human capital levels in regression sets (1)-(4) have negative signs, significant at the 1 percent level. Taken together, the results in Tables 3 and 4 provide strong evidence of unconditional convergence in enrollment rates and in life expectancy.

Table 5A reports results for unconditional human capital convergence for teacher-pupil ratios at the primary and secondary levels and life expectancy. For the regression on the change in the primary ratio, the coefficient is statistically insignificant, and the point estimate is actually positive. In contrast, results for the secondary teacher-pupil ratio support unconditional convergence, with the coefficient on the initial ratio negative and significant at the 1 percent level. However, in Table 5B, we present the results for unconditional convergence of the adjusted teacher-pupil ratios. These results indicate unconditional convergence for the adjusted primary ratio at the 5 percent level. In each significant case, the speed of convergence is on the order of 0.01, giving a half life on the order of 70 years.

[10] The speed of convergence, λ, of a given variable is calculated by taking the negative of the natural log of one plus the coefficient on the lagged dependent variable divided by the period under observation. Thus, from Equation (1), $\lambda_1=-ln(1+b)/\tau$ and from Equation (2), $\lambda_2=-ln(1+b')/\tau$, where τ is the period in the analysis . The half-life, t*, is the solution to $e^{-\lambda t^*}=0.5$. Taking logs of both sides, $t^*=-\ln(0.5)/\lambda$.

B. Conditional convergence of human capital

Finally, we consider joint effects more explicitly, by also conditioning health improvement on initial education, and vice-versa. Our first hypothesis is that education (health) human capital will grow faster in countries with low initial values of education (health), also after controlling for the initial value of health (education) human capital. Our second hypothesis is that countries with higher initial health (education) will have higher conditional growth rates of education (health).

Our approach is similar to Cohen's (1996) analysis of conditional convergence of inputs in the aggregate production function.[11] We use a 3SLS procedure with instrumental variables in our analysis of conditional convergence, because of the several potential joint effects across health and education, reviewed in Section II. Our model of conditional human capital convergence is thus an extension of the framework we use above to examine unconditional convergence.

The conditional convergence equations for human capital in this framework are:

$$Dedu = \ln(edu_i)_{96} - \ln(edu_i)_{75} = a + b\ln(edu_i)_{75} + c\ln(life_i)_{75} \qquad (3)$$

$$Dlife = \ln(life_i)_{96} - \ln(life_i)_{75} = a' + b'\ln(edu_i)_{75} + c'\ln(life_i)_{75} \qquad (4)$$

The left-hand side in equation (3), Dedu, represents the difference of logs for our education indicators, proxied successively by overall enrollment rates at the three levels and enrollment by gender, and by the teacher-pupil ratios. The left-hand side in equation (4), Dlife, represents the difference in logs of the level of health, and is proxied by life expectancy. In both cases, the change in the indicator over 1975–96 is examined. The right hand side variables are the corresponding initial 1975 values of the education indicators and life expectancy, respectively. Again, 3SLS is used and the instruments are the 1970 values of the right-hand side variables.

[11] As left-hand side variables Cohen used the average growth rates from 1965-85 of the per worker stock of physical and human capital, while the right-hand side variables were the corresponding initial 1965 values.

As an additional test, following Cohen (1996), there is evidence for conditional convergence in human capital if the following conditions holds in equations (3) and (4):[12]

$$b + c' < 0 \text{ and } bc' - b'c > 0$$

Table 6 reports conditional human capital convergence for average enrollment rates at different levels, and life expectancy. Regression set (1) reports results for growth of the primary enrollment rate and life expectancy. As seen in equation (1.1) on primary education growth in Table 6, the coefficient on initial primary education has a negative and statistically significant sign indicating that a country starting with an initial low primary enrollment rate will experience faster than average conditional growth in the primary enrollment rate, other things equal. The coefficient on life expectancy ('cross-effect') is actually negative at the 10 percent level; but this finding reflects the initially near-universal coverage of primary education in the advanced countries. However, in equation (1.2) on growth of life expectancy in Table 6, the coefficient on the initial value of primary enrollment rate is positive and significant at the 10 percent level. The negative and statistically significant coefficient on life expectancy of course also indicates conditional convergence. The eigenvalue tests for conditional convergence of the system consistently hold with statistical significance.

In regression set (2) in Table 6 we present results for growth of the secondary enrollment rate and life expectancy. Equation (2.1) has a negative and significant sign on the initial value of the secondary enrollment rate, indicating convergence. The coefficient on initial life expectancy is positive and statistically significant at the 1 percent level, supporting the link between education and health. The positive sign may be interpreted as an indication that an improvement in health will have a positive effect on the secondary enrollment growth rate. An explanation is that a longer-lived individual will have more years to earn a return on educational investments (Mushkin, 1962). In addition, a healthier individual will be more able to learn, and more able to use the benefits of secondary school education during any given year of working life; educational human capital may depreciate at a lower rate. Equation (2.2) also features a negative coefficient on the initial value of life expectancy, and a positive coefficient on the initial value of secondary enrollment, both significant at the 1 percent level, further supporting the joint effects.

The link between education and health can again be seen in regression set (3) in Table 6. In equation (3.1) the coefficient on the initial value of the tertiary enrollment rate is negative, while that on the initial value of life expectancy is positive, both statistically significant at the 1 percent level, and indicating the importance of health on tertiary enrollment growth rates in

[12] These are of course just eigenvalue stability conditions for a pair of difference equations. As Cohen interprets them, 'in that case poor countries' resources are appropriately rising over the years and asymptotically converge to the rich countries' endowments.' This provides a test of conditional convergence for the system of equations.

the process of convergence. In equation (3.2), the joint effect in convergence is again seen; the coefficient on the initial value of the tertiary enrollment rate is positive and significant at the 1 percent level, likely reflecting, among other things, that more higher education leads to the training of more doctors and other health professionals. In sum, the evidence for joint effects is very strong at the secondary and tertiary levels, but somewhat weaker at the primary level.

The values of λ for conditional convergence are in general higher than those for unconditional convergence. Under conditional convergence, the primary enrollment rate moves halfway to the steady state in about 22 years, secondary enrollments in 26 years, and tertiary enrollments in 35 years.

Table 7 reports conditional human capital convergence results for male and female enrollment rates at the primary and secondary levels and life expectancy. In regression set (1) there is evidence for convergence in male primary enrollment rate and life expectancy in equations (1.1) and (1.2) respectively, from the negative coefficients on initial values. Again the negative coefficient on the initial value of life expectancy in equation (1.1) reflects the nearly full coverage of primary education in advanced countries. However, a positive effect on initial primary education on life expectancy growth is found in equation (1.2). In regression set (2), equation (2.1), the coefficient on initial female primary schooling is negative, while in equation (2.2) the coefficient on initial health is negative, both at the 1 percent level, indicating convergence.

In regression set (3) in Table 7 we present the set of equations for the growth of the male secondary enrollment rate and life expectancy. In equation (3.1) the coefficient on the initial value of the male secondary enrollment rate is negative and significant indicating convergence, while that on life expectancy is positive and significant (both at the 1 percent level), further evidence that education and health act as joint investments. A negative sign on the initial value of life expectancy is likewise seen in equation (3.2), along with a positive coefficient on secondary enrollment, again both significant at the 1 percent level.

Regression set (4) in Table 7 shows the set of equations for growth of the female secondary enrollment rate and life expectancy. In equation (4.1) the negative coefficient on the initial value of the female secondary enrollment rate and the positive coefficient on life expectancy, both significant at the 1 percent level, offer another indication of convergence and of the association between female education and health. Similarly, in equation (4.2) on life expectancy, the coefficients again show the pattern of convergence and of the association between female education and health, with statistical significance at the 1 percent level. In sum, when the data are broken down by gender, the evidence for joint effects is still very strong at the secondary level, but somewhat weaker at the primary level.

The eigenvalue tests for conditional convergence of the system consistently hold for all four regression sets in Table 7, at the 1 percent level of statistical significance, confirming human capital convergence across countries for both men and women.

In Table 8A we turn to the conditional human capital convergence results for our education capital quality indicators, the teacher-pupil ratios, together with life expectancy. In regression set (1), we see that the results for the primary ratio are now unambiguous, with all of the signs indicating convergence. In particular, and in contrast to the insignificant results in the unconditional convergence analysis, the coefficient on the initial primary teacher-pupil ratio is now negative, and significant at the 1 percent level. Cross effects are both positive, with initial health (as proxied by life expectancy) positively associated with the rate of improvement in the teacher-pupil ratio, at the 1 percent significance level. The eigenvalue tests also have the correct sign, though only the first condition is statistically significant, at the 1 percent level. The results for the secondary teacher-pupil ratio are similar; and in this case, the eigenvalue tests for conditional convergence of the system hold at the 1 percent level. Thus, while the simple statistics for the unadjusted teacher-pupil ratios failed to demonstrate convergence, the joint human capital analysis offers evidence supporting the eventual convergence of these important indicators of human capital quality. The data suggest that as health (proxied by life expectancy) improves, we may expect improvement in the secondary teacher-pupil ratio. However, the effect of the initial secondary teacher-pupil ratio on the growth in life expectancy is statistically insignificant (the point estimate is actually negative).

Finally, in Table 8B, we present the results for conditional convergence of the adjusted teacher-pupil ratios. These results confirm conditional convergence at the 1 percent level. Moreover, all of the cross effects are now positive and statistically significant at the 1 percent level and the tests for conditional convergence of the system also hold.

From the results in this section, we can conclude that, in general, there is conditional convergence in health and education across countries. This convergence extends both to male and female human capital, and also to our qualitative indicators, the teacher-pupil ratios and life expectancy. In particular, the results offer support for the links between education and health, especially for secondary and tertiary education enrollment rates and primary and secondary teacher-pupil ratios.

As seen in Tables 6, 7, and 8, the cross-effects between education and health are very different in magnitude. The impact of higher levels of initial health on education indicator growth is much larger quantitatively than the impact of higher levels of initial education on health indicator (life expectancy) growth. For example, in Table 6, regression set (3), the results indicate that a 1 percent higher initial life expectancy leads to about 2 percent improvement in the growth of tertiary education enrollment. On the other hand, a 1 percent higher initial tertiary enrollment leads to just a 0.04 percent improvement in the growth of life expectancy. As seen in Table 8A, the effect of initial teacher-pupil ratio on life expectancy growth is not even statistically significant. On the one hand, these results may suggest that it is intrinsically more difficult to extend life than to improve educational enrollments and teacher-pupil ratios. But they may also indicate that health plays a greater role in the accumulation of education capital, than does education in the accumulation of health capital.

V. Conclusions

This paper has examined the patterns of human capital convergence for a sample of 100 countries and considered education and health as joint investments. Although in the literature results on income convergence across countries are controversial, this study finds overwhelming evidence of human capital convergence both globally and within regions. We found that primary, secondary, and tertiary enrollment rates are converging over time; convergence in the primary enrollment rate is most dramatic, probably reflecting the trend toward universal primary education, but there is unambiguous evidence of convergence in secondary and tertiary enrollment rates as well. Moreover, both male and female enrollment rates at the primary and secondary levels are converging across countries over time. Evidence also supports a significant reduction in gender inequality within countries. While the evidence of convergence in the overall primary teacher-pupil ratio is weaker, when examining the ratio adjusted for enrolments we find clear evidence for convergence. Moreover, there is clear evidence for unconditional convergence in the secondary teacher-pupil ratio; and when conditioning on life expectancy, there is also clear evidence of convergence in the primary teacher-pupil ratio. Life expectancy and infant survival rates are unconditionally converging across countries and within all regions. The unconditional speed of convergence for life expectancy is found to be on the order of 0.01, while the unconditional speeds of convergence for total primary, secondary, and tertiary enrollment rates are on the order of 0.04, 0.02, and 0.01, respectively.

Our 3SLS approach allowed us to capture the links between education and health. These links were particularly evident for life expectancy jointly with enrollments above the primary level and with class size. Several explanations for these links were reviewed in the paper, including the greater incentive for accumulation of higher levels of human capital with a longer life expectancy, and that a child with better health can perform better in school. At the same time, an individual with more education will be endowed with basic hygiene and sanitation skills learned at school, as well as knowledge needed to improve the health of her children. In addition, skills developed at higher levels of education, including medical education, may be used directly or indirectly to improve the overall level of health in society.

Our findings of human capital convergence represent good news for development, viewed in the broad sense of encompassing health and education as objectives in their own right, alongside incomes. Our findings may also be good news for eventual conditional income convergence. Both health and education capital are understood to be important inputs in the aggregate production function, and important determinants of the possibilities for low-income countries to rapidly catch up with the developed world. The fact that human capital convergence has not yet translated unambiguously into international income convergence likely reflects three factors. First, most developing countries still have very young populations; there is likely to be a substantial lag between human capital accumulation and measured increased productivity and incomes. Second, education is likely to be a complementary input with other factors; Romer's (1993) suggestion that rapid development results from the interaction of human capital with the availability of productive ideas is particularly instructive. Developing countries will need to increase their rate of technology transfer, which will require increased openness as well as international assistance. Third, the general policy environment is also a significant determinant of the incentives to use education capital productively. In this regard, continued efforts will be needed to improve the policy environment, to raise the return to using education for productive activities, rather than for rent seeking.

The improvement in health and education standards in developing countries, and their convergence toward standards of developed countries, has been due in part to government policy. In addition, aid agencies, notably including both international and nongovernmental organizations (NGOs), have also played critical roles in recent decades in improving health and education levels. These efforts have brought modern public health practices and basic schooling opportunities even to remote rural areas of Africa, Asia, and Latin America, resulting in improvements in the infant survival rate, and bringing the goal of universal primary education within reach. However, despite the positive trends, and the encouraging results of this research, this is clearly no time for complacency on the part of the international community, as infant survival remains tragically, and unnecessarily, low in the poorest countries. The current health crises in Africa (notably, HIV/AIDS as well as tuberculosis and malaria) will require additional resources, to prevent a catastrophic loss of the hard-won gains of the last decades.

Even without the dangers posed by the spread of infectious diseases, the fact that life expectancies are converging around the world at the rates we have found would offer no grounds for complacency. In fact, we may anticipate that the rate of convergence makes for some rather grim news for a typical villager living in Africa or South Asia. For example, with a life expectancy convergence rate of 0.01, the message is bleak: "You will die 20 years sooner than your counterpart in the developing world. But, 70 years from now, your grandchild or great-grandchild will die only 10 years sooner than his or her counterpart." This news is unlikely to prove very reassuring.

Beyond this, the somewhat weaker evidence for convergence in class size points up the vital next stage in research on human capital convergence, and a necessary focus of education policy for developing countries, namely increased attention to improving schooling quality as well as schooling quantity. This will require the focused attention of NGOs, developing country governments, and international development agencies.

The clear evidence that health and education are joint investments may offer scope for a more integrated policy approach. It may be that one of the most effective investments we can make in education quality is to improve child health. Similarly, one of the most effective investments we could make in health may be to improve the quality of education. The results thus offer some support at the macro level for poverty programs that take an integrated approach to addressing education, health, and nutrition, such as the program (PROGRESA) in Mexico (SEDESOL, 2001).

In fact, the results in this paper strongly suggest that these effects are not symmetric: there is a much larger effect of initial health on education growth, than of initial education on health growth. While it would be premature to use these results alone to guide the design of policy on such an important question, the results are certainly suggestive that improvement in health is more critical to successful improvement in education, than is the improvement of education to successful improvement in health. This will be a very valuable direction for future research.

Table 1. List of Countries by Regions

Advanced Countries	Sub-Sahara Africa	Asia	Middle East, North Africa, and Developing Europe	Western Hemisphere Countries
Australia	Benin	Cambodia	Albania	Argentina
Austria	Burkina Faso	China	Algeria	Bolivia
Belgium	Burundi	India	Bulgaria	Brazil
Canada	Cameroon	Indonesia	Egypt, Arab Rep.	Chile
Denmark	Congo, Dem. Rep.	Lao PDR	Hungary	Colombia
Finland	Congo, Rep.	Malaysia	Iran, Islamic Rep.	Costa Rica
France	Cote d'Ivoire	Mongolia	Kuwait	Cuba
Greece	Ethiopia	Myanmar	Morocco	Dominican Republic
Hong Kong	Gabon	Nepal	Poland	Ecuador
Iceland	Ghana	Pakistan	Romania	El Salvador
Ireland	Guinea	Papua New Guinea	Saudi Arabia	Guatemala
Israel	Kenya	Philippines	Tunisia	Guyana
Italy	Lesotho	Sri Lanka	Turkey	Honduras
Japan	Madagascar	Thailand		Jamaica
Korea, Rep.	Malawi			Mexico
Luxembourg	Mali			Nicaragua
Netherlands	Mauritius			Paraguay
New Zealand	Mozambique			Peru
Norway	Nigeria			Suriname
Portugal	Senegal			Trinidad and Tobago
Singapore	South Africa			Uruguay
Spain	Sudan			Venezuela, RB
Sweden	Swaziland			
United Kingdom	Togo			
	Uganda			
	Zambia			
	Zimbabwe			

Table 2. Analysis of Convergence in Social Indicators
(Averages, coefficient of variation, and standard deviations in education and health variables: 1970 and 1996) 1/

	Averages		Difference in the Average	Coefficients of Variation		Standard Deviations		Number of
	1970	1996	1970-96	1970	1996	1970	1996	Countries
Primary enrollment rates								
World	85.783	98.974	13.19***	0.34	0.21	29.49	20.49	100
Advanced countries	103.892	102.283	-1.61	0.09	0.07	9.43	7.40	24
SSA	63.181	86.926	23.74**	0.56	0.36	35.69	31.20	27
Asia	73.221	103.779	30.56***	0.39	0.15	28.24	15.49	14
MENA	86.723	98.523	11.80	0.25	0.12	22.00	12.22	13
WHD	101.205	107.359	6.15	0.16	0.13	16.36	13.85	22
Secondary enrollment rate								
World	34.651	62.848	28.20***	0.78	0.57	27.19	35.80	100
Advanced countries	70.167	111.025	40.86***	0.25	0.18	17.27	20.37	24
SSA	9.795	29.304	19.51***	0.72	0.71	7.01	20.94	27
Asia	25.371	47.929	22.56***	0.85	0.43	21.45	20.68	14
MENA	37.469	68.738	31.27***	0.61	0.27	22.73	18.45	13
WHD	30.650	57.473	26.82***	0.47	0.30	14.28	16.97	22
Tertiary enrollment rate								
World	6.490	21.283	14.79***	1.17	0.96	7.59	20.49	100
Advanced countries	15.108	50.513	35.40***	0.64	0.33	9.62	16.89	24
SSA	0.809	3.637	2.83***	1.10	0.97	0.89	3.52	27
Asia	3.192	9.793	6.60**	1.31	0.96	4.19	9.41	14
MENA	6.615	19.962	13.35***	0.72	0.40	4.75	7.98	13
WHD	6.086	19.145	13.06***	0.55	0.49	3.36	9.44	22
Male primary enrollment rate								
World	91.294	102.050	10.76***	0.29	0.19	26.88	19.16	100
Advanced countries	104.167	101.942	-2.22	0.09	0.08	9.68	8.59	24
SSA	72.799	93.674	20.88**	0.50	0.32	36.23	29.69	27
Asia	80.829	110.093	29.26***	0.30	0.13	24.20	13.77	14
MENA	97.008	101.469	4.46	0.19	0.12	18.53	12.60	13
WHD	103.232	107.673	4.44	0.15	0.13	15.73	13.52	22
Female primary enrollment rate								
World	80.453	95.335	14.88***	0.41	0.24	33.05	22.67	100
Advanced countries	103.613	101.796	-1.82	0.09	0.07	9.44	7.25	24
SSA	54.973	80.437	25.46**	0.66	0.42	36.52	33.82	27
Asia	64.686	97.793	33.11***	0.50	0.20	32.56	19.62	14
MENA	76.008	95.446	19.44**	0.36	0.13	27.72	12.76	13
WHD	99.118	104.941	5.82	0.18	0.13	17.74	13.55	22

Table 2. Analysis of Convergence in Social Indicators
(Averages, coefficient of variation, and standard deviations in education
and health variables: 1970 and 1996) 1/

	Averages		Difference in the Average	Coefficients of Variation		Standard Deviations		Number of
	1970	1996	1970-96	1970	1996	1970	1996	Countries
Male secondary enrollment rate								
World	37.492	62.682	25.19***	0.71	0.54	26.79	33.96	100
Advanced countries	72.783	108.879	36.10***	0.23	0.18	16.81	19.17	24
SSA	13.030	32.644	19.61***	0.63	0.61	8.17	19.81	27
Asia	29.400	48.257	18.86**	0.68	0.38	20.07	18.56	14
MENA	43.715	70.923	27.21***	0.48	0.25	21.15	17.54	13
WHD	30.484	53.459	22.97***	0.43	0.32	13.25	16.99	22
Female secondary enrollment rate								
World	31.741	61.772	30.03***	0.88	0.62	28.03	38.55	100
Advanced countries	67.408	113.112	45.70***	0.28	0.20	18.63	22.52	24
SSA	6.571	25.830	19.26***	0.97	0.88	6.37	22.70	27
Asia	21.193	43.707	22.51**	1.10	0.54	23.28	23.60	14
MENA	30.992	66.454	35.46***	0.80	0.30	24.79	19.87	13
WHD	30.876	58.605	27.73***	0.51	0.31	15.64	18.12	22
Female to male primary enrollment rate								
World	0.845	0.927	0.08***	0.25	0.13	0.21	0.12	100
Advanced countries	0.995	1.000	0.00	0.03	0.02	0.03	0.02	24
SSA	0.707	0.836	0.13**	0.33	0.18	0.23	0.15	27
Asia	0.749	0.890	0.14*	0.32	0.17	0.24	0.16	14
MENA	0.763	0.942	0.18***	0.26	0.07	0.19	0.07	13
WHD	0.958	0.975	0.02	0.08	0.04	0.08	0.04	22
Female to male secondary enrollment rate								
World	0.727	0.931	0.20***	0.40	0.25	0.29	0.23	100
Advanced countries	0.921	1.036	0.12***	0.13	0.06	0.12	0.06	24
SSA	0.467	0.729	0.26***	0.46	0.35	0.22	0.25	27
Asia	0.584	0.868	0.28***	0.47	0.29	0.27	0.25	14
MENA	0.610	0.930	0.32***	0.41	0.11	0.25	0.10	13
WHD	0.994	1.106	0.11**	0.16	0.12	0.16	0.13	22
Teacher-pupil ratio at the primary level								
World	0.033	0.042	0.01***	0.39	0.50	0.01	0.02	100
Advanced countries	0.043	0.065	0.02***	0.39	0.31	0.02	0.02	24
SSA	0.024	0.024	0.00	0.22	0.29	0.01	0.01	27
Asia	0.033	0.032	0.00	0.29	0.34	0.01	0.01	14
MENA	0.038	0.053	0.02**	0.34	0.34	0.01	0.02	13
WHD	0.030	0.040	0.01***	0.26	0.33	0.01	0.01	22

Table 2. Analysis of Convergence in Social Indicators
(Averages, coefficient of variation, and standard deviations in education and health variables: 1970 and 1996) 1/

	Averages		Difference in the Average	Coefficients of Variation		Standard Deviations		Number of
	1970	1996	1970-96	1970	1996	1970	1996	Countries
Teacher-pupil ratio at the secondary level								
World	0.056	0.060	0.00	0.36	0.39	0.02	0.02	92
Advanced countries	0.065	0.079	0.01*	0.32	0.34	0.02	0.03	22
SSA	0.050	0.042	-0.01**	0.24	0.22	0.01	0.01	25
Asia	0.048	0.052	0.00	0.25	0.27	0.01	0.01	14
MENA	0.052	0.067	0.01*	0.38	0.30	0.02	0.02	13
WHD	0.064	0.062	0.00	0.43	0.33	0.03	0.02	18
Adjusted teacher-pupil ratio at the primary level								
World	2.895	4.264	1.37***	0.55	0.54	1.60	2.31	100
Advanced countries	4.410	6.687	2.28***	0.35	0.33	1.56	2.18	24
SSA	1.493	2.088	0.59**	0.59	0.46	0.88	0.95	27
Asia	2.339	3.368	1.03**	0.39	0.37	0.92	1.25	14
MENA	3.353	5.180	1.83***	0.47	0.31	1.56	1.59	13
WHD	3.047	4.321	1.27***	0.32	0.37	0.99	1.59	22
Adjusted teacher-pupil ratio at the secondary level								
World	2.064	4.100	2.04***	1.01	0.84	2.08	3.45	92
Advanced countries	4.585	8.638	4.05***	0.43	0.38	1.97	3.25	22
SSA	0.428	1.145	0.72***	0.68	0.69	0.29	0.79	25
Asia	1.148	2.437	1.29***	0.86	0.49	0.99	1.19	14
MENA	2.228	4.629	2.40***	0.92	0.47	2.06	2.16	13
WHD	1.851	3.569	1.72***	0.67	0.48	1.25	1.73	18
Life expectancy								
World	57.731	66.088	8.36***	0.20	0.17	11.29	11.16	100
Advanced countries	71.081	77.554	6.47***	0.04	0.02	2.95	1.58	24
SSA	45.235	51.060	5.82***	0.12	0.14	5.23	6.97	27
Asia	51.692	64.050	12.36***	0.15	0.10	7.86	6.69	14
MENA	60.381	70.771	10.39***	0.13	0.04	8.02	2.58	13
WHD	60.782	70.555	9.77***	0.10	0.06	6.30	3.91	22
Survival rate								
World	914.381	957.302	42.92***	0.06	0.04	51.67	37.12	100
Advanced countries	978.133	994.930	16.80***	0.01	0.00	10.58	1.42	24
SSA	867.636	911.377	43.74***	0.04	0.03	32.88	25.44	27
Asia	891.543	944.056	52.51***	0.05	0.03	40.66	30.43	14
MENA	907.408	974.109	66.70***	0.05	0.01	48.81	13.67	13
WHD	920.855	971.113	50.26***	0.03	0.01	29.40	13.87	22

1/ Latest year available; most data are for 1996.
Notes: SSA denotes Sub-Sahara Africa; MENA constitutes Middle East, North Africa, and developing Europe; WHD indicates Western Hemisphere countries.

Table 3. Analysis of Unconditional Human Capital Convergence with 3SLS
Dependent Variables: Log Difference Enrollment Rates and Life Expectancy, 1975–96 1/

	Regression (1)			Regression (2)	
	Equation (1) Dpri	Equation (2) Dlife		Equation (1) Dsec	Equation (2) Dlife
Observations	100	100		100	100
Constant	2.56***	0.69***	constant	1.53***	0.77***
	(0.15)	(0.17)		(0.11)	(0.17)
ln(pri75)	-0.55***		ln(sec75)	-0.30***	
	(0.03)			(0.03)	
ln(life75)		-0.14***	ln(life75)		-0.16***
		(0.04)			(0.04)
λ	0.038***	0.007***	λ	0.017***	0.008***
	(0.004)	(0.002)		(0.002)	(0.002)

	Regression (3)	
	Equation (1) Dter	Equation (2) Dlife
Observations	100	100
constant	1.11***	0.76***
	(0.07)	(0.17)
ln(ter75)	-0.13***	
	(0.03)	
ln(life75)		-0.16***
		(0.04)
λ	0.007***	0.008***
	(0.002)	(0.002)

1/ Latest year available; most data are for 1996.

Notes: Standard errors are in parenthesis. R^2 is not reported since it is not bounded between 0 and 1. (***), (**), (*) denote statistical significance at the 1, 5, and 10 percent levels, respectively. Dpri, Dsec, and Dter denote the log difference primary, secondary, and tertiary enrollment rates, respectively; Dlife represents the log difference life expectancy; pri75, sec75, and ter75 represent primary, secondary, and tertiary enrollment rates, respectively in 1975; life75 represents life expectancy in 1975; and λ is the speed of convergence.

Table 4. Analysis of Unconditional Human Capital Convergence with 3SLS
Dependent Variables: Log Difference Enrollment Rates by Gender and Life Expectancy, 1975–96 1/

	Regression (1)			Regression (2)	
	Equation (1) Dprm	Equation (2) Dlife		Equation (1) Dprf	Equation (2) Dlife
Observations	100	100		100	100
constant	2.75***	0.68***	constant	2.55***	0.70***
	(0.18)	(0.17)		(0.14)	(0.18)
ln(prm75)	-0.59***		ln(prf75)	-0.55***	
	(0.04)			(0.03)	
ln(life75)		-0.14***	ln(life75)		-0.15***
		(0.04)			(0.04)
λ	0.042***	0.007***	λ	0.038***	0.008***
	(0.005)	(0.002)		(0.003)	(0.002)
	Regression (3)			Regression (4)	
	Equation (1) Dsem	Equation (2) Dlife		Equation (1) Dsef	Equation (2) Dlife
Observations	100	100		100	100
constant	1.45***	0.75***	constant	1.68***	0.77***
	(0.12)	(0.17)		(0.10)	(0.17)
ln(sem75)	-0.29***		ln(sef75)	-0.32***	
	(0.03)			(0.03)	
ln(life75)		-0.16***	ln(life75)		-0.16***
		(0.04)			(0.04)
λ	0.016***	0.008***	λ	0.019***	0.009***
	(0.002)	(0.002)		(0.002)	(0.002)

1/ Latest year available; most data are for 1996.

Notes: Standard errors are in parenthesis. R^2 is not reported since it is not bounded between 0 and 1. (***), (**), (*) denote statistical significance at the 1, 5, and 10 percent levels, respectively. Dprm and Dprf denote the log difference male and female primary enrollment rates, respectively; Dsem and Dsef represent the log difference male and female secondary enrollment rates, respectively; Dlife represents the log difference life expectancy; prm75 and prf75 denote male and female primary enrollment rate, respectively, in 1975; sem75 and sef75 represent male and female secondary enrollment rates, respectively, in 1975; life75 represents life expectancy in 1975; and λ is the speed of convergence.

Table 5A. Analysis of Unconditional Human Capital Convergence with 3SLS
Dependent Variables: Log Difference Teacher-Pupil Ratios and Life Expectancy, 1975–96 1/

	Regression (1)			Regression (2)	
	Equation (1) Dtpp	Equation (2) DLife		Equation (1) Dtps	Equation (2) Dlife
Observations	100	100	Observations	90	90
Constant	0.41	0.72***	Constant	-0.66***	0.88***
	(0.34)	(0.17)		(0.24)	(0.17)
Ln(tpp75)	0.07		Ln(tps75)	-0.26***	
	(0.10)			(0.08)	
Ln(life75)		-0.15***	Ln(life75)		-0.19***
		(0.04)			(0.04)
λ	-0.003	0.008***	λ	0.014***	0.010***
	(0.004)	(0.002)		(0.005)	(0.002)

Table 5B. Analysis of Unconditional Human Capital Convergence with 3SLS
Dependent Variables: Log Difference in Adjusted Teacher-Pupil Ratios and Life Expectancy, 1975–96 1/

	Regression (1)			Regression (2)	
	Equation (1) Dtpp	Equation (2) DLife		Equation (1) Dtps	Equation (2) Dlife
Observations	100	100	Observations	90	90
Constant	0.44***	0.73***	Constant	0.72***	0.82***
	(0.07)	(0.17)		(0.04)	(0.17)
Ln(tpp75)	-0.13**		Ln(tps75)	-0.20***	
	(0.06			(0.03)	
Ln(life75)		-0.15***	Ln(life75)		-0.18***
		(0.04)			(0.04)
λ	0.007**	0.008***	λ	0.010***	0.009***
	(0.003	(0.002)		(0.002)	(0.002)

1/ Latest year available; most data are for 1996.

Notes: Standard errors are in parenthesis. R^2 is not reported since it is not bounded between 0 and 1. (***), (**), (*) denote statistical significance at the 1, 5, and 10 percent levels, respectively. Dtpp and Dtps denote the log difference teacher-pupil ratios at the primary and secondary levels, respectively; Dlife represent the log difference life expectancy; tpp75 and tps75 represent teacher-pupil ratios at the primary and secondary levels, respectively, in 1975; life75 represents life expectancy in 1975; and λ is the speed of convergence.

Table 6. Analysis of Conditional Human Capital Convergence with 3SLS
Dependent Variables: Log Difference Enrollment Rates and Life Expectancy, 1975—96 1/

	Regression (1)			Regression (2)	
	Equation (1) Dpri	Equation (2) Dlife		Equation (1) Dsec	Equation (2) Dlife
Observations	100	100		100	100
Constant	2.98***	0.77***	constant	-1.31	1.56***
	(0.30)	(0.17)		(0.98)	(0.26)
Ln(pri75)	-0.49***	0.04*	ln(sec75)	-0.43***	0.06***
	(0.04)	(0.02)		(0.06)	(0.02)
Ln(life75)	-0.17*	-0.21***	ln(life75)	0.81***	-0.41***
	(0.09)	(0.05)		(0.28)	(0.08)
b+c'<0	-0.70***		b+c'<0	-0.84***	
	(0.07)			(0.09)	
bc' -b'c>0	0.11***		bc' -b'c>0	0.13***	
	(0.03)			(0.03)	
λ	0.032***	0.011***	λ	0.027***	0.025***
	(0.004)	(0.003)		(0.005)	(0.006)

	Regression (3)	
	Equation (1) Dter	Equation (2) Dlife
Observations	100	100
Constant	-6.41***	1.60***
	(1.39)	(0.25)
Ln(ter75)	-0.35***	0.04***
	(0.05)	(0.01)
Ln(life75)	1.93***	-0.38***
	(0.36)	(0.06)
b+c'<0	-0.73***	
	(0.07)	
bc' -b'c>0	0.05***	
	(0.02)	
λ	0.020***	0.023***
	(0.004)	(0.005)

1/ Latest year available; most data are for 1996.

Notes: Standard errors are in parenthesis. R^2 is not reported since it is not bounded between 0 and 1. (***), (**), (*) denote statistical significance at the 1, 5, and 10 percent levels, respectively. Dpri, Dsec, and Dter denote the log difference primary, secondary, and tertiary enrollment rates, respectively; Dlife represents the log difference life expectancy; pri75, sec75, and ter75 represent primary, secondary, and tertiary enrollment rates, respectively in 1975; life75 represents life expectancy in 1975; and λ is the speed of convergence.

Table 7. Analysis of Conditional Human Capital Convergence with 3SLS
Dependent Variables: Log Difference Enrollment Rates by Gender and Life Expectancy, 1975–96 1/

	Regression (1)			Regression (2)	
	Equation (1)	Equation (2)		Equation (1)	Equation (2)
	Dprm	Dlife		Dprf	Dlife
Observations	100	100		100	100
Constant	3.19***	0.70***	constant	2.88***	0.81***
	(0.29)	(0.17)		(0.37)	(0.18)
ln(prm75)	-0.52***	0.05*	ln(prf75)	-0.51***	0.03
	(0.05)	(0.03)		(0.04)	(0.02)
ln(life75)	-0.18**	-0.20***	ln(life75)	-0.12	-0.20***
	(0.09)	(0.05)		(0.12)	(0.06)
b+c'<0	-0.72***		b+c'<0	-0.71***	
	(0.07)			(0.07)	
bc' -b'c>0	0.11***		bc' -b'c>0	0.10***	
	(0.03)			(0.03)	
λ	0.035***	0.010***	λ	0.034***	0.010***
	(0.005)	(0.003)		(0.004)	(0.003)
	Regression (3)			Regression (4)	
	Equation (1)	Equation (2)		Equation (1)	Equation (2)
	Dsem	Dlife		Dsef	Dlife
Observations	100	100		100	100
Constant	-0.70	1.33***	Constant	-1.64	1.77***
	(0.83)	(0.23)		(1.23)	(0.30)
ln(sem75)	-0.41***	0.06***	ln(sef75)	-0.45***	0.06***
	(0.06)	(0.02)		(0.06)	(0.01)
ln(life75)	0.63***	-0.35***	ln(life75)	0.92***	-0.46***
	(0.24)	(0.70)		(0.34)	(0.08)
b+c'<0	-0.76***		b+c'<0	-0.91***	
	(0.08)			(0.09)	
bc' -b'c>0	0.11***		bc' -b'c>0	0.15***	
	(0.02)			(0.03)	
λ	0.025***	0.021***	λ	0.029***	0.029***
	(0.005)	(0.005)		(0.005)	(0.007)

1/ Latest year available; most data are for 1996.

Notes: Standard errors are in parenthesis. R^2 is not reported since it is not bounded between 0 and 1. (***), (**), (*) denote statistical significance at the 1, 5, and 10 percent levels, respectively. Dprm and Dprf denote the log difference male and female primary enrollment rates, respectively; Dsem and Dsef represent the log difference male and female secondary enrollment rates, respectively; Dlife represents the log difference life expectancy; prm75 and prf75 denote male and female primary enrollment rates, respectively, in 1975; sem75 and sef75 represent male and female secondary enrollment rates, respectively, in 1975; life75 represents life expectancy in 1975; and λ is the speed of convergence.

Table 8A. Analysis of Conditional Human Capital Convergence with 3SLS
Dependent Variables: Log Difference Teacher-Pupil Ratios and Life Expectancy, 1975–96 1/

	Regression (1)			Regression (2)	
	Equation (1) Dtpp	Equation (2) Dlife		Equation (1) Dtps	Equation (2) Dlife
Observations	100	100	Observations	90	90
Constant	-6.78***	1.03***	Constant	-4.18***	0.69***
	(1.26)	(0.30)		(0.72)	(0.25)
ln(tpp75)	-0.39***	0.03	Ln(tps75)	-0.46***	-0.01
	(0.12)	(0.03)		(0.08)	(0.03)
ln(life75)	1.38***	-0.20***	Ln(life75)	0.71***	-0.15***
	(0.24)	(0.06)		(0.14)	(0.05)
b+c'<0	-0.59***		b+c'<0	-0.62***	
	(0.13)			(0.09)	
bc' -b'c>0	0.03		bc' -b'c>0	0.08***	
	(0.03)			(0.03)	
λ	0.024***	0.011***	λ	0.030***	0.008***
	(0.009)	(0.003)		(0.007)	(0.003)

Table 8B. Analysis of Conditional Human Capital Convergence with 3SLS
Dependent Variables: Log Difference in Adjusted Teacher-Pupil Ratios and Life Expectancy, 1975–96 1/

	Regression (1)			Regression (2)	
	Equation (1) Dtpp	Equation (2) Dlife		Equation (1) Dtps	Equation (2) Dlife
Observations	100	100	Observations	90	90
Constant	-3.91***	1.26***	Constant	-4.45***	1.89***
	(1.23)	(0.27)		(1.50)	(0.34)
ln(tpp75)	-0.41***	0.05**	Ln(tps75)	-0.39***	0.06***
	(0.10)	(0.02)		(0.07)	(0.02)
ln(life75)	1.14***	-0.30***	Ln(life75)	1.29***	-0.44***
	(0.32)	(0.07)		(0.37)	(0.08)
b+c'<0	-0.71***		b+c'<0	-0.83***	
	(0.12)			(0.09)	
bc' -b'c>0	0.06**		bc' -b'c>0	0.10***	
	(0.03)			(0.02)	
λ	0.026***	0.017***	λ	0.024***	0.028***
	(0.008)	(0.005)		(0.005)	(0.007)

1/ Latest year available; most data are for 1996.

Notes: Standard errors are in parenthesis. R^2 is not reported since it is not bounded between 0 and 1. (***), (**), (*) denote statistical significance at the 1, 5, and 10 percent levels, respectively. Dtpp and Dtps denote the log difference teacher-pupil ratios at the primary and secondary levels, respectively; Dlife is the log difference life expectancy; tpp75 and tps75 represent teacher-pupil ratios at the primary and secondary levels, respectively, in 1975; life75 represents life expectancy in 1975; and λ is the speed of convergence.

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